

## COMPUTER-AIDED DESIGN SYSTEMS

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<sup>1</sup>V. M. Sineglazov, Dr. Sci. (Eng.), Prof.,  
<sup>2</sup>A. A. Titarchuk, Dr. Sci. (Eng.), Prof.

### THE CONCEPT OF CREATING OF COMPUTER-AIDED DESIGN OF PROCESS EQUIPMENT

<sup>1</sup>Institute of Aerospace Control Systems of National Aviation University, e-mail: [svm@nau.edu.ua](mailto:svm@nau.edu.ua)

<sup>2</sup>Cherkasy State Technological University, e-mail: [chstu@chstu.cherkassy.ua](mailto:chstu@chstu.cherkassy.ua)

**Abstrakt.** *The solution of creating a computer-aided design problem of technological equipment by applying a systematic approach to the methodology of the machine system and its information and the mathematical provisions constructing is offered, methods of new technical solutions searching are used.*

**Keywords:** computer-aided design, methodology, technical system, process computer-aided machine, system of machine, processes of designing, systematization, heuristics, branch of industry.

**Introduction.** Today one of the priority directions of development of industries in all industrialized countries is the development and implementation of automated systems for production purposes. Computer-aided design of process equipment is the most urgent task.

**Analysis of recent research and publications.** Almost all design engineering units of machine manufacturing branch specializing in the creation of process equipment are equipped by personal computers, graphical computing systems like Auto CAD, Compass, T-flex and others. These CAD systems solve the problem of a two-dimensional, three-dimensional geometric model of the product. However, the main task is creating of constructive solutions of devices, machines, automatic machines and it is fulfilled by designer. The qualities of development, its scientific and technical level, the date of creation depend on the professional competence of designer. It necessitates the creation of special algorithms, rules, information systems, which should form the basis of new computer technologies aimed at the design process automation.

**Statement of the task.** The core objective of the article is to develop scientific and methodological foundations of the automation concept of the process equipment in the machine manufacturing branch of industry.

**Basic Content.** Methodology of computer-aided design organically combines achievements in the development of the general theory of system design with the capabilities of modern technical means of design. The principles of systematic approach, mathematical modeling techniques of design tasks and mathematical apparatus of complex systems optimization are assigned at the core of these methods. Practical implementation of the mentioned problems is possible only within the framework of CAD [1, p. 38]. Theoretical basis of complex technical systems design is the provision of a systematic approach, which more commonly referred to systematology, mathematical apparatus of the complex systems theory and methods of mathematical modeling.

In this article, the subject of the study is a set of theoretical, methodological and practical problems of technological machines designing. Machine is a device performing mechanical movements for transformation of energy, materials and information in order to replace or facilitate physical and intellectual human labor. Technological machine (cutting machines, rolling mills, packaging machines, etc.) changes the shape, dimensions, properties, condition of initial materials and workpieces according to the process.

The scientific literature review of technological equipment design proves that scientific research works on evaluation of dependence of properties of machines from their parameters,

structure, links are virtually absent (sectoral research works are conducted in the direction of the executive bodies' determination of the effect on ascending materials) which is one of major problems on design process automation. The problems of automation are caused by the lack of computer design methodology and adapted information system. The task of technological machine creating is the development of structure, designs and its constituent elements, which under certain requirements, restrictions, should provide the most efficient conversion of the subject of work.

The general theory of design can be formed on research basis of disparate design methods, which are highlighted in the scientific and technical literature, and normative regulations of the State Standard of Ukraine – The State Standard of Ukraine, The State Standard of Russia, summarizing the domestic and international experience of designing and which, in fact, are the generic method or design technology being the ordered sequence of stages and processes of creation, under which the object design is consistently highlighted, formalized from the beginning of the initial apparent until the geometrical representation of the design.

Stages of construction:

**I. System analysis of needs, objectives.** Formation of the initial requirements.

**II. Creating of conceptual model and functional scheme of the process machine**

**III. Formation of the technical specification.** Setting of main purpose, characteristics, indices of quality (The State Standard of Russia 15.011–87, The State Standard of Russia 15.014–87).

**IV. Creating of technical proposals.** Rational argumentation of development. The specification solution of clear patent creating (The State Standard of Russia 2.118–83).

**V. Development of conceptual design.** Determination of the fundamental design decisions, machinery construction, basic parameters, dimensions (The State Standard of Russia 2.119–83).

**VI. Developing of technical design.** Determination of the final technical solutions giving a complete picture of the design of the new TM-A (The State Standard of Russia 2.120–83).

**VII. Working draft.** Full geometric image design of parts, assemblies and technological machine in general.

As part of the system of design methodology is the mathematical modeling of design problems using computers.

The technological machine consists of a large number of links and connections between them, having functional and spatial forms of existence, interaction of components in the middle of themselves and with the environment; it is a complex technical system. In the absence of research of dependencies of parameters and properties of the system on constructing patterns, relationships between elements a mathematical model of the creation and product as a whole can not formally be described and constructed. These problems are solved by means of decomposition according to morphological structure of the technological machines by hierarchical levels: executive bodies – gear unit – details.

In this approach, the problem of product modeling leads to design mechanisms together with the use of methods of theory of machines and mechanisms: structural, kinematic and dynamic analysis-synthesis mechanisms, machine parts, resistance of materials (the calculations for strength) and research results of mechanisms, descriptions of structures used in modern machines of different industries.

After the formal analysis of a system the next step is to develop mathematical models, systems and processes that are studied, to solve these problems, find global extremum of functions (often many variables (parameters)) with constraints on these parameters in the form of functional equations and inequalities.

Determination of interrelated criteria complex allows to every level of decomposition to determine optimal system parameters using formal methods and evaluate objectively the results of the design that is one of the most important tasks of the system design [2; 3].

Thus, the automation of technological machines mechanisms designing requires the use of mathematical models and methods of analysis, synthesis and optimization of parameters of mechanisms and information files:

- mechanical laws of motion and equilibrium of material bodies (the basis of theoretical mechanics);
- methods, rules and regulations of details design, their optimal shapes, sizes, quality surfaces, materials selection assignment (basic machine parts);
- basis of calculation of the strength of structural components (strength of materials);
- methods of structural and dynamic analysis-synthesis of mechanisms (basic theory of machines and mechanisms) and others.

New technology is created on the basis of existing science, engineering and technology with the introduction of scientific and technological progress.

The present stage of technical systems is characterized by the creation of flexible automated production systems based on automation approach, which is the creation of machines system with modular structures consisting of uniform blocks, components, parts. Technological machine is considered as part of an integrated system of machines (referred as the system of machine), consisting of a full range of process equipment branch of industry, produced and mastered in manufacturing enterprises and organizations of relevant ministries and agencies, as well as imported from other countries.

Creation of technical systems requires the study of future equipment environment, sources of matter, energy and information. Problems of implementation of science and technology with limited supplies of raw materials now are being solved by means of complex processing of raw materials, the use of non-waste technology, energy conservation, and creation of fundamentally new technology: integrated production systems – systems of machines. The implementation of a systematic approach to manufacturing automation that is creation of machines with modular designs (uniformed blocks, components, parts) can significantly increase seriality, reduce the price and simplify manufacture, installation and operation.

Systematization of machine industry is a system of machines, a means of intensifying and improving the integrated production efficiency.

The development and research of machinery industry realizes the decomposition process of social production equipment and a modern approach to the creation of engineering, being originated foundation, on the basis of which a technological machine is created and it is a necessary prerequisite for the formation of arrays of information technologies, physics and technical knowledge, technical solutions in sphere of computer design.

When creating a system of machines, according to the research results of machinery branch of industry, which manufactures equipment for processing and operating industries, information files are created in these sectors.

As a result of organizing, optimizing the system of machines hardware information files are created: technical documentation fund (technical solutions) hardware, which is systematized by executive bodies, transfer devices, engines; by functional feature; fund of analogues, patent fund, restricting norms on hard metis components, spending products and so on.

The development of non-existing products can be made through the use of previously known principles of design decisions, constructive decisions, but it is necessary to apply these decisions so as to achieve a qualitatively new results, which requires the search for new technical solutions, creative approach to design.

The technical progress is achieved by both evolutionary and implementation of technical solutions, obtained as a result of inventive activity. Process design consists of algorithmic and heuristic procedures precluding their full automation. Human intelligence and a set of formalized knowledge, information files, stored in the computer, must be combined in the automated system of design.

**Conclusions.** We offer to solve the problem of computer-aided design of process equipment by means of next steps:

1. Decomposition of process equipment of social production (industrial production).
2. Formation of designing methodology by using systematic approach to systematic patterns of development of technical systems, disparate methods and techniques of construction, industry procedures for the stages of creating the product.
3. Establishment of system of machine, research of equipment of the appropriate branch of machinery industry that will localize the volume of physics and technical knowledge being a scientific and technical basis on which a new technique is constituted.
4. Formation of technical documentation funds (technical solutions) hardware, mathematical models of mechanisms, methods of analysis-synthesis and optimization of mathematical models, logical and informative diagrams of design processes information systems of automation.
5. Use of search methods of new technical solutions, development of proposals as to their using will allow to organize and intensify search for technical solutions in sphere of the design.

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В. М. Синеглазов, А. О. Титарчук

#### **Концепція створення системи автоматизованого проектування технологічного обладнання**

Розглянуто вирішення проблеми створення системи автоматизованого проектування технологічного обладнання. Запропоновано використовувати системний підхід у методології побудови системи-машини. Визначено методи пошуку нових технічних рішень.

В. М. Синеглазов, А. А. Титарчук

#### **Концепция создания системы автоматизированного проектирования технологического оборудования**

Рассмотрено решение проблемы создания системы автоматизированного проектирования технологического оборудования. Предложено использовать системный подход в методологии построения системы-машины. Определены методы поиска новых технических решений.