ON THE ROLE OF DESIGNING IN SCIENTIFIC AND TECHNICAL CREATIVITY OF CHILDREN – FUTURE ENGINEERS

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ABSTRACT

At the heart of the article is the thesis about the expediency of starting earlier not only the basics, but also many fundamental aspects of engineering design, literally from the preschool years, when a child first gets acquainted with the children's construction sets, details of machines and mechanisms. Based on the experience of production of the domestic construction set AVToys, the authors of the journal created educational programs that allow them to conduct design lessons for children of different ages using mathematical logic and methods for programming model and game processes.

Keywords: engineering design, training, children's scientific and technical creativity, lessons, educational programs.

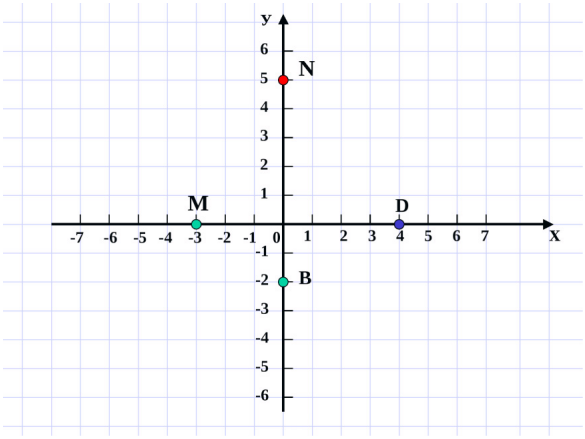
Background. *Engineers who received their education in the field of transport engineering, construction and other technical areas and specialties, studied the basics of design in the university. However, having started the production of the domestic construction set AVToys and the development of educational programs based on it, we are firmly convinced that it is necessary to study the fundamental principles of design from the preschool age.*

Objective. *The objective of the authors is to consider the role of designing in education of future engineers from the early childhood.*

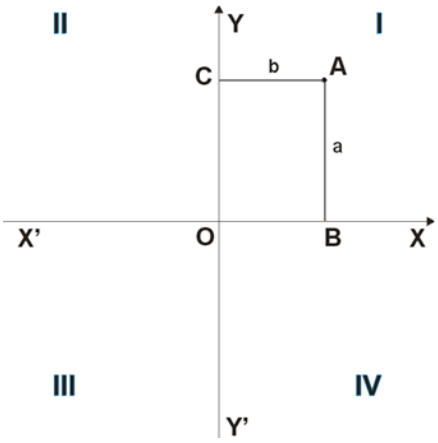
Methods. *The authors use general scientific and engineering methods, analysis, comparative method, scientific description.*

Results. *When we talk about the processes of constructing a model of a finite object on a plane, we rely on the laws of geometry that determine the position and intersection of straight and curved lines, as well as the laws of replacing the plane with polygons of different types.*

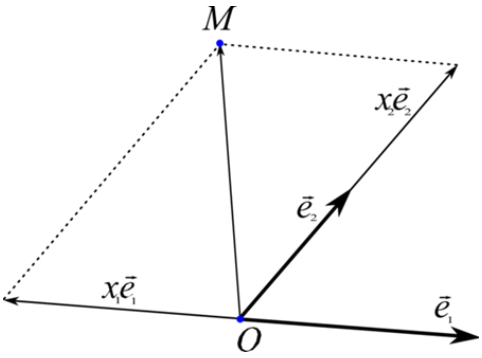
The result of designing on a flat surface is a drawing on which straight, curved lines and points-nodes of their intersection are depicted, or a mosaic pattern composed of details in the form of polygons or pieces of sheet material of a curvilinear contour. The most important in the design of models on the plane is the choice of the coordinate system (Pic. 1), which determines the dimensions of the details of the type of the construction set



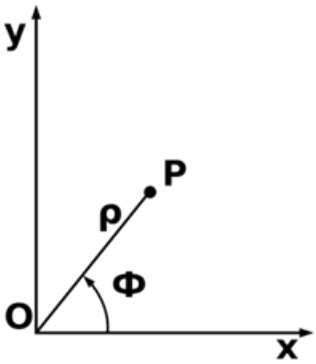
Pic. 1. Coordinate system.



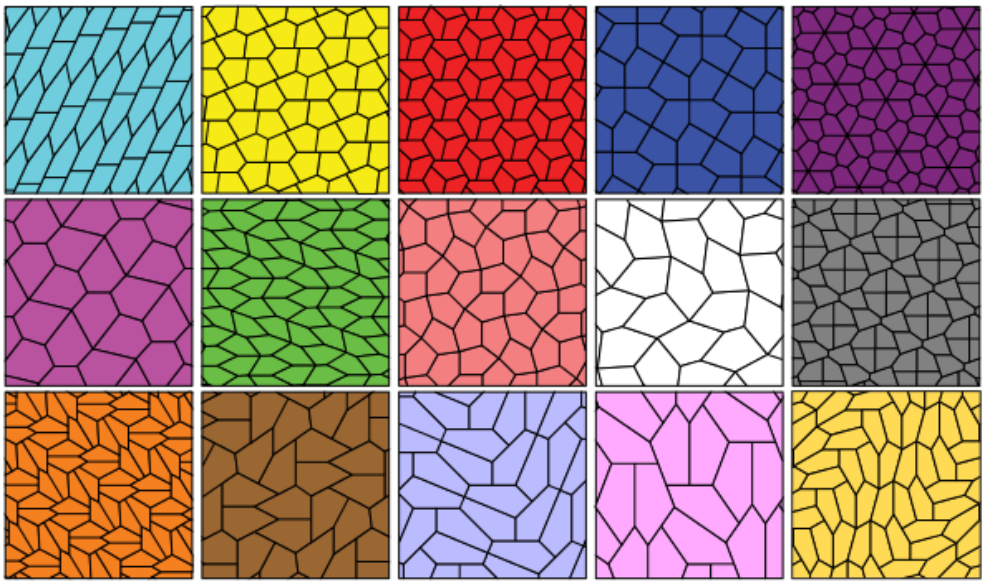
Pic. 2. Model of the Cartesian coordinate system.



Pic. 3. The oblique system.



Pic. 4. Polar coordinate system.



Pic. 5. The theory of parquets.

and the geometry of their connection in the plane with each other [1].

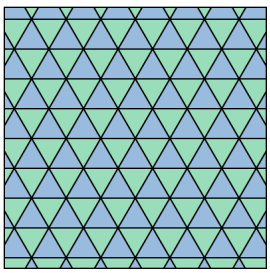
The most common when building an image-picture-drawing on a plane is a rectangular Cartesian coordinate system (Pic. 2) [2].

There are also construction sets and mosaics projected on an affine (oblique) coordinate system, where the details are used in the form of combinations of triangles and hexagons (Pic. 3) [3].

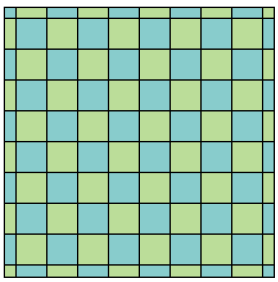
The model of the Cartesian coordinate system and the oblique system are supplemented by elements constructed on the polar coordinate system (Pic. 4) with details that look like parts of arcs of circles of different radii [1].

All types of construction sets are connected in accordance with the «theory of parquet» or the principle of filling. «The theory of parquet» (Pic. 5–7) is directly related to the image of polyhedral surfaces and all types of structures obtained from sheet materials, for example, the cut of clothing, the shell and carcass plating in vehicles and construction, etc.

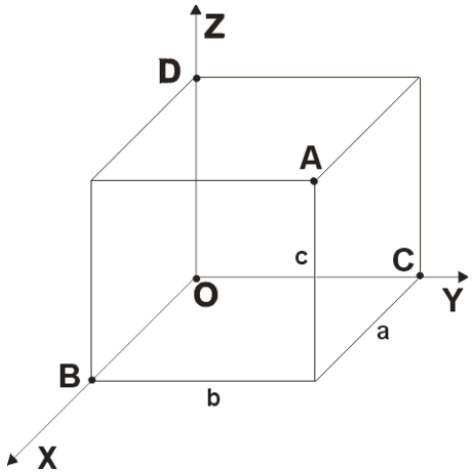
The designing in space differs from the designing on the plane (Pic. 8–10) in that two principles of assembling the «body» and the «skin» of the projected model are realized [4].



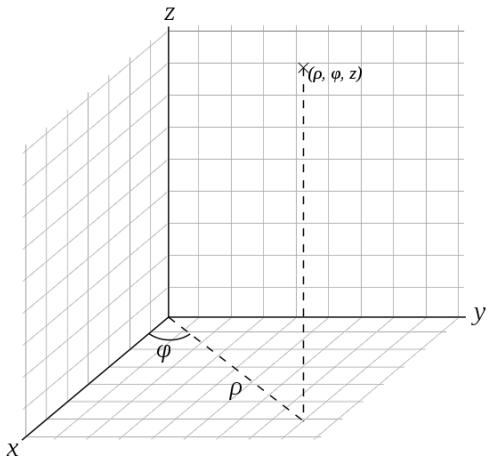
Pic. 6. Triangular parquet.



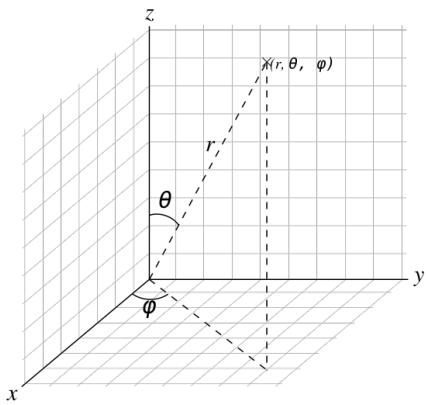
Pic. 7. Square parquet.



Pic. 8. Rectangular Cartesian coordinate system in space.



Pic. 9. Cylindrical coordinate system.



Pic. 10. Spherical coordinate system.

Pic. 11. Model of the construction set Jovo.

Pic. 12. Models of the construction set «Polydron».

Pic. 13. Model of the domestic construction set AVToys.

In accordance with the first method, the «method of rendering on the imaginary surface» the details of the selected type of construction set are taken, with which the imaginary body-volume of the future model in space «is pasted» (the technology of creating paper plastics, braiding with ropes soaked in PVA, balloons, etc.).

The frame-frame type construction sets include construction sets Jovo (Pic. 11), Polydron (Pic. 12) and the domestic construction set AVToys (Pic. 13).

Within the framework of this method, cylindrical and spherical spatial coordinate systems are actively used.

The second method is the «method of intersection of planes». Let's imagine a «watermelon», which we cut into horizontal layers (like disks in a children's pyramid), and then vertical planes that intersect at an angle of 90 degrees as the x and y axes in the Cartesian coordinate system.

Each «plane» can be composed of both polyhedra (for example, cubes, tetrahedra and octahedra), and from flat polygon plates (triangles, squares, etc.). Instead of cubes, we can take prisms with a base in the form of any polygon that allows filling the plane according to the «theory of parquets».

Within the framework of three educational programs for children aged 5–10 years (Pic. 14), developed on the basis of the AVToys construction set, we identified the modules, basic load-bearing structures and elements that are being built into the framework-body of the model, as well as the parts that serve as the cladding Or decorative design in accordance with the universal alphabet-design system of typical assembly units-modules-parts, similar to the alphabet of Russian or foreign languages.

During the creation of our lessons in educational programs, topics were identified in accordance with the field of application of the models being assembled or projected, the requirements for the materials used and the color solution of the details of the chosen type of the construction set were specified, the assembly and design techniques (with instructions), and the logical chains of assembly routes Based on mathematical logic and experience in programming automatic and game processes using TRIZ methods [5].

Pic. 14. Annotations of educational programs based on the AVToys construction set.

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Conclusion. *Already the first experimental check shows the obvious interest of children in the design lessons according to the proposed method. And this only strengthened our confidence in the correctness of the position stated at the beginning of the article about the benefits of an earlier, than usual, serious training in the design and search for engineering talents.*

There is no doubt that the application of the fundamental principles of design in early scientific and technical creativity will help the development of structured logical thinking, spatial imagination, 3D vision and micromotorics in pre-school and early school children. The qualities that a modern engineer-designer is called upon to possess.

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