Monika SROKA-BIZOŃ, Ewa TERCZYŃSKA
Silesian University of Technology
Geometry and Engineering Graphics Centre
ul. Krzywoustego 7, 44-100 Gliwice
tel. +48 32 237 26 58
monika.sroka-bizon@polsl.pl, ewa.terczynska@polsl.pl

PERCEPTION OF VIEW – HOW TO DEVELOP SPATIAL IMAGINATION. [1]

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The oldest learning rule formulated in the nineteenth century by Pestalozzi based on the theorem saying that sensory cognition is the foundation of knowledge. A particular importance was attributed to the method of ascertaining the element from general to specific, so as to make the teaching educational which will develop the ability of independent thinking. In this way was born the principle of vividness which requires reliance of whole science on ascertaining the reality itself, and thus the concrete things, phenomena and processes. There are two types of vividness:
- direct cognition of the phenomenon such as observation of naturally occurring phenomenon
- indirect cognition referring to the imagination produced on the ground of previous observations of the object (a real model or teaching tool in the form of model, image, diagram, chart or other). [3] [4]

The principle of vividness is most relevant in the teaching of geometry, descriptive geometry, and subjects referring to geometry such as engineering graphics, because it significantly influences the growth and development of spatial imagination.

The spatial imagination is understood to mean the ability to create in the mind an image or a geometric object compliant with its real shape and position. The man has a spatial imagination, if on the ground of a drawing, model or description he can imagine, analyze, extend and describe the shape and position of geometric objects.

One of the methods in the process of proper associating and development of spatial thinking is the use of models as means of indirect representation of reality. Model according to definition is a pattern which facilitates the development of spatial imagination. [2] The use of models at the beginning by watching, building, bonding and then making their projections, sections or drawing of axonometry allows for flexible operation in the development of spatial thinking. Such thinking may be understood as an exercise to see, present and process information, and a chance to achieve the desired success can be increased by the use of various illustrative means. They implement many functions (explaining, verifying, imitating), but also help in creation of the spatial image.

In working with students at the courses of Descriptive Geometry and Engineering Graphics often there is a problem of an approach to the problem of space, its development and reproduction. This raises the question – whether to stay with traditional education methods involving mainly the use of drawing as part of developing spatial imagination, after all drawings require the ability to read their contents and the ability to make drawings, so that content created in the author's mind could reach the recipient?

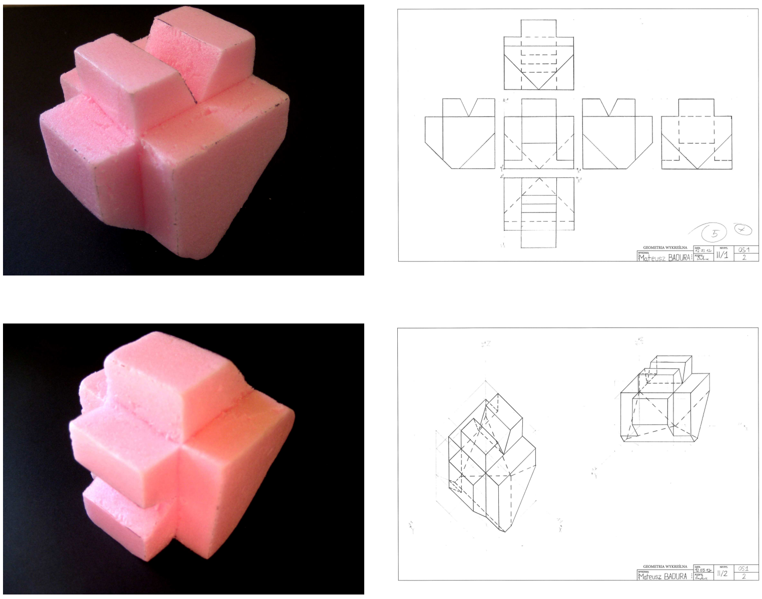
Or maybe one should in the classes to strengthen the emphasis on the model formation, using physical models, both for reading and making technical drawings? Selection of appropriate and effective teaching methods becomes extremely important when the time for the implementation of the classes program is small and issues are presented to the students of the so-called „non-design" courses and provide them with a complete novelty.

Since 2008 at the Faculty of Energy and Environmental Engineering of the Silesian University of Technology there is conducted a branch of study - Environmental Protection. Graduates of this branch of study are to be professionals prepared for working in the field of development and protection of environment and should be prepared to work in environmental protection inspectorates, centres of research and environmental development and in research laboratories. The program of the first year of Engineer's degree studies includes the following principal subjects: Chemistry (120 hours), Mathematics (105 hours), Biology (75 hours), Physics (75 hours), Information Technology (30 hours), Engineering Graphics (30 hours) and speciality subjects such as: Ecology (90 hours), Environmental Protection (60 hours), Law and Economy in Environmental Protection (105 hours), Industrial Technologies (15 hours), The Risk of Civilization and Balanced Development (30 hours), Hydrobiology (45 hours). [5] Engineering Graphics course includes 15 hours of lecture and 15 hours of design classes. The course object covers such issues as the orthographic projection in the mapping and reconstruction of parts of space, axonometry as a basic form of creation of illustrative drawings (freehand sketch), the main forms of graphic recording recommended by the standards (projection, section drawings, dimensioning), marking projection as a method of recording used in the design of terrain, urban drawing. The main objectives of the course were:

- development of skills to make technical drawings prepared in a variety of techniques,
- knowledge of the principles of preparing technical drawings using standard symbols,
- development of skills to read the contents of the technical drawings,
- development of spatial imagination.

Therefore that Environmental Protection course does not belong to the so-called „design" courses (graduates of which are not likely to work as designers), and the drawing for students of this course is not a commonly used way of conveying information, a lot of emphasis in the classes was placed on presenting practical aspects of the subject – trying to convince students that "one picture – drawing is worth a thousand words". Experience gained by the author in the course of teaching such subjects as Engineering Graphics, Technical Drawing, CAD Mappings carried out for various technical courses allows to state that one of the most difficult issues for the students learning forms of graphic recording is an orthographic projection. While many courses of Engineering Graphics and Technical Drawing, conducted by the author, this issue was presented to students during the lecture on the example of axonometric drawing of three-dimensional object, which was then mapped in orthographic projections. Subsequently, students in the design classes were solving on their own the task based on the same assumptions, i. e. three-dimensional object shown in the axonometric drawing had to be mapped in orthographic projections. The greatest difficulty for students was the appropriate reading of the shape of the object represented in the axonometric drawing and the correct mapping of these parts of the object that had been in the position projecting against drawing projection planes. Equally difficult was the correct presentation of the edges occurring in the object and invisible in a projection.

The design task in this shape required the students to refer to a spatial model constructed in the imagination. Therefore it met the demand of indirect vividness, but in itself it didn't contain direct vividness – student didn't have the possibility of direct observation of the model, manipulation of it and observing its positions relative to the projection plane. Gained teaching experience of the authors has inspired to introduce the physical model as a part of facilitating the study of the principles of graphic mapping of spatial elements. Described earlier design task, solved while the classes, was preceded by three-stage homework being an introduction to the task. Students in the homework made individually designed physical models of spatial elements according to certain presuppositions such as the shape and size of the basic block and a number of cutting planes. The physical model was then mapped in orthographic projections according to the standard rules (students made six projections/views of the block including the invisible edges) and in two axonometric projections recommended by the PN (Polish Standard) – in isometry and in skew dimetry. Working with hand-made model, whose shape was designed by the student, significantly facilitated the graphical mapping of the spatial component on the plane of the drawing, whether it was in orthographic or in axonometric projections. The possibility of physical manipulation of the model, conducting a survey of the changing positions of the elements of spatial object against projection plane significantly facilitated the understanding of the principles of the orthographic projections and the essence of the positions of the projecting spatial elements such as edges and planes against projection plane. The students' work done this way was a direct cognition of this phenomenon – thus fulfilled the postulate of direct vividness cited in the introduction. The solution of design task based on the preceding homework was an indirect cognition of the phenomenon referring to the imagination created on the ground of previous observations of the object – it fulfilled the postulate of indirect vividness. It appears to be purposeful in the mind of the authors a further development of the task with the part to be solved with the use of CAD software – the students in the later part of the task would develop a digital block model of the spatial element designed by themselves, making further observations of graphical mapping in the virtual space.



Rys. 1, 2, 3, 4. Design taks – mapping in orthographic and axonometric projections and models

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