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# SYSTEM ANALYSIS AND COMPUTER SOFTWARE IN THE DESIGN OF OPTIMIZATION OF ENGINEERING STRUCTURES AND STRUCTURES

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***Abstract.*** *This article discusses the design processes of mechanical engineering products according to specified criteria. For fast and high-quality product development, a comprehensive analysis and calculation of the designed object at the development stage is required. The first design task is to develop the correct engineering solution to ensure that the product performs its functions. To find the only final result, it is necessary to make a decision from a set of alternative solutions. Thus, obtained on the basis of models of intelligent decision support, the process of designing machine-building products in CAD is provided with information. For this, first of all, it is necessary to analyze the existing types of CAD systems and determine the possibility of increasing the intelligence of their subsystems.*

***Keywords:*** *engineering product, mathematical models, mathematical modeling, optimization algorithms, expert system, decision making, design process, automation, optimization problems, system approach.*

# MUHANDISLIK KONSTRUKSIYALARI VA INSHOOTLARINI OPTIMALLASHTIRISHNI LOYIHALASHDA TIZIMLI TAHLIL VA KOMPYUTER DASTURLARI

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***Annotatsiya.*** *Ushbu maqolada belgilangan mezonlarga muvofiq mashinasozlik mahsulotlarini loyihalash jarayonlari muhokama qilinadi. Tez va sifatli mahsulotni ishlab chiqish uchun ishlab chiqish bosqichida loyihalashtirilgan ob'ektni har tomonlama tahlil qilish va hisoblash talab qilinadi. Birinchi dizayn vazifasi mahsulot o'z vazifalarini bajarishini ta'minlash uchun to'g'ri muhandislik yechimini ishlab chiqishdir. Yakuniy natijani topish uchun muqobil echimlar to'plamidan qaror qabul qilish kerak. Shunday qilib, aqlli qarorlarni qo'llab-quvvatlash modellari asosida olingan, SAPRda mashinasozlik mahsulotlarini loyihalash jarayoni ma'lumotlar bilan ta'minlanadi. Bu –*

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*ning uchun, birinchi navbatda, SAPR tizimlarining mavjud turlarini tahlil qilish va ularning quyi tizimlarining intellektini oshirish imkoniyatlarini aniqlash kerak.*
***Kalit so'zlar:*** *muhandislik mahsuloti, matematik modellar, matematik modellashtirish, optimallashtirish algoritmlari, ekspert tizimi, qaror qabul qilish, loyihalash jarayoni, avtomatlashtirish, optimallashtirish masalalari, tizimli yondashuv.*

# СИСТЕМНЫЙ АНАЛИЗ И ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ ЭВМ ПРИ ПРОЕКТИРОВАНИИ ОПТИМИЗАЦИИ ИНЖЕНЕРНЫХ КОНСТРУКЦИЙ И СООРУЖЕНИЙ

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***Аннотация.*** *В данной статье рассматриваются процессы проектирования изделий машиностроения по заданным критериям. Для быстрой и качественной разработки продукта необходим комплексный анализ и расчет проектируемого объекта на этапе разработки. Первой задачей проектирования является разработка правильного инженерного решения, обеспечивающего выполнение изделия своих функций. Чтобы найти единственный конечный результат, необходимо принять решение из множества альтернативных решений. Таким образом, полученной на основе моделей интеллектуальной поддержки принятия решений информацией обеспечивается процесс проектирования машиностроительных изделий в САПР. Для этого, прежде всего, необходимо проанализировать существующие типы САПР и определить возможность повышения интеллекта их подсистем.*
***Ключевые слова:*** *инженерный продукт, математические модели, математическое моделирование, алгоритмы оптимизации, экспертная система, принятие решений, процесс проектирования, автоматизация, задачи оптимизации, системный подход.*

**Introduction.** The implementation of mathematical support in CAD is software.

Software is an organized set of program modules (a module is a semantically closed program unit with a name), implementing functionality and binding to a specific computer system, satisfying system agreements documented in accordance with system rules and executed on a computer directly or using other programs. [1-14].

The increase in the level of technical progress is accompanied by the complication of manufactured technological products and methods of obtaining them. For fast and high-quality product development, a comprehensive analysis and calculation of the designed object at the development stage is required. The first design task is to develop the correct engineering solution to ensure that the product performs its functions. To find the only final result, it is necessary to make a decision from a set of alternative solutions.

**Experimental.** For optimizing the design of engineering structures and structures, CAD software must consider the

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specifics and limitations of the computing environment in which the system operates. Nevertheless, there are fairly general properties of any CAD software, knowledge of which is necessary for both developers and CAD users. CAD systems for engineering structures and structures are created based on a wide range of computers equipped with various general-purpose software. This is the so-called system software (SPO), designed mainly for the efficient organization of computing on a computer and resource management. Open-source software is developed simultaneously with the development of computer hardware and is supplied along with it. The specifics of open source software impose significant restrictions on another part of the CAD system for engineering structures and structures - application software (APS), in which the CAD software is implemented in software.

A significant part of open source software refers to the operating system (OS), which is a set of programs designed to increase productivity (computers in general, automate the processes of preparation and debugging of programs, create and maintain library databases) of users, and facilitate the working conditions of service personnel.

Modern operating systems are complex and expensive software systems, so there are usually no significant changes to these systems during the operation of the computer. In this regard, when developing CAD for engineering structures and structures, one has to focus on the standard OS of the corresponding machine[4-6, 9-13].

One of the most important bases based on which CAD software for optimization of engineering structures and structures is created is the methods of computational mathematics. However, the “adaptation” of these methods to a form that is possible and convenient to implement using computer technology is a complex and time-consuming process that represents the life cycle of creating a software product. The most important stage of this process is the development of algorithmic support.

**Results and Discussion.** The concept of an algorithm is defined by A.A. Markov as a precise prescription that defines the process of transforming source data into the desired result and has the following properties: effectiveness - the ability to lead to the desired result after a finite number of fairly simple steps; those. suitability for solving a problem from a certain class of problems.

The difficulties of creating algorithmic support lie, in particular, in its properties and the “finiteness” of the algorithm. Naturally, the algorithm must terminate after a finite cycle of steps (this property is called potential feasibility), and the number of steps is a critical parameter that determines the efficiency (and complexity) of the algorithm. In principle, a large number of problems can be solved algorithmically, but the time required to obtain a solution can be so long that in practice the problem remains unsolved. Therefore, a practically implementable algorithm should answer a relatively small number of steps that can be completed in a fairly short period on a computer.

Since the essence of design is often to find a satisfactory rather than an exact solution, approximate methods and algorithms that impose requirements on a computer are of considerable interest. This achieves a significant reduction in computa-

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tional time (and memory space). Therefore, the development of algorithmic procedures for CAD should be based on the principle of a satisfactory solution using economical computational procedures.

After an algorithm for solving a particular problem has been compiled, the programming process begins, i.e. coding the algorithm in terms of the chosen high-level programming language or directly in terms of machine instructions.

For specific designed engineering products, a place in the general structure of other systems must be determined. The systematic approach requires a reasonable allocation of the system under study in the general composition of systems designed to maintain normalizing parameters, dividing it into subsystems.

Mechanical engineering products are considered as an independent object of study and optimization, but taking into account the necessary exchange of information with adjacent and external systems and within it - between subsystems.

The selected general structure of systems should clearly outline the boundaries of the system under study and facilitate the selection (structuring) of such subsystems that are available for research in terms of their size and are homogeneous in description. All this ensures the organization of connections at each successive level of descent from the system to individual elements from top to bottom, with the subsequent transfer of the received aggregated information upward (bottom-up).

Integrity properties must be inherent in both the general structure of compensation systems and the subsystems of mechanical engineering products: changes that have arisen in any of their parts affect both other parts and their entire set.

Engineering products are presented as a model. When designing complex systems, such as engineering products, knowledge is required about the quantitative and qualitative patterns of behavior of the system and its individual elements, depending on the nature of changes in numerous factors (parameters).

The model should be similar to the original, but also different from it. Its distinctive features are manifested in the fact that it undergoes such transformations in the desired direction, which are impossible with a direct study of the original.

**Conclusions.** Created (developed) PPP for optimization of engineering structures and structures must have the following properties:

- be built according to a modular (system-based) principle;
- Have certain flexibility concerning the software and hardware of the operating environment;
- Accessibility to specialists poorly trained in the field of computer technology;
- Using developed friendly problem-oriented dialogue;
- Allow an interface with instrumental support systems: databases, graphical systems, DBMS;
- Allow modification and expansion.

Thus, obtained on the basis of models of intelligent decision support, the process of designing machine-building products in CAD is provided with information.

- For this, first of all, it is necessary to analyze the existing types of CAD and determine the possibility of

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increasing the intelligence of their subsystems;
- Develop mathematical models of a decision support system for design development;
- Develop an algorithm for optimizing the designed product;
- Develop an expert decision support system to ensure the manufacturability of the product.

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