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The Armed Forces of Ukraine unmanned systems future development

Valery Zaluzhnyi
Philosophy Doctor
Commander-in-Chief of the Armed Forces of Ukraine
General Staff of the Armed Forces of Ukraine
03168, Air Force of Ukraine Avenue, 6, Kyiv, Ukraine
e-mail: uzvk_mou@post.mil.gov.ua
ORCID : 0000-0002-1947-501X

Ruslan Hryshchuk
Honored Statesman of Science and Technology of Ukraine, Doctor of Technical Sciences,
Professor, Head of the Central Research Institute of the Armed Forces of Ukraine
Central Research Institute of the Armed Forces of Ukraine
03049, Air Force of Ukraine Avenue, 28 B, Kyiv, Ukraine
e-mail: Dr.Hry@i.ua
ORCID : 0000-0001-9985-8477

Oleksiy Solomytskyi
Doctor of Military Sciences, Senior Researcher
Head of Department
Central Research Institute of the Armed Forces of Ukraine
03049, Air Force of Ukraine Avenue, 28 B, Kyiv, Ukraine
e-mail: solosa1@gmail.com
ORCID: 0000-0001-8061-8895

Ihor Hrachov
Head of Department
Captured and Advanced Weapons and Military Equipment Research Center
General Staff of the Armed Forces of Ukraine
03168, Air Force of Ukraine Avenue, 6, Kyiv, Ukraine
e-mail: ig43194@gmail.com
ORCID: 0009-0003-9108-7059

Abstract. The relevance of the article is due to the Armed Forces of Ukraine unmanned systems development normative forecasting need in order to achieve a superiority over the enemy. One of the futures` main provisions of the Armed Forces of Ukraine unmanned systems development has been outlined. Futures have been developed by using a modified method of "branches" as a component of foresight (scenario forecasting). Elements of SWOT analysis and the cognitive-dynamic method of forecasting were also applied in the part regarding normative forecasting. The future of the Armed Forces of Ukraine unmanned systems development is presented as the desired version of the development of these systems in the future, using cause-and-effect logic. Within its framework, the main trends in the development of unmanned systems in the leading countries of the World were considered. The list and content of the main stages of development of futures according to the modified method of "branches" are presented. The forecasting horizon is defined. The author's view on the ecosystem of unmanned systems that has apeared in Ukraine is offered. The results of the analysis of the stakeholders of the considered ecosystem are presented with the distribution of their

influence and interest according to the Mendelov and Johnson matrices. Based on the analysis of external and internal factors that will influence the development of unmanned systems, as well as the future operating environment, the key results that must be achieved to realize the main development goal and the main ways (actions, influences) to achieve them are determined. The key results cover two main areas - as organizational and technological and as combat also. In addition, the priority directions for the unmanned systems of the Armed Forces of Ukraine development by components, levels, types and technical aspects have been determined. The proposed futures may be used both as for more detailed regulatory forecasting of the unmanned systems development, for example, when developing of a corresponding foresight, as during the program documents (strategies, concepts, etc.) development or priorities of the State's military and technical policy determination.

Keywords: unmanned systems, forecasting, futures, foresight.

Introduction

Unmanned systems (USs) have been gradually developing for several decades, but recently, as a result of technological breakthroughs, this process has become explosive. USs have rapidly broken the realities of combat activities, their role on the battlefield has significantly increased, they have occupied their niche and are rapidly expanding it, becoming indispensable during the performance of a number of missions, multiplying the capabilities of some elements of conventional forces and means and nullifying the advantages of others.

The rapid USs development has attracted a lot of attention to forecasting the prospects of their development. Quite a lot of analytical (Volkogon V., 2019; Kuprinenko O., 2021; Shugurov O., 2007), scientific and prognostic (Zaluzhnyi V., 2023; Semenenko O., 2023; Pathak M., 2017) and of a program nature (Kohn E., 2020; Heiming G., 2021; Chawla S., 2015) publications have appeared on this issue.

Ukraine currently occupies a leading position in the USs application, the tactics for their use development, and the main directions of their development for the near future formation. It is necessary to maintain and consolidate the position of the leader in this field, acquiring opportunities for the development and scaling of the USs production, that will allow to achieve an asymmetric advantage over the enemy.

Many countries of the World are making a lot of efforts to develop USs, based on their views on warfare, needs and capabilities. Ukraine, being in a state of war, is currently at the forefront of the USs development process, given the possibility of testing them under combat conditions. It should be noted that each country chooses its own vector of security development, taking into account the realities of the military and political situation, the range of threats and the views of the military and political leadership on the development of the national armed forces. The results of the priority directions analysis of the views on the USs development in the leading countries of the world are shown in the table. 1.

However, the USs development is somewhat chaotic, without a unified plan. Therefore, it is necessary to determine the main trends, it is necessary to develop them specifically in accordance with the needs of the Armed Forces of Ukraine (AF of Ukraine).

That is why the development of scenarios for the Armed Forces of Ukraine USs development is an urgent task.

Methodological Framework

The basis of the USs development proposed futures (forecast) of the is based on the modified method of "branches" as an element of the methodology of scenario forecasting (foresight) (Rhydderch, 2009). At the same time, by futures we mean the desired version of the development of the USs of the AF of Ukraine in the future, developed using cause-and-effect logic (Zgurovsky Z., 2021).

Table 1. The main directions of the USs development in the leading countries of the World

Country	Directions of development	A promising goal
USA	Use of artificial intelligence, autonomous systems and smart sensors in robotic agents. The development of systems that can function in interaction with human beings, increasing the speed of decision-making and providing advantages in the military operations conductment.	Increasing the ability of troops to adapt to a changing combat environment and ensure a technological advantage over potential adversaries.
United Kingdom	Development and implementation of autonomous systems to support combat operations. Developing systems with artificial intelligence and machine learning to increase the efficiency and security of its own military forces.	Ensuring the level of readiness and combat capabilities, the ability to adapt to complex modern threats and dynamic combat conditions.
France	Development of the USs to provide support for combat operations and logistics on the ground. The development of robotics to increase the efficiency of combat maneuvers and optimize supplies.	Improving the capability for the operational mobility and providing support in changing combat environments.
Germany	The development of the USs, that are focused on medical, intelligence and logistical directions. The emphasis is also placed on issues related to the ethics and safety of using USs systems application in the military operations.	Ensuring the health and safety of servicemen, expanding the capabilities of conducting intelligence and supporting logistical processes on the battlefield.
Turkey	Development of various types of USs, including combat robots, intelligence systems and logistics systems, etc. Attention is focused on the creation and implementation of advanced technologies.	Increasing the combat capabilities of military forces, providing additional support for military operations and reducing risks for military personnel.

Results and Discussions

The development of futures based on the "branches" method (Rhydderch, 2009) involves the following stages (Fig. 1).

1. Tasks forecasting definition and time horizon.
2. Identification of stakeholders (drivers), trends and key factors and events that influence the development process.
3. Determination of key (required) results to focus on.
4. Determination of factors or actions that must be implemented to achieve the desired results.

In accordance with the proposed procedure, the future development of the USs of the Armed Forces of Ukraine has been developed.

1st stage. The main goal of the military purposes USs development is to increase the combat effectiveness of their use and combat capability of the Armed Forces of Ukraine with the provision of technological superiority. At the same time, attention should be focused on saving people's lives and military resources (ammunition, weapons and military equipment, etc.).

This goal should be achieved in the next year and a half, that determines the futures horizon.

When having achieved this goal, we will have the opportunity to:

effectively solve the complex missions of a wide range under the conditions of confrontation with an enemy that has a numerical advantage;

preserve the life and health of military personnel;

to fetter the enemy's initiative, limit his operational capabilities;

to contribute to the innovative development of the national defense-industrial complex (DIC);

expand military-technological partnership with other countries.

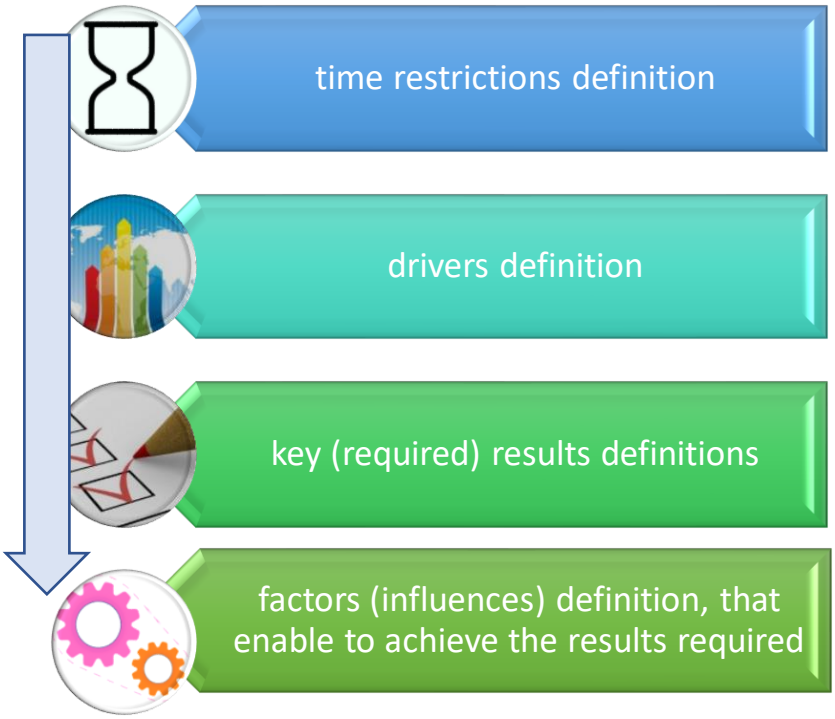


Figure 1. The main stages of futures developing

2nd stage. In Ukraine, the USs ecosystem (Fig. 2) origin, as built on the principles of synergy and self-organization, is a closely interconnected set of unmanned vehicles of various purposes, organizations and structures, that engaged in their development, production, procurement, supply and operation, control subsystems, logistics and personnel training, which ensure the development and application of USs as intended, and also determines the legal, economic, organizational and other conditions of these processes.

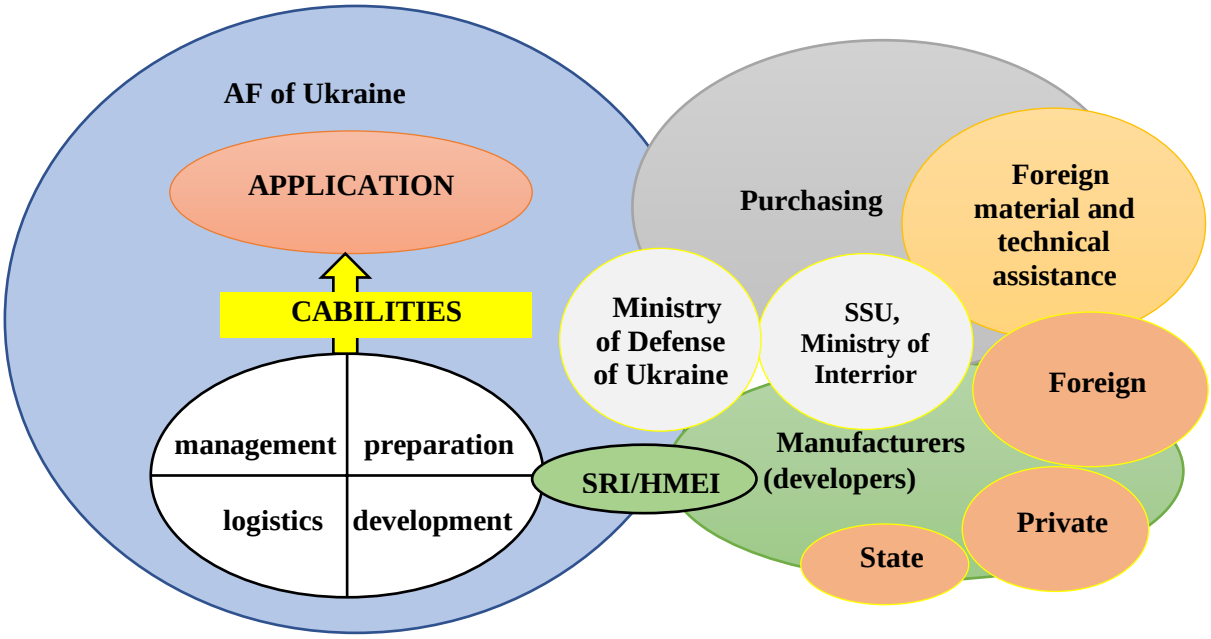


Figure 2. The ecosystem of unmanned systems

The overall goal of the ecosystem participants is to create an environment and ensure conditions for the effective development and application of USs, implementation of innovative breakthroughs and maintaining a technological advantage over the enemy.

According to the ecosystem participant's analysis results, the stakeholders were divided according to the "influence – interest" criterion (Fig. 3), that will allow a more rational distribution of efforts during the organization of the USs development. The distribution of their interest and influence in the development processes of USs is shown in fig. 4 by the Johnson matrix. It should be noted that the degree of influence and interest is indicated in a relative form, while the leaders occupy approximately the same positions.

The nearest future USs development will be influenced by a combination of external and internal factors, that are presented in the table. 2.



Figure 3. Mendelian matrix "influence – interest"

Thus, the development of security will take place in the conditions of an unstable external environment, which will be characterized by multi-vectored and asymmetric threats, the instability and ineffectiveness of international security organizations, the preservation of confrontation with the russian federation (even in the "frozen" phase), the rapid development of technologies, in particular artificial intelligence, and their uncontrolled distribution.

When determining the prospects for the development of USs, it is necessary to take into account that this process will be complicated due to limited funding, insufficient development of the production base, dependence on foreign technologies and components, as well as conflicts of interests.

At the same time, it is necessary to ensure the harmonious development of the USs ecosystem: increasing the share of ground-based and maritime USs and at the same time expanding the

possibilities of their application.

The operational environment in the part related to USs will be characterized by the following factors:

USs on the battlefield became its integral component, besides, they turned out to be a fairly universal tool – relatively inexpensive, one that does not require complex technological processes, easy to use (manage) and capable of performing a wide range of missions;

USs change the nature and course of war, forcing to review the role and place of other combat systems on the battlefield and the tactics of their use;

USs have a shortened life cycle (due to the rapid development of technologies), which determines the dynamism and continuity of further changes in the future;

advanced technologies (USs swarms, artificial intelligence, innovative materials, etc.) will even more radically change the nature of warfare.

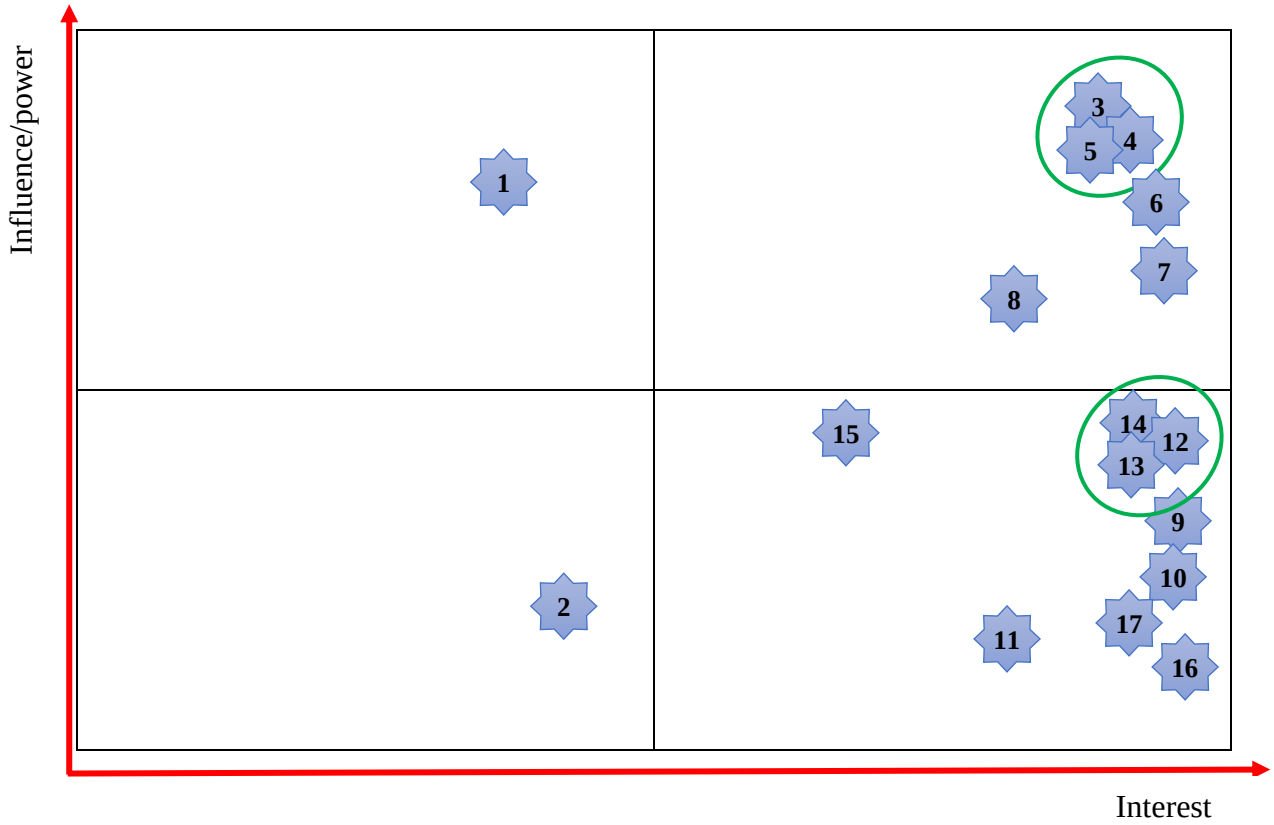


Figure 4. Johnson's matrix "influence - interest"
(stakeholders are numbered according to Fig. 3)

***3rd stage*.** Further implementation of USs will increase the efficiency and accuracy of operations, reduce risks to servicemen, and expand the capabilities of the Armed Forces of Ukraine. For the successful development of the Armed Forces of Ukraine USs, attention should be paid to the development of appropriate strategies, financing of scientific research and development of the defense industry. Multifaceted cooperation with foreign partners is also important.

In order to ensure the sustainable development of USs, it is necessary to create prerequisites for the formation of a self-sufficient, sustainable and high-tech ecosystem of USs in the AF of Ukraine, which will become a provider of relevant capabilities for our armed forces.

This will make it possible to provide the AF of Ukraine with the latest unmanned weapons and highly qualified personnel, and, as a result, to form an asymmetric strategic advantage over the

enemy, which dominates in terms of numbers, resources and industrial base.

Table 2. The main external and internal factors that will affect the development of unmanned systems in the short term

External factors (military and political environment)	Internal factors
The military and political situation in the World and around Ukraine in the next few years will remain tense and unstable and will be characterized by global rivalry between the democratic and authoritarian worlds.	The drone industry in Ukraine remains fragmented and unsystematic.
	Production and technological capacities are insufficient and cannot meet the needs of the Armed Forces of Ukraine.
Ukraine will continue to be on the edge of the conflict between the two worlds, and russia will remain a strategic threat to its statehood.	The financial provision of the needs of the Armed Forces of Ukraine in USs remains at a relatively high, but insufficient level, and the structure of funding sources and expenditures do not contribute to the harmonious development of the industry.
The West (Partners) will continue to support Ukraine, but the level of support may vary depending on the domestic political situation in the Partner States and the presence of other sources of tension in the World.	The combat component is presented fragmentarily, mostly by the tactical link of unmanned aerial systems.
Ukraine will have access to technologies, markets and global production capacities, but this will be dependent on lots of factors.	The existing system of staffing and training of USs crews does not allow to fully realize the potential of unmanned capabilities.

The realization of the goal of the development of USs involves the achievement of the following key results:

1. Moderation mechanisms of the USs ecosystem have been formed, which will allow directing the development of the industry in the interests of meeting the needs of the AF of Ukraine.
2. An effective combat component of the USs has been formed, which will make it possible to gain an asymmetric advantage on the battlefield.

4th stage. To achieve the first key result, it is necessary to:

1. Create effective communication mechanisms between manufacturers of unmanned systems, The Ministry of Defense of Ukraine (MoD of Ukraine), the AF of Ukraine and other interested institutions. For this purpose, it is necessary:

to improve the regulatory framework for regulation of production, certification, licensing, procurement, operation and granting of rights regarding the possibility of using USs;

create a proactive system of interaction between the customer (the Ministry of Defense of Ukraine) and developers (manufacturers) for the prompt provision/receipt of requirements for safety and security, introduce coordination councils, online platforms (portals), technology parks (techno-hubs), etc.;

to introduce the practice of organizing conferences (round tables, etc.) with the participation of customers and developers (manufacturers) on the creation and production of USs;

implement a system of scientific support (feedback) during the development (production) of USs.

2.To implement stimulating mechanisms of Research & Development (R&D) (competitions, tenders) for the creation of USs in priority areas, increasing the scientific and technological potential of the sector and creating the latest breakthrough technologies. For this, it is necessary to initiate at the state level issues regarding the stimulation of R&D, in particular regarding:

deduction of investments in R&D from the tax base of companies, preferential tax rates and "tax holidays", accelerated depreciation of fixed assets;

simplification and acceleration of the processes of development of requirements, technical

tasks, tests, certification and acceptance into service (revision and development of DSTU (State Standards of Ukraine);

creation of a grant (incentive) system for the implementation of priorities and requirements for samples, as well as stimulation of developers (manufacturers) during the execution of an order for the creation of USs;

implementation of transparent tenders in areas of development of USs;

expansion of the codification system in relation to USs of military purpose.

3. To develop effective mechanisms of system integration of technological solutions of various manufacturers (technological system integrator of the national level in the field of unmanned systems). Ways to achieve this task are:

implementation of world quality standards and certification during the development of technical tasks and acceptance into service, organization of cooperation between domestic developers and manufacturers of BPS within the state, as well as with foreign developers and manufacturers;

creation of a single coordination center for the system integration of technological solutions of various manufacturers;

introduction of an effective system of centralized management of access to modern safety and security technologies; implementation of an adaptive contracting system (in order to quickly make changes to technological solutions);

creation of patent boxes, mechanisms for protecting intellectual property and payment of royalties, etc.

4. Implement mechanisms for rapid scaling of serial production of unmanned systems. To introduce these mechanisms, it is necessary:

to provide priority financing for the development and production of USs as one of the main and promising areas of development of the defense industry of Ukraine;

to search for and use new ways and areas of realizing the potential of enterprises in the changing conditions of the external environment within the framework of the chosen mission, giving priority to the evolutionary type of innovative policy and offensive strategy;

implement innovations in the technical re-equipment of industry enterprises based on new digital technologies and industrial robotics technologies;

to contribute to the creation of conditions for the organization of production of components for USs, reduction of dependence on foreign suppliers and organization of USs production on the basis of the most successful solutions.

5. To improve the mechanisms of organizing the procurement of unmanned systems. For this you need:

carry out further development of the electronic procurement system taking into account EU requirements and standards, best international practice;

to expand international cooperation in the field of public procurement;

take systematic measures to reduce corruption risks and increase the level of transparency and control over the actions of customers and the responsibility of officials, as well as strengthen internal control;

implement mechanisms for ensuring the fulfillment of obligations;

initiate at the state level the creation of credit lines for developers and manufacturers;

to ensure the simplification of the contracting procedure in the Ministry of Defense and the Armed Forces of Ukraine, as well as the procedures for collecting documents and admitting to the operation of USs.

To achieve the second key result, it is necessary to:

1. To ensure the creation (improvement/expansion) of the USs management vertical in the areas of generation (development, preparation, provision) and application management. For this purpose,

you need:

to improve the USs management system (select a separate vertical);

to implement modern processes and procedures of planning and application of USs with further integration of USs military management bodies into a single combat information space, to ensure the effective operation of which to create an automated control system (ACS) of USs based on the principles of interoperability with existing (prospective) ACS troops and information systems;

during the work of the military management bodies, implement modern decision-making procedures and planning the use of USs at the operational and strategic levels;

to create a system of logistical support for the USs of the AF of Ukraine.

2. Create mechanisms for effective selection, recruitment and training of personnel. For this:

implement effective mechanisms for the selection and recruitment of professionally trained personnel with the professional, psychological, and moral and business qualities necessary for the management of USs;

to implement a single standardized multi-level (from tactical to strategic level) system of training of USs specialists, taking into account the specifics of the missions to be performed, to integrate into the system of personnel training of the AF of Ukraine the system of training in non-state (volunteer, private and foreign) schools thanks to the synchronization of training programs, as well as to carry out special training of specialists for the logistics support units to acquire knowledge and skills of technical maintenance and repair of USs;

to improve the management system and career management of USs specialists.

3. To increase the system of collection, study and implementation of experience in the application of USs. Ways of implementation are:

inclusion in the existing system of summarizing the experience of the issue of the application of USs;

using the experience gained during the improvement of the existing and creating perspective organizational structures of the tactical, operational and strategic level, which are responsible for the use of USs, taking into account the adoption of new models of USs;

taking into account the experience gained during the development of guidance documents on the combat use of USs;

improvement of the mechanism of dissemination of experience (examples) of USs application and its introduction into the USs specialist training system.

4. To increase the capabilities of the operational and strategic link of the air component of the USs, as well as the ground and sea components. The development of the capabilities (carriers of capabilities) of the USs shall be carried out in order of priority:

causing damage;

support (demining, demining, etc.);

reconnaissance (increasing awareness in the environment);

command and control (creation of USs networks for various purposes);

movement, maneuvering, logistics.

At the same time, the main efforts must be concentrated in the following areas (Table 3).

High autonomy, modularity, the ability to connect to a network and exchange data, the implementation of combined control and navigation systems (satellite/inertial/terrain), and the development of optical homing systems should be considered the main principles during the development of USs.

One of the main technical aspects during the development of USs is the implementation of elements of artificial intelligence in control systems, which will allow automatic recognition of objects (targets), capture, tracking and guidance of USs, automated data exchange between system elements.

This will significantly increase the efficiency of the application of USs, as well as make it

possible to reduce the burden on operators and the requirements for their competence. In the future, the process of using, for example, an attack UAV should look like this (Fig. 5).

In addition, during the development of a new generation of security systems, it is necessary to implement dual-purpose technologies, for example, LIDAR (Light Identification, Detection and Ranging) – a technology for obtaining and processing information about distant objectives using active optical systems to detect even disguised targets; non-lethal laser weapons (LWS/NL) for blinding guidance and personnel, etc.

Table 3. Prospective development directions of the Armed Forces of Ukraine unmanned systems

Component	Level	Type	Technical aspects
AIR	strategic	percussion (kamikaze); intelligence	development of unmanned aerial vehicles (UAVs) capable of ensuring the missions at the operational-tactical (operational, strategic) level (increased range and power, capable of operating in large groups with high autonomy, interconnection and different functional purposes (UAV groups - reconnaissance/strike/EW etc)); development of means capable of independently receiving external targeting from other UAVs, detecting, identifying, homing and hitting targets with minimal operator intervention (only at the stage of attack confirmation); creation of "swarms of drones", when one operator is able to control several UAVs simultaneously.
	operative	impact (reusable, kamikaze, FPV); intelligence	
	tactical	impact (reusable, kamikaze, FPV); intelligence	
GROUND	tactical	minesweeping (mining and demining); strike; intelligence; logistic (security)	Development: demining/demining robots; impact robots (machine gun, missile, anti-tank, artillery, mortar, anti-aircraft defense, kamikaze (self-propelled mines)) with a high degree of autonomy (see aviation); reconnaissance robots (network of remote sensors - optical, acoustic, seismic, etc.); portable (portable) robots of various purposes (impact, reconnaissance); auxiliary robots (for evacuating the wounded, transporting goods, transporting ammunition, CEW, etc.)
SEA	operative	strike (reusable, kamikaze); mine barriers	Development: surface/semi-submerged and underwater (shock and reconnaissance); surface/semi-submerged and underwater carriers of missile (anti-ship) torpedo and mine weapons (mine barriers).

Conclusion

Thus, the proposed futures reveal such a version of the future that will allow in a relatively short time to ensure the development of USs in the most important directions for the AF of Ukraine, taking into account existing trends, the capabilities of the state and partners, and is the most acceptable, from the point of view of the authors. At the same time, the trends for Ukraine were determined taking into account the experience of the other countries, but depending on the needs of our State.

During the development of the futures, the sequence of implementation of certain measures aimed at the development of USs was not established, given the need to implement them in a very short time, the aggression of the russian federation, the difficult economic situation and the limited technological capabilities of Ukraine.

It should be noted that the analysis of stakeholders indicates a relatively low degree of involvement of scientific research institutions (SRIs) of the Armed Forces of Ukraine in the development of USs. In order to provide effective scientific support for the processes of development, adoption and operation of the latest anti-aircraft defense systems, it is necessary to increase the role

and weight of theSRIs.

The directions of further research may be the development of a foresight for the development of the Armed Forces of Ukraine USs and program documents regarding the development of the USs (strategies, concepts, doctrines, etc.).

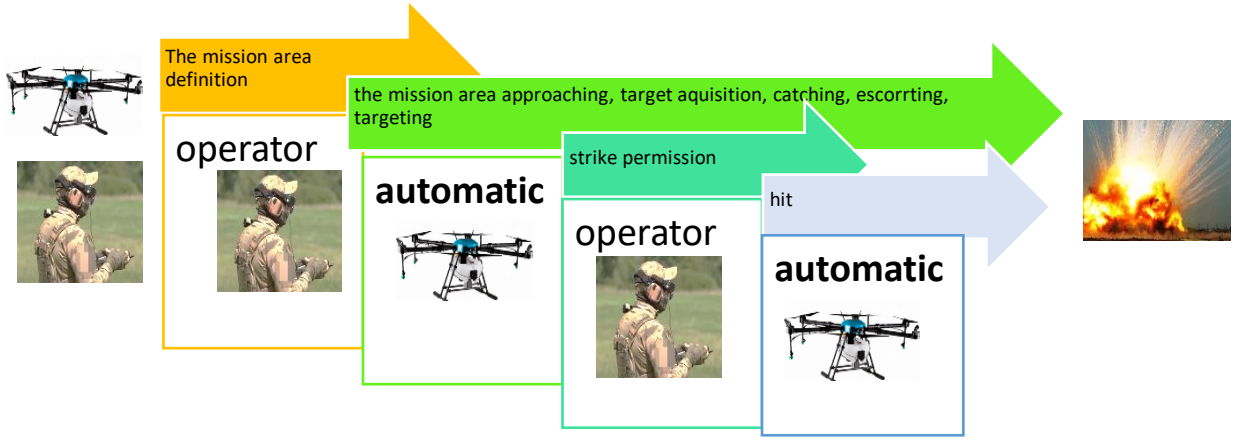


Figure 5. A promising procedure for the high degree of autonomy attack UAV application

Recommendations

The materials of the article my be used as an integral part of the foresight of the development of the unmanned systems of the Armed Forces of Ukraine, as well as during the formation and implementation of the military and military-technical policy of Ukraine. The article may be useful to specialists of information and analytical services, scientists and analysts that are involved in the development of the forecasts, development and justification of State decisions regarding the development of the USs domain.

References

1. "Eyes of the Army" US Army Roadmap for Unmanned Aircraft Systems 2010–2035. (2009). US Army UAS Center of Excellence: Fort Rucker, Alabama.
2. Albus, J., Cross R., & Duffy, J. (2018). Robotics and Autonomous Systems for Military Applications. *Journal of Defense Management*.
3. Bajart, A., & Förstner, W. (2021). *Robotics in Defense and Public Safety*. Springer.
4. British Army Approach to Robotics and Autonomous Systems. (2021). United Kingdom.
5. Carpin, S., Lewis, M., Liu, M., & Wang, M. (2018). *Field and Service Robotics*: Results of the 11th International Conference. Springer.
6. Chawla, S., Sreeram, A. N., & Pai, R. U. (2015). Application of Unmanned Aerial Vehicles in Modern Warfare. *International Journal of Computer Science and Mobile Computing*.
7. Croft, H. (2021). *Smarter Customer: The British Army & the Tech Revolution*. https://www.defenceiq.com/army-land-forces/editorials/smarter-customer-thebritisharmy the-tech-revolution/
8. Defense Advanced Research Projects Agency (DARPA) publications. https://www.darpa.mil/
9. Developing Future Capabilities: Robotics and Autonomous Systems. (2023). STC.
10. Kohn, E. (2020). *Concept for robotic and autonomous systems*. Australian Defense Force.
11. Heiming, G., & Geiger, W. (2021). *UGV Probot in der Felderprobung der Bundeswehr*. https://soldat-undtechnik.de/2021/10/mobilitaet/28943/ugvprobot in der felderprobung der bundeswehr/
12. Pathak, M., Bhandari, V. & Kumar, R. (2017). Autonomous Systems in Defense Environments:

Challenges and Opportunities. *International Journal of Advanced Research in Computer Science and Software Engineering*.
13. Rhydderch, A. (2009). *Scenario Planning*. Foresight Horizon Scanning Centre. https://gisf.ngo/wp-content/uploads/2020/02/0350-Rhyddarch-2009-Foresight-Horizon-Scanning-CentreScenario-Planning.pdf
14. Siciliano, B., & Khatib, O. (2016). *Springer Handbook of Robotics*, 2nd Edition. Springer.
15. Singh, AK, Verma, R., & Kumar, S. (2016). Applications of Robotics in Defense. *International Journal of Computer Science and Information Technologies*.
16. Singh, P., Khanna, A., & Bhatia, R. (2017). Unmanned Ground Vehicles for Military Applications. *Defense Science Journal*.
17. Strode, T., Beckworth, J. (2015). *Manned Unmanned Teaming (Ground) (MUM-T (G)) in Network Integration Evaluation (NIE)* 16.1, Maneuver Battle Lab.
18. The US Army Operating Concept – Win a Complex World 2020–2040. (2020). *TRADOC Pamphlet 525-3-1*. 2014.
19. The US Army Robotic and Autonomous Systems Strategy. (2021).
20. Tucker, P. (2021). US Army to Stage Largest Robot Tank Experiment Ever. https://www.defenseone.com/technology/2021/10/us-army-stage-largest-robottank-experimentever/186110/
21. US Army Capabilities Integration Centers System Threat Assessment Report (STAR) for Soldier as a System (SaaS) for 2022. (2022). US Department of the Army.https://apps.dtic.mil/sti/citations/AD1059546
22. Volkogon, V. V., Rul, O. M. & Volosyanko, M. M. (2019). Development and Application of Robotic Systems in the Armed Forces of Ukraine. *Military Technical Collection*.
23. Automated robotic weapons systems: a new challenge to the military security of Ukraine. (2017). https://niss.gov.ua/sites/default/files/2017-02/Ozhevan-86924.pdf
24. Blinkov, Yu. Prospects for the development of unmanned aviation in leading NATO countries. https://mil.in.ua/
25. Zaluzhnyi, V. F., Shaptala, S. O., & Koval, V. V. (2023). *Principles of development of robotic systems in the Armed Forces of Ukraine* (Ed. Semenenko, O. M.). Central Research Institute of the Armed Forces of Ukraine.
26. Zgurovsky Z. (Ed.) (2021). *Foresight of the development of the defense-industrial complex of Ukraine in the time horizon of 2021–2030*. KPI named after Igor Sikorskyi, "Polytechnic" Publishing House.
27. Kuprinenko, O. M. (2021). *Problems of creating ground robotic complexes for the needs of the Armed Forces of Ukraine*. https://doi.org/1034169/2414-0651.2021.4(32)
28. Semenenko, O., Baranov, S., Akinina, T., Dobrovolsky, Yu., Yarmolchyk, M. & Musienko, V. (2023). Conceptual views on the development and application of robotic complexes in the Armed Forces of Ukraine (concept, tasks, classification, management system, application tasks, prospects). *Social Development and Security*, No. 13 (3), P. 24–42. https://doi.org/10.33445/sds.2023.13.3.2
29. Solomytskyi, O. I. (2020). *Development of the theory and practice of forecasting the military and political situation* [Diss. dr. troops Sciences, Central Research Institute of the Armed Forces of Ukraine].
30. Shershakov, O., Shemaev, V., Begma, V. & Sklyar, N. (2020). *Regarding the development of the production of unmanned robotic systems based on public-private partnerships: an analytical note*. Institute of Strategic Studies.
31. Shugurov, O. S. (2007). Development of military ground robotic systems in the context of new concepts of management: perspectives of Ukraine. *Strategic priorities*. No. 4 (5). P. 198–205.