UDC 656.11:004.7 **doi: 10.26906/SUNZ.2025.1.55-61**

O. Fedorovich, L. Malieiev

National Aerospace University "KhAI", Kharkiv, Ukraine

MATRIX MODEL OF STRATIFIED REPRESENTATION OF THE HIGH-TECH PRODUCTS MODERNIZATION PROJECT BASED ON COMPONENT AND RISK-ORIENTED APPROACHES

Abstract. The subject of research in this article is the projects of modernization of high-tech products (HTP). The aim is to improve the quality of the HTP modernization processes by developing a stratified project representation based on the component and risk-based approaches. The methods of system decomposition, stratification, component approach and risk identification are used. The article analyzes the features of the modernization projects of the HTP, forms a model of the life cycle of the modernization project, that separates the stages of design and technological preparation of production, logistics tasks of procurement. The developed matrix model of stratified project representation allows planning work in two areas of detail: according to the main stages of the life cycle and the selected strata (structural, technological and risk strata).

Keywords: high-tech products, modernization projects, life cycle, multicomponent, risks, stratification, system model, design, 3D modeling, additive technologies.

Introduction

The main direction of development of high-tech production is the modernization of complex equipment, which allows to ensure its compliance with new functionalities and modern requirements of the sharpening process and to be competitive. The purpose of modernization of high-tech products (HTP) is to improve the technical and quality characteristics of equipment, expand its capabilities at lower costs than the purchase of new equipment [1-3].

Due to the need to ensure the competitiveness of industrial enterprises in Ukraine, the relevance of modernization in modern conditions is growing significantly.

The current level of high-tech products requires the search for effective methods of analyzing and managing projects for their modernization.

An analysis of the results of partial modernization projects of complex equipment shows that their implementation was accompanied by exceeding the planned deadlines, financial resources and, in some cases, failure to achieve the expected improvement or restoration of the functional quality of the equipment. Another complicated issue is the identification and supply of the necessary components for the modernization of sophisticated equipment, especially when the latest foreign-made components are used.

For example, in early 2022, when developing a project to modernize An-178-100R aircraft intended for the Ukrainian Air Force [4], it turned out that about a third of the components were russian-made [5]. Therefore, the basis of this project was the strategy of import substitution with the transition to Ukrainian analogues, as well as products from Canada, China, and the United States.

Such decisions require significant attention and project funds to ensure logistics processes. On the other hand, the production of new components and parts is developing at the enterprises that are part of Ukroboronprom[6].

Therefore, the article deals with the urgent task of forming a systematic view of the project for modernization of high-tech products based on component and risk-oriented approaches. At the same time, it is necessary to highlight the innovative component of high-tech products and plan project activities for its design and subsequent manufacture.

Analysis of recent research and publications

The principles of integration in the design of complex products are implemented in the methodology of structural and parametric modeling, which consists not only in combining the stages of the life cycle, but also in the use of appropriate geometric modeling tools in the form of an appropriate mathematical apparatus. The main provisions of the method of reducing the area of design solutions are considered [7].

In automated design systems, the CALS technology has been improved to ensure the connection of the stages of building 3D models of a complex equipment object based on knowledge-based technologies during the cycle of their creation and data exchange between different components [8].

Among the generally accepted methods used in HTP system design are decomposition methods, methods for creating a block structure [9], morphological analysis, and modeling methods [10].

Recently, the importance of the modular (component) approach to the design of complex technical systems has increased, as libraries and component catalogs have been created in many areas [11].

Proven solutions are formalized in the form of reusable components and are involved in new developments, thereby reducing design risk, reducing development time and financial costs [12]. The widespread use of the component approach to the design of complex systems requires new models for describing an innovative product and the use of multiple (combinatorial) synthesis.

In the process of designing complex technical systems, a multi-level analysis is used [13].

The design object can be divided using the methods of functional and structural analysis and synthesis of technical systems [14, 15]. Based on the results of the functional analysis, the design task is divided into parts,

which is carried out in several stages: analysis of the functions of the technical system, synthesis of the functional structure, construction of a multilevel structure of the design object, identification of partial design tasks, development of a technical system design strategy.

When creating a new complex product, many risks arise. Identification and analysis of risks, especially in the early stages of technical systems development, requires special models and methods with the possibility of their automation [16].

Among the methods for assessing project risks are the following:

– statistical methods,
– methods of expert assessments,
– methods of simulation modeling,
– the method of building a “decision tree”,
– sensitivity analysis, probabilistic analysis,
– fuzzy set theory [17].

Aims and objectives of the work

The modernization of complex equipment in Ukraine is carried out in the context of military aggression, and, as a result, limited funding, in the absence of workable methods and algorithms for solving this class of problems.

This fact necessitates the development of a methodological apparatus that will allow for reasonable decision-making support in the context of limited resources for the modernization of high-tech products during its planning and implementation.

From the review, it can be concluded that promising areas for improving the efficiency of HTP modernization project management are the systematic decomposition of the project product using a component approach, the use of additive manufacturing technologies for innovative components, and the assessment of relevant risks.

Thus, the purpose of the proposed study is to improve the quality of HTP modernization processes by developing a stratified project representation based on the component and risk-based approaches. The article solves the following tasks:

1. Formation of a life cycle model of the HTP modernization project.

2. Substantiation of the component approach to the management of the HTP modernization project.

3. Development of a matrix model for a stratified representation of the HTP modernization project.

Research results

Let us consider the features and form a *life cycle model of* the HTP modernization project.

Projects for the modernization of high-tech products are characterized by [18]:

- innovation of the project content;
- complex component composition,
- multilevel detailing;
- significant flows of design and control information;
- a high level of risk in the creation of high-tech products due to the innovation of projects and limited resources;
- the presence of uncertainty and a large number of internal and external random factors affecting the project.

The modernization project should achieve certain goals:

- Ensuring the advantage in properties (characteristics) of the modernized HTP compared to the prototype, which is maintained over the forecast period of time due to the introduction of the latest technologies;
- cost optimization at all stages of the project;
- applying the principles of cost minimization in the industrial production of HTPs to increase the profitability of production.

To ensure the competitiveness of products at all stages of the HTP, it is necessary to take into account the changing market environment of high-tech products consumers.

Changes in environmental parameters such as the volume of demand, advances in science and technology, and the growth of competitors' markets necessitate the modernization of existing models.

At each stage of the life cycle (LC) of HTP design or modernization, certain design activities are carried out [16]:

- analysis of external factors affecting the properties of the HTP prototype being modernized;
- development of the concept of creation and formation of the technical outline of the HTP;
- preparation and approval of organizational documents for the creation of the prototype;
- implementation of an advance design to determine the basic requirements for the prototype;
- development of the tactical and technical task;
- development of preliminary and technical designs;
- development of working design documentation;
- manufacture of a prototype and its submission for testing;
- conducting tests;
- technical and technological preparation of production;
- serial production of modernized equipment;
- commissioning;
- analysis of the functioning of the prototype (amendments to the documentation);
- checking its current scientific and technical level;
- carrying out repair or restoration work;
- making a decision on sample utilization.

Based on these standard stages, a life cycle model of the HTP modernization project was formed, taking into account the component composition and the use of additive manufacturing technologies (Fig. 1).

At the R&D stage, research and development work (RDW) is carried out to modernize products and determine the scale of distribution of new products (markets and their capacity), as well as the direction of work at the next stages.

In today's environment, the main direction of modernization of high-tech products is to improve their quality parameters during development and production. The parameters that characterize the realization of the development of any technical system change under the influence of the external environment. In most cases, this influence is stochastic.

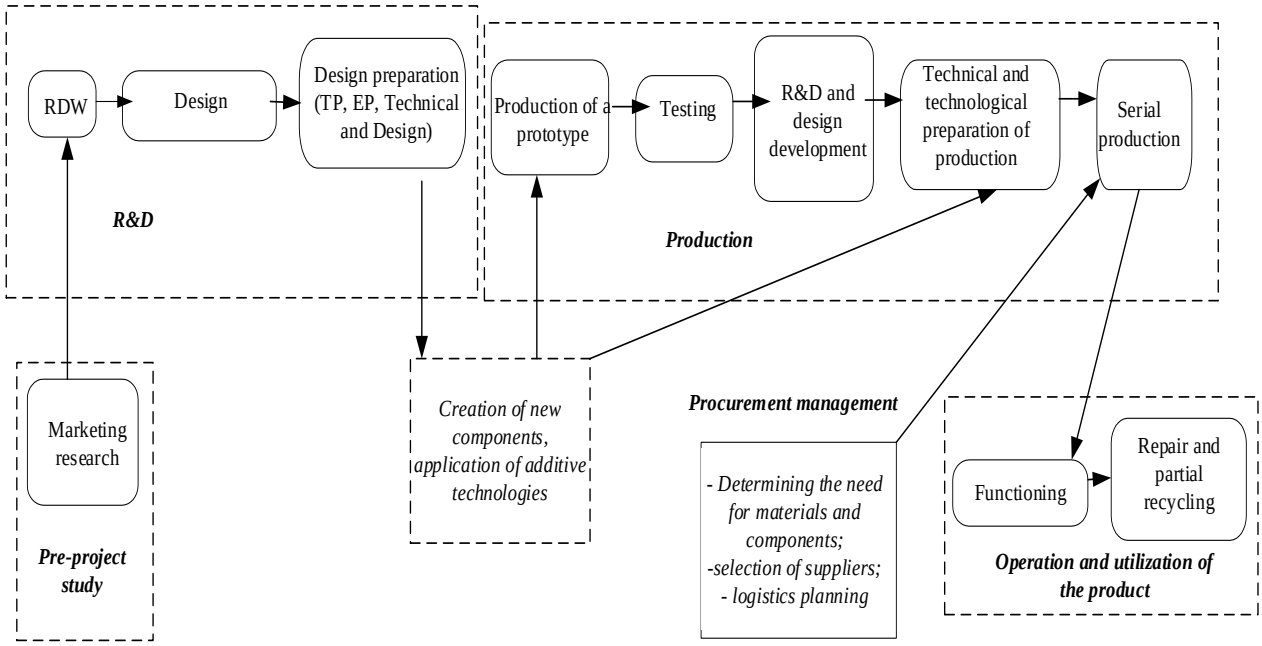

Fig. 1. HTP modernization project life cycle model

Therefore, at the initial stage of design, the technical outline of the HTP is synthesized - a set of structural and parametric data describing its most significant technical solutions and features, the component architecture of the modernized product, the composition and method of combining functionally related blocks and elements with each other are formed [19].

Typically, the initial data for creating new products is the technical specification provided by the customer.

The documentation created at the early stages of product modification contains information on the basis of which a database of many similar developments can be formed.

A preliminary design, compared to a technical design, provides a more complete picture of the product design.

Both the terms of reference and the preliminary design include textual, graphical, and quantitative (technical characteristics) information [20].

In addition, most of the information in the documents is interrelated: one information clarifies another or is an integral part of it.

Therefore, the use of ontological models in the form of semantic networks is effective for structuring information about complex modifiable products [21].

The design stage also includes experimental research, which involves the formation of a set and modeling of innovative components and ends with a technical design and preparation of working design documentation.

However, it should be noted that the first stage of modeling innovative products involves collecting various types of information:

sketches,

drawings,

photographs and videos,

drawings, and often even a finished sample of an analog product (or a damaged sample of a part in equipment remanufacturing projects).

Based on the information received, a three-dimensional model is created in a 3D editor or CAD program.

Technical preparation of production involves the development of methods for manufacturing innovative products. Modern technologies in mechanical engineering have led to the use of 3D printing in the development of new parts and mechanisms. The use of 3D printing in the modernization and replacement of individual HTP elements allows solving design problems cheaper and faster. [22]. Thus, the expanded capabilities of 3D printing can increase the efficiency of HTP modernization projects at manufacturing enterprises of both general engineering and military and defense industries.

The quality of technological preparation is determined by minimizing labor resources and material costs for the implementation of technological processes, manufacturing and assembly of the product with the rational use of production assets.

At this stage, logistical tasks of procurement management arise, created to determine the needs for material and technical resources and ways to provide them [23].

This is especially important when procuring individual reusable components.

Let's consider the features of *component synthesis* in the management of high-tech product modernization projects.

Due to the multicomponent nature of HTP, a change in the characteristics of a set of interconnected elements leads to a change in the individual characteristics of their elements and, in general, may cause a decrease in the quality of performance of HTP functional tasks.

The compliance of HTP properties with the general requirements defined in the modernization project characterizes its scientific and technical level, which is assessed by the quality of performance of all tasks by the HTP sample and the level of its technical perfection. The general composition of HTP properties is a hierarchical structure. The indicators and characteristics of HTP properties are also complex in nature and have a corresponding hierarchical structure.

HTP properties are grouped into certain groups that define the relevant qualities, for example:

- the group of purpose indicators characterizes the purpose and scope of the HTP;
- the group of performance indicators and serviceability characterizes the adaptation of the HTP to reliable operation and preservation of its serviceability;
- the group of technical and economic solutions determines the feasibility of implementing a certain variant of a given modernization model, etc.

The main groups that determine the quality of the sample characterize the features (tactical and technical, technical and economic, operational and technical, production and technological) of the HTP improvement, which are used to compare its scientific and technical level with the prototype level.

The coordination of customer and contractor requirements is reflected in the technical task, which sets out the basic requirements and characteristics of the product. This includes the data necessary to form the HTP component architecture.

At the initial stages of a project, important decisions are not always made on the basis of sound reasoning regarding the choice of components of a complex product and the overall design scheme. Errors and shortcomings made in this process are difficult to eliminate at subsequent stages of the life cycle, and their elimination is associated with significant expenditures of project resources. In this regard, the pre-project work is often associated with a great deal of uncertainty in the initial data.

All project management decisions are focused on obtaining a new component architecture for the modernized product. Therefore, the project also has a component architecture, in which the project component and the product components are inextricably linked and subordinated to the global project goal. A project component is a set of managerial, organizational, technical and production actions aimed at creating a separate structural element (component) of a complex technical product [18]. From the point of view of design activity, a component is a process associated with a certain element of the architecture of a complex product, where the design process involves not only the creation of simple components, but also the combination and integration of complex ones.

The peculiarity of the component approach is that a project component simultaneously characterizes a complex product (product) and the process associated with its creation.

The project component in the information representation is an elementary information element of the project.

This information representation links the product architecture and the project structure behind its creation.

It should be noted that the component approach has the greatest impact on design decisions at the stages of general (preliminary) project planning, feasibility study, product design, and production planning for high-tech products. Therefore, we will consider these stages in the following.

Let's form *a stratified view of* the HTP modernization project.

Stratification involves representing HTP as a complex system in many aspects.

Generally, the following strata of complex system decomposition are used:

– target,
– functional,
– mathematical,
– information,
– algorithmic,
– strata of hardware and software [24].

The description of the HTP at each stratum is usually presented in the technical documentation for the creation or operation of a complex system.

To solve the problem of component synthesis of a complex product, the functional stratum and the technical stratum are important. It is on this stratum that the functional and technical requirements (quantitative characteristics) for individual, including innovative, HTP components are considered. Based on these requirements, individual components are searched for modernization.

For the HTP modernization project, the stratification is applied to other aspects:

– Structural. Component-based project management determines the structural stratum, which reflects the hierarchical structure and types of HTP components;

– Technological. Types of components with different levels of innovation require appropriate technological solutions;

– Risk. In addition to typical project risks, modernization projects require procedures for managing partial risks associated with innovative components.

The proposed matrix model of stratified project presentation has two levels of elements (Fig. 2):

– horizontal, which is based on the main stages of the project (in accordance with the LCA of innovative products) that require appropriate solutions in HTP modernization projects;

– vertical, whose elements correspond to the three strata mentioned above.

Thus, at the general planning stage and the feasibility study stage, the HTP is decomposed into components and partial parameters, taking into account functional, structural and parametric characteristics. As a result, the properties of the components to be modified are displayed. This makes it possible to subsequently search for relevant precedents (analog products) at low levels of decomposition and find precedents with a high level of similarity of innovative components.

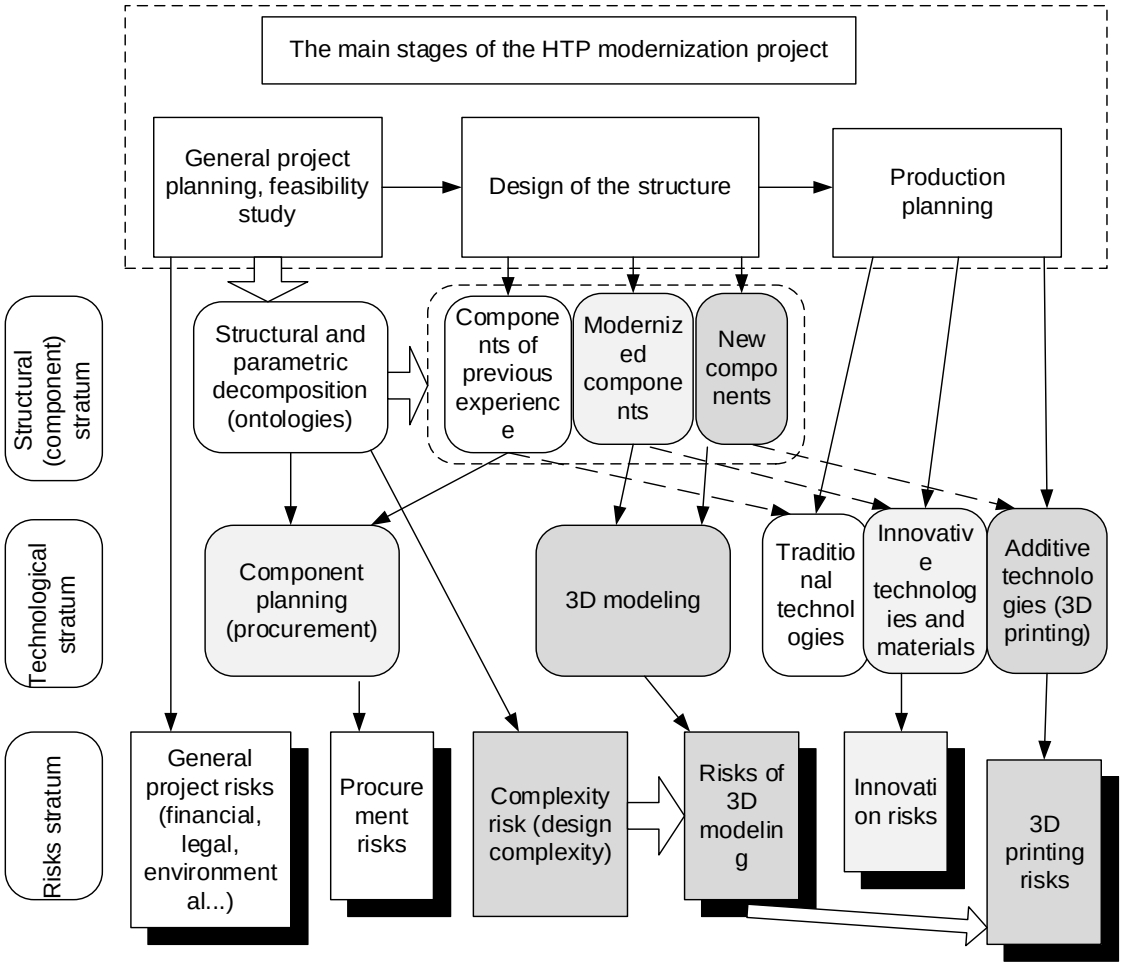

Fig. 2. Matrix model of stratified representation of the HTP modernization project based on component and risk-based approaches

Modern PLM systems implement sequential detailing during HTP design in CAD/CAM/CAE systems, which then requires systematic component synthesis.

Data decomposition and synthesis are provided by universal algorithms implemented in the design system and based on information in databases. This approach does not allow the application of standard procedures for innovative HTP components. The use of an ontological approach facilitates the process of creating a model of a complex product and allows for the coordination of parallel and sequential work of specialists on the project of its modernization.

According to the component approach, three types of components are distinguished in the product architecture based on the main information from the technical specifications [18]

- components of past experience - not subject to modernization. For them, there is a complete set of documentation and technology and experience in their production, or the project provides for the procurement of such components as finished structural elements;

- new (innovative) components - these are the components that pose the greatest risk both in design and in their production;

- components to be modernized - a combination of “old” and “new” components.

The production planning stage also requires dividing project activities according to these types of components.

Let's consider the elements of the technological stratum. At the general planning stage, the reusable components face the challenges of supply and the formation of appropriate logistics channels. At the feasibility study stage, optimization models should be used to compare two design solutions: procurement of components of a certain assortment or manufacturing of components using additive technologies.

At the design stage, for components that have a certain degree of novelty (new or modernized), the technical documentation may be incomplete or heterogeneous (data on foreign analogues, individual drawings or visual representations of the product). Modern technologies in mechanical engineering have led to the use of artificial intelligence, 3D modeling and printing in the development of new parts and mechanisms. In turn, the resulting models are the basis for further manufacturing of modeled parts using additive technologies.

Innovative technologies should also be applied at the production planning stage. The use of 3D printing allows optimizing the geometry of parts, reducing weight and increasing efficiency. 3D printing of metal components creates complex parts that are difficult to

manufacture using traditional methods, reducing waste and costs. Additive technologies are being actively implemented in the manufacture of modernized samples of high-tech products, as well as for the repair and maintenance of complex equipment. Generative design and shape optimization create parts with optimal parameters, taking into account functional, economic, and operational requirements [22]. However, despite the possibility of creating complex shapes and structures, existing additive manufacturing technologies may face limitations in the size and dimensions of products, which may limit their application in specific projects. In addition, the high cost of equipment and materials is also a significant barrier to the widespread use of additive manufacturing in the aviation and defense industries.

Consideration of risks in the management of the HTP modernization project, in particular risk assessment and management, is a mandatory attribute of the military equipment modernization system in both peacetime and wartime. Risk management should take place throughout the entire project life cycle.

Let's consider the causes and interconnection of partial project risks associated with the multicomponent composition of HTP.

The procurement processes of reusable components cause supplier selection risks, logistics risks (transportation), and communication risks [25].

At the design and production stages, scientific, technical, and production and technological factors are in effect. The scientific and technical factors should take into account the degree of novelty of the HTP, which depends on the planned degree of modernization. Production and technological factors cause the risk of integrating elements of complex equipment, which in turn is caused by both the complexity of the design and the presence of new components. Due to the innovativeness of modified HTPs and the corresponding complexity of modeling, the volume and complexity of geometric models of the structure, systems and equipment for the production and modernization of HTPs is significantly increasing. The actual characteristics formed after integration do not always coincide with the planned ones. There is a risk of assembly that affects the ability of HTP elements to perform the specified functions.

The quality of a printed part depends heavily on the digital model of the part used for printing. Therefore, the quality of modeling a three-dimensional part before printing plays a very important role. In addition, production and technological factors include risks associated with the use of new materials when using additive manufacturing technologies.

It should be noted that these partial risks arise at successive stages of the project's LC, i.e. they have a synergistic effect, which complicates the procedures for their quantitative analysis.

Conclusions

The identified features of HTP modernization projects, such as the complexity and multicomponent nature of the project product, high level of innovation and uncertainty at the design stage, necessitate the use of system, component and risk-based approaches to managing these projects.

A life cycle model of the HTP modernization project has been formed, which, based on the typical stages of the life cycle of innovative products, separates the stages of design and technological preparation of production, logistics tasks of procurement of components.

These processes have their own peculiarities due to the multi-component nature of the HTP and determine the consideration of individual project activities from the perspective of the component approach.

The systemic approach requires consideration and management decisions to be made on the following strata: structural, technological, and risk strata.

The developed matrix model of the stratified representation of the HTP modernization project allows planning the project activities in two areas of detail: the main stages of the life cycle and the three selected strata, respectively.

The presence of components of various types of novelty and uncertainty requires the use of 3D modeling and printing technologies in the design and manufacture of innovative components of this type, which is reflected in all strata and the corresponding stages of the project's life cycle.

In the risk stratum, partial risks of the project due to the factors of multicomponent and innovative HTP are highlighted. The direction of further research is to form a model for quantifying these risks and studying their synergistic effect.

References

1. Захарченко В. І., Єрмак С. О. Методологічні засади створення організаційно-технологічних систем у високотехнологічному виробництві // Економіка: реалії часу. – 2021. – №. 3 (55). – С. 49-60. DOI: 10.15276/ETR.03.2021.6
2. Lindgren M., Bandhold H. Scenario Planning: The link between future and strategy. Palgrave Macmillan UK. – 2002. – 180 p. DOI: 10.1057/9780230511620.
3. Xiao X., Joshi S. Decomposition and sequencing for a 5-axis hybrid manufacturing process // International Manufacturing Science and Engineering Conference. American Society of Mechanical Engineers. – 2020. – Vol. 84256. – DOI: 10.1115/MSEC2020-8385
4. У Києві презентували перший серійний літак Ан-178-100Р. Укрінформ. 29.12.2021 [Електронний ресурс] - Режим доступу: https://www.ukrinform.ua/rubric-other_news/3376665-u-kievi-prezentuvali-persij-serijnij-litak-an178100r-infografika.html (дата звернення: 21.11.2024). – Назва з екрана
5. Президент ДП "Антонов": з Boeing у нас робочі стосунки. Економічна правда. 14 вересня 2020р. [Електронний ресурс] - Режим доступу: https://www.epravda.com.ua/publications/2020/09/14/665044 (дата звернення: 21.11.2024). – Назва з екрана

6. УКРОБОРОНПРОМ | РІЧНИЙ ЗВІТ 2020, URL: https://ukroboronprom.com.ua/storage/documents/Report_ua.pdf25
7. Яблонський П. М. Деякі питання узагальнення засобів геометричного моделювання для проектування технічних об'єктів // Сучасні проблеми моделювання. – 2019. – №. 13. – С. 192-198. DOI: https://doi.org/10.32347/0131-579x.2020.97.16-22
8. Konotop D. I., Zinchenko V. P. 3D-models design concept of complex technical objects using knowledge-based technology // Механіка гіроскопічних систем. – 2017. – Вип. 34. – С. 5-13. DOI: 10.20535/0203-3771342017130222
9. Amaran S. et al. Simulation optimization: a review of algorithms and applications // Annals of Operations Research. – 2015. – Vol. 240. – No. 1. – Pp. 351–380. DOI: https://doi.org/10.1007/s10479-015-2019-x
10. Федорович О. Є., Лутай Л. М., Малєєва Ю. А., Замірець Я. О., Пісклова Т. С. Моделювання комплексного формування запасів військової техніки в зоні воєнного конфлікту з використанням компонентного методу // Авіаційно-космічна техніка і технологія. – 2023. – № 2. – С. 56-66. DOI: https://doi.org/10.32620/aktt.2023.2.06
11. Upare P., Kalatkar A., Shelke R. Review on study of design optimization for additive manufacturing of various mechanical/machine components // IOP Conference Series: Materials Science and Engineering. – 2022. – Vol. 1259, – No. 1. – Pp. 012039. DOI: https://doi.org/10.1088/1757-899x/1259/1/01203963
12. Кравцова Д. Ю., Зюган У. І. Пошук оптимальних рішень для технічних систем в умовах невизначеності зі комп'ютерізацією розрахунків у табличному процесорі // Гірничий вісник. – 2024.– Вип. 112. – С.63-68. doi: 10.31721/2306-5435-2024-1-112-63-68
13. Abdulsamad H., Peters J. Hierarchical decomposition of nonlinear dynamics and control for system identification and policy distillation // Proceedings of the 2nd Conference on Learning for Dynamics and Control. In: Proceedings of Machine Learning Research. – 2020. – Vol. 120. – P. 904-914.
14. Узунов О. В. Системне представлення складних технічних об'єктів в задачах аналізу та синтезу // Вісник Національного технічного університету. Серія: Машинобудування. – 2016. – №. 1. – С. 126-132. DOI: 10.20535/2305-9001.2016.76.68755
15. Dzwigol H. Research methodology in management science: Triangulation // Virtual Economics. – 2022. – Vol. 5. – No. 1. – Pp. 78-93.
16. Демідов Б. О., Величко О. Ф Кучеренко Ю. Ф., Куцак М. В. Управління проектами зі створення зразків озброєння та військової техніки в умовах прояву факторів невизначеності та ризику // Озброєння та військова техніка – 2016. – № 2(10). – С.15-19.
17. Raskin L., Sira O., Parfeniuk Y., Bazilevych K. Development of methods for supply management in transportation networks under conditions of uncertainty of transportation cost values // Eureka: Physics and Engineering. – 2021. – No. 2. – Pp. 108-123. DOI: 10.21303/2461-4262.2021.001691
18. Федорович О.Є., Яшина О.С., Белецький І.В. Компонентне проектування аерокосмічної техніки. Х.: Національний аерокосмічний університет «ХАІ». – 2012. – 180с.
19. Нікул С. О., Головань В. Г., Головань А. В. Моделі забезпечення процесу прогнозування обрису складної технічної системи при її проектуванні // Збірник наукових праць. Одеса : ВА. – 2016. – Вип. 1 (5). – С. 17-22.
20. ДСТУ 3974-2000 Система розроблення та поставлення продукції на виробництво. Правила виконання дослідно-конструкторських робіт. Загальні положення. Режим доступу: https://www.dnu.dp.ua/docs/ndc/standarts/DSTU_3974-2000.pdf (дата звернення : 06.04.2024)
21. Федорович О. Є., Малєєв Л. В. Онтологічна модель структури та параметрів компонент високотехнологічних виробів у проєктах їх модернізації // Сучасний стан наукових досліджень та технологій в промисловості. – 2024. – № 1(27). – С. 179–191. DOI: 10.30837/ITSSI.2024.27.179
22. Yang L., Zhang J., Yang Y. Advances and challenges in the additive manufacturing of aerospace materials // Frontiers of Materials Science. – 2020. – No. 14(3). – Pp. 295-319. DOI: 10.1088/2631-7990/ad5424
23. Fedorovych O., Kritskiy D., Malieiev L., Rybka K., Rybka, A. Military logistics planning models for enemy targets attack by a swarm of combat drones // Радіоелектронні і комп'ютерні системи. – 2024. – № 1. – С. 207-216. DOI: https://doi.org/10.32620/reks.2024.1.16
24. Задоров В. Б. Підхід до створення технології попереднього системного проектування КІС підприємств // Управління розвитком складних систем. – 2010. – №. 1. – С. 56-64.
25. Lytvynenko D., Malyeyeva O. (2022). Risk management in projects of restoration the regional transport structure on the basis of participants' communication // Сучасний стан наукових досліджень і технологій в промисловості. – 2022. – № 2 (20). – С. 44–51. DOI: https://doi.org/10.30837/ITSSI.2022.20.044

Received (Надійшла) 26.11.2024
Accepted for publication (Прийнята до друку) 12.02.2025

Матрична модель стратифікованого уявлення проекту модернізації високотехнологічних виробів на основі компонентного та ризик-орієнтованого підходів

О. Є. Федорович, Л. В. Малєєв

Анотація. Предметом дослідження в статті є проекти модернізації високотехнологічних виробів (ВТВ). Мета - підвищення якості процесів модернізації ВТВ шляхом розробки стратифікованого уявлення проекту на основі компонентного та ризик-орієнтованого підходів. Використовуються методи системної декомпозиції, стратифікації, компонентного підходу та ідентифікації ризиків. В статті проаналізовано особливості проектів модернізації ВТВ, сформовано модель життєвого циклу проекту модернізації, яка відокремлює етапи конструкторської та технологічної підготовки виробництва, логістичні задачі закупівель. Розроблена матрична модель стратифікованого уявлення проекту дозволяє планувати роботи на двох напрямках деталізації: відповідно основних стадій життєвого циклу та виділених страт (структурної, технологічної та страті ризиків).

Ключові слова: високотехнологічні вироби, проекти модернізації, життєвий цикл, багатокомпонентність, ризики, стратифікація, системна модель, проектування, 3D-моделювання, адитивні технології.