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Wars in the later 21st century: Forecast developments in the methods of warfare

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Abstract

Objectives: This paper attempts to forecast the future of methods of warfare in the forthcoming decades of the 21st century. The predictions reflect on the current trends observed in the development of military and civil (dual-use) technologies and changes in thought constructs developed for hostilities.

Methods: Empirical and theoretical research methods were utilised in the study. The research data, obtained from a review of source materials, was subsequently subjected to examination through analysis, synthesis and comparison.

Results: The methods of warfare of the 21st century are likely to reflect the technological evolution of the modern age. Considering the present-day trends, it is very likely that our technology-driven lives will transform people into hybrids of biological organisms merged with the technological environment, integrated with the body. Therefore, hostile action against human soldiers could be taken on three major levels: the biological organism, the mass communication technology integrated into the body, and the mental level – both in the conscious and the subconscious sphere. The study into how the soldier's mental sphere can be influenced to anticipate and shape behaviour may contribute to further research on the third level impact on enemy soldiers.

Conclusions: The conclusions formulated in this analysis may carry significant implications for work on an innovative methodology of future warfare, accounting for the technological progress in the next decades of the 21st century, and a methodology for countering future military threats.

Keywords:

forecasting, future warfare, military technologies, dual-use technologies, hostilities

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Introduction

The war of the future is bound to resemble no previous conflict. In a relatively short time, humanity will have achieved incredible technological progress, which will radically change our approach to the methods of armed warfare. In fact, virtually all its aspects, including the term "armed combat," should be interpreted in a completely new way. In the future, the self concept of *a weapon* will no longer be inseparably connected with or defined by the domain of *the military*, as a matter of fact, it is *the non-military* that will have become available for the purpose of military applications – to the possibility for use as *arms*. Furthermore, the said shift from the standard understanding of a weapon includes the abandonment of the conventional idea of material weapons, non-material directed-energy weapons, non-lethal weapons, and also weapons that change the state of matter (gas, liquid, solid). The weapons of tomorrow target weak points pinpointed in enemy resources, *i.e.* both in the material (elements of biological organisms, technological or biotechnological elements) and the non-material dimension (electric and magnetic fields, sound waves, light waves, and quanta). In the long run, it is expected that the purpose of military attacks will no longer be to incapacitate or destroy designated targets but to assume control over them. The objectives of the war of the future will, therefore, focus on gaining control of the enemy potential with the purpose of, *inter alia*, strengthening one's own capabilities as a means to gradually absorb the potential of other enemies. Should such incorporation prove impossible or should it occur that the destruction of (material/non-material) hostile targets is a non-optimal solution, then the eventual solution will be their destruction. Anything one has at one's disposal may be turned into a weapon, which will be directly targeted at selected objects.

Considering the future background outlined in the paragraph above, this research seeks to address the following question: *What will be the methods of warfare in the 21st century?* In the course of the outlined investigations addressed, the question was subjected to prediction with the implementation of selected heuristic methods of forecasting: the historical analogy approach and the method of space-time analogy. The data for this study was collected using an empirical research method, namely a review of source materials, and subsequently examined by means of theoretical research methods – analysis and synthesis. In *Conclusions*, the comparative approach was utilised to formulate the findings from this analysis (Cieślarczyk 2006, pp. 40-62). Given the innovative nature of this study and the predictive character of the conclusions derived from it, it would be far-fetched to put forward any conclusive hypothesis. Therefore, the scientific effort was focused on the attempts to obtain an answer to the key question.

The vision of the future: The clash between armies of two technological speeds

A hypothetical assumption that a technologically advanced army of the present would stand no chance against the army of the 21st century may, at least initially, seem irrational. After all, the most technologically advanced American army failed to defeat the primitive measures of Vietnamese guerrilla warfare, nor was it able to successfully combat Iraqi or Afghan rebels. Be that as it may, those events took place at the end of the 20th and in the first two decades of the 21st century. Nevertheless, the capabilities of the most advanced of future armies will certainly be dramatically different. The military technology of the future is a virtually inexhaustible topic; however, prior to the presentation of the current developments in the field and predictions for the future evolution of the armed forces, let us now consider

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a vision of hostilities between an army of the early 21st century and an army of the end of the 21st century.

Although the vision to unfold is planned as a light-hearted introduction, an attempt to draw the reader into the necessary mindset, and push in a direction that may seem surprising at first, all its elements are rooted in the current research on military and dual-use technologies, to be presented in the subsequent section of this text.

Imagine an anonymous enemy, boasting a numerous army of mechanised and armoured troops, launching a coordinated attack simultaneously in several directions. Land forces receive support from artillery, air forces and communications forces operating both satellite and traditional infrastructure. The movements of the armed forces follow a carefully crafted plan, based on thorough intelligence and always preceded by the operation of unmanned reconnaissance machines, in air and on land. From the bay, the attack receives naval support, enhanced by their strategic deployment in tactical positions. What surprises the headquarters of the advancing army is that despite the reconnaissance data at their disposal, their troops are confronted by no enemy troops or any form of resistance. The assaulting army occupies subsequent, previously determined points, continually advancing their forward lines with no contact from the enemy party. It is only after a few hours that the malfunctioning of the entire ICT and radar infrastructure comes to light. More surprisingly, the soldiers' eyesight is found to have been compromised and the reality becomes distorted even further: the soldiers see dirt roads and forests where cities should be expected. Soon the counterattack begins, and yet its source cannot be clearly identified. Meanwhile, the ICT and radar equipment begins to misreport on enemy troops, whereas the senses of the soldiers (sight, hearing) confirm this erroneous information. A fratricidal battle that begins is not stopped until after a few hours and massive numbers of casualties incurred. It is at that moment that the advancing troops are reported to have become divided into smaller units under enemy fire with directed-energy weapons launched from land, air and space. One second, the enemy vehicles appear, and a second later, vanish into thin air. High-efficiency of strikes, surgical precision, destruction of pinpointed targets of stunned aggressor troops ensue. The soldiers are unable to concentrate or take any logical actions as they are constantly bombarded by thousands of contradictory thoughts, memories and sensory impressions. They experience cold and hot alternately. Chills shake their bodies and they sweat profusely, profoundly increasing their water intake. Autonomous systems remain incapacitated. At breaking point, as the enemy troops experience an overwhelming and insistent thought of surrender, they slowly begin to follow the instructions in their heads, ordering them to leave their vehicles and lie on the ground with their hands on their necks. Incapable of concentrating and having lost full control of their bodies, soldiers begin to recognise that further resistance is pointless. Not until much later does it emerge that, in fact, the losses were not that serious and the majority of soldiers, after penetrating kilometres-deep into the attacked territory, gave up without a fight.

The vision of hostilities outlined above is, admittedly, somewhat provocative and is deliberately evocative of an excerpt from a novel. The analysis to follow attempts to substantiate this science-fiction imagery employed in the presentation of immense disproportions between two technologically ill-matched armies, representing modern technology and the technology of the near future. Given the central research question is an open one, as an attentive reader might have certainly identified, therefore, the study falls within the scope of proper research. As expressed in the introduction, there is a definite correlation between technological evolution and a gradual change in the methodology of warfare, which results from the modernisation and new combat measures being introduced. Hence, it can be assumed that the hypothesis introduced here substantiates the formulation of the central research question. Technological innovations intended for future im-

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plementation constitute the independent variable affecting the dependent variable – the methodology of warfare. The following part of this paper moves on to describe in greater detail the technological novelty as a condition for the warfare evolution forecasts in the next decades of the present century.

Directed energy, electric and magnetic field: on a new battlefield

Research on directed energy concerns such solutions as (*Nowe założenia* ... 2014, p. 4): High Power Microwaves (HPM), High-Altitude Electromagnetic Pulse (HEMP), Microwave Stun Gun (MSG), High-Power Radio-Frequency (HPRF) weapons, and Radio Frequency Directed Energy (RFDE) systems. All these weapons are designed to fire directed energy at enemy soldiers so as to prevent them from continuing fighting. Therefore, developing weapons that utilise directed energy to influence the functioning of the five basic senses appears to be only a matter of the imminent future. In that case, it will be possible to influence the proper functioning of the senses, hence to project false sensations in soldiers or *e.g.* visual stimuli allowing the eye and brain to visualise an image perceived as reality. The same goes for any other sense. For instance, with respect to the sense of hearing, the photoacoustic imaging technology employs a laser beam that sends sound directly to the ear without the need for the use of headphones (Sullenberger *et al.* 2019). In the context of possible influence by means of directed energy, another important aspect concerns changes in the intensity of the magnetic, electric or electromagnetic field with the purpose of interfering with the proper functioning of human senses or overall destabilisation of the human organism.

The use of very precise destruction systems (both by directed energy, change of electromagnetic fields as well as microwave beam) (Wrzosek *et al.* 2018) completely changes the way of looking at warfare, especially with the use of a directed energy beam capable of destroying even very armoured targets. It turns out that nowadays, the mass production of means of destruction can be successfully replaced by the quality achieved by both precision and dispersion of these means of destruction. As a result, we are dealing with widely scattered means of destruction with directed energy, the effectiveness of which is one hundred percent every time. Referring to the contemporary conflicts in Ukraine and the Middle East, both these conflicts have been notable for the mass use of military equipment of the older generation supported to a limited extent by modern technology, such as: network-centric combat systems and cyber warfare technologies. In practice, it was a combination of the existing armaments with elements of the modern battlefield, which was a manifestation of the developing hybridisation of the way in which warfare was conducted during modern armed conflicts.

At the same time, it is not easy to talk about next-generation wars if both sides in the conflict used modernised or upgraded equipment with a genesis dating back several decades. The introduced elements of reconnaissance and network centricity allowed only more effective management of combat forces and means in real time, but the methodology of warfare itself was and still is strongly rooted in the above-mentioned conflicts in the 20th century. Simply put, any ammunition using a combination of a bullet, a powder charge, an incendiary charge and a shell that connects all these elements is now a relic. Old war technology functions only thanks to successive modernisations. In the industrial era, it was equally possible to create better and better bow and crossbow arches, as well as to refine the arrows and bolts used to fire them. However, this does not change the fact that the gap between the bow and the rifle was and still is enormous. Since nowadays, all

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armies of the world base their functioning on firearms, it is obvious that this weapon will not be withdrawn suddenly. At the same time, however, research should be carried out into the development of alternative means of destruction based on innovative technologies, such as directed energy. Otherwise, over the next few decades, armies based only on increasingly better firearms will be able to buy from those countries which, in the meantime, will be able to develop modern means of destruction. Now is the time to develop and test these weapons. Such an approach will make it possible to find oneself in an exclusive club of countries with their own solutions within the next few decades. Then, in relations with other disposers of such means of destruction, it will be possible to conduct talks on equal terms. Countries which have only gunpowder and ballistic technology will then be able to act as petitioners asking for less advanced solutions in relation to those used in the most modern armies at that time.

Autonomous and automated weapons as key elements of new military operations

Considering the aspect foreshadowed in the conclusion of the previous section, it should be noted that the autonomisation of land, air, sea and submersible weapons is progressing (Ha *et al.* 2019). An important representative in the new wave of weapon systems is the Orca Extra-Large Unmanned Undersea Vehicle, a 51-feet-long vessel weighing approximately 50 tons, capable of operating for several months without surfacing (Mizokami 2019). Another novelty: miniature flying drones that will soon be available to every American soldier. They are designed to increase the detection capability of distant threats to ensure reliable elimination of concealed targets (Pickrell 2019). What must not be omitted from the list is the famous drone design, Kratos XQ-58 Valkyrie, an economical, high-speed unmanned combat air vehicle (UCAV) developed for the United States Air Force.

The largest armaments companies such as Rheinmetall, Lockheed Martin, Northrop Grumman, and BAE Systems have started to develop the new applications of autonomous systems.

Lockheed Martin, for example, has presented an unmanned ground vehicle (UGV) for carrying equipment, weapons, medical supplies, as well as rations. Northrop Grumman's autonomous vehicle was projected to improve airbase operations and BAE Systems is still developing a project dedicated to the medevac vehicle for transporting wounded soldiers back to base. Similar kinds of military services based on UGV technologyare also being developed by the Rheinmetall company. Much research is also being carried out in this field by Northrop Grumman in collaboration with DARPA (an autonomous vehicle for use on airbases to aid in airfield related tasks, such as towing and equipment transportation) and Uber (project ACUGOTA).

In practice, today, almost all available technology allows soldiers to command teams of autonomous machines in the form of land, water and air platforms. These vehicles can independently map the area and choose the most convenient route to reach the destination (Osario and Pinto 2019). Today, armaments companies are working on a range of vehicles that autonomously follow the lead vehicle, which in turn follows the soldier. The vehicles in their modern versions are used mainly for transport purposes, but, in the future, they will be able to serve as a combat team performing the instructions of a human commander, deploying themselves on the battlefield and performing the tasks entrusted to them. Machines equipped with artificial intelligence modules will be able to independently assess the situation on the battlefield and make optimal decisions. Such vehicles will be able

to operate in an environment that is extremely unfriendly to human beings, which may be affected by numerous factors of a climatic, environmental, and even biological and chemical nature. In the future, the fighting environment may also become the ocean deep and space (Esch *et al.* 2017). A certain solution allowing a soldier to be directly present together with his troop of autonomous machines may, in the future, be improved assisted armour, which is an advanced form of modern exoskeletons (Crouch 2019).

Finally, bearing in mind the potential exhibited by modern exoskeleton designs and sophisticated biotechnological microchip implantation in humans, the physical and intellectual capabilities of future soldiers may vastly exceed the present-day idea of the future combat effectiveness of human soldiers (Mudie *et al.* 2016).

Thus, in summary, human combat commanders of tactical combat teams composed mainly of machines will be able to operate in different environments with the support of network-centric technologies, including battlefield imaging provided by tiny scaling and image processing devices scattered over the theatre of operations in real time. Nowadays, this role is played by small drones, which the American army has introduced into th its soldiers' equipment. This is only the beginning of the revolution, which will culminate in the so-called "battle dust" composed of tiny drones (the size of an insect) and the ability to record all changes in the area of warfare (Wrzosek *et al.* 2018). In combination with autonomous vehicles and the possibilities resulting from the use of assisted armour and fire support in the form of energy-driven means of destruction and changing the intensity of electromagnetic fields, such teams will be able to paralyse the actions of a much larger enemy using only modern military technologies.

It is also worth mentioning the camouflaging systems, which are currently under development, such as one of the latest inventions of BAE. Scientists have developed a method of camouflaging combat vehicles, which allows the infrared traces left by these vehicles to be hidden, which means that even night vision devices will not be able to detect a trace of such a camouflaged machine. This technology is known as Adaptive, which very quickly changes the temperature emitted by the vehicle, which also eliminates the light trail seen by night vision devices. Another type of camouflage is the so-called e-camouflage, which in turn uses sensors placed on the vehicle's armour, emitting an image behind the vehicle, which has a similar effect to the one known from Predator's pop culture. These sensors placed on the machine work in a similar way to the chameleon skin. Scientists at the University of Dallas, on the other hand, used the refractive effect of the light waves in contact with the water surface by artificially inducing temperature differences. When exposed to high temperatures, the light wave bypasses the masked object and makes it invisible to the human eye. Physicist Baile Zhang has developed a material that refracts light so perfectly that the vehicle hidden underneath it becomes almost completely invisible to humans. Research and development work are constantly being carried out on more and more advanced camouflaging technologies that allow a given object to be hidden from human sight, as well as thermovision, infrared and radiolocation (Wang *et al.* 2013). Therefore, it can be assumed that in the next decade, it will be possible to almost perfectly cover/camouflage entire units. These technologies will be further improved in the next few decades.

Modern weapons as a network-centric, asymmetric-hybrid system

The elements above, combined to form one coherent system, will form an army, whose priority will be to perform highly advanced disinformation focused on both

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the biological and technical components of enemy troops. To this end, it is likely to utilise directed energy technology (magnetic/electric field strength modulation), reinforced by the deployment of chemical and biological agents (Bigley and Raushel 2019). The next stage of hostilities will consist in the destruction of enemy forces with the implementation of masking technology, which virtually excludes the possibility of incurring any loss. The primary objective of the army of the future will not be to destroy the entire enemy's military potential; it will rather focus on assuming control or, eventually, eliminating those points of the enemy potential, at the absence of which, further combat becomes pointless. It is then that the future army, having seized the entire enemy potential, will subsequently utilise it to serve their purposes. Moreover, the human factor in future conflicts will be limited to the absolute minimum, *i.e.* to exert command and control over complex special operations directly on the battlefield by means of autonomous weapons (Górnikiewicz and Szczurek 2018, pp. 119–137). The advanced high-tech forecasting methodology is expected to become a significant element in the prediction of an enemy's decision-making process by operating on in-depth knowledge of subconscious individual and cultural codes determining decisions that are conditioned by specific stimuli (Górnikiewicz 2018, pp. 99–126).

The art of future warfare

Therefore, the question that follows is what contemporary technological developments in robotics and AI could eventually replace the deployment of human soldiers on the battlefield. This issue was addressed by Prof. T. Szczurek in his book on the possibilities of using automata and artificial intelligence programmes in battlefield action (Szczurek 2019). Two manufacturers are particularly noteworthy, Boston Dynamics and Sarcos. Their focus is on the development of "bodies" for future autonomous vehicles, including androids (Boston Dynamics). At the current level of development, the remote-controlled android body is reported to possess the capability to cover inequalities of elevation and the configuration of land in various weather conditions (rain, snow, wind etc.). Considering R&D companies researching AI-based software, which could contribute their technology to the autonomous robots in question, there are two perfect representatives, Hanson Robotics and Hiroshi Ishiguro Laboratories. Currently, AI programs that copy the human mind are still not self-aware but are improving their conversation skills with a living person and make logical decisions based on the information they have (Burmaoglu and Saritas 2017). With respect to the most advanced works on self-aware artificial intelligence, it is worth mentioning the IBM Watson project, Google and Facebook programmes. Last but not least, Samsung is intensively developing the Internet of Things (IoT) methodology, as well as virtual assistant programmes implemented by the above-mentioned companies and e.g. the Amazon corporation (Szczurek 2019, pp. 139–200). What must necessarily be included in this pantheon of technological innovations is the ongoing research on cultural reconnaissance as a means to study and reveal the human decision-making process. The objective of the research is to develop a mechanism that would enable the subconscious thought process to be anticipated well in advance, before it manifests itself as a specific decision at the conscious level. In principle, this could allow high-precision anticipation of the enemy army's decisions and, thus, skilful manipulation of the decision-making process by directing the actions of hostile armies (Górnikiewicz 2018). Therefore, not only would the army of the future employ specialised technology enabling seizure and destruction of key elements of the enemy potential (both technological and biological), but would also acquire the extraordinary ability to accurately predict and guide the decision-making process of enemy command. The war against the opponent exhibiting such overwhelming superiority resembles a fight between

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an amateur and a professional boxer: the latter, with virtually no effort, delivers a barrage of blows while accurately predicting the former's next moves and even manipulating his actions and reactions. A knockout, in this case, depends solely on the decision of the professional boxer. With every passing second, the blind and deaf amateur is losing stamina, strength and willpower. After a short exchange of blows, the amateur still knows nothing of his opponent, while the professional boxer has obtained all the necessary information.

Conclusions: What will be the methods of warfare in the later 21st century?

It can be safely assumed, based on the presented literary review and analysis, that the armed forces of the future will certainly follow new methods of warfare. The first and the most instantly visible factor will be the composition of armies, which are forecast to constitute 90% of robotic systems, of different levels of autonomy (or fully-controlled biological organisms), and 10% of people in command. Considering human soldiers, their biological capabilities (physical, intellectual and emotional) will be significantly reinforced and enhanced, initially by technological solutions, and in the long term, with biotechnology. The parallel activities performed, on an unimaginable scale, by soldiers will fall into three domains:

- The psychological influence (forecasting decisions, the methodology of influencing the decision-making process: perception and decision-making);
- The influence by directed energy and force field intensity (influencing an enemy infrastructure with IT methods coupled with directed energy, magnetic/electric field energy and biotechnological means, designed to destroy, incapacitate, damage or seize enemy communications);
- Conventional and special influence (as part of hybrid and asymmetric operations: mass armies incapacitated by pinpoint strikes, and technologically advanced armies by exploitation of vulnerabilities at the command level, connectivity and autonomous software).

Modern armies also conduct such activities; however, as for now, the psychological and cybernetic activities constitute auxiliary measures supporting conventional and special activities (Górnikiewicz 2013; Robinson and Jones and Janicke 2015). In the future, all three types of activities will be strongly interconnected and their objective will be shifted from destruction to assuming control over enemy resources.

Conventional operations will be performed by unmanned air, ground, underground and naval units. Special operations, however, will necessitate the involvement of the human factor – a commander having direct operational command over a team of various specialised machines (or bio-machines) executing the mission on the battlefield. Autonomous bio-mechanical operational teams will receive constant support of controlled mental and energetic influence on the enemy. Among the considered scenarios, there is a possibility that direct human presence/participation in the hostilities will be unnecessary, as control over the team may be virtual and operators could switch from automatic/autonomous to manual control mode and between machines. The direct involvement of people at the tactical level will depend on the degree of complexity of the task performed, and whether it is categorised as a special operation. Conventional activities requiring the involvement of an army of robots will by no means indicate a clash of two robotised armies, executing previously planned pinpointed strikes. Ultimately, this is a human commander that will be in charge of the operations; therefore, psychological warfare units will perform their

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tasks not only in the conscious and the subconscious domains but also in the sphere of enemy sensual perception. In parallel with the developments in AI, knowledge about the mechanisms of human brain activity will be increasing, and thus sensory and subconscious influence will be capable of projecting false visual, auditory, tactile, taste and olfactory sensations. The moment the phone in the pocket is abandoned and people switch to various microchip implants integrated into selected areas of the body or directly in the brain, the merger between psychological and cybernetic activities will enter a completely new realm of interaction. Psychological warfare teams will also employ chemical and biological agents, which in the case of the latter are likely to take the form of biotechnological interactions (*e.g.* nanorobots). Should the considered scenario take place, no modern army would be capable of fighting against the army with such a massive technological advantage, regardless of the size and the firepower of the former. The army of the future could deliver clinical strikes at the weakest points of its modern enemy, i.e. directly into the defenceless minds of soldiers, thus introducing confusion and taking control over the enemy. Combined with the cybernetic and electromagnetic influence, the advancing troops would be immensely confused as to their actual location (the inability to determine their location in space, which can also be accomplished by targeting the senses of balance and proprioception), mission objectives, let alone their own or enemy's identity. However, if for any reason, the scenario were to be realised in part, an army with such a technological advantage could still engage the opponent by eliminating those elements of its potential that could be the cause of the greatest disruption. Even a direct battle against autonomous robots alone would be doomed to failure: the modern army would not have the capacity to withstand the combination of constant confusion and high-precision direct strikes executed with the intense involvement of the element of surprise.

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