COMPUTER GRAPHIC MODELS AS INSTRUMENT OF COGNITION IS IN ENGINEERING EDUCATION

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В статье предлагается использование системы компьютерного графического моделирования в общеинженерной подготовке студентов технических вузов как инструментария повышения качества образования, особенно в дистанционной его форме.

If to take a model of social, economic or technical system, in a general view it is possible to write down: $P(y) = f(\beta x, \xi)$, where P - reliability of appearance of right results, y_k as function from the entrance data, x_i with weight β_u at influence of uncertain casual parameters ξ_j. The written down system of the equations it is possible to illustrate with the graphic model (fig. 1).

In any case the converter of the entrance data at any uncertain parameters will be represented as technical system. Even PR-technologies in any elective process cannot be carried out without technical maintenance though they are traditionally belonged to a humanitarian field of activity of the person. In the majority of systems converters are either technical or technological subsystems. It is hardly necessary to explain, why the state has recently turned to the high technical education.

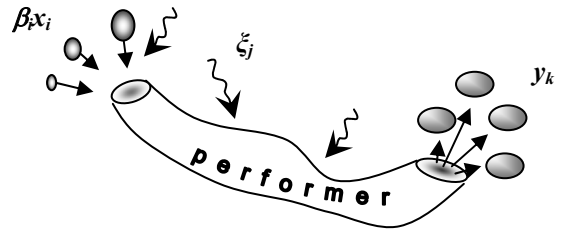

Fig.1. Model of the system of production of results

At the same time the classical structure of a technical education does not work (fig. 2) in the conditions of access to the information of any level for all students.

Development of new structure of a technical education will be based on the classical scheme owning to conservatism of psychology of the person and an education system as a whole. Hence, turning each compound of classical scheme into the modern one and improving it we are capable to work up the modern structure of a technical education. The greatest advantage of a technical education over scholarship was always amplification of verbal system of teaching by graphic language and graphic models of objects that's why it is necessary to discuss a role of graphic in a technical education of the informational society.

It is difficult to say when for the first time the person could transfer the information to other person by means of image, the fact is the oldest rock paintings which were discovered in various caves, give an idea of high developed imagination of people. We can only guess about the reasons which gave impetus to creation of such paintings, but we can comprehend their purpose.

It is hardly possible to say confidently, that people so owned the second alarm system that they could especially use verbal receptions in chronicle.

Hence, referring on known authorities, it is possible to make the first conclusion: without written speech and in conditions ***of imperfect second alarm system graphic models served as means of the communications between people and as visual teaching methods.***

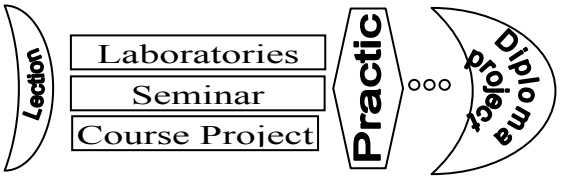

Fig. 2. Model of structure of a technical education

Developing of a written language is considered to be the evolution of the coding by graphic symbols of separate sounds of oral speech or the second alarm system. At first concepts were transferred by the separate coordinated symbols which reminded different animals and people, then the subsequent stylization and detailed elaboration of a written language to a cuneiform writing until the rules of separation of each elementary sound appeared in every nation that had a written language.

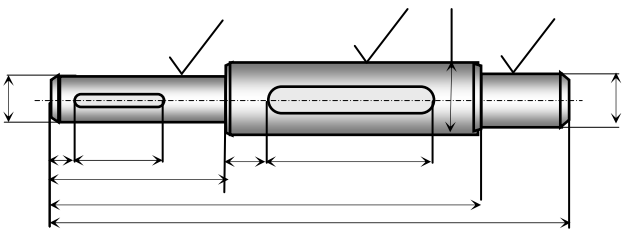

Fig.3. Draft|dwg| of billow|bank| (system model)

During the subsequent developing of a civilization the vocabulary of language grew, foreign words appeared and adapted, and due to the accepted codes a written language quite correspond to the second alarm system. But many system objects, processes, the phenomena and events which could not be described by separate concepts shortly have gradually appeared and demanded the long verbal de-

scription, quantitative characteristics, therefore artificial languages therefore have been created, as a rule, written ones which were conditioned by graphic symbolism, and the conditionality was made out by corresponding agreements which then were used as standards. The most vivid example of such artificial graphic written language is the drawing – "language of technics". The drawing allows to describe shortly quantitative and structural characteristics of objects of artificial origins (fig.3).

On the other hand, some aspects of human activity, processes in which men and women take part, it is impossible to describe shortly neither usual language, nor drawing, therefore "have appeared" other symbolism to be clear or intuitively or by means of advertising (fig.4).Graphic models have been widely spread in private life, in official functions, in diplomatic negotiations, so therefore the techniques based on substitution of text fragments by drawings. In figure 5 the attempt of representation of a part of the biography of one of the authors is shown in which there are no doubts that all moments are clear.

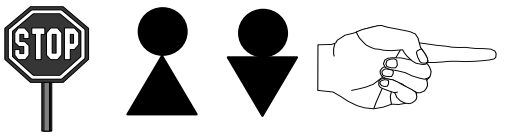

Fig.4. Various generally accepted signum|signum|-models

Graphic models always took leading positions in pedagogical process. Since times of Pythagoras Archi-

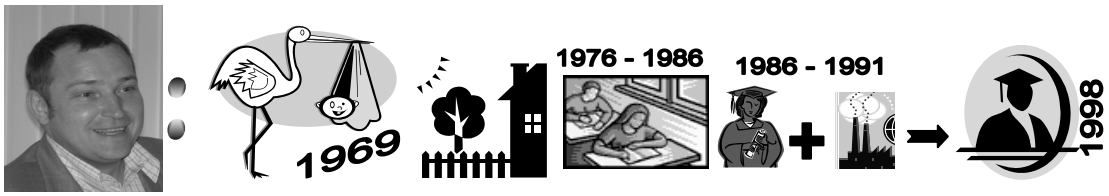

Fig.5. Attempt of biographic description by graphic|plot| models

medes graphic representation of the mathematical equations and functions is known. For the first time the theory of graphic modeling of the real world on the basis of axioms of geometry was developed and represented by French engineer Gasper Monzh, German engineers kept on the developing the idea. They used the first standards on the drawing of artificial products. Otto Mohr offered some "working graphic models" of the processes described by the mathematical equations. Generally, in educational process the graphic representation of the mathematical functions and the equations found the greatest using because of difficulty to present a reality by means of mathematical symbols. The great mathematician of XX century Hilbert truly said about leaving of one of the pupils to poetry: "I always knew, that he had not enough imagination for mathematician!" Unfortunately, that scientific discipline which found an application for graphic models at first as means of the communication with "equal" and then and in educational process. Nowadays the practice in application for graphic models has almost lost. As a result efficiency of teaching and number of scientists-mathematicians have been decreased.. The alarm on this account was expressed in 1976 at the first congress of mechanics of the USSR by academician L.Sedov.

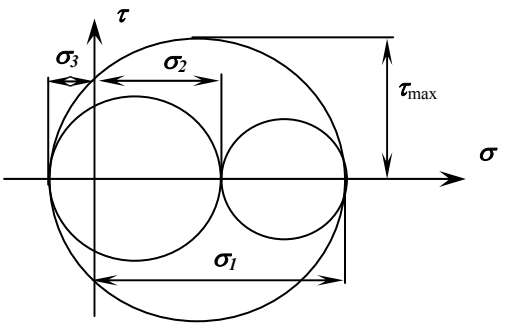

Fig.6. Circles of O.Mohr

Graphic models play the most significant role for training of engineers. It is difficult to imagine semantics of the general engineering disciplines of mechanical (theoretical mechanics, resistance of materials, the theory of mechanisms and machines, hydraulics, etc.) or of electrotechnical (the electrical engineering, theoretical bases of electrical engineering) directions without wide application of graphic models in teaching of these disciplines.

At teaching disciplines of engineering cycle for almost 200 years creation of explaining and illustrative graphic models of natural and technical objects has got very high qualification, especially illustrating of text and proofs. So, Otto Mohr offered an illustratively - working graphic model of an intense state in a point of load body (fig.6) that it is possible to consider to be ultrahigh qualification of the composer of graphic models! This flat image is "a copy" of an intense state in a point of a body choosing any direction in space under stationary (simple) loading of body. But circles of Mor can be applied for studying of non-stationary processes and for dynamical models.

Graphic models take special place in teaching, which illustrate this or that position, the formula. Such models, as a rule, have evolving character and are gradually constructed during lectures. In textbooks these models are resulted in a final kind, the most part of readers of the textbook who are students cannot entirely under-

stand all proofs which are almost always based on evolution of model of object or process. One way is only known to show all stages of evolution of model on paper is “a method of comics” but it demands considerable quantity of paper, therefore this method is seldom seen in textbooks of disciplines engineering cycle.

Nevertheless, such models quite suited the teaching focused upon a lecture way of transfer of the information, students tried to attend all lectures of a training course and not to miss the process of construction of models during studying processes, objects and accompanying comments of the lecturer.

But now similar achievements of professors of the past are not almost used. What is the reason? Eventually the transformation of a postindustrial society in informational one is the answer this question, in opinion of authors.

A lecture already cannot be considered as the main means of transfer of the information because of the reasons:

1. The opportunity has appeared to receive more full information from other sources than a lecturer could give students during the lecture.
2. A lecture as the method imposes rigid limits of the certain format on the contents, structure and volume of the teaching material for the lecture that does not let explain the teaching material promptly for perception of the information about facts, processes and objects the students. As a result it does not respond the principle of personality.
3. Lectures more and more have the character of review and directive that is such in which the technique of studying of various sections of the given course is taught.
4. Using of video data at lecture with the purpose of supply of the best perception of the educational information by students can be only fragmentary because of shortage of time, therefore, as a rule, is not frequently used.
5. On the other hand, a tendency of changing of educational process for self-instruction of students promotes the new approach to essence of lecture, and opens new horizons for application of graphic models in electronic "performance".

As a whole the prospects of development of a technical education cannot be presented without inclusion of the whole unit of knowledge: creation and using of the models for technical systems which can be called calculating, fundamental, structural and other schemes or models of environments, processes and so forth. In any case without resort to evolving graphic images of models the process of training to a technique of modeling hardly can be up to standard, therefore and it is impossible to image a technical education without application of computer technique with its unlimited opportunities in mobile graphics.

Display of the real object
Display of imagination of au-
A label is symbol
Illustration of text
Illustration of proof
Tool of direct calculation
Tool of indirect calculation

Fig.9.Basic functions of graphic model

If to speak about practice of training, it is necessary to notice, that the dynamic graphic modeling has recently begun to use, in particular, the graphic animation of imagined processes and models of real objects, processes, the phenomena therefore the animation graphic models are frequently applied in advertising the goods, technologies.

What should computer the graphic model be at teaching and training? Certainly, it is very necessary to answer this question for a practical realization of the given concrete model of object of studying in concrete discipline of the curriculum, therefore there is an attempt to find out the graphic computer model requirement depending on its function. The functions of graphic model are resulted in the classification scheme on fig.9.

1. *Display of real object*, as a rule, gives the student or the reader to imagine better the object which has not been seen before. The graphic models of this type are photos or figures, displaying the real objects in photos.
2. *Display of imagination of the author.* The author approves his vision of the world, an imagined or surrounding reality by means of the graphic models.
3. *A label - symbol.* The graphic model which may be a label or a symbol for the certain designation of the trade mark or the stamp represents object of many research disciplines and requires uncommon creativity at the invention of a new symbol. Such graphic model serves as the trade mark for firms - manufacturers, advertising attribute of this firm. The symbol can carry out indicating function (an exit, a kind of sports, the underground and so forth).
4. *An illustration of the text.* The graphic model as an illustration of the text has explanatory function. It explains those aspects which, in opinion of authors, are not covered in the text, or are not represented insufficiently clearly, or require additional work with other sources of the information. Such models can be carried out as posters, columns, schedules, drawings and so forth.
5. *An illustration of the proof.* There is the unique type of the graphic model, which is evolving in a process of the construction. It illustrates this or that statement, this or that argument with each step of evolution.

The development of the model goes together with the propagation of reduction and in a final kind the model can appear absolutely not clear, therefore it demands, as a rule, to apply a method of "comics" at construction. The model has dynamic character – the dynamic graphic model.

6. *The tool of direct calculation.* Very interesting graphic objects have started to be used with development of technics because of necessity to calculate the unified or similar technical constructions, mechanisms and machines. It is necessary to have similar units for similar operating conditions. The calculations of the latter are also similar. It is much easier to make once calculations in a general view, and connection between parameters which are in the formula of the final result to show as the original ***n-dimensional*** scheme, where ***n*** is a number of the parameters which are included in the formula. Such cumulative scheme is called nomogram. Nomogram was widely used at the end of XIX and at the beginning of XX century. Now nomogram have especially historical interest, but sometimes they are still used in simple thermotechnical calculations.
7. *The tool of indirect calculation.* The graphic model which evidently shows the researched parameters of the object at the present time, that is the factors of the stationary state of the object, is constructed by the certain rules, actually such model is the graphic decision of the equation or the system of the equations, therefore it can serve as result of designing or studying of behavior of objects at construction of some models. They are widely used in teaching of many engineering disciplines in educational process of high technical educational institutions, they are not actually used for industrial needs.

The most perspective from the point of view of training are the graphic models described in the 5-th item of the list. Let's make demands to such models. The graphic model in the educational process is the important additional means of communication (the basic means of communication is verbal) and it should respond to the fundamental principles of communicativeness in such quality. In particular, the computer graphic model should consist of intuitively clear or standard graphic primitives. Such model should take into account a possible low level of perception. When a model is being constructed all stages of its evolution without exceptions, should be traced into account with the purpose of the most full and deep understanding of processes and events in the object of which the model is considered. The step over the stages of evolution of the person is explained with different reasons, down to mystical ones, and each step over the stage of evolution of the model uniquely confirms a low qualification of the composer of the model. Certainly, the model should entirely and completely respond to a teaching material of the training course and to the main principles of the educational process. It is desirable, that the model had generalizing character and interested students in creative searches.

As the computer graphic model is discussed, it is necessary to recollect its economic and methodological profitability. The model should be the separate program or a file which is written down in any ready form of [1] environments, or by one of programming languages and "is easily entered" in the electronic textbook, the lecture, the tutorial for self-contained practical and laboratory works. The function of returning to any concrete stage of evolution of the model should be stipulated in all cases in the program of the model. The interface of the program should be neutral and at the same time is capable to fast readjustment, and it is better "to be entered" in the interface of the basic computer program. For the best perception the model should be fulfilled in several "manners" with the following testing of each approach to construction of a computer graphic image.

It is hardly possible to count listed all necessary requirements to models and to their creation, but presence of three groups of requirements is not subject to doubt, namely: communicativeness, perception, profitability.

Unfortunately, it is difficult to show graphic models which evolving in the process of the proof of the necessary positions on a paper. It is necessary to use the method of comics for this purpose, but it is not perceived by publishing houses that's why this method is seldom used in the educational literature, nevertheless the students willingly carry out such graphic images basically in MS Power Point environment (MS Office 2003) under the direction of the authors.

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