Challenges of the Fourth Industrial Revolution (4IR), transformation of modern armed forces and the ethical dilemma of robotic automation

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Abstract:

Introduction/purpose: The first industrial revolution used the power of steam and water for the mechanization of manufacturing. The second one used electricity for mass production. The third one used electronics and information technologies for the automation of production, while the fourth industrial revolution aims to enable erasing of the boundaries between the physical, digital and biological spheres in order to reach smart automation and increase the interconnection of system elements. Thus, previous industrial revolutions changed the way we work, the next one is changing the way we think. Our generation is privileged of being a contemporary of tectonic technological changes, a witness to changes that fundamentally convert production processes and relations in production, but also a witness to the changes that those products bring to the functioning of the mankind, from individuals to state organizations, including the military as well. The main goal of this paper is to indicate to the wider military academic community the need for coordination and interdependent development of combat systems, doctrine and structure of defence organizations.

Methods: This paper will use general scientific methods that are used, or can be used, to acquire scientific knowledge in all scientific fields and disciplines. We highlight the hypothetical-deductive method, the analytical-deductive method and the comparative method.

Results: (Increased) Equipping with weapons and military equipment generated from the current technological revolution requires radical changes in the defence area, both in the combat component, i.e. changes of basic combat units that should optimally use these weapons (their doctrines, tactics, organization, training, etc.) as well as the *administrative-bureaucratic component of the national defence system that deals with the procedures of weapons development, production and procurement, which should follow the fastest pace of innovation ever in the commercial industry area.*

Conclusion: The authors would like to point out the interdependence between the emerging challenges of the 4IR and the directions of transformation of modern armed forces.

Keywords: industrial revolution, organization, transformation, war, unmanned/robotized platforms.

Introduction

Unmanned/robotized platforms significantly increase the operational capabilities of modern armed forces, presenting one of the main force multipliers of the military operation power, especially their collaborative action in combined arms operations, integrated into units equipped with manned combat platforms and supported with Command Informational Systems (CIS) of the new generation based on artificial intelligence. Such a combination enables to make maximum use of huge sensor potentials, reaction speed and lethality of robotic systems with cognitive capabilities of soldiers in manned platforms. The level of force protection is significantly improved and at the same time the level of situational awareness, the quality and speed of decision making by commands, with accelerated combat dynamics will radicaly change and reshape the combat philosophy in the near future. Despite the advantages of their application in armed forces, no military in the world is able to quickly introduce radical structural changes that the appearance of unmanned platforms and robotic automation inevitably brings with it, especially not at the speed at which these platforms are developing.

Therefore, it is necessary to have a holistic approach and develop robotic platforms and in parallel the related doctrines of their usage, and finally, most importantly, the organization of the forces that use them, with a lot of experimentation until reaching the optimal solution.

Tectonic global changes are accelerating since the establishment and then the demise of the bipolar world, i.e. since its transformation into the unipolar world with the multipolar world emerging before our eyes, at a speed that is difficult to understand, since we are accustomed to conditions that last for several centuries, a whole century or at least 50 years.

The speed of social changes is conditioned, first of all, by technological achievements that are developing like never before in the entire human history. In relation to the overall development of the mankind, the journey of one and a half century, which man has travelled from pre-industry to the 4IR, to which we are contemporaries, is quite short.

Nowadays, the pace of changes makes a clear difference between "small and big players", i.e., between those who are only able to use the results of technological achievements, and those who develop these achievements.

In other words, in the modern world, the former will remain deaf and blind consumers of the knowledge of technology owners, and the latter will be able to leverage their role in the development of innovations through the paradigm of the overall struggle for supremacy in international relations. The use of the 4IR achievements for military purposes has potential and tendency to change the philosophy of combat operations, the existing doctrines of each and every branch and service of the armed forces, the strategy and the usage of armed formations in war.

Although the time to come will judge the correctness of the following lines, we predict that even small countries (in terms of territory, population, economic strength, etc.) that can manage to keep pace with the development, production of robotic combat systems and their integration into combat units (in the previously described way), will in the very near future ensure the necessary level of capability and competence of their armed forces to enable security independence or neutrality primarily through deterrence.

Fundamentals and terms

Industrial revolutions and their basic characteristics are (Schwab, 2016):

- First industrial revolution: Water and the power of steam bring unprecedented mechanization of production,
- Second industrial revolution: Electricity and electrical machines enable mass production,
- Third industrial revolution: Electronics and information technologies will enable the automation of production and increase in produced quantities, and
- Fourth industrial revolution: Erasing the boundaries between the physical, digital and biological spheres with the aim of smart automation and increasing the interconnection of system elements.

The basic technological innovations in the Fourth Industrial Revolution are (Schwab, 2016):

- Artificial intelligence[1],
- Robotics,
- Autonomous systems,
- Fast production technologies/3D printing,
- Nanotechnologies,
- Biotechnologies,
- Energy storage, and
- Quantum computing.

In the future, the mentioned and unmentioned technological innovations will bring an increase in the overall combat capabilities of armed forces, including an increase in the ability to manoeuvre, fire and move, protect one's own forces and increase situational awareness on the battlefield from the strategic command level down to the individual soldier.

The need to introduce automatization in the process of decision making, command and the use of forces is rapidly emerging, and the reaction time from receiving reconnaissance data to the target engagement will be measured in minutes/seconds (Bishop, 2006).

At the very centre of the development of the mentioned abilities that are related to artificial intelligence (AI), there is an activity called machine learning (ML). Such learning involves the development and use of a computer system that, without prior explicit instructions, using algorithms and statistical models, analyses and derives conclusions/predictions from "patterns" in the data and it can be (Russel & Norvig, 2016):

- supervised learning,
- unsupervised learning, and
- reinforcement learning.

For military purposes, a model will be used that enables the highest possible combat capabilities, regardless of ethical obstacles (which will be discussed later) that have not prevented the world's armed forces from renouncing their firepower or lethal power.

[1] Author's remark: A computer system that, by using a large set of data, is aimed to perform tasks that normally require human intelligence - visual and audio perception and recognition, reasoning and decision making (digital intuition).

Robotic combat platforms (RCP)

Robotic combat platforms or robotic combat systems (RCP or RCS) in use, and especially those under development, can be divided into two main categories, depending on their concepts.

The first group includes those designed to imitate the behaviour of insects - to be used en masse (in swarms) thus overcoming the opponent's defence - not their individual qualities, but their numbers and coordinated movements and actions. Such platforms are an expendable resource; a good part of them can be considered ammunition (killer/kamikaze drones) and must be as cheap as possible. They will incorporate fast production technologies, ultralight materials, miniature sensors, and protected telecommunications with very high bandwidth and of course artificial intelligence (AI), i.e., powerful algorithms with machine learning (ML) for image processing (Sutton & Barto, 1998), target recognition and coordination of the movement of the entire swarm during the execution of the task (e.g. attack on the given types of targets).

The second group includes robotic combat systems designed to imitate a human warrior or a manned combat platform and should be integrated and used within formations/units that use conventional manned ground, air or naval weapon systems. Such platforms are much more valuable, more expensive, with individual combat characteristics similar to corresponding manned platforms and will require an increased level of combat toughness. All current technologies applied to newly developed manned platforms are relevant to this class of robotic combat systems.

Airborne robotic combat systems, either offensive (UCAV[2]), which as a rule are sent into the enemy's airspace in front of piloted formations and controlled from the ground, or those of the *Loyal wingmen*[3] type, which will be integrated into piloted aircraft formations and directly controlled by them, have a stealth design, are made of a new generation of composite materials, have similar flight-dynamic characteristics and are equipped with similar sensors (radar and optoelectronic), systems for electronic reconnaissance, anti-electronic combat and self-protection, links and weapons as multipurpose aircraft of the latest generation.

Therefore, all applied technologies for the development and production of the aforementioned subsystems will be applied to airborne

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[2] Author's remark: UCAV (Unmanned combat aerial vehicle) - an unmanned combat aircraft with the task of surveillance, reconnaissance and combat action on observed or assigned targets.

[3] Author's remark: The first flight of the robotic combat system *Loyal wingmen* was carried out by the RAAF, Boeing Australia, on 27 February 2021.

robotic combat platforms. The exception, of course, are systems for the direct functioning of the pilot (survival, visualization, control, etc.) whose overall system and subsystems design, due to the absence of the pilot, require a somewhat reduced level of redundancies due to the generally reduced required level of reliability of the entire system, which contributes to the reduction of its price and mass and can affect the increase of dynamic characteristics. Certainly, both artificial intelligence and machine learning are essential for the functioning of these RCPs because they should provide them with the necessary level of autonomy - from avoiding obstacles, collisions in airspace to avoiding or responding appropriately to perceived threats and detecting and recognizing targets and using their own weapons.

Ground robotic combat platforms have a concept similar to that of manned vehicles, most often tracked, less often wheeled; they are equipped with remote-controlled weapon stations, generally standard ones, i.e. developed for manned combat vehicles. Therefore, as with air and ground robotic combat platforms, all the technologies planned for application on current platforms with crew, sensors, weapons, ammunition, protection, camouflage, propulsion and transmission, etc. will be used. Also, the design of both manned platforms and RCPs will represent an appropriate compromise of technical solutions in order to achieve a balanced ratio of protection, tactical agility and lethality in accordance with the tactical-technical requirements (TTR) for a given vehicle category.

The current US strategy for the development of (robotic) ground land forces (and which will probably be followed by other advanced armies, both allied and adversary), envisages the development of three categories of robotic platforms (U.S. Army Training and Doctrine Command, 2017). The first consists of light robotic combat systems that are deployed in front of other forces both in attack and defence and will be the first to cross the line of contact with the enemy; the second group are medium robotic platforms deployed between light and heavy ones with an increased level of protection and lethality; and finally heavy platforms deployed together with formations of manned vehicles (MUM – manned – unmanned teams) and with the characteristics (protection, lethality and mobility) at their level.

When it comes to protection, it will represent a combination of camouflage measures, emission management in the EM spectrum (reduction of reflection in all parts of the EM spectrum and the probability of detection or identification) and passive (les often active) ballistic protection, depending on the vehicle-system category. The level of ballistic protection will certainly be lower than that required for modern manned vehicles and will range from minimum protection of vital subsystems for observation and communication in light RCPs (in order to preserve at least the reconnaissance functions in the event of combat damage to the platform), through protection at the level of STANAG 4569[4] level 2–3 in medium RCPs, up to the level of protection for the heavy RCP equivalent to the one for the main battle tank. The Serbian robotic combat platform *Mali Miloš* was conceived from the beginning as fully protected with armoured steel plates. The next version of this family will have a modern composite armour made of ceramics and HMWP polyethylene plates.

The next generation of such vehicles will benefit from the progress in developing new materials such as lighter and more resistant materials, for example non-Newtonian fluids for ballistic protection, materials enabling advanced camouflage through biomimicry (Biomimetic), as well as intelligent materials which will enable the collection of energy from the environment - Energy Harvesting or the monitoring of the state of an unmanned system in real time - Structural Health Monitoring. They will even enable self-healing in some domain - Self-Healing Materials (Miloradović, 2022).

The most important technologies applied to RCPs

The physical environment in which unmanned autonomous systems operate varies on land, at sea, under water, in the air, and in space. Electromagnetic waves, light, vibrations, and heat spread differently through different media. Also, the principles of movement in the air and in the water cannot be the same due to the different density of matter and the corresponding laws of fluid dynamics that are completely different from those that apply to movement on the land. Therefore, some technologies, materials from which the structure is built, power units, systems that ensure manoeuvrability, observation and communication systems applied to RCPs specialized for operations in these different domains will certainly be different. Also, optimal energy sources for use in different domains will be different. For example, fuel cells are more suitable for underwater systems, batteries and hybrid drives are more suitable for light air and land platforms, and fossil fuel power units are still optimal for heavy land and air platforms which use oxygen from the air.

Of course, there are also technologies that, with more or less variations, are applicable in all four domains. For example, the architecture of electronic components is the same for all applications in all domains. In addition, the 4IR tends to encompass and pervade all aspects and

[4] Author's remark: NATO AEP-55 STANAG 4569 - NATO standardization for "Protection Level for Occupants of Logistic and Light Armoured Vehicles".

domains of human life and actions equally, and it is in its essence to unite different domains and worlds.

It is certain that all technologies related to humans, from the individual combatant/system operator to the highest joint command of armed forces, will by their nature converge towards more or less similar solutions in all domains. More precisely, in the coming revolution in the warfare of combined human-robot armed forces, the human factor becomes the key limiting element and its ability to manage all these systems (and management and control will practically be the only functions left for exclusive human actions) will require a significant technological reinforcement adapted to the man as a unique biological mechanism, regardless of the domain in which the object of his management is.

This, therefore, refers to command and information systems (CIS) and management control consoles and devices (Man Machine Interface - MMI) which have been operated in all physical domains with all available forces, including all available manned and unmanned platforms and all application hardware and software solutions (Miloradović, 2022).

It is in this area that AI/ML will be of great importance and will make a huge difference in the combat capability between armed forces that make such advances in force integration and command and those that continue to perform this function in the traditional way; this difference will probably be more significant than the difference any single combat system or a planned "superweapon" can bring (Miloradović, 2022).

It is evident that within the framework of the new geopolitical paradigm of the renewed competition of global powers in the multipolar world, as well as under the influence of the revolutionary development of new military technologies, especially those that are the subject of this discussion, a fundamental change is taking place in the capabilities of the armed forces of the main global players from the highest strategic down to the lowest tactical level. Operations will be carried out simultaneously in as many as five domains (land, water, air, space and cyberspace) and will involve the application of a wide range of combat and non-combat activities where the commander of the operation will, optimally and much faster than before, use the resources assigned to him from all five domains and choose "services" that are necessary for him at a given moment or are the most appropriate.

The first task that such an organization should achieve is decision dominance in relation to the adversary, i.e., to faster analyse and understand the operational picture of the battlefield formed on the basis of information collected from all the mentioned domains formed and refreshed in real time, and make decisions faster and act faster than a potential adversary (U.S. Army Acquisition Command, 2022).

One of the current Battle Management Systems (BMS), being developed with such a goal, is the American CJADC2 (Connecting Joint All-Domain Command and Control), which on a global level provides assistance in command (U.S. Army Acquisition Command, 2022). That system, helped by massive AI/MU algorithms, significantly shortens the time that the command staff would spend on deciding in certain situations and allows the order/instruction and the necessary data for the operation to be transmitted in seconds to the best positioned units or effectors.

Apart from this example of AI-supported BMS at the highest strategic level of command, and as an illustration of currently applicable technologies, we also cite an example of AI-supported BMS at the lowest tactical level, i.e., at the level of an infantry (robotized) platoon, and the individual soldier/operator within it. It is called AISUM (Artificial Intelligence for Small Manoeuvre Unit) and is a part of the US Army project 10X Platoon[5] (Platoon - robotic - tenfold increased combat capabilities). A specific requirement that this BMS should achieve is a tenfold shortening of the OODA loop[6].

The system enables the data fusion of sensors integrated on both robots and soldiers, creation of a simplified picture of the situation with indicated goals and instructions of the higher command, its analysis and recommendation of specific activities, with the aim of improving and greatly accelerating the decision-making and execution process. At the robot level, the BMS enables autonomy of movement and even opening fire on targets previously approved by the operator, which significantly reduces the burden on the soldier and speeds up the control of the robot - individually and collectively at the platoon level.

The visualization system integrated on the soldier's helmet projects symbology onto a realistic 2D image of the environment. The system is connected by radio to both the soldier's personal weaponry and the RCP which the soldier controls thus enabling the use of different packages of weapons that the RCP can be equipped with.

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[5] Author's remark: still in the experimental phase.
[6] Author's remark: OODA - Observe, Orient, Decide, Act.

Ethical issues of the use of the RCP and artificial intelligence in general

Every new technology, especially the so-called "disruptive technologies" (Armstrong, 2017), in addition to solving a certain class of problems, also brings with it the unknown as well as many organizational and ethical problems and dilemmas. But since the discovery of the atomic bomb, nothing has agitated the imagination of both the civilian and military public as much as artificial intelligence, and especially weaponized artificial intelligence, i.e., artificial intelligence-controlled RCPs. The atomic bomb created the possibility that the human race could destroy itself with its technology, and artificial intelligence brings a theoretical possibility that technology could destroy the human race without the latter's participation or will. It has captured the global attention for the last 30 years and brings significant revenue to the sci-fi film industry ever since.

In the last two decades, this issue has been seriously discussed at the level of the armed forces and defence ministries of a number of countries. The first legal regulations were passed and adopted, the essence of which boils down to the following: "autonomous and semi-autonomous weapon systems must be designed to enable commanders and operators to exercise an appropriate level of human judgment over the use of lethal force" (Department of Defence US army, 2012), which means that a robot must not be allowed to (independently) decide to kill a human.

According to the currently generally accepted gradation of the autonomy of unmanned systems (from Level 1- fully remotely controlled by a human to Level 10 - fully autonomous in the execution of a task previously obtained by a human) RCPs can be divided into those with "man in the loop", "man over the loop", and "a man out of the loop". The world famous unmanned aerial vehicle *Predator* was probably in Level 2 on the said scale. RCP systems under development today mainly belong to those with a "man over the loop" with a high level of autonomy in movement and limited autonomy in fire action, i.e., that the operator issues an instruction based on the recommendation of the artificial intelligence, and the sighting and shooting process is performed by the robot with the possibility of the operator stopping it. Imagined combat actions in the future with mass strikes of robotic "swarms" from the air, purely robotic or mixed human-robotic ground combat formations, require a dramatic shortening of the OODA loop.

In just a few seconds, it is necessary to detect the threat, evaluate the threat, choose an adequate response and take action, while the number of possible simultaneous threats is measured in the hundreds. It simply exceeds the mental and physical capabilities of the man. Human capabilities barely allow a quick response to an individual threat. It is clear that humans (in other words, the limitations of human biology and ability, i.e., slowness in processing information and reacting) reduce the overall efficiency of future human-robot armies and individual RBPs (used in groups); therefore, they will inevitably become more and more autonomous, and the above described moral dilemmas and risks of misuse are increasing.

The previously described MMI (man-machine interface) and CIS are tasked with ensuring maximum efficiency of the system, i.e., to facilitate and speed up human reaction and still provide sufficient control over the effect of weapons in accordance with current legal norms. One can imagine the consequences of a situation in which the artificial intelligence of the above-mentioned global CIS, which controls a huge number of combat systems (including autonomous ones), issues a "wrong recommendation" to the commanders, and they, not seeing the error or errors, transmit such commands and coordinates for action.

A similar level of moral-ethical dilemmas (with enormous possible progress) also brings the issue of the potential application of HA - "human augmentation" - the improvement of human abilities with the application of technology. Science (medicine) has been working for millennia on technologies for maintaining and repairing the human body, i.e., restoring its abilities degraded by aging, diseases or physical injuries. However, the technologies that will enable not renewed but "superhuman abilities" are maturing rapidly and of course will find military application first. We can conditionally divide them into "wearable" ones, i.e. placed on the human body, and "built-in" ones, i.e. which are implanted (surgically) in the human body. The beginning of the (massive) use of the former is a matter of solving the remaining (not crucial) technological problems and does not carry with it any moral dilemmas. To mention some of the most interesting ones: shortening the OODA loop is key to increasing the efficiency of any weapon system or military formation, and AR (AR - Augmented Reality[7]) is currently a key technology for that purpose (Miloradović, 2022). AR allows the transmission of symbology, imagery (processed by AI), information and instructions from sensors, weapon systems, and CIS to a helmet-mounted device.

[7] Author's remark: AR - Augmented Reality - augmented reality with digital information about the environment in real time, i.e. an image of the real environment with perceptual information generated through it from the sensor into the user's field of vision.

It has been in use in aviation for decades, and through numerous projects of "soldiers of the future", this ability will soon be acquired by most infantrymen of modern armies, as well as combat vehicles crews (Through Armour Vision[8]) (Miloradović, 2022). For the needs of the Serbian Armed Forces, at least two helmet systems are currently being developed, for which there are ambitions to be further refined with AI technologies. RCP management at a low tactical level will be dominantly based on this technology.

By using a (powered) exoskeleton, a soldier will be able to carry a standard load of clothes, equipment, ammunition and tools - 60+ kg according to today's standards (Headquarters Department of the US Army, 1990) and uphill, with the effort of walking on the beach in a bathing suit. And in the near future (when new energy sources of higher energy density become operational), soldiers will be able to carry heavier and stronger armour as well as more powerful and heavier weapons.

Another ones, built-in (implanted) technologies, "threaten" to move rapidly from the domain of science fiction to the domain of real application.

The miniaturization of sensors, computers and communication systems will allow IR, acoustic sensors, position sensors, and others, to be "embedded" in or behind the human eye and ear, enabling significantly increased sensitivity. This will also enable embedding processors with AI/ML algorithms which will process information from these and natural sensors and communicate with the human brain, giving it "superior cognitive abilities", or installing RF transceivers that would enable "telepathic" communication, as well as supplying all of these with either artificial or natural energy sources available in the human body. The moral dilemmas related to the emergence of such super-soldiers with "technological implants provided with superhuman abilities" are comparable in importance to those related to the emergence of "self-aware armed artificial intelligence" and will probably slow down the application of the mentioned technologies, but cannot completely prevent it (Miloradović, 2022).

Organizational problems and dilemmas

Martek's Law (Brinker, 2013), states that "technology changes exponentially, while the organizational structure changes logarithmically", meaning much more slowly. Organizations work on the basis of

[8] Author's remark: Visibility through armor - a set of monitors including head-mounted ones that project an image of the environment from cameras/sensors deployed on vehicles, giving full visibility of the environment.

regulations and procedures, and the related bureaucracy, as a rule, "defends itself against changes" by using those regulations, and tends constantly to enlarge itself and to "regulate or prohibit something additionally". This especially could be applied to revolutionary technologies because they inevitably bring dramatic changes to the organization, and the administration, which naturally tries to delay this happening stressing potential hazards and the need to "further improve technology" before it is applied.

However, when the international circumstances reach the point they are now at, with the increased danger of the outbreak of a direct global armed conflict, which otherwise is already raging in all but the kinetic - armed phase, the management of the leading military organizations become aware, and rightly so, that the technological progress of potential adversaries threatens significantly to change the balance of power. Then the hunger for "disruptive technologies" overrides the comfort and established practice of the bureaucracy, and the threshold of tolerance for new and not yet fully perfected technologies grows, as does the budget for their acquisition.

By its nature, the technology of the 4IR brings the democratization of industry and production in general, because it enables a small group of people working from their homes, without huge investments in production facilities with numerous highly specialized workforce, to achieve notable technological development and commercial success. We see that the defence organizations of the most powerful countries (MoD of France Directorate for Innovation, numerous agencies under the DoD and the commands of the US Armed Forces) and even multinational organizations (NATO - DIANA) are urgently reorienting themselves and their operational procedures to use such entities (SME - Small to Medium Enterprises) as the main actors of technological development.

Also, there are more and more doctrinal documents and instructions announcing greater innovation within military organizations, the need for "a cultural change that follows changes in the economy, civil technologies, organizations and society in general..." (U.S. Army Training and Doctrine Command, 2017) constant improvement (not only related to weapons), constant reorganization and transformation, in other words: "transformation is a way of life thus it never ends, one can only finish the ongoing phase of it". It also demands constant experimentation with both organization and technology, preferably at the same time (Miloradović, 2022). We see that, through the Soldiertouch series (repeated experiments organized in a simulated combat environment as realistically as possible), experimental units are testing systems of "commercial quality" and at an increasingly lower level of technology readiness/maturity (TRL - Technology Readiness Level).

As history teaches us, the results and lessons learned from globally significant wars (the one currently being fought in Europe certainly comes into this category) dramatically speed up the change. Naturally, and following the instinct for self-preservation, smaller countries should be even more aggressive, bolder in experimenting and applying both technological and organizational novelties in order to balance or (at least partially) reduce the natural advantage of larger and by nature more bureaucratized and regarding innovations slower potential opponents. Undoubtedly, there are such examples (Miloradović, 2022). Time is probably the only natural resource that is equally distributed to everyone. Those who manage that resource more successfully, i.e., do not spend it (too much) on procedures, bureaucracy, internal tensions regarding responsibilities and priorities, accept risks and implement innovations (proven to be useful and feasible by experiemnts), adopt visions faster, make decisions that will be, with (other) available resources, implemented quickly - have a chance to gain an advantage over opponents who use that resource less successfully, even though their other potentials are greater.

Therefore, we believe that we will see an increasingly rapid application of "revolutionary weapons" in the immediate future, including RCPs that are the subject of this paper, and that the ethical issues related to their application by the main global factors will "become less relevant".

Certainly, the technologies described here will be used for some time (probably by the end of the next decade) to increase the effectiveness of actions based on already existing concepts of operations, without dramatic changes in the structure of military organizations and hierarchies. It is likely that advances in technology (perhaps by the middle of this century) will cause a dramatic change in concepts of operations and lead to heralded dramatic changes in the military organization itself (Hubin, 2012). It is possible that at the end of the century we will face the described catastrophic scenarios of the conflict between the human race and its self-aware artificially intelligent technology. We believe that the former will be naturally intelligent enough to restrain the latter and ensure their joint journey into the future, and thus their further prosperity.

The Serbian Armed Forces capabilities development by implementing the achievements of the 4IR focusing especially on robotic automation

By following actively the global trends in equipping with armaments and military equipment (AME), as well as by analysing the lessons from low and high intensity conflicts worldwide (Middle East, Central Asia and West Africa, above all) and especially these from the ongoing war on our continent (in Europe), the Serbian military also recognized an urgent need for the development of robotic capabilities.The collected war experience, especially from the current war in Ukraine, unequivocally confirms that the described tectonic changes already exist in all areas of development, production and use of RCPs for military purposes.

It should be mentioned that the Serbian Armed Forces have already been equipped with various ground and airborn unmanned platforms for many years, intended mainly for combat operations, reconnaissance and logistical support. They were developed and procured at the individual request of certain branches and services of the armed forces. They are the result of domestic development and production or produced in cooperation with foreign partners or acquired as finished products from foreign suppliers. Nevertheless, following the collected experiences, and with the aim of implementing the achievements of the Fourth Industrial Revolution in the armed forces, the need has emerged to have a comprehensive approach and further massively equip all branches and services of our armed forces with robotic/unmanned platforms. Special attention should be paid to the transition from remotely controlled platforms to robotic platforms. In this way, the emphasis will be on the development and procurement of new unmanned platforms with more autonomous functions based on artificial intelligence but also on the successive improvement of the already introduced systems without the mentioned functions in order to expand their autonomous capabilities.

In the following period (and in accordance with the already determined types and quantities), it is necessary to equip the Serbian Armed Forces with ground and aerial unmanned platforms, starting from the lowest tactical level in infantry, mechanized and special forces, up to the level of artillery and aviation brigades. At the same time, assessing the current threats to the security (in view of the Serbian military neutrality), it is necessary to complete the structure of their optimal deployment in military units and enable their integration into a unified CIS operating on advanced software solutions. The mentioned activities should be carried out in order to:

- Improve situational awareness at all tactical/operational levels,
- Improve the command&control with the development of appropriate CIS,
- Increase force protection, and
- Increase the effective range and lethality of combat units armed with unmanned platforms.

In this regard, it is necessary to equip the Serbian Armed Forces with several dozens of types of ground and air combat, reconnaissance and logistics unmanned systems. Bearing in mind the increasing combat importance of *Loitering munitions* - i.e., killer drones, which have shown great effectiveness in current conflicts, it is essential to procure large quantities of various types and categories of these assets.

It is necessary to perform equipping following the principle of successive, individual and incremental introduction of one system at a time, along with the development of the doctrine of use and the user's organization. Also in parallel, the entire military-industrial complex of the Republic of Serbia (with their foreign partners) has to make additional effort to develop/produce appropriate unmanned platforms and to experiment with the aim of finding optimal solutions: technical, doctrinal and organizational.

Conclusion

The current trend of technological development within the most modern armed forces: USA, Western countries, but also technological giants of the Far East (China, Japan, Korea), indicates that, in the coming period (not later than 2030), a new generation of weapons will be implemented based on the achievements of the Fourth Industrial Revolution followed by the corresponding transformation of their armed forces. In addition, by 2050, there will probably be a drastic change - a "revolution in military affairs" as well as derogation from hundreds of years old principles of classic military structures and their combat operation principles.

One of the basic elements of that revolution is (gradual) robotic automation, both in terms of the increasingly massive application of unmanned and robotic platforms, as well as the automation of command and decision-making functions.

Spectacular results in this area have been achieved so far by many advanced militaries worldwide, accompanied by various experiments, conducted from the technological aspect as well as the tactical one. Due to many challenges and constrains, the process has a slow pace, with none of the armed foces having implemented it completely throughout all branches/services and unit levels, especially not within the entire ground forces.

The US Army have achieved most in this direction, planning to form the first robotic companies within cavalry battalions in the Army brigades by 2028/2030.

The Serbian Armed Forces are currently the regional leader in this area, having achieved more than many bigger and more developed European countries, especially in terms of the development/procurement and operational use of armed drones and remotely controlled ground combat platforms. It should be emphasized that such types of platforms are significantly more complex to operate than purely reconnaissance ones, but they contribute much more to the overall operational capability due to their ability to perform a wide range of missions.

Today, the Serbian military industrial complex has significant technological capabilities in this area.

The Ministry of Defense of Serbia intends to further expand the technological base predominantly by including more scientific research organizations, technical institutes and private companies that have the ability to master appropriate technologies needed for development and production of unmanned and robotic platforms.

In the next ten-year period, a huge gap in capabilities will arise between the armed forces that will implement the results of this "robotic revolution", and those that fail to do it; consequently, the Republic of Serbia, as a militarily neutral country, must not lag behind.

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Вызовы четвертой промышленной революции, трансформация современных вооруженных сил и моральная дилемма, связанная с роботизацией

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РУБРИКА ГРНТИ: 78.03.02 Общие проблемы войны,
78.19.13 Теория управления вооруженными силами,
78.25.00 Вооружение и военная техника,
ВИД СТАТЬИ: обзорная статья

Резюме:

Введение/цель: Первая промышленная революция использовала энергию пара и воды для механизации производства. Вторая − использовала электроэнергию для массового производства. Третья промышленная революция использовала электронику и информационные технологии для автоматизации производства, в то время как четвертая промышленная революция направлена на стирание границ между физической, цифровой и биологической сферами, с целью достижения интеллектуальной автоматизации и увеличения взаимосвязи элементов системы. Таким образом, предыдущие промышленные революции изменили то, как мы работаем, а следующая меняет то, как мы размышляем. Нашему поколению выпала привилегия быть современником тектонических технологических изменений, стать свидетелем изменений, которые коренным образом преобразуют производственные процессы и отношения на производстве, а также свидетелем изменений, которые эти продукты привносят в функционирование человечества, начиная с отдельных людей и кончая государственными организациями, включая Вооруженные силы. Основная цель данной статьи − указать широкому военно-академическому сообществу на необходимость координации и взаимозависимого развития боевых систем, доктрин и организации.

Методы: В данной статье применялись общенаучные методы, которые используются или могут быть использованы для приобретения научных знаний во всех научных областях и дисциплинах. Между ними выделяются: гипотетико-дедуктивный метод, дедуктивно-аналитикий метод и сравнительный метод.

Результаты: Настоящая технологическая революция повлекла за собой ускоренное вооружение и оснащение военной техникой и, безусловно, требует радикальных изменений в области обороны как в боевой части, то есть изменений в основных боевых подразделениях, которые должны оптимально использовать это оружие (доктрины, тактика, организация, подготовка и т.д.), так и в административно-бюрократической части системы национальной обороны, управляющей процедурами разработки, производства и закупок вооружения и военной техники, которые должны соответствовать скорейшему темпу внедрения инноваций в сфере коммерческой промышленности.

Выводы: Авторы статьи обращают особое внимание на взаимозависимость между возникающими вызовами Четвертой *промышленной революции и направлениями трансформации современных вооруженных сил.*

Ключевые слова: промышленная революция, организация, трансформация, война, беспилотные/роботизированные платформы.

Изазови четврте индустријске револуције, трансформација савремених оружаних снага и морална дилема у вези са роботизацијом

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ОБЛАСТ: технологије, инжењерство, машинско учење и апликације
КАТЕГОРИЈА (ТИП) ЧЛАНКА: прегледни рад

Сажетак:

Увод/циљ: Прва индустријска револуција искористила је моћ паре и воде за механизацију производње, друга – електричну енергију за масовну производњу, трећа – електронику и информационе технологије за аутоматизацију производње, док четврта индустријска револуција тежи брисању граница између физичке, дигиталне и биолошке сфере у циљу паметне аутоматизације и повећања међусобне повезаности елемената система. Дакле, претходне индустријске револуције промениле су начин на који радимо, док последња мења начин на који мислимо. Данашња генерација има привилегију да буде сведок тектонских технолошких промена, промена које суштински мењају производне процесе и односе у производњи, али и промена које производи уносе у начине функционисања планете, од индивидуа до државних организација, укључујући и војну. Основни циљ овог рада јесте указивање на потребу усклађивања развоја борбених система, доктрине и организације.

Методе: У овом раду примењују се опште научне методе које се користе, или се могу користити, за стицање научног сазнања у свим научним областима и дисциплинама, као што су: хипотетичко-дедуктивна метода, аналитичко-дедуктивна метода и компаративна метода.

Резултати: Опремање (убрзано) наоружањем и војном опремом, проистеклом из актуелне технолошке револуције, захтева радикалне промене система одбране. То се односи како на борбени део, тј. основне борбене јединице које то наоружање треба оптимално да употребе (њихове доктрине, тактике, организације, *обуке...), тако и на административно-бирократски део система националне одбране који се бави процедурама његовог развоја, производње и набавке, који треба да прати никад бржи темпо иновација у сектору комерцијалне индустрије.*

Закључак: Указано је на међузависност појавних изазова четврте индустријске револуције и праваца трансформације савремених оружаних снага.

Кључне речи: индустријска револуција, организација, трансформација, рат, беспосадне/роботизоване платформе.

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