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Future disruptive defence technologies

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This Food for Thought paper is a document that gives an initial reflection on the theme. The content is not reflecting the positions of the member states but consists of elements that can initiate and feed the discussions and analyses in the domain of the theme. All our studies are available on www.finabel.org

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Definition of Disruptive technologies

The complexity and uncertainty of contemporary society are influenced by globalisation, which pushes technological innovations to keep up with today's ambiguity. This aspect of globalisation forces businesses and industries to develop innovative technologies to gain a competitive advantage in the global market. Market competition is the key motivating factor pushing industries to adopt the culture of innovation, so to find better solutions to existing and emerging problems (Lele, 2019 pg. 18,19). The European Union and key NATO allies are considering prioritising disruptive innovation to boost their economy and defence sector through rigorous training for multi-domain operations.
Innovation is the process of researching, experimenting and developing original ideas into practical and useful techniques or products. Industries and institutions pull in human and financial resources in support of innovation projects, thus improving and enhancing the processes, products and services offered (Ibid, pg.19). Disruptive innovation radically changes operability and significantly impacts how armed forces operate (Kikiras, 2017). Both innovation and disruption influence the status quo of markets, but with different impacts. Disruption causes systemic changes as it displaces or disrupts an existing technology, significantly impacting the economic market. Simultaneously, innovation is a rational process that upgrades or adds value to products and techniques. Sometimes disruptive technologies can be unpredictable and damaging, as societies and industries have little or no control over the changes they bring about (Ibid., pg. 23). Innovations in defence are inspired by strategies and tactics of disruptive technologies including Robotics, Quantum computing, Defence Internet of Things, Autonomy in defence, Big data analytics, Blockchain technology, Artificial intelligence, Future advanced nanotech materials, Additive manufacturing and Next generation sequencing (Hall, Black, Keep & Bekeers, 2017).
In the defence sector, both types of innovations are key to improved and efficient military capabilities to curb emerging threats and challenges (Ibid.). To support the integration of new ideas and technologies into the defence sector, the European Defence Agency

(EDA) launched a toolchain which identifies such initiatives and invites Member States to assess them and choose the ones they would like to invest in (Ibid.). However, this represents a challenge to European Interoperability because it enables countries without a strong industrial defence base to weaken European defence structures.

The evolving nature of warfare

War is unpredictable and is continuously evolving. Consequently, categorising future conflicts could be difficult as their complexity could lead to more ambiguity between conventional and unconventional or asymmetric warfare conflicts, which may include elements of hybrid warfare, proxy wars, use of cyber capabilities and strategic attacks aimed at infrastructure destruction in areas that highly value data integrity, such as financial services and high-profile political institutions like the EU institutions. Actors waging war are likely to shift in between physical (land, air, sea and space) and virtual (cyberspace) domains, seeking to exploit areas that give them the most advantage or where they have superior capabilities (Keep, Black, Melling & Plumridge, 2018 pg. 16). Wars have evolved from armed clashes where military forces determine the winner to asymmetric warfare, defeated by wits and intelligent technological advancement (Feith & Chorey, 2020). The evolved complexity of wars renders states vulnerable because the military techniques employed are designed to weaken societies' social and political cohesion and rarely lead to a military resolution. On the other hand, states still possess tanks, mechanised weapons and fighter aircrafts, meaning that traditional armed clashes still pose a threat, as the current Nagorno and Karabakh conflict over disputed territory between Armenia and Azerbaijan exemplifies. As another example, the US national security is primarily concerned about the military threat posed by China and Russia in the form of inter-state strategic competition (Ibid.).

Increased worldwide information flows powered through the Internet, small satellites, drones, mobile phones, video cameras and broadband connectivity make for more complex wars and politics. These technologies pave the way for cyber warfare, hacking,

and manipulating foreign political systems through the spread of propaganda, narratives and images that serve as primary instruments for achieving war aims. Such war strategies blur the lines between domestic and international, civilian and military and between diplomacy and armed conflict (Ibid.). Therefore, states are left with the heavy responsibility of protecting everything from their territory, to their infrastructure and population.

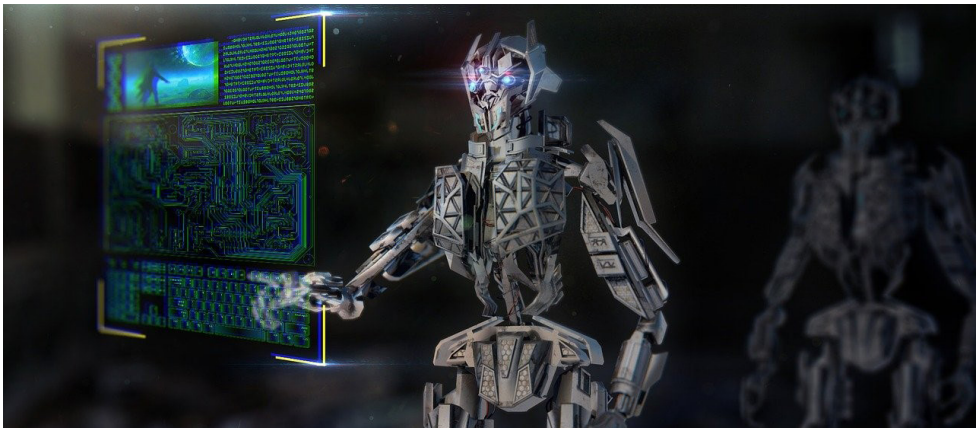
The threats faced by these states suggest that military preparedness alone is not enough to help curb their development. Understanding evolving threats and disruptive technologies should be at the forefront of military strategic planning and threat assessments. The pace at which technology has transformed the modern battlefield has shifted the focus away from how armies fight to what they fight with. The ever-shifting balance of power, the pace at which military technologies are developed and employed, and the challenging political environment present continually evolving threats to European militaries and their allies. These new technologies allow military forces to detect targets and strike them with great precision from long distances. Assessing how all these changes in modern war should alter the ways military force is developed and used is critical to ensure flexible deterrence of measured military force combined with political incentives (Feith & Chorey, 2020).

Therefore, this research will focus on how European Armed Forces collaborate through the European Defence Agency (EDA) to support the innovation and incorporation of new technologies into the defence domain and ensure that Europe and its allies maintain their advantage in the military-technological competition. This paper will discuss what 'disruptive defence technologies' exactly are and how European countries are preparing for future disruptive defence technologies including planning, research and budgeting as well as their implications for European allies and NATO. The present paper also examines how disruptive technology has shaped warfare and societies throughout the centuries and current trends in the field. Furthermore, recommendations will be made regarding what can and should be done to ensure continued interoperability and cooperation amongst the European Member States' militaries to ensure primacy and ascendency in offensive and defensive technologies.

DISRUPTIVE TECHNOLOGIES

History of Disruptive technologies

Throughout history, the constant struggle for supremacy and power has resulted in technological innovations and developments designed to gain the battlefield's upper hand. Empires have fought and disappeared due to new and powerful technologies being developed by their opponents. The transition from the Bronze Age to the Iron Age is a clear example of how disruptive technologies can change warfare. Around 1000 BC iron smelting technologies and knowledge began to spread from West Africa to Southern Europe, finally reaching the British Isles and Scandinavia; the Celts, who originated in the British Isles and spread throughout Europe, assured their dominance in battles partially through their utilisation of iron weapons. These weapons were stronger and deadlier than anything seen before in Europe, and their use helped the Celts gain victory in many battles (Whipps, 2008). The next



great advancement in weapon technology was the invention and diffuse use of gunpowder. During the Battle of Beverhoutsveld of 1382, the army of Ghent launched a light artillery attack against the Count of Flanders; this event is regarded as the first successful European use of gunpowder in war and would change the future of warfare forever. Cannons, artillery, semi-automatic rifles, and machine guns can trace their roots back to manipulating and utilising gunpowder for military means.

Recently, nuclear fission and the creation of nuclear weapons have changed the way wars are fought and the way international relations are carried out. Following the discovery of nuclear fission by two German scientists in 1938, there was serious concern amongst the scientific community regarding the tremendous potential this technology had in the wrong hands. The fear that the German atomic bomb project would weaponize nuclear fission first was so great that an international team of scientists penned the "Einstein-Szilard Letter" urging the United States to accelerate their nuclear program to ensure that a weapon with 'a destructiveness vastly greater than anything now known' would not be developed by Nazi Germany and used against the allied powers (Hewlett & Anderson, 1962, pg.16). This letter persuaded the American government to significantly fund scientists working with nuclear material. The Manhattan Project, as the research and development of nuclear weapons, would come to be known, resulted in the production of two nuclear weapons dropped on Hiroshima and Nagasaki in Japan in 1945. At the time it was widely acknowledged that these weapons represented a new epoch in warfare and human history, with Harry S. Truman stating: "[...] If they do not now accept our terms, they may expect a rain of ruin from the air, the like of which has never been seen on this earth" (Welna, 2020). The bombs did not only usher in a new era of warfare but also introduced the world to destructive forces beyond imagination and on an unforeseeable scale. Nuclear weapons have also changed the political and social landscape: the competition and stockpiling of nuclear weapons by the Soviet Union and the United States resulted in nearly fifty years of hostile relationships and humanity's survival laying in the balance. Furthermore, the competition and rivalry between the world's two superpowers at the time led to a constant need for technological advances

and scientific breakthroughs in weaponry and military equipment, to ensure continued superiority and security.

This competition for technological leverage, which was the American Cold War strategy's lynchpin, continues today. The drive to achieve a technological advantage emerged because of the Cold War competition with the Soviet Union. At the time, the United States could not compete with the sheer size and numbers of the Soviet military. Instead, they adopted a policy of developing fewer, but better-performing technologies that would give them the edge in modern warfare. Examples of these technologies include stealth technologies, long-range cruise missiles and precision munitions (Brimley, FitzGerald & Sayler, 2013, pg. 9). This proved crucial throughout the Cold War, as disruptive technologies acted as a deterrent to potential attacks or conflicts, while also contributing to the decline of the Soviet Union. It was in the 1980s that the Soviet Union began to openly worry about a military-technical revolution occurring in the United States (Ibid., pg.7). This strategy of technological dominance continued well into the 21st century, as the United States held a monopoly on precision-guided missiles with no near-peer rival on the horizon (Ibid.). The United States' dominant position as the world leader in high-quality disruptive technologies secured its allies' defensive capabilities and security, including NATO Member States – as the mutual defence treaty ensured threat deterrence against any potential adversary. According to Royall (2016), this deterrence is akin to a wall: the more technologically and militarily advanced the United States and its allies are, the taller and more stable the wall is; however, any gap in technology or cohesion renders the height of the wall irrelevant and exposes the alliances to geopolitical threats. Therefore, Western military allies must maintain their technological advance in the face of new and emerging threats.

In this section, I will list and describe the disruptive technologies available on the market and the ones still at the innovation and implementation stage. Additionally, I will discuss their use in the defence sector and their implication for the European defence capabilities and military bodies.

List and descriptions of Key technologies

Robotics

Robots are less expensive, more flexible and less bulky machines that are easier to use in risky, complex and dangerous military operations. They can be deployed in hostile zones to perform dangerous tasks without the armed forces worrying about their soldiers' lives because they can be controlled remotely. In Europe, the EDA has put in place several robotic projects to explore their integration into the defence sector (Detratti, 2017).

- The Scenarios for Multiple Unmanned Vehicles Operations assesses the viability of robots in field operations
- The Multi-Robot Control in support of the Soldier (MUROC) project provides a report on the robotics focusing on multi-robot control
- The Aid to Situation Management based on Multimodal, MultiUAVs, Multilevel acquisition Techniques (ASIMUT) project intends to improve surveillance and detection capabilities of defence operations using robot machines
- The Inside Building Awareness and Navigation for Urban Warfare (SPIDER) project favours using mobile robots to improve soldiers' inside-building awareness.
- The Unmanned Heterogeneous Swarm of Sensor Platforms (Euro SWARM) project looks for up-to-date, efficient operations of unmanned heterogeneous swarm systems.

The major challenge impeding their full integration in the defence sector is human-machine trust. Humans and robots operate differently: robots are digital, have low transparency and expression, while human beings are analogue and are more expressive. Therefore, it becomes quite difficult for humans to trust robots with the execution of some missions. As a solution, Detratti proposes the development of more vigorous machines that can acquire more sensitive, reliable and accurate data (Ibid.).

Artificial Intelligence and Cognitive computing

Cognitive computing uses advanced algorithms to command machines into performing tasks that require human intelligence. Similarly to human beings, these machines collect information from bulk data, their environment and past mistakes and improve their performance. During a workshop organised by the EDA in 2015 and following its success with Facebook, Apple and Google, this deep learning technology was studied to integrate it in the defence sector. This tech analyses existing data in networks and sensors to predict future trends and patterns and could help detect malicious traffic in encrypted networks for cyber defence and suspicious behaviour in people's gestures. Unfortunately, this tech's existence and its potential use in face, voice and text recognition threatens human civilisation as its future impact on society is unpredictable (Montiel-Sanchez, 2017 pg. 14).

Internet of Things

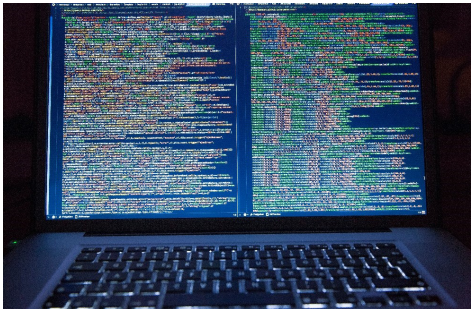
This tech is useful for improving land forces combat intelligence by creating awareness and control over conflict zones. The innumerable sensors in the Internet of Things (IoT) utilities enhance the efficiency of ground troops by providing the commanders with military intelligence, command and control of defence activities. In 2007, the EDA attempted to develop a military IOT by launching an ARMS project to discover wireless connectivity in autonomous systems for improved command and control of communications, surveillance and intelligence systems. The project revealed that IOT lacked 24/7 surveillance in large areas and was difficult to install in hostile areas. The EDA calls upon Member States to invest in research as it prepares to launch Wireless sensor networks in urban areas for surveillance and for the analysis of sensor networks' behaviour (Ibid., pg. 15).

Autonomous systems

Autonomous systems in the defence sector, especially sensors and effectors, are used for carrying out specific missions. The EDA has launched two projects in relation to these systems. One of them is focused on the viability of mounted missions of unmanned systems coordinated by physically operated vehicles. This project is known as the Hybrid Manned-Unmanned Platooning (HyMUP). The second project is referred to as the Autonomous Decision-Making based coordination techniques for Heterogeneous Autonomous Vehicles (ADM-H), and it focuses on improving decision-making algorithms for the coordination of groups of unmanned military systems. However, given that such systems alter military procedures and tactics, the EDA advocates for the review and update of their legal and ethical aspects (Kalbarczyk, 2017).

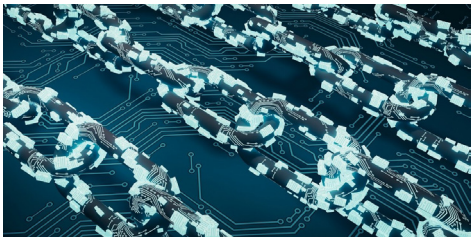
Big data analytics

This technology allows the filtration of information through bulk data in emails, GPS, satellite images, spreadsheets, Pdf documents, social media data etc. to better predict future events. This means improved decision-making and a better understanding of the needs of defence capabilities. The military is already using big data analytics to develop its simulation systems to support operations, training, system development and programme preparation. To ensure the cooperation between joint Force operations and European military bodies, the EDA seeks to integrate big data analytics into modelling and simulation of military activities (Montiel-Sanchez, 2017 pg. 16).



Blockchain Technology

Blockchain technology has recorded a prodigious success in the financial domain, as it boosted the users' trust in providers and their confidence in conducting digital financial transactions involving cryptocurrencies. Through this technology, a copy of the encrypted data is encoded into the network. In the defence sector, the EDA explores its use



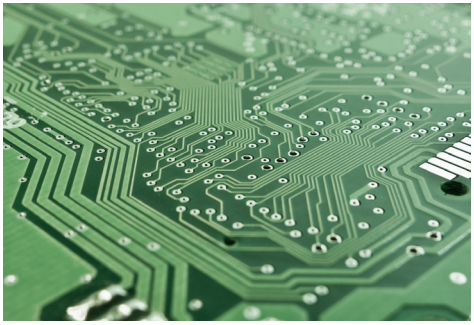
for information security, data protection and data integrity under the Cyber Strategic Research Agenda. This technology creates trust in digital data and proves the authenticity of data by securing it through a digital record. Blockchain technology could be useful in boosting cyber defence, dynamic communications, networking and secure messaging (Sanchez, 2017b).

Artificial Intelligence

Artificial technology has had a breakthrough in the automobile industry, where self-driving cars were successfully manufactured. This tech allows machines to react accordingly to surrounding stimuli. In the defence sector, the main application area is cyber defence for improved risk management, malware detection and decision-making support systems. Unfortunately, the project had to be abandoned after Facebook encountered a challenge with this tech when the chatbot created their language that human beings could not understand. To foster European investment in the research of AI systems, the EDA occasionally organises workshops to encourage cooperation between industries, armed forces and the academic sector (Sanchez, 2017a).

Additive manufacturing

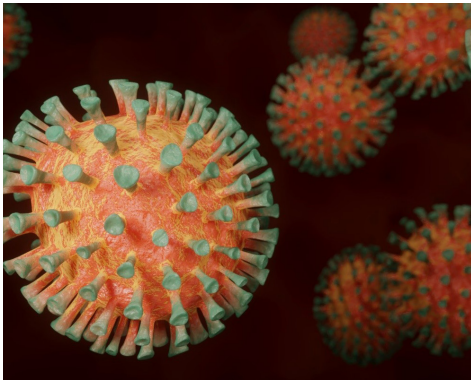
This tech is useful in producing lightweight materials that can be used to fabricate military spare parts and equipment. The European Commission identified this technology as crucial to ensuring increased technical and industrial competition. The European Defence sector is sure to benefit from additive manufacturing, as it ensures production costs cuts through the rapid and flexible manufacturing of durable and resistant products. Through the EDA, Europe launched the 'additive manufacturing feasibility study & technology demonstration' project, which successfully showcased this tech's use in a lab in Zaragoza in June 2017. The defence sector is yet to fully exploit the potential of additive manufacturing, but the EDA encourages the exchange of information among interested Member States to foster prospective cooperation (Vicente 2017a).



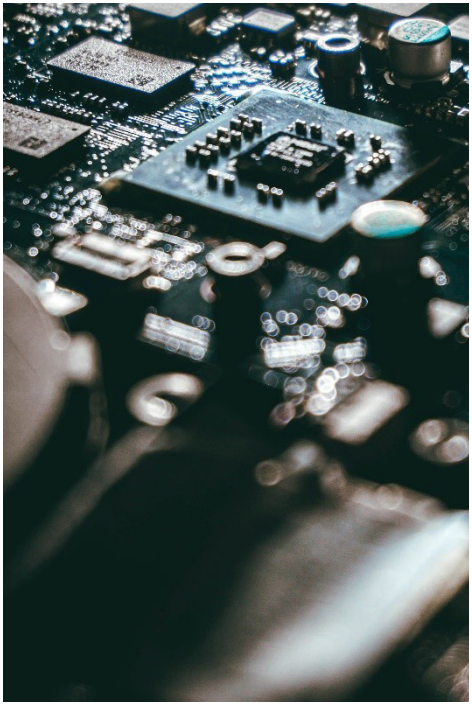
Next Generation Sequencing

This technology helps detect pathogens that could cause an epidemic or genotypes in case of a biological threat. Sequencing uses advanced bioinformatics to detect the origins of an outbreak of biological threats. Armed forces could use it to react to the menace with rapid and appropriate biodefence mechanisms. However, the difficulty in determining if the bio-threat is intentional or natural poses a major challenge in using this tech (Ali, 2017).

Together with the EDA, the European States collaborate on two main projects to try and make this technology a success. These projects include: (a) the European Biodefence Laboratory Network (EBLN) project centred on designing and organising a shared database on the identification of B agents (b) the EBLN II project, focused on encouraging Member States to improve their ability to respond to bio attacks or to the outbreak of infectious diseases using microbial strains characterisation to identify illustrators of emerging epidemics, including intent to spread them (Ali, 2017). Its use in detecting the pathogens causing the coronavirus should be further explored to find ways to stop its widespread propagation.



Future advanced materials: Nanotechnology



The complexity of military systems calls for a revamp of the materials being used to fabricate their machines. In this sector, the EDA expects to explore the use of nanotechnology in developing armour fabrics, self-healing, health monitoring and camouflage military materials. The EDA's focus is on developing smart textiles and fabrics for land forces using nanotechnology through the PATCHBOND project, while further research is underway through the ALOA and ALOMAS projects. The EDA also addressed the importance of nanotechnology through the Combat Equipment for Dismounted Soldier studies, which aims at making soldiers more protected with better performing uniforms and platforms

(Vicente, 2017b). The EDA's next strategic key step is to exploit nanotechnology to boost the capabilities of European Armed forces. Part of their plan is to fabricate multipurpose quality products to reduce maintenance costs such as washable, recyclable, and repairable uniforms (Ibid.). The following section will thoroughly explore to what extent nanotechnology can be of use to the armed forces. Professor Richard Feynman discovered this tech that involves the manipulation of atomic particles depending on their thermal, mechanical, electrical and durability properties. Defence areas that can be revolutionised using this technology include troops functionality, aeronautics, weapons, security surveillance, logistics, naval vessels and satellites. Topmost countries investing in nanotech programs include the United States, Japan, Germany, Russia, the Netherlands, the United Kingdom, China and Taiwan. Among others, the US already possess nanomagnetic materials for DNA detection and 3Hz-50GHz sensitive spectrum analysers (Sharon, 2019, pg. 2-4).

Soldiers

Scientists intend to use nanotech to improve combat suits' quality by developing multipurpose suits that can shield soldiers from bullets, biological and chemical attacks. Moreover, uniforms will be provided with communication equipment and health monitors to examine vital signs through embedded physiological sensors on the nano fabrics that monitor heart rate, respiration, temperature and dehydration. All the improvements mentioned above are possible because scientists have discovered that nanotech fabrics can perform different functions under different circumstances (Sharon, 2019, pg. 5-10). For instance, nano fabrics can reduce projectile impact, resist chemical gases and bacteria, reduce the impact of heat and sound, camouflage, self-repair and administer medicines to who wears them (Gallardo, 2019). More so, thanks to their high tolerance to temperature, nano fabrics can warm or cool a soldier's body. Anti-microbial nano fabrics can protect soldiers from microbial infections, while nano fabrics fitted with compressed gases can neutralise the effects of toxic gases or smog. If manipulated using light, the same fabric could make soldiers invisible in the eyes of the enemies. A group known as the Hao proved the viability of this idea by fabricating seven nanocomposites ultrathin invisibility layers (Ibid., pg. 5,6, 8).

The use of electrochromic camouflage on nano fabrics can enhance the efficiency of draping tanks, vehicles and soldier suits by making them change or adapt to the colour of their environment like chameleons do. A practical example of this tech was produced in Israel at the Tel Aviv university, where a transparent protein nanosphere that self assembles and could be used in fabricating body armours was developed. The ceramic plate currently used by soldiers to fabricate their bullet-proof vests can be improved if smart nanotech fabrics are used to develop uniforms that are more resistant to bullets (Ibid., pg. 6-10).

Regarding the intensive medical care of wounded soldiers, nano fabrics fitted with sensors can be used to monitor their heart rate and brain signal. The fabric can also be used to compress and prevent excessive blood loss in case of an arm or leg injury (Ibid., pg. 10-12).

Weapons

Nanotech can be used to manufacture cheap-

er, lighter and non-lethal weapons which focus on precise targeting and intelligence. Such weapons include microwave and laser weapons that are more accurate, aluminium nanoparticles bombs that are more powerful and less harmful, mini nukes fabricated with less fissionable materials (Sharon, 2019, pg. 15-16). Weapons developed through nanotechnology are more efficient and present fewer risks when armed forces use them.

Vehicles

Because of their lightweight, energy efficiency and intelligent equipped communication systems, vehicles developed with nanotech could be convenient for soldiers. The Defence Advanced Research Projects Agency (DARPA) of the USA is working on manufacturing a transformer vehicle that can partially take off, cross rough terrains and evade landmines or ambushes. Nanotechnology can be used to manufacture paint which, if sprayed on a vehicle's surface, renders it more resistant to ultraviolet rays, mechanical and chemical damage (Ibid, pg. 23-24).

Currently, the defence devices fabricated using nanotech include accelerometers, additives in food and cosmetics, condition sensors, nanocatalysts, nanocomposites, paints, polymers, tire pressure sensors and wireless sensor networks (Ibid).

DISRUPTIVE TECHNOLOGIES WITHIN THE EUROPEAN UNION

Planning for disruptive technologies

Understanding the value and potential of disruptive technologies can determine the strategic outcome of military competition. A disruptive technology represents a continuous shift from one prevailing paradigm to another, changing the way of operation and therefore, the way things are done. This new technology uses new paradigms to reach levels of performance far exceeding the limits of traditional, evolutionary advances (Kikiras, 2017). Defensive innovation requires staying on top of emerging technologies in third countries and researching and developing disruptive technologies of one's own. Planning and preparation for disruptive technologies are imperative for Western military alliances

-including NATO- to ensure continued resilience, collective defence and cooperation. According to Kramer, Binnendijk and Hamilton (2015), NATO must adopt a new strategy built on the concept of ensuring stability in the NATO region and reducing threats in its neighbourhood. An important component of this new strategy is meeting key risks facing the alliance in information and burden sharing, as well as ensuring adequate technical budgetary mechanisms are in place to focus on disruptive technologies (p.2).

In 2008, Europe established the Capability Development Plan (CDP) to identify European priorities and collaboration opportunities. Since its establishment, so much has changed in the defence sector ranging from the evolution of threats, the security and defence environment and the European defence budgets. CDP is crucial in offering guidance to national defence organisations in their efforts to build the capabilities needed to protect European security, values and interests (Keep, Black, Melling & Plumridge, 2018 pg. 8). EU initiatives in fostering cooperation and dedication to the developments of future technologies are highlighted by the existence of institutions such as the Coordinated Annual Review on Defence (CARD), Permanent Structured Cooperation (PESCO) and the European Defence Fund (EDF). The EU and NATO enjoy a cooperation relationship in research, development and testing of upcoming technologies in countering hybrid threats, cyber defence, military mobility and counterterrorism. Their partnership also boosts knowledge sharing and enhances the creation of industrial and user capacities and skills (Ibid., pg. 40).

As part of the EDA's long-term Capability Development plan (CDP)RAND Europe, an independent non-profit research organisation, was contracted to provide military decision-makers and capability planners with an overview of the prospective impact of technological advancements up to 2035 and beyond (Hall, Black, Keep & Bekeers, 2017). In 2017, The EU Commission authorised the

EDA to implement the Preparatory Action on Defence Research (PADR) as the groundwork for a European Defence Research Programme. So far, 190 entities from 25 Member States have expressed their willingness to participate in the research programme in advanced soldier systems, situational awareness in the maritime sector, force protection and strategic military foresight. The EU set aside a budget of 90 million euros for PADR for three years (2017-2019). The Croatian government also received co-funding under the European Structural and Investment Funds (ESIF) for a defence research project to develop a cyber conflict simulator. This shows an improvement in the EU's efforts towards openness to funding such defence projects (EDA, 2017, pg. 5).

The Capability Technology Groups (CAPTECHS), a network of defence Research and Technology (R&T) experts, expresses the importance of strategic and technological foresight to attract Europe's armed forces attention in investing in the right capabilities for future purposes. CAPTECHS also engages with non-traditional Research and Defence communities and innovators to improve access to emerging and potentially disruptive research. Simultaneously, the European Defence Technological and Industrial Base (EDTIB) supplies the European States with the necessary cutting-edge technologies in a timely manner (Ibid pg. 5- 9).3.2 Implications of disruptive technologies

Technological development is unpredictable and has a potentially large impact on society in general. The rate at which disruptive technologies shall evolve cannot be fully anticipated, making the future uncertain. These emerging technologies will most definitely challenge the existing international law principles governing the use of military force. Disruptive technologies evoke applying international law to technological advances, such as Artificial Intelligence and autonomous technologies. A potential lack of an overall interpretation of international laws provides no guarantee that other states will abide by the law of Armed Conflict. Different interpretations of these laws will most definitely have an increasing impact on military operations systems and future warfare. Furthermore, increased use of autonomous systems may cause a shift in the understanding of the military duty and the related ideas of honour and patriotism (Keep, Black, Melling & Plumridge,

2018 pg. 15,30).

The western dominance in military technology is more fragile than ever. This newfound fragility is primarily due to three important reasons: first, the rise of globalisation has lowered the barrier to access and develop sophisticated military technology, enabling even non-state actors to become a threat to the international order. This is most apparent in China's rise, which has undertaken a significant military modernisation program to challenge Western military dominance and stake its claims in the South Pacific; second, the trend of commercial interests acting as greater catalysts of technological advancement than traditional military actors. Unless western powers apply consistent research and development in commercial enterprises to utilise them militarily, they risk falling behind and letting their technological advantages atrophy. Finally, as western powers struggle with military budget cuts and austerity, maintaining the adequate spending necessary to invest in disruptive technologies and retain technological dominance will result difficult (Brimley, FitzGerald & Sayler, pg.9-10). Disruptive technologies partially cause this trend of power diffusion. Improved access to technology, coupled with a substantially lower cost of advanced technologies means that powerful tools once only available to militaries and governments -such as cloud computing and smartphones- are now accessible to everyone. This means anyone, anywhere in the world, has access to an unfathomable amount of information. This fact, in addition to the emergence and rise of Artificial Intelligence, robotic systems and big data means that more and more disruptive technologies are on the horizon and are advancing at a faster pace than anyone thought possible (Pavel, Engelke & Ward, 2016, pg. iii). Retaining the technological advantage and being at the forefront of disruptive technologies is a strategic decision. It cannot be taken for granted, assuming that the technological advantage will continue in the absence of active investments and military technology innovations. Moreover, it is a fallacy to assume that enhanced technological access will lead individuals to enlightenment; social media and other information technologies allow people to communicate and organise with (potentially dangerous) like-minded people who can threaten state security. Therefore, remaining at the forefront and preventing the widespread dissipation of new technology guarantees stability and security.

CONCLUSION AND RECOMMENDATIONS

We cannot stop innovation and technological evolution, but we can control how they are integrated into different societal domains, especially the defence sector. States must cooperate to meet the challenges presented by the changing nature of warfare, including asymmetric political-military conflicts. Secure information sharing tools, civil-military cooperation and rapid decision-making are key requirements for enhancing future military capability. Although research and development programmes in Europe are being pushed, there's often fragmentation between different EDA Member States. This makes

much of the investments come from the civilian sector, including multinational and non-EU actors (e.g. United States, China). Taking this into account, European Members States need to increasingly invest in research and development to effectively, rapidly and flexibly respond to the threats posed by state and non-state actors by relying on interoperability and cooperation based on trust. Given that effective military technologies can take decades to research, develop, and integrate into the field yet new threats emerge with little or no warning. European militaries must undertake constant planning and research to ensure they stay ahead of the curve on new and emerging threats.

As technology may provide solutions to emerging threats, they may create new security vulnerabilities that cause moral, ethical and legal concerns. They may also create a misleading perception among decision-makers which could lead to over-relying on them. Therefore, the subject of disruptive technologies should be treated with caution.

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