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INNOVATIONS IN THE DEFENSE-INDUSTRIAL COMPLEX: CURRENT STATUS AND DEVELOPMENT PROSPECTS

Purpose. Improving the theoretical foundations of military innovations and their use as a tool for identifying and eliminating obstacles to the innovation process in the military sphere. The objectives of the paper are identifying problems, obstacles to and factors of promoting the innovative development of the defense-industrial complex (DIC); developing proposals for removing obstacles and improving the process of military innovations.

Methodology. The following methods were used in the research: comparative analysis to study the current state and prospects for innovative development of DIC; critical analysis to identify problems and obstacles to innovative development; dialectical method of scientific analysis to improve the theoretical foundations of military innovations.

Findings. The trend of a decrease in the country's innovation level is indicated. Directions for strengthening institutional and organizational support for the process of military innovations are indicated. It is indicated that the growth of the share of private enterprises in the DIC contributes to the emergence of an innovation ecosystem, but the lack of institutional influence leads to significant defragmentation of the specified ecosystem. Comparison of financial indicators of defense industry enterprises, budget financing indicated that the lack of financial support reduces the possibility of supporting the innovation process. Not only obstacles, but also factors facilitating the innovation process were identified. Proposals were developed to eliminate obstacles and improve the process of military innovation.

Originality. It is proposed to consider military innovations not only as an event or pilot model, but as a systemic process aimed at obtaining operational and (or) strategic advantages and requiring financial, organizational, institutional support and the creation of a favorable environment for implementation. Based on the revision of theoretical foundations, the authors propose a definition of military innovation.

Practical value. The development of proposals will allow one to begin eliminating obstacles and improving the process of military innovation in view of shaping the prospects for the development of the defense industry.

Keywords: *military innovations, weapons, military equipment, innovation process, defense-industrial complex*

Introduction. The development of the defense-industrial complex (DIC) not only determines the development of the state's economy and its defense capability, but also contributes to the growth of Ukraine's geopolitical role. Effective management of the defense industry today is becoming a decisive factor in ensuring national security and rational use of national resources. The indicated development of the DIC directly depends on the knowledge-intensiveness of production and the level of military innovations. Significant changes in the military-political and economic situation of Ukraine after the start of the aggressive war indicated that, due to the lack of human and material resources, strategic provisions regarding the strengthening of the role of military innovations in order to gain operational and tactical advantages need to be revised.

The war revealed significant gaps in the production of weapons and dual-use products (DUPs). Moreover, there is a shortage not only of serial production of DUPs but also of design developments, which is evidence of the insufficient level of development of military innovations in the times preceding the war. To a large extent, this was caused by the chaotic and disorganized conversion and diversification of defense enterprises, the lack of an adequate amount of working capital at defense industry enterprises to finance innovative developments, non-compliance with strategic plans for the development of innovative activity [1], the critical state and even the reduction of specialized scientific institutions, and subjectivity in the allocation of budget resources for financial support of individual areas of

technological development of the defense industry. The above, in conditions of a war of considerable intensity, creates a significant level of threat and requires research into the current state of innovation activity in the defense sector and the development of recommendations for its development.

Literature review. When studying innovations in the production of weapons and dual-use products (DUPs), scientists often limit themselves to their impact on increasing the effectiveness of combat operations and changing certain functional characteristics of military formations [2]. At the same time, leading world scientists indicate that even the very definition of "military innovation" causes controversy in the scientific community [3]. If we consider the changes in the conditions of war caused by it as a sign of innovation, then this often becomes clear only over time [4]. The introduction of post-factum explanatory models only complicates the formalization of innovations, which is needed already at the stage of substantiating the military-industrial complex strategy. Therefore, scientists and military analysts often introduce other definitions, for example, "military technological innovations" [2], etc., and thereby limit the innovation process. At the same time, an article by the authoritative military theorist McMaster [5] indicates that excessive technoptimism regarding the decisive importance of innovations in military affairs is dangerous. McMaster notes that technologies are a prerequisite for military innovation and only their use allows to find out whether their impact is truly transformative, but in the scientific works by Ukrainian scientists, even with a clear ranking of the substructures of military innovation ecosystems [6], the main goal of military innovations is often not taken into account – gaining an advantage over the enemy. At the same

time, research by Ukrainian scientists confirms that the conditions of war are an incentive for the development of military innovations [7], and military innovations determine not only the development of the defense sector [8]. They significantly shape the technological development of other sectors of the economy, which is especially important for the post-war recovery of the country, the formation of forms and methods that are ahead of the implementation of Economy 5.0 [8].

In the article by Yemanov [9] it is indicated that as of 2022, Ukraine lacks an appropriate scientific, technical and production base for the effective development and implementation of innovative military equipment and, moreover, an insufficient level of market approaches to the formation of the organizational structure and management system of defense industry enterprises. According to data for 2021, a significant part of defense industry enterprises were unable to conduct innovative activities at the proper level, since out of the first hundred most modern enterprises, a low state of production and economic potential was noted in 20 % of them, moderate – in 37.5 % [10]. This indicates that in the absence of targeted state funding for innovations, a significant part of defense industry enterprises are unable to financially support their own innovative activities. Studies also confirm that in the times preceding the large-scale war, no instruments were formed to stimulate innovations [11]. The need during wartime to increase the pace of R&D and testing innovative W&DUP contribute to the restoration of specialized research and development structures. State orders for the latest W&DUP shape the long-term development of not only the defense industry but also enterprises in related sectors of the economy [11]. The article by Perminova [12] notes a change by 2021 of the downward trend in the country's GDP science intensity to an upward one and the fact that military innovations are becoming not only a driver of the country's defense capability but also a factor in economic growth and, in strategic terms, a transition from an export-oriented raw material model to a model of high-tech development of the country.

In scientific works by Ukrainian scientists, attention is mainly paid to the development of state-owned enterprises of the defense industry and the level of technology modernization is studied [13]. At the same time, the problem of adapting the defense industry to the innovative renewal of the arms market and the slowdown of this adaptation by bureaucratic procedures characteristic of state-owned enterprises remains out of focus.

The presented review of recent research and publications on the issue of military innovations indicates not only differences in the interpretation of this concept, but also, despite the unconditional need for innovative development, the presence of significant problems in its implementation. The war led to an increase in the role of military innovations and indicated the need for prompt elimination of shortcomings in their implementation. This, accordingly, creates the need both to improve the theoretical basis of military innovations and to identify the prospects for their development when assessing their current state.

The purpose of the article. The purpose of the article is to improve the theoretical foundations of military innovations and their use as a tool for identifying and eliminating obstacles to the innovation process in the military sphere.

The tasks that need to be solved are: identifying problems, obstacles and factors contributing to the innovative development of the defense-industrial complex (DIC); developing proposals for eliminating obstacles and improving the process of military innovations with a view to forming the prospects for the development of the defense-industrial complex.

Methods. The following methods were used in the research: comparative analysis to study the current state and prospects of innovative development of the defense industry; critical analysis to identify problems and obstacles to innovative development; dialectical method of scientific analysis to improve the theoretical foundations of military innovations.

The article proposes the following hypotheses:

Hypothesis 1: military innovation is not just an event or a pilot sample, it is primarily a systemic process aimed at obtaining operational and (or) strategic advantage and requires financial, organizational, institutional support and the creation of a favorable environment for implementation.

Hypothesis 2: the process of military innovation occurs as a sequence of subprocesses: idea promotion, R&D, organization (or adaptation of the existing) production and logistics base, testing, implementation in production, use or threat of use. The level of implementation of each stage determines the success of military innovation or its failure.

Hypothesis 3: war stimulates and accelerates the innovation process, making time one of its main resources. The time resource for military innovation, especially in war conditions, is a decreasing parameter, therefore, assessing the effectiveness of innovation requires using the parameter "pace of the innovation process" and predicting the rate of technological obsolescence of military innovation.

Results. The presented study, in view of Hypothesis 1, is based on the definition of military innovation not only as an event, but also as a process of gaining military or political advantage, which integrates: the potential of R&D; new capabilities of the troops; use of institutional and organizational resources; technological development; new concepts, ideas, their implementation, testing and use. Military innovations today require economic efforts, a process, sometimes long-term, of preparing a production and element base, and ensuring external supplies of components. This, in turn, requires a relevant assessment of the military utility of innovative breakthrough technologies.

The ability to advance innovative development of military technologies, the organization and financing of R&D with the subsequent implementation of these technologies also becomes critically important for the state to acquire subjectivity in the international political arena. Therefore, military innovations and, in particular, military technological innovations in the modern world are gaining special importance not only for creating technological and operational advantages on the battlefield, but also for ensuring political advantages. Industry 4.0 contributed to the spread of civil technological innovations, which later became the basis for the development of military equipment. The intensification of local wars and the threat of globalization of conflicts necessitates innovative breakthroughs in military technologies, which will also have a deterrent effect for the aggressor. At the same time, it should be noted that dynamic changes in the directions of the innovation process, due to the experience of military operations, can quickly lead to the technological obsolescence of even ultra-modern combat systems (which confirms Hypothesis 3).

For Ukraine's limited capabilities to confront the aggressor, which prevails in the number of manpower and equipment, the effectiveness and pace of military innovations are a condition for survival, but the regulatory and legal framework of Ukraine does not even provide a definition of the concept of military (defense) tech, a component of which is the concept of military innovations. This leads to complications in their institutional and organizational support.

With the beginning of large-scale military operations, the lack of institutional and organizational support leads to the loss of positions acquired in previous periods in the rating according to the Global Innovation Index [14] (Table 1). And this is not only the loss of 15 rating positions since 2020 – but also the deterioration of financing and effective implementation of innovations. This indicates not only the deterioration of the country's innovation potential, but also of military innovations, as its component.

Defining innovation not only as a patent or product, but as a process makes it possible to establish that the innovation process can stop at the stage of an idea or R&D due to the discrepancy between the technological advantages declared in the W&DUP and their ability to provide operational and (or) stra-

Table 1

Rankings of Ukraine according to the Global Innovation Index

Years	Position in the ranking	Position in terms of innovation spending	Position in terms of innovation performance
2020	45	71	37
2021	49	76	37
2022	57	75	48
2023	255	78	42
2024	60	78	54

ategic advantages over the enemy in real combat use, due to the lack of resources necessary for the implementation of the innovation, in particular, the lack of time. Another problem of the innovation process extended in time is the possibility of technological obsolescence. This is especially clearly manifested during the active phase of the war, for example, when the advertised innovations in the armored vehicles of the Russian Federation, in particular the Armata tanks, turned out to be unpromising due to the practice of widespread use of portable anti-tank missile systems (which confirms Hypothesis 3). That is, if there is only an idea or even a pilot sample, innovation as a whole may not occur, which confirms Hypotheses 1 and 2.

The experience of the innovation process during the war pointed not only to the need for a radical change in the organization of interaction between scientific institutions and defense industry enterprises [15] but also to a broader problem of the military innovation process – not so much a lack of ideas or scientific personnel, but the lack of an ecosystem to support them, stimulate demand for military innovations and organizational and financial support for their implementation.

To promote the innovation process, there is a world experience in the formation of innovation ecosystems [16], one of the advantages of which is the formation of network platforms to provide proper organizational support in the integration of economic, scientific, technological capabilities to various participants in the innovation process and to create common values for financial support for each of the named participants. Such platforms allow the idea generator, in the absence of its own resources, skills, production base, etc., to implement the innovation process to the stage of use. In the conditions of lack of financial, scientific and other opportunities for the implementation of innovations in manufacturing enterprises, such platforms will also allow them to consolidate around themselves the participants of the innovation process. Such consolidation occurs using the process of natural rotation of promising industries with the broad involvement of small and medium-sized companies. Therefore, the experience of the EU, where military corporations are built on the principle of a consortium, integrating promising enterprises into their composition, looks promising. With such a structure, each of its participants knows their role and participation in the result of the work.

By 2022, ~80 % of the volume of defense industry products was produced by state-owned enterprises. In the following period, private enterprises began to enter the W&DUP market. Private enterprises turned out to be more flexible and adaptive to the challenges of war [17] and less bureaucratized than state-owned enterprises. If the current pace of private business growth in the defense industry is maintained, there are prospects for increasing the share of private companies in the defense industry by more than 50 %. This process contributed to the emergence of an ecosystem of innovations, but relying mainly on disparate private initiatives even in a relatively stable period – before the start of large-scale hostilities – led to significant defragmentation of the ecosystem, in particular, due to the lack of institutional regulatory influence. For example, 20 IT clusters and 4 industrial high-tech clusters (including

the cluster of the “Association of Industrial Automation Enterprises of Ukraine” and 3 aerospace clusters) out of the 3rd cluster declared in official documents [1], about 100 R&D centers (including the Pivdenne Design Bureau) and the Sikorsky Challenge Ukraine innovation incubation zone were operating. Of the 16 technoparks declared in the “Strategy for the Development of the Sphere of Innovation Activity for the Period Until 2030” [1], only 4 were operating before the full-scale war, and out of 40 industrial parks, only the Bila Tserkva Industrial Park is operating. The enthusiasm of developers in the first period of the war ensured the emergence of breakthrough military innovations in the field of digital technologies. But, unlike software, many other areas, for example, in the field of missile weapons, ammunition, electronic warfare systems, etc., already at the R&D stage require significant financial costs for components, require the availability of resource and production bases, without which the innovation process will not take place and the products will not even be brought to the testing stage. This substantiates *Hypothesis 2*.

At the beginning of the war, the discrepancies between the needs of the Armed Forces of Ukraine in W&DUP and their availability were 50–240 %, the modernization of W&DUP by their main types was almost stopped – the annual modernization rate after 2012 was 0.2–0.6 % [18]. Only individual products had an innovative nature during this period, for example, ATGMs and missiles of the “Luch” Design Bureau, and most of the innovative products were at the stage of purchasing samples or at the stage of introducing them into production. One of the reasons for this was insufficient funding.

A comparison of the average financial indicators of defense industry enterprises for the period 2014–2021 for aerospace companies; armored vehicle manufacturers; enterprises producing ammunition, precision weapons and air defense systems shows that their profitability was –7.185; –0.27875; 1.75125 %, respectively.

Even according to the results of 2022, this indicator was, respectively: –5.00; –6.13; –4.04 % [19]. The average value of the coefficient of compliance of the actual level of sales profitability with the critical level for the named industries was: 0.0; 0.16; 0.28, and the values of the same indicator according to the results of 2022 were, respectively: 0.03; 0.34; 0.47 [19]. This indicates the limited capabilities of enterprises to financially support the innovation process.

At the same time, the financial support of the Ministry of Defense of Ukraine (Table 2) since 2023, taking into account the change in the national currency exchange rate, shows a consistent decrease [20].

With the growing needs of the armed forces in ammunition, fuel, military equipment, etc., the share of R&D funding from both the budget of the Ministry of Defense and the own funds of a significant part of the defense industry enterprises is decreasing, which reduces the possibility of supporting the process of military innovations. A compensating factor could

Table 2

Dynamics of budget financing of the Ministry of Defense of Ukraine

Years	Amount of financing, UAH billion	Year-on-year increase, %	Share of GDP, %	USD exchange rate, UA	Amount of financing, \$ billion	Year-on-year increase, %
2019	101.1	1.20	2.40	27.68	2.70	0.90
2020	116.6	1.20	3.2	23.29	5.00	1.90
2021	120.1	1.03	2.1	28.60	4.20	0.90
2022	920.5	7.70	21.1	27.21	33.80	8.10
2023	1141.1	1.20	18.2	36.57	31.20	0.92
2024	1164.0	0.15	18.0	40.50	28.74	0.92

be domestic investments, but this source of financing in the context of the economic crisis also tends to decrease.

With such restrictions in the choice of sources of financing, the ways to solve this problem may be, firstly, lifting the ban on Ukrainian enterprises entering the global arms market with the unquestionable requirement to fully provide internal orders of both the Ministry of Defense of Ukraine and orders of external and internal financial donors. Secondly, a significant expansion of cooperation with partner countries regarding external purchases of Ukrainian weapons for their further use by the Armed Forces of Ukraine.

This will be facilitated by the fact that innovations provide the domestic defense-industrial complex (DIC) with the appropriate level of competitiveness in the global arms market. Although the war has changed the export orientation of the Ukrainian defense industry, supplies of DIC to the global market continue, and this helps domestic enterprises to ensure profits and attract investments. According to the article by Wezeman, et al. [21], Ukraine today occupies 19th position in the list of global arms suppliers, although its share of global exports decreased by 73 % compared to the period 2014–2018. The state has limited arms exports in wartime, but joint development of DIC under foreign orders, repair and modernization of Soviet military equipment and equipment under foreign contracts continue to be executed.

In terms of arms imports, Ukraine took 4th place in the ranking, its share in the world volume of arms imports reached 4.9 %, i.e. compared to the period 2014–2018, it increased by 66.33 times [22]. The share of private enterprises in the volume of production of W&DUP during the war increased significantly and reached ~15 billion USD, which is facilitated not only by the increase in government procurement, but also by the unification of these enterprises into the National Association of Defense Industry Enterprises (NAUDI). The creation of NAUDI provided an opportunity for private manufacturers to work in joint projects that require significant capital investments, mutually beneficial transfer of innovative technologies, as well as the elimination of internal competition in the international market. Today, the main areas of activity of the NAUDI association enterprises are the development and production of: armored vehicles, missile and artillery equipment, unmanned aerial vehicles (UAVs); radars; electronic warfare (EW) equipment; surveillance, guidance and reconnaissance; ammunition [22].

The experience of high-intensity military operations has given Imarcgroup [23] reason to predict a rapid increase in the market for robotics software, and not only for military purposes (Fig. 1).

The innovativeness of the specified software lies, in particular, in the implementation of the capabilities of cognitive artificial intelligence, especially for the tasks of operational data analysis of reconnaissance robots and interaction with fighters on the battlefield, which, for example, also includes the task of natural language processing. The use of artificial intelligence

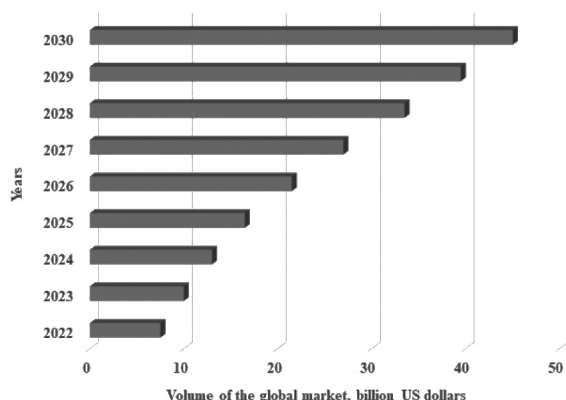


Fig. 1. Forecast of the dynamics of the global robotics software market

today determines the formulation of the task of information dominance, as evidenced, in particular, by the large-scale exercises of the US and Canadian Armed Forces for the “Global Information Dominance Experiments” (GIDE).

Ukrainian innovations, in particular in control systems for drones, reconnaissance robots, etc., open up opportunities for the Ukrainian defense industry to obtain a share of this robotics software market in the post-war period (Fig. 1).

Military innovations significantly increase the responsibility for the relevance of forecasts for their implementation, not only because they are a significant factor in war, but also because they require the development of an appropriate military-industrial base [24]. With significant dynamics of threats, the success of their forecasts may determine the proper distribution of budget funding and, accordingly, the effectiveness of the implementation of military innovations.

Since the relevance of long-term forecasts of technological modernization of production is not absolute, the development of the military-industrial base must be flexible, adaptive, provide the possibility of rapid deployment and scaling of production of innovative military equipment and rely on generally recognized directions of Industry 4.0: knowledge management; intellectualization of production; digital transformation, etc.

In the context of not only rapid technological renewal but also a radical revision of military doctrines regarding the use of W&DUP, the task of building element base and universal component production facilities, forming personnel potential, and overhauling production facilities in such a way that they could be quickly reoriented in accordance with the current needs of the Armed Forces of Ukraine. Some enterprises that have enough of their own financial resources, for example, Ukroboronservis, have already understood the need to form their own element base for their innovative W&DUP [13].

Although Industry 4.0 forms areas of innovative development that do not require an industrial base, in particular, in the field of artificial intelligence, overcoming administrative and bureaucratic obstacles and mental unpreparedness of both institutional structures and military command to perceive the opportunities they open up remains important for ultra-modern military innovations. Their support by users – lower-level military personnel, is named as a factor accelerating the pace of the innovation process, which confirms the thesis of Hypothesis 3. This movement of introducing military innovations can be defined as “bottom-up”.

As an example, the situation with the introduction of innovative software complexes can be cited, because in the midst of the war it turned out that the Armed Forces of Ukraine had only outdated Soviet topographic maps at their disposal. Then two military innovations were launched in parallel. “Army SOS” developed the “Kropyva” geographic location program for artillerymen, and programmers from the companies “Geo-Soft”, Breeze Software and Primeway Ukraine in cooperation developed the “GisArta” software complex. Since 2022, “Kropyva” has been used by up to 95 % of artillery units, which gives it a significant tactical advantage. “GisArta” provides military planning by headquarters. These military innovations have not yet received an official decision to adopt them. The same situation is with the “Armor” software complex for attacking the enemy from closed positions. Another example is the introduction of high-precision ammunition, the Skif portable anti-tank complex, and other products of the Luch Design Bureau, which have already proven their effectiveness in combat [13], although the innovative process of their widespread implementation has not been uniform due to the suspension of its financial support. At the same time, the introduction of new institutional initiatives is intensifying the implementation of the latest W&DUP tools. Thus, the implementation of the Drone Army project using the UNITED24 platform has ensured the procurement of not only UAVs from foreign but also from Ukrainian manufacturers. Over the 7 months of the project, UAH 3.3 billion has been allocated for the purchase of 1,600 drones

[8]. The BRAVE1 project has been launched, the purpose of which is to intensify military innovations and accelerate the implementation of new W&DUP models. According to the results of 2023, 820 innovative products were submitted for consideration under the BRAVE1 project at the R&D stage, of which 446 passed the expert assessment stage and more than 80 received funding in the total amount of up to 1.5 million USD [8]. The Ukrainian Startup Fund [25] directed its activities not only to financial support of W&DUP projects, but also to their non-financial support, in particular, in organizing access to resources. The goal of the fund is not only to increase defense capabilities but also to ensure post-war economic recovery.

The significance of the need to develop organizational and institutional support for innovations in the military-industrial complex is the introduction of the national Agency for Defense Technologies, the creation in 2020 of the Ministry for Strategic Industries of Ukraine, etc. The priorities of the Ministry are defined as intensification of R&D of defense enterprises, support for innovative developments in the military-industrial complex, acquisition by the defense industry of an appropriate level of competitiveness in the world market, establishment of cooperation and collaboration with foreign scientific organizations and manufacturing companies (which confirms *Hypothesis 1*).

It is characteristic of the innovation process during war that their pace is significantly accelerated during war not only due to the growing urgent need to update the W&DUP. The possibility of direct testing of military innovations during hostilities allows one not only to determine their effectiveness, but also to identify and correct shortcomings, to ensure a high rate of introduction of the pilot model into mass production (which confirms *Hypothesis 3*).

The fact that changes in the enemy's countermeasure tactics to promptly identify directions for further development of its own innovative technologies also contributes to the acceleration of the military innovation process [26]. This creates the prerequisites for the widespread entry of domestic military innovations into the world W&DUP markets, a technological breakthrough in the development of the national economy. Thus, the war in Ukraine revealed a significant need for the latest UAVs. The number of Ukrainian drone manufacturers today exceeds 100 companies. This requires a significant acceleration of all stages of military innovations in this area. In particular, such developments are known as: the E620 "Kazhan" attack jet; Heavy Shot is a product of the Ukrainian company Gurzuf Defence, etc. Their production required significant organizational and institutional efforts, establishing cooperation with leading foreign suppliers of components (which confirms *Hypotheses 1* and *3*). As an example of the significant pace of the innovation process, the successful use of the Vampire attack hexacopter in combat conditions in early 2023 can be cited, while its development began only in June 2020.

Due to the limitation of the possibility of publishing information on the volume of supplies and manufacturers of domestic UAVs, the data available in literary sources [2] on UAV supplies by foreign companies as of May 2023 are given (Fig. 2).

As it can be seen from Fig. 2, there is a significant disparity between companies even from one partner country in UAV deliveries. For example, the company "Tactical unmanned aerial system" (USA) produces a wide range of devices; however, the total volume of devices delivered by them is 16 times less than the Phoenix Ghost UAS. Some companies delivered only 30–70 devices (Fig. 2), which also indicates the need to test UAVs even from foreign companies in real combat conditions. This will allow not only identifying their shortcomings, but also increasing the company's rating on the global arms market and, accordingly, confirms Hypotheses 1–3.

In the conditions of insufficient compliance with the requirements of secrecy and the presence of an outflow of information about military innovations of Ukrainian defense enterprises, an example of which is the receipt by Russia of Ukrainian know-how about military "invisibility cloaks", it is advisable to extend the concept of "military innovations" also to those developments that are not used directly in combat. In particular, it is advisable to create a digital "twin" of an enterprise in virtual space, which can be based on a model of interaction of physical objects, processes and resources. The creation of such a "twin" will make it difficult to establish the geographical location of the enterprise, will allow for more tight control of information flows to the outside and will have significant advantages in the organization of production, in particular, in the reengineering of business processes.

The Stockholm International Peace Research Institute (Stockholm International Peace Research Institute – SIPRI) has identified priority areas of innovative development of the production of weapons and dual-use products (W&DUP). These are the introduction of artificial intelligence technologies, the autonomization of weapons systems, additive, missile technologies and cyber warfare. In all these areas, not only scientific developments are being carried out in Ukraine today, but also the production and use of innovative equipment in combat conditions.

At the same time, as the immediate and strategic measures to eliminate obstacles and improve the process of military innovations in view of the formation of prospects for the development of the defense industry, the following is necessary:

- formation of network platforms to provide proper organizational support in the integration of economic, scientific, and technological capabilities to various participants in the innovation process. Strengthening the interaction of W&DUP manufacturers vertically and horizontally; intellectualization of weapons, moving away from analog information processing; use of the latest business models in the production of W&DUP;

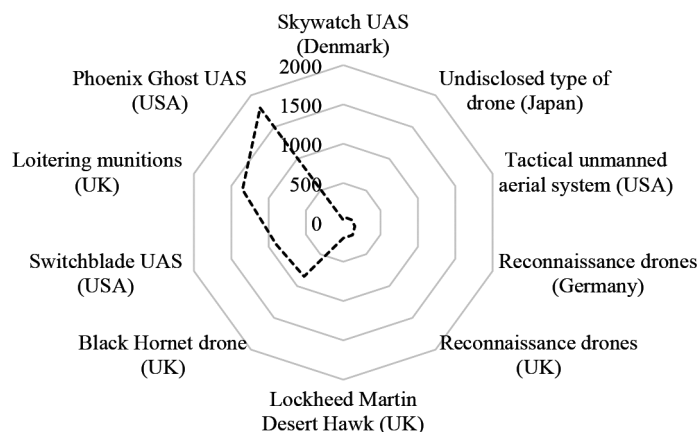


Fig. 2. Volumes of UAV supplies to Ukraine by foreign manufacturers as of May 2023, units

- overcoming structural deformation and imbalance of the defense industry due to chaos and disorganization during the conversion and diversification in past periods;

- expansion, under restrictions on arms trade, of the transfer of military innovations and the sale of licenses for the production of weapons. Subject to the implementation of W&DUP supply programs for the Armed Forces of Ukraine, providing the opportunity to export part of the products of defense industry enterprises to ensure financing of their own innovative developments;

- grant support to citizens of Ukraine for their presentation of ideas and samples of military innovations and, in case of a positive expert assessment, their further financial support in creating their own business in these areas;

- improving the system of state defense orders, their long-term planning and the formation of an economically feasible pricing model for W&DUP to ensure that defense industry enterprises can finance the innovation process from their own resources;

- introducing the W&DUP innovation level as a component of defense resources in the system of resource provision of the Armed Forces of Ukraine, which will be calculated as the share of innovative defense products used to ensure operational and (or) strategic advantages in the total volume of domestic W&DUP supplied to the Armed Forces of Ukraine;

- ensuring flexible, adaptive development of defense industry enterprises, the possibility of rapid deployment and scaling of production of innovative military equipment. Relying on generally recognized directions of Industry 4.0: knowledge management; intellectualization of production; digital transformation; development of the military-industrial base;

- development of the military-industrial element base and universal components, formation of human resources and capital renovation of production capacities in such a way that they could be quickly reoriented in accordance with the current needs of the Armed Forces of Ukraine;

- broad funding of startups, since relying on past experience leads to subjectivity in the allocation of budgetary resources for financial support of military innovation, which can lead to a significant mismatch of innovative development directions with the needs of the battlefield.

The war became a catalyst for military innovations, an incentive for the reorganization of the defense industry. In the post-war period, this will increase the level of national security and contribute to the development of the economy. Understanding the comprehensive impact of military innovations will contribute to the proper use of its potential in strategic areas. The multiplier effect of military innovations on the development of the science-intensiveness of domestic production is that the intensification of breakthrough scientific defense developments causes a chain reaction in the formation of new ideas and approaches, and not only in the military sphere, becoming the basis for the advanced innovative development of the economy.

Conclusions. It is proposed to consider military innovations not only as an event or a pilot model, but, first of all, as a systemic process aimed at obtaining an operational and (or) strategic advantage and requiring financial, organizational, institutional support and the creation of a favorable environment for implementation. By reviewing the theoretical foundations, a definition of military innovations is proposed. The above has not only theoretical significance, but can be used as a tool for identifying and eliminating obstacles to the innovation process in the military sphere, ensuring their systematic organizational, institutional and financial support, and becoming the basis for forming an ecosystem of military innovations.

It is indicated that with the beginning of large-scale military operations, the lack of institutional and organizational support leads to the loss of positions acquired in previous periods in the rating according to the World Innovation Index. And this is not only the loss of 15 rating positions since 2020, but also the deterioration of financing and effective implementa-

tion of innovations. This indicates not only the deterioration of the country's innovation potential, but also military innovations, as its component. It is noted that private companies turned out to be less bureaucratized than state-owned enterprises and more flexible and adaptive to the challenges of war. While maintaining the existing pace of private business growth in the defense industry, there are prospects for increasing the share of private companies in the defense industry by more than 50 %. This contributed to the emergence of an innovation ecosystem, but relying mainly on disparate private initiatives leads to significant defragmentation of the ecosystem, in particular, due to the lack of institutional regulatory influence. A comparison of the average financial indicators of defense industry enterprises for the period 2014–2021 for the most modern defense industry sectors and the dynamics of budget financing of the Ministry of Defense of Ukraine for the period 2019–2024 with the needs of the Armed Forces of Ukraine indicated that the lack of financial support reduces the possibility of supporting the process of military innovation. Domestic investments could be a compensating factor, but this source of financing in the context of the economic crisis also tends to decrease. With such restrictions on the choice of sources of financing, it is proposed, first, to lift the ban on Ukrainian enterprises entering the global arms market with an unquestionable requirement to fully provide internal orders from both the Ministry of Defense of Ukraine and external and internal financial donors. Secondly, a significant expansion of cooperation with partner countries regarding external purchases of Ukrainian weapons for their further use by the Armed Forces of Ukraine. This will be facilitated by the fact that innovations provide the domestic defense industry with an appropriate level of competitiveness in the global arms market. It is significant for Ukrainian developers that the possibility of direct testing of military innovations during combat operations allows one not only to determine their effectiveness, but also to identify and correct shortcomings, and to ensure a high rate of introduction of a pilot model into mass production. The fact that changes in the enemy's countermeasure tactics to promptly identify directions for further development of their own innovative technologies also contributes to the acceleration of the process of military innovations. Their support by users – lower-level military personnel is named as a factor in increasing the pace of the innovation process. This movement of introducing military innovations is defined as “bottom-up”.

As a result of the research, proposals were made as the immediate and strategic measures to eliminate obstacles and improve the process of military innovations in view of the formation of prospects for the development of the defense industry, to eliminate obstacles and improve the process of military innovations. Prospects for further development of scientific research in this direction consist in determining the necessary changes to legal norms in the field of innovative development of the defense industry, detailing the improvement of institutional, organizational and financial support for the process of military innovations.

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Інновації в оборонно-промисловому комплексі: сучасний стан і перспективи розвитку

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Мета. Удосконалення теоретичних засад військових інновацій та їх використання як інструменту виявлення та усунення перешкод інноваційному процесу у військовій сфері. Завдання роботи: визначення проблем, перешкод і факторів сприяння інноваційному розвитку оборонно-промислового комплексу (ОПК); розроблення пропозицій щодо усунення перешкод і вдосконалення процесу військових інновацій.

Методика. При виконанні дослідження застосовані наступні методи: порівняльного аналізу для дослідження сучасного стану й перспектив інноваційного розвитку ОПК; критичного аналізу – для виявлення проблем і перешкод інноваційному розвитку; діалектичний метод наукового аналізу – для вдосконалення теоретичних засад військових інновацій.

Результати. Вказано на тенденцію зниження інноваційного рівня країни. Зазначені напрями посилення інституційної та організаційної підтримки процесу військових інновацій. Указано, що зростання частки приватних підприємств в ОПК сприяє зародженню екосистеми інновацій, але недостатність інституційного впливу призводить до значної дефрагментації зазначеної екосистеми. Порівняння фінансових показників підприємств ОПК, динаміки бюджетного фінансування з потребами ЗСУ вказало, що нестача фінансового забезпечення зменшує можливість підтримки інноваційного процесу. Виявлені не лише перешкоди, але й фактори сприяння інноваційному процесу. Розроблені пропозиції щодо усунення перешкод і вдосконалення процесу військових інновацій.

Наукова новизна. Запропоновано розглядати військові інновації не лише як подію чи пілотний зразок, але й як системний процес, що має на меті отримання оперативної і (чи) стратегічної переваги й потребує фінансової, організаційної, інституційної підтримки та створення сприятливого для впровадження середовища. За перегляду теоретичних засад запропоноване визначення військових інновацій.

Практична значимість. Розроблені пропозиції дозволять розпочати усунення перешкод і вдосконалення процесу військових інновацій з огляду на формування перспектив розвитку ОПК.

Ключові слова: військові інновації, озброєння, військова техніка, інноваційний процес, оборонно-промисловий комплекс

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