SHAPING OF THE DESIGN SKILLS OF FUTURE EXPERTS IN TECHNOLOGY DURING THE TEACHING OF "MACHINE ELEMENTS" COURSE

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Abstract.*Thearticleexaminesthemainpsychologicalandpedagogicalapproachestothedesignmethodsinteachinggeneraltechnicalgraphicscourses. Thistaskisimportantbecausethediversityofexistingcalculationsofmachineparts,thelackofrelevantliteraturebasedonthenewstandardsforthesecalculationsandthelackofvisibilityofeducationalmaterialcreatesomedifficultiesforstudents.Theformulationofpedagogicalapproachestomethodsofconstructingunderlies subject-subject activityofscientificandpedagogicalstaffandstudentsaimedatshapingthegraphiccompetenceandabilitytoperformoccupationalgraphictasksinvolvingmeansofcomputergraphics.*

The modern state of graphic preparation in higher technical educational establishments is characterized by the permanent search of new, effective forms and methods of studies, that would answer modern requirements to quality of preparation of future specialists. There is a process of forming of new technology of graphic preparation of future technical specialists, that needs the system of perfection of both maintenance of graphic knowledge, abilities and skills and didactics providing.

Keywords:*highereducation, highereducationalinstitutions, graphicspreparation, designandconstruction, designandengineeringactivities, computer-aided design, qualityassurance, thefuturespecialist.*

Formulation of the problem. Creation of new machines, which would meet modern requirements, is related to the need for training of highly qualified engineers specialized in machine building,capable to solve the problems of calculations, construction, manufacture and maintenance of high-end machines.This training is based on students being taughtthe fundamental general education, general engineering disciplines and specialty. The final stage of general engineering education is the study of the "Machine elements" course. In accordance to existing standard programs and curriculum this discipline can beentitled: "Machine Elements", "Design Fundamentals", "Machine Elements and Design Fundamentals" and others.

Designs of machines being continuously improved in accordance with the requirements to their operation and production, as well as the new opportunities due to thescientific and technical research, the emergence of new materials and methods for providing them with the necessary forms and properties. The way, teaching of "Machine elements" is organized, significantly affects the quality of students' knowledge in graphics and skills in designing and constructing machinery, which is the key to effective training of competent professionals.

The current state of graphic preparation in institutions ofhigher technical education is characterized by a constant search for new and effective methods of training that would meet modern requirements for quality training of future professionals. The process of forming a new technology ofgraphics trainingof future technicians is in need for improvement in graphic content knowledge, skills and didactic support.

Analysis of the latest publications and sources of domestic and foreign pedagogy shows that the theory and practice have accumulated considerable experience that can become the basis for the formation of graphical competence of future professionals.

The problem of graphics skillstraining in highereducation institutionshas been theoretically and experimentally investigated by V.Burynskiy, P.Buyanov, A.Hedzyk, I.Holiyad, O.Dzhedzhula, M.Kozyar, V.Nilova, I.Nyschak, T.Oliferenko, H.Raykovska, V.Rukavishnikov, O.Slobodyanyuk, T.Fedoryna, T.Chemodanova, R.Chepok, M.Yusupova, Yu.Feschuketc.

The analysis of the actual state of the students' graphics skills training in theinstitutions of higher technical education indicates its discrepancy from the modern requirements to the graphics knowledge and skills of qualified designers. Insufficient formation of student abilities in such spheres as using the graphical images for indirect cognition of reality, planning of their own actions in designing, development of theconstructing process in the images, and reproducing it in graphical form by means of computer-aided design (CAD) systems, reduces the

quality of training and future career activity, makes it impossible to solve the creative designing tasks and inventing.

The objective of the article. The variety of existing calculations of machine elements,the lack of relevant literary sources, based on the new standards for these calculations and the lack of clarity of educational material create certain difficulties for students. The objective of the article is to specify the peculiarities of using pedagogical approaches to methods of the designing in process of teaching the discipline "Machine elements" in the context of maintaining a constant level of graphics education that provides complete didactic cycle of drawing training (Engineering and Computer Graphics - Machine Elements–Fundamentals of Design) and allow to optimize the mastering of the graphics competence by student.

The main material of research. The formulation of pedagogical approaches to methods of constructing underlies subject-subjectactivity of scientific and pedagogical staff and students aimed at shaping the graphic competence and ability to perform occupational tasks involving means of computer graphics (CAD). This approach allows to organize educational activity of all subjects of teaching and to create the conditions for high-quality implementation of information and communication technologies (ICT) and interactive teaching methods based on professionally oriented technologies and individual characteristics of students.

The most important aspect of the application of this approach is the formation of the students' general methods of thinking and spatial imagination of technical assets (circuits, components, assemblies), development of the ability to understand the content of the technical drawing, mastering the skills of algorithmic thinking and graphic analysis, the formation of logical reasoning skills and the ability to predict results of the designing activity.

To realize the aforementioned components of professionally oriented education indesigning it is necessary to provide scientific and pedagogical workers with means for organizing and managing the cognitive activity of students, and students -with learning tools that stimulate them, activate their self-educational and

cognitive activity on practical classes, promote the efficiency of education in general and provide their personal development.

Designed didactic support for "Machine elements" discipline is a set of interrelated learning tools that have a single target - activation of student learning activities and can be used in the various forms of training.

In developing the pedagogical approaches we followed the interpretation of learning tools as "objects that form the learning environment and participate in educational activities" [1] and their division into two groups by the subject of use: students and scientific and educational workers.

Let’s consider and describe the main pedagogical approaches to defined problem.

For the better understanding of the design engineer work in modern production it is necessary to describe the stages and content of the technical object manufacturing process and to transfer its scientific bases to future engineers activity as a component of their training.

V.Kachnyev, considering the production activities of an experienced designer, says that it involves calculation, material selection, constructive development of shapes, design adjustment, budgeting. At the same time the designer must be familiar with all stages of manufacturing and processing of his machines or products,have topredict all the possible complications related with manufacturing and application of theproduct, must have rich scientific and technical knowledge and skills to apply them in solving specific problems, advanced creative imagination, daring intuition. Activity of designer on the modern production passes through three stages: preparation of the specification, development of conceptual, technical and business projects [72].

Analyzing the professional design, Ye.Zyeyer focuses on two stages: determining the content of designer knowledge and skills and computation of the variety of organizational, settlement and graphic, technological and other design problems in the process of constructing [63].

According to V.Molyako, there are three main cycles of design activity [104]:

1) Understanding of the technical requirements - familiarization with the condition of given task. "Understanding the conditions of the problem is an essential factor of the following successful actions of the subject, an important regulator of the decision process," - marks the scientist.

2) Building of concept - "... idea is the second regulator of decision process, so its content, completeness, context relevance, etc. - everything is of paramount importance for the decision process" - writes the author.

3) Confirmation or disconfirmation of conception correctness - verification of conception, approbation of the realized strategy with the obtaining of constructively potential system. These three cycles are associated with taking the three major decisions: the evaluation of problem, prediction via plan (design of future construction), evaluation of the project through thinking - drawing experiment.

J. Diksonsdividesengineeringdesignactivityonthreeparts: inventiveactivity, analysis, decision-making. Inventiveactivityisdefinedasanindividual'sabilitytooffernewandoriginaltechnicalideasthatcanbeusedinsolvingengineeringproblems.Inventionactivityinherent ininincompleteness, thereforetheeffectivenessofthisactivitydependsonthesusceptibilityandexperienceofthedesigner. Thedesignanalysis, accordingtotheauthor, isresolving theissuesof engineeringnature.Althoughthisactivityhascreativefeatures, itisbasedoncommonsense, expertiseand hasnarrowercharacterthaninventionactivity. Decisionmakingis a selectionofthebestoptionfrom a numberofpossible [58].

Slightlydifferentstagesofthedesignactivitywere detected by P. Hill [161].They are assessmentoffeasibility (perceptionofinitialinformation, creationof a setofsolutionoptionsfor the theproductas a whole),schematicdesign (selectinganddevelopingtheconceptthat isthebestsolution), workingdesign (essentialdisclosureof

engineeringdesigninvolvingevaluationandpossiblesolutionschangeaccordingtoproductionrequirements, prospected operationandliquidationofusedproduct).

There are certaincommonpatternsin designactivity: understandingof theconditionsofproblem,constructionof itssolutionconceptionandrealizationoftheoverallsolutionstrategy. Thesethreemaincomponentsofthedesigndecisionsprocesscharacterizecreativityandarethemainregulatorsofthesolutionprocessofalldesignactivities.

V.Aleksyeyevsetconsecutivestepsofdesigninganddeterminednatureoftheactivitiesateachstage. Hesuggestedvariousactionswithgraphicdocumentation: introductiontodesignsolutionsbydrawingsandpictures, theiranalysis, implementationoftheobjectconcept, a mathematicalscheme, sketchdesigning,elementsdrawing [3].

V.Kachnyevofferedthefollowingorderintheformationmethodofengineeringandtechnologicalknowledgeandskills [72]: explanationofthedeviceandexploringthe "designing" concept, explainingtheprinciplesofdesigning, developmentofsketches, readingthedrawing, solvingofdesignproblems in the process of sketching, designchangeanditsimaginginthesketch, elementsdesigning.

S.Shabalovoffers a differentsequencesettingofdesigningtasks: explanationof a givendevicedesignandindicationofitsmaindimensions, applicationoftheprincipleoftheknownconstructionon a given, fillinginthelinksmissinginthedesign, [171].

Famousresearchers, engineers, psychologistshavedifferentconceptsrevealingspecificityof "designing" and "constructing." InUkrainianPedagogicaldictionaryconstructing (Latinconstruo - build, create) isunderstoodas "theprocessofcreating a model, machine, building, technologywithprojectandsettlementimplementation" [49].

Designingandconstructingprocessesareinterrelated, complementingeachother. Thestructuralshapeoftheobjectspecifiedviadesigntechniques. Designisonlypossiblefor pre-acceptedvariantsofconstructiveexecutionofanobject.

Often, thesetwoprocessesarenotseparated, becausetheyareperformedbyspecialistsofthesameprofession - designengineer. However, thedesigningandconstructingaredifferentprocesses [6, p. 14]. Constructingprecedesdesigningandis a searchforscientificallyjustified, technicallyfeasibleandeconomicallyviablesolutions.

O.Polovynkindefinesdesigningas "a kindofengineeringworkbeingconductedinvariousfieldsofhumanactivity: thedesignoftechnicalsystems... inengineeringconstructionisanintegralpartofthedesigningandassociatedwiththedevelopmentoftechnicalsystemsconstructionsthatlatermaterializedatmanufacturing... "[124, p. 73].Authorexplainsthedesigningas "theprocessofcreatingtheprojectintheformofprojectdocumentationrequiredforthemanufactureorrenovation ofthe technologicalfacilityor forexaminationwith a viewtodecidewhether tomanufacture, renovate ..." [124, p. 144].

The famous constructor A.Tupolyev in conversation with Mr. Jacobson expressed the following views on the process of his work, "you doing thinking through questions. There are known stock of knowledge, structural shapes, charts, technical principles while using. You imagine yourself in general terms a definite decision, pass to one other solution in order reflection. In the meantime all of this is a quest. When it comes to a final solution, an image of what you want to create, then all savings, stocks charts, individual decisions, the whole mass of existing thoughts arranges. This image becomes the center. This is because there is already a concept in which all material of searches can be nested. Now it can be specified "[199].

V.Kalinin, V.Nikiforov, I.Anikyeyev described the constructing as "a logical thought process, which combines ability to maintain focused creative work, intuition, the ability to build a logical design processembodying the logic into every line, every element. Designing should envisage the development of the product drawings considering actually existing conditions.Constructor should always possess the method that can consistently and confidently find the best

possible or at least satisfactory solution". The authors of this work by analyzing the the activities of constructor emphasize that intuition is desirable, but to rely solely on it is risky, it is necessary to pay attention to the method and the logic of work performed [67, p. 15].

V.Malaschenko, V.Yankiv indicated that mastering the fundamentals of designing, constructing and calculation is important in the training system of engineers of various basic directions. Design is a creative process. Therefore, knowledge of theory, calculation methods etc. is often not enough. It is necessary to be able to analyze the structure that you want to design from different perspectives at all stages of its creation [5, p. 11].

Pavlysche VT points out that designing and constructing are the types of mental activities associated with the creation of a specific image. Visional image undergoes a mental transformation (components rearrangement, replacing them with other elements, or providing them with different form). Simultaneously the alteration effect isassessed, the impact of changes at the final result being determined. Visional image of the object is created according to the general principles of logical thinking and subsequently acquires final, technically justified form and structure [6, p. 14-15].

The conducted analysis allowed us to determine the following graphics knowledge that future professionals must possess: knowledge of basic theoretical positions, methods and techniques of graphic constructions, patterns and properties of three-dimensional objects in the world (geometrical and technical) that is the subject branch of descriptive geometry and conceptual apparatus of the science; understanding of the practical purpose of graphics language in scientific and technical communication, which allows to operate the spatial images of different objects, the ability to competently reproduce these graphics objects; knowledge of the theoretical foundations of engineering and computer graphics, machine elements; the development of scientific and technical logical thinking, including spatial imagination, designing and graphics knowledge; knowledge of basic designing and constructing phases, their content; knowledge of computer modeling

and designing of technical facilities; knowledge of methods of technical creativity; knowledge of technical design principles; knowledge of design and drafting in accordance with national and international standards; knowledge of the requirements of technical aesthetics and ergonomics, reasonable methods of products manufacturing, tools and appliances selecting, basic processing modes; knowledge of manufacturing processes simulating by means of computer graphics. Graphics activity is multifaceted and includes not only features typical for creative activity, but also designing skills, determined by the level of modern science and production development.

Modern specialist cannot successfully face the professional designing tasks, without having sufficient knowledge about the subject of his activities, all methods and tools and make a creative solution of these problems. Thus, the implementation of this goal is only possible on the basis of the specific content of courses and the use of CAD in educational process. Emphasis is made on the introduction of a special graphics software in the educational process. The modern approach to engineering training is characterized by the complexity of decisions: on the one hand it is the automation of designing by means of CAD tools, and on the other - the automation of technological operations using computer aided design processes.

The use of CAD systems industrial technologies during the improving of graphics training and solving of applied problems by means of geometric 2D i 3D modeling effect on the goals and means of graphic training of students in universities [2, p. 175].

Let’s revise and describe the basic elements of the methodological support of the "Machine elements" discipline.

According to the curriculum and the work program of courses "Machine elements" the workshop was created [3]. It included an information pack of practical classes by topics, indicated amount of course designing and execution of calculations and drawings.

Considering the orientation on the professional graphics competence of a prospected specialist and hisneed to work in the international technical environment, the students were given some knowledge of preparation of drawings in accordance with the ISO standards [4].

For efficient perception of educational material of "Machine elements" courseit is suggested to use multimedia presentations created in Microsoft Power Point environment. It is because they provide a scientific and pedagogical worker a chance to reproduce a significant amount of material in a short time, present it in an unusual perspective, introduce students to the imaging, amplify their yet vague idea of technical objects and improve their knowledge.

Fig. 1 shows a fragment of the didactic accompaniment performed by means of CAD systems, which contribute to the formation of informational, intellectual and motivational components of graphic design expertise on the designing ofelements, components and assemblies and enables you to create dynamic textbook that combined with the paper version becoming the most productive learning tool.

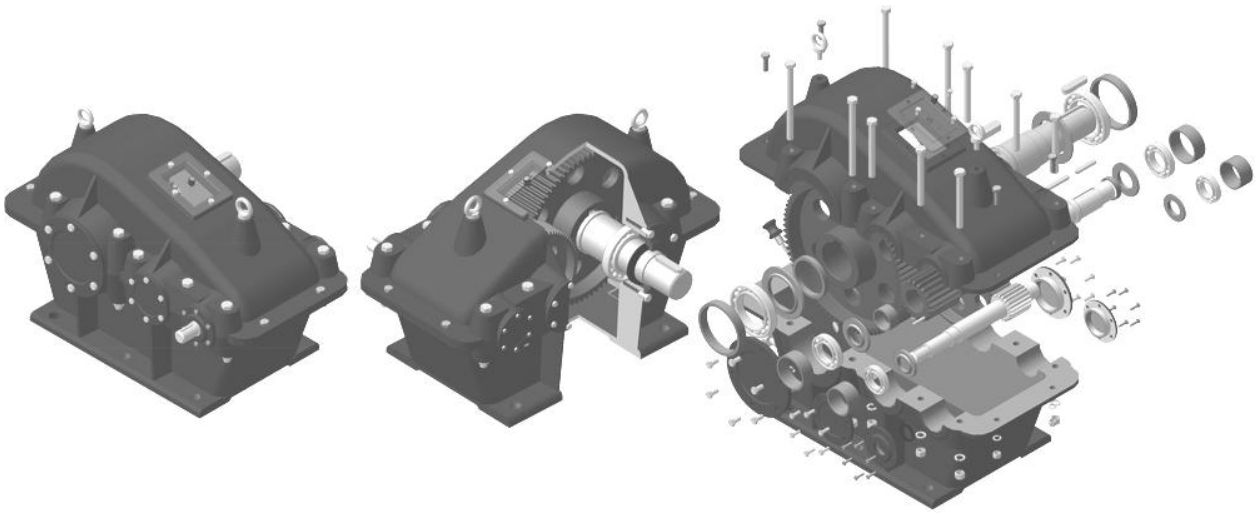

Fig. 1. Fragment of didactic accompaniment

Such organization of learning activities allows students to master the course material using three types of memory - visual, auditory and motor, promotes the development of skills of logical, analytical and figurative thinking, associativity, independence, focusing and intensifying conscious implementation of a course project.

The availability of information resources today - one of the decisive factors in the efficiency of the person.

Conclusions. Suggested methodical approaches to establishing the foundations of designing activities in teaching the "Machine elements" coursewill provide quality of graphicstraining by improving the illustrative part and accessibility of training material, developing of cognitive interests of students, individualizingand intensification of their self-employment, providing professional direction for thegraphicstraining and developing individual style in professional activities.

Theuseof CAD systemsallowestosimplifytheconstructingofgeometricelements, certainfragmentscopying, graphicsandtextinformationediting, shading, sizedrawing, improvesgeneralqualityofthedocuments.

Prospectsforfurtherresearch. Thedevelopmentofnewmethodsofgraphicdisciplinesteachingrequirefurtheractionthatwillensure a highlevelofeducationalprocess, using ofinteractiveteachingmethods, and willprovidetheopportunitytoworkwithmanystudentswithpreservationofanindividual approach.

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