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## **INNOVATIONS IN SECURITY AND DEFENSE: THE ROLE OF SCIENCE IN THE DEVELOPMENT OF WARTIME TECHNOLOGIES**

**Abstract.** *The article examines the development of innovations in the global defense industry and identified the leading technologies used in warfare. The world leaders in the production and financing of innovations in the field of security and defense on a global scale are also identified. The use of innovations in military operations in Ukraine is studied, and the potential for technology development in this area is determined. As a result, it is noted that Ukraine has actively begun creating an innovative ecosystem for the renewed domestic defense industry, the products of which can meet the needs of the Ukrainian army and the rest of the world.*

**Keywords:** *defense industry, technology, innovation, UAV, robotics, drone.*

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## **ІННОВАЦІЇ В СФЕРІ БЕЗПЕКИ ТА ОБОРОНИ: РОЛЬ НАУКИ У РОЗВИТКУ ТЕХНОЛОГІЙ ВОЄННОГО ЧАСУ**

**Анотація.** *У статті досліджено розвиток інновацій у глобальній оборонній промисловості та визначено провідні технології, що використовуються у війні. Також визначено світових лідерів з виробництва та фінансування інновацій у сфері безпеки та оборони на глобальному рівні. Досліджено використання інновацій у військових операціях в Україні та визначено потенціал розвитку технологій у цій сфері. В результаті відзначається, що Україна активно почала створювати інноваційну екосистему для відновленої вітчизняної оборонної промисловості, продукти якої можуть задовольнити потреби української армії та решити світу.*

**Ключові слова:** *оборонно-промисловий комплекс, технології, інновації, БПЛА, робототехніка, дрон.*

**Introduction.** The military-industrial complex (MIC) is a set of organizations that includes research centers, product testing centers, and manufacturing enterprises that develop, manufacture, store, supply, and provide the security forces with military and special equipment, parts, and ammunition, as well as sell it for export. In the digital economy, the entire defense industry apparatus has focused on developing and producing innovative products, as this significantly increases the efficiency of the country's military structures, ensuring its security and power advantage. In the context of martial law in Ukraine, developing defense innovations is one of the most critical areas that will help the Ukrainian military defeat the enemy in terms of technology.

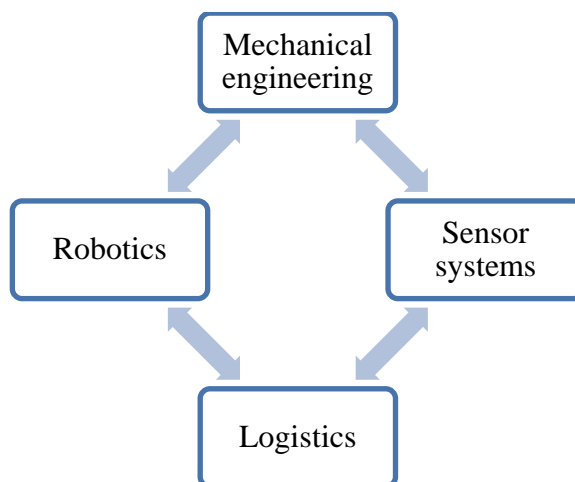
The issue of innovations in the development of defense and security has been studied by such Ukrainian researchers as T.V. Pysarenko, T.K. Kuranda, T.V. Havrys and A.B. Osadcha [7], V.M. Begma and O.O. Sverhunov [1], Nan Tian, Diego Lopes da Silva, Xiao Liang and Lorenzo Scarazzato [10] and others.

**Statement of the problem.** The purpose of the article is to study the development of innovative activities in security and defense and to analyze the use of innovative technologies in the military-industrial complex of Ukraine.

**Research results.** The development of innovations implies not only military vehicles equipped with firing equipment, but also intelligent machines. They can perform the bureaucratic functions of managers and technicians, thereby saving on human capital and

significantly reducing the price of the final product. This strategy helped solve the rising production costs per unit of military products after World War II.

The defense industry has identified several priority areas of development, as shown in Figure 1.



Source: developed by the authors based on [1].

Figure 1. Significant innovations in the defense industry

So, let us move on to analyze innovations in robotics in the defense industry. Robotics is an innovative field that began to develop actively only in the post-industrial economy. Most robots in the defense industry use a wheeled or tracked chassis. Miniaturization of equipment does not provide advantages in terms of tactical and technical characteristics. Using robots at least one decimeter in length is advisable, as they cannot move over rough terrain [2]. An exciting way to develop military robotics is to create wheeled models that use the jumping method of transportation. An equally promising method is the creation of arthropod-like robots, i.e., moving on “legs” [3]. However, the miniaturization of machines is an urgent task for robotics development. In particular, aerial and underwater robots are being developed [4].

Below (Table 1) is a list of public and private companies currently the most prominent unmanned aerial vehicle industry players.

Table 1

**Major UAV manufacturers**

Company	Main types of UAVs	Region of operation	Year of foundation	Market share, %
DJI (Dajiang)	Mavic, Phantom	Shenzhen, China	2006	76,8
Intel	Shooting star, Falcon 8	Santa Clara, USA	2015	3,7
Yuneec	h520, Thypoon H	Hong Kong, China	2010	3,1
Parrot	Anafi, Bepop 2	Paris, France	2009	2,2
Gopro	Karma	San Mateo, USA	2016	1,8
BDR	Solo	Berkeley, USA	2009	1,5
Holy stone	HS100, HS700	Taipei, Taiwan	2014	0,8
Autel	X-Star Premium, EVO	Bozell, USA	2014	0,8
SenseFly	eBee	Lausanne, Switzerland	2009	0,3
Kerspry	Kerspry Drone 2	Menlo Park, USA	2013	0,3

Source: developed by the authors based on [5, 6].

DJI Innovations, based in Shenzhen, China, is the most popular UAV manufacturer in the industry, with a market share of 76.8%, and can be considered a powerful oligopolist. DJI

Innovations is followed by Intel and Yuneec, respectively, with market shares of 3.7% and 3.3% [6].

The development of touch technologies in the defense industry is worth mentioning separately. Touch screens are used everywhere in the armed forces. They are used in radio engineering troops, chemical troops, space troops, etc. The touch screen allows one to visualize information, control devices using an intuitive approach, and work much faster and more efficiently. However, touch technologies are not limited to screens; they include all kinds of innovative monitoring and data acquisition systems actively used in military and radio-location equipment.

Logistics is an equally important area of activity in the defense industry. Often, the success of a military operation depends on timely supplies and the supply of combat units. Innovations are driven by the use of big data technologies, warehouse management systems (WMS), artificial intelligence technologies in flow management and inventory tracking, and the introduction of robotics, including drones. Sensor logistics and RFID tags are being developed, allowing for real-time monitoring of deliveries. It ensures constant monitoring of the cargo, storage, and transportation conditions, which is helpful in the defense industry, as military cargo has unique requirements for storage and transportation, and tracking the movement helps to eliminate force majeure situations [7].

The income of giant defense corporations amounts to tens of billions of dollars. Significantly, in recent years, Chinese companies have begun to enter this market (Table 2).

Table 2

**Rating of companies involved in the creation of military products**

Company	Country of origin	Revenue 2020, million dollars	Revenue 2021, million dollars	Change, %
Lockheed Martin	USA	47985	50536	5,32
Boeing	USA	20561	34050	65,60
Northrop Grumman	USA	21700	25300	16,59
Raytheon Company	USA	23573,64	25163,94	6,75
Aviation Industry Corporation of China	China	22898,73	24902,01	8,75
General Dynamics	USA	19587	24055	22,81
BAE Systems	Great Britain	22380,04	22477,48	0,44
China North Industries Group Corporation Limited	China	14206,36	14777,77	4,02
Airbus	Netherland/France	11185,91	13063,82	16,79
China Aerospace Science and Industry Corporation	China	11206,28	12130,93	8,25

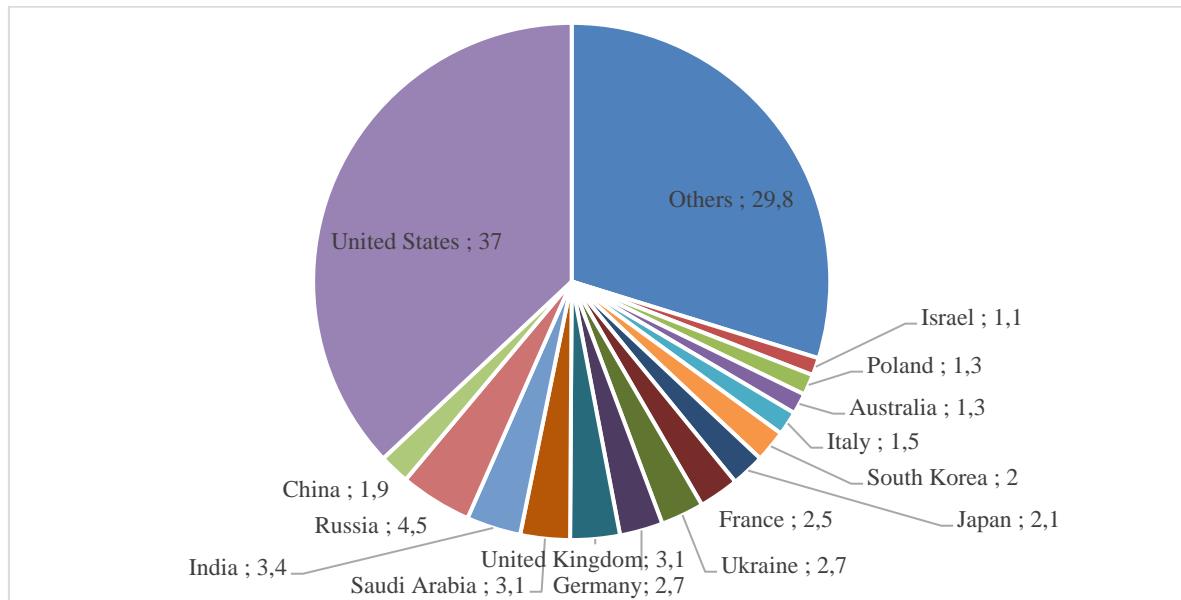
Source: developed by the authors based on [8].

In war, enterprises that produce various weapons cannot earn money alone. There are severe arguments according to which Halliburton was one of the agents of the second war between the United States and Iraq. As a result, it received approximately \$100 billion worth of orders to rebuild the Iraqi oil industry [9].

In addition to big business, less significant economic agents also have opportunities to make money in war. The conflict zone is riddled with illegitimate practices (smuggling, illegal movement of people, imitation of military operations to achieve private goals, etc.). When the war acquires a positional character, a sharp difference arises between the line of confrontation and the life of the rest of the country, which outwardly returns to peaceful life. However,

weapons and the practice of violent solutions to any problems are spreading from the conflict zone.

Having analyzed the innovations in the defense industry, one should analyze the financial component. Let us analyze the expenditures of countries on the defense industry (Figure 2).



Source: developed by the authors based on [10].

**Figure 2. Structure of countries by expenditures on defense industry development in 2022, %**

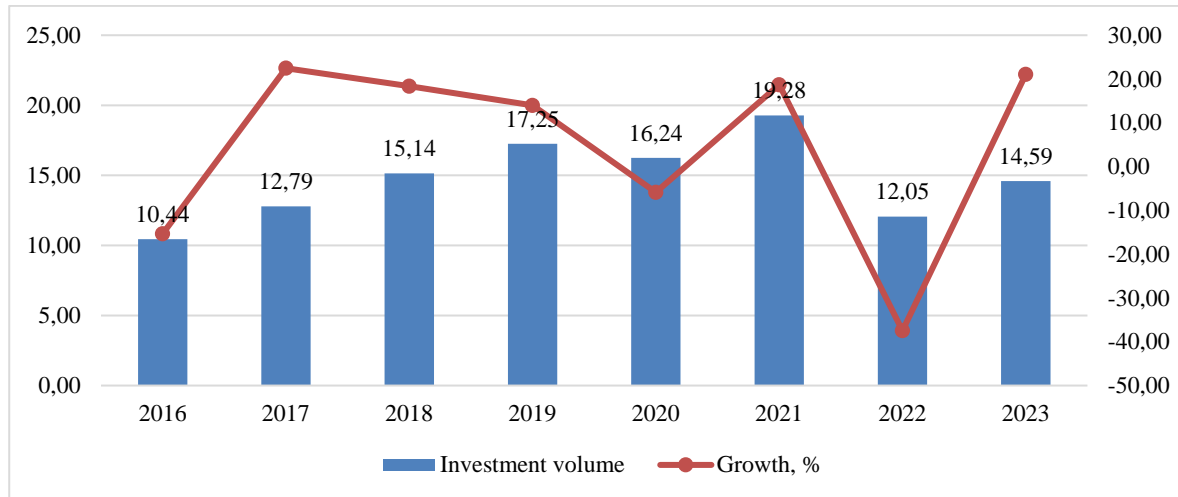
The absolute leader in arms spending is the United States, which spends \$732 billion and accounts for 37% of global defense spending, while Ukraine's share is 2.7%.

Next, we propose to analyze Ukraine's innovative activities in military equipment and defense. Since the beginning of the war in Ukraine, a coordination platform in the field of Defense Tech Brave1 [11] has been created, which is positioned as a single network of cooperation between Defense Tech companies, the state, and the military, as well as investors, volunteer foundations, media and everyone who helps bring victory closer through technology. In just seven months, the cluster has received over 780 applications from Ukrainian startups and awarded 84 grants worth \$1.53 million. THE CLUSTER HAS PROVIDED 84 GRANTS WORTH \$1.53 MILLION. Currently, 35 developments using artificial intelligence (AI) methods are registered with Brave1, 29 of which have passed military expertise. The strategic goal of Brave1 is to make Ukraine one of the leaders in the global defense technology market. In the context of active combat, the main task for Ukrainian developers is to provide AI solutions for the frontline. One example is the Griselda system, which uses AI to collect intelligence and increase the situational awareness of troops. It can process thousands of messages from satellites, drones, social networks, media, and hacked enemy databases. The technology is integrated with the Delta situational awareness system and applications for artillery and tankers such as Armor, Kropyva, Ukrop, and GisArt [12].

To accelerate development, the Ministry of Defense has created the Innovation Development Accelerator, which aims to speed up the department's processing of innovative projects in the interests of the Armed Forces. Using modern management methods and IT solutions, it organizationally combines the expertise and powers of the Ministry of Defense's specialized units and a particular Project Office. Applications for cooperation from the Ministry

of Defense of Ukraine are submitted to the RIA based on the principle of a “single window” and process automation [13].

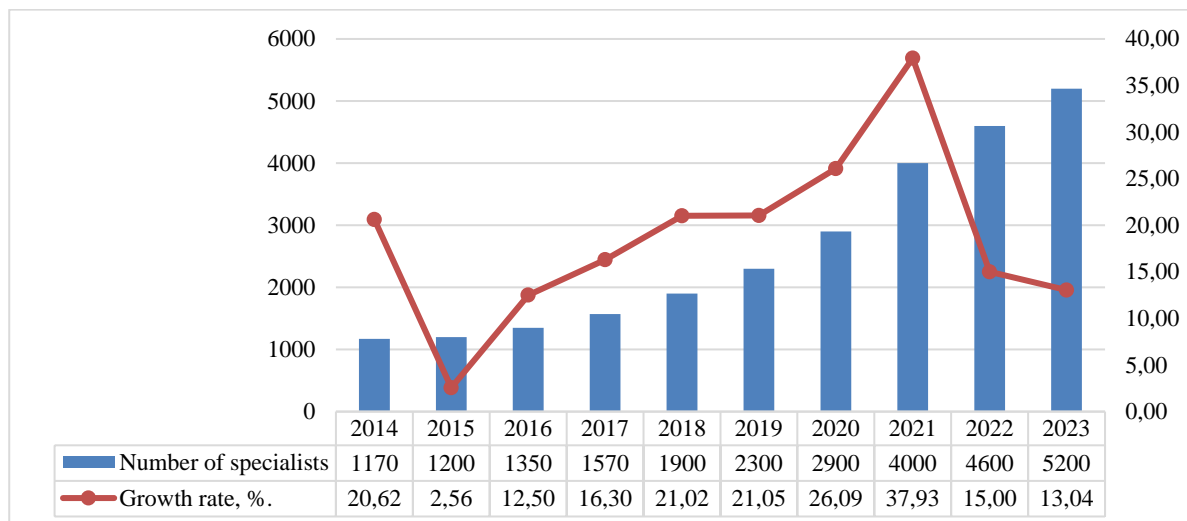
Fig. 3 shows the dynamics of funding for the development of AI innovations and technologies by the Ukrainian government.



Source: developed by the authors based on [14]

Figure 3. Dynamics of government funding for innovation and technology development in Ukraine in 2015–2023, USD million USD

Ukraine’s advantage in creating innovative weapons is the availability of highly qualified specialists, the dynamics of which are growing every year (Fig. 4).



Source: developed by the authors based on [15]

Figure 4. Dynamics of the number of specialists in the field of innovation and technology development in Ukraine for the period 2010–2023

Thus, based on Figure 4, we can see that over 9 years in Ukraine, the number of specialists has increased by 4.5 times, which indicates the popularization of the profession in the field of innovation services and the development of the high-tech sector market as a promising area for the work and growth of specialists.

Ukraine has begun and is actively creating an innovative ecosystem of the renewed domestic defense industry, whose products can meet the needs of the Ukrainian army and, after the war is over – foreign buyers.

**Conclusions.** The defense industry is vital for the country, its economy, and the national economy, as it ensures its defense and security. Innovations in the digital economy are essential. Therefore, the defense industry seeks to introduce the most advanced technologies. Innovations are taking place in the identified priority areas: robotics, military engineering, sensor systems, and logistics. In robotics, the development trend is aimed at miniaturizing robots while maintaining their technical qualities. In the context of martial law in Ukraine, developments have begun in the defense sector, which has already been tested and represents a promising direction for the future of our country, especially after the victory.

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