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THE COMPREHENSIVE APPROACH OF MILITARY STRATEGIC OPERATIONS PLANNING AND ITS SUPPORT BY ARTIFICIAL INTELLIGENCE

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ABSTRACT: *Military operations are always preceded by political decisions and the transition to military means in the management of conflicts in order to pursue political goals takes place in either national or alliance context. Information operations, all-source intelligence as tools for intelligence and counter-intelligence play a key role in the planning of military operations. The last two decades have brought with them the explosive spread of digital technologies. The application of communication technology (5G), sensor systems, IoT (Internet of Things) produces a huge amount and multiple types of data, from which Big Data analytic systems and algorithms using Artificial Intelligence (AI) gain usable information. Accordingly, applications supported by AI play an increasingly important role in military operations on strategic, operational, and tactical levels. The analysis of data collection from all-source intelligence – especially SIGINT (Signal Intelligence) and OSINT (Open-Source Intelligence) and the AI-supported analysis is a key to success for Effect based Operations (EBO).*

KEYWORDS: *MDMP, M&S modelling and simulation, DIME, PMESII, ASCOPE, Wargaming, Information warfare, OPLAN*

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INTRODUCTION

The objectives of the article are twofold but interrelated: our first aim is to provide a short summary of the new NATO Operations Planning methodology detailed in the COPD v3.0 COMPREHENSIVE OPERATIONS PLANNING DIRECTIVE, the second is to provide an overview and analysis of the application of AI in supporting the Operations Planning process especially at strategic and operational levels.

Military planning went through an evolution[1] since the late nineteenth and early twentieth centuries, when the Prussian Great General Staff as the first sophisticated planning organization started to focus on mobilization scheduling, logistics, replacements, and the effective use of the railroad, the telegraph and breech-loading artillery and machine guns.

[1] Ehlers R. and Blannin, P. "Integrated Planning and Campaigning for Complex Problems," *The US Army War College Quarterly: Parameters* 51, No. 2 (18 May 2021). https://press.armywarcollege.edu/parameters/vol51/iss2/10.

The Prussian planning model was adopted by other great powers, including the United States, and it worked well as long as the industrial warfare based on mass conscription was the military technological paradigm. The two world wars and the development of nuclear weapons resulted in a paradigm shift, nevertheless both the North Atlantic Treaty Organization (NATO) and the Warsaw Pact continued to plan for conventional war in Europe and used, tried, and tested planning processes. *Figure 1* describes the change in the character of warfare as it was published in the article written by General of the Army Valery Gerasimov, Chief of the General Staff of the and Russian Federation Armed Forces in 2013.

According to Gerasimov: "The very »rules of war« have changed. The role of non-military means of achieving political and strategic goals has grown, and, in many cases, they have exceeded the power of force of weapons in their effectiveness."[2]

POLITICAL CRISIS AND CONFLICT RESOLUTION

"War is thus an act of force to compel our enemy to do our will."
"War is merely the continuation of politics with other means."
Carl von Clausewitz[3]

The use of military force is a political act, and the political objectives always have higher importance in the conduct of a military operation or campaign. During the conduct of military operations, the contributing nations have varying interests and objectives that have to be taken into account. That means that the aims and objectives stated are often results of compromises.

Figure 1 indicates the role of non-military methods in the resolution of interstate conflicts and presents the primary phases of conflict development as described in 2013 in the famous article of General of the Army Gerasimov, which later was labelled as the Gerasimov Doctrine[4]. He outlined the modern-day Russian Military Strategy and defined the attributes of the modern hybrid warfare of combining military, technological, information, diplomatic, economic, cultural, and other tactics for the purpose of achieving strategic goals.

[2] Gerasimov, V. "The Value of Science Is in the Foresight New Challenges Demand Rethinking the Forms and Methods of Carrying out Combat Operations." *MILITARY REVIEW,* January-February 2016 (n.d.). https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/January-February-2016/

[3] Clausewitz, C. *On War.* (Princeton, NJ: Princeton University Press, 1976)

[4] Gerasimov, V. "The Value of Science Is in the Foresight." (in Russian) *Voenno-Promishlenni Kurier.* 27 February 2013. https://vpk-news.ru/articles/14632. Accessed on 31 December 2021.

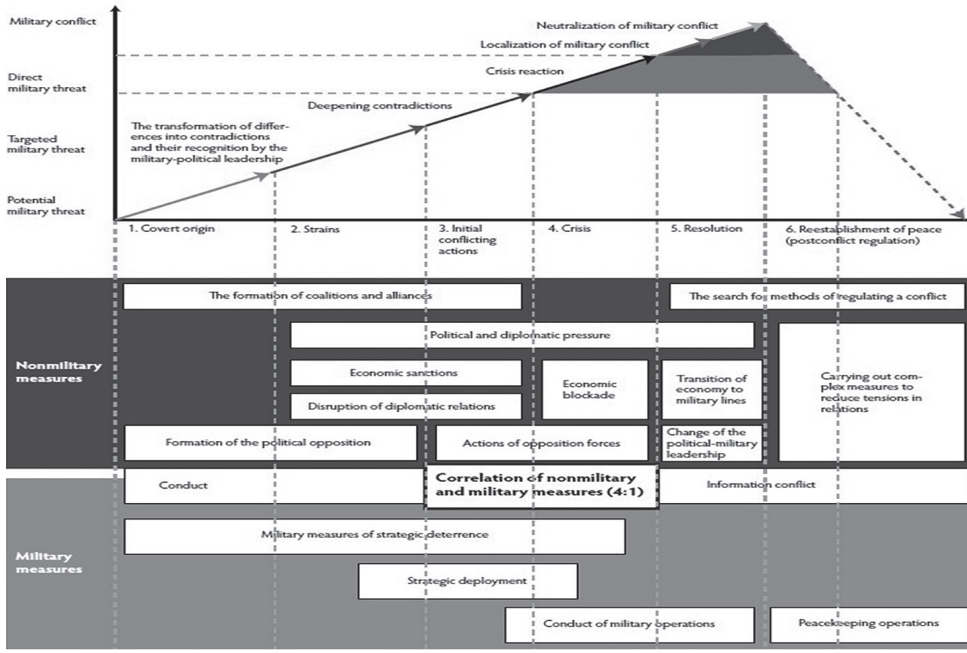

Figure 1 *The Role of Non-military Methods in the Resolution of Interstate Conflicts*
Source: *V. Gerasimov's article in Voyenno-Promyshlennyy Kurier, 26 February 2013, translated by Charles Bartles*[5]

Having identified a critical situation, the requirement of influence emerges. In order to be influential, it requires understanding of the situation, to obtain and develop the knowledge to enable insight *(knowing **why** something has happened or is happening)* and foresight (*being able to identify and anticipate what **may** happen).*[6]

The development of understanding is based upon the situational awareness (SA) to identify the problem. Analysis of the situational awareness results in greater comprehension, insight of the problem, and assessments based on this comprehension provide understanding of the problem – foresight. *Figure 2* depicts the correlation of the factors playing a role in the influence.

[5] Gerasimov, V. "The Value of Science Is in the Foresight."

[6] *JDP 2-00 Understanding And Intelligence Support To Joint Operations. 3rd edition, with change 1.* (Shrivenham: 2014).

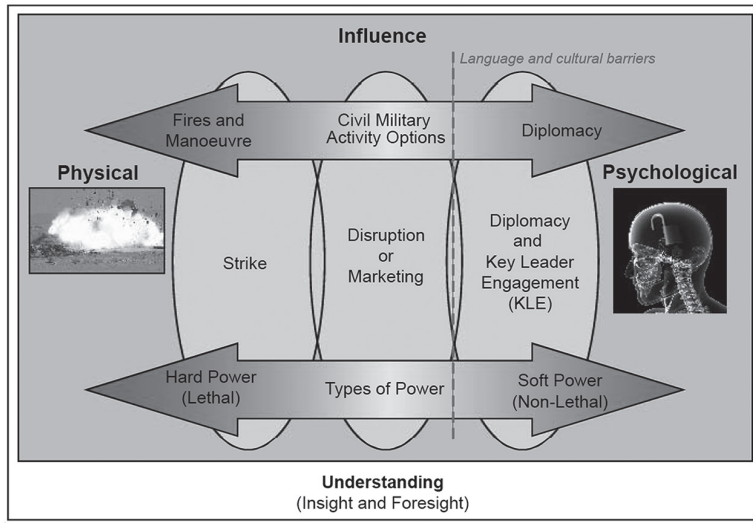

Figure 2 *The Spectrum of Influence*[7]
Source: *Jdp2_00_ed3_Understanding and Intelligence Support to Joint Operations_with_change 1_20110830*

The Euro-Atlantic community has two basic structures of evaluating and developing political and military strategies of defence and crisis resolution: NATO and the EU.

In order to enable the European Union to assume its responsibilities for crisis management, the European Council (Nice, December 2000) decided to establish permanent political and military structures.[8] The Common Security and Defence Policy (CSDP) outlines the EU's leading role in peacekeeping operations, conflict prevention, and strengthening the international security as an integral part of the EU's comprehensive approach towards crisis management, involving civilian and military assets.

NATO utilizes four levels to describe operational activities; political, strategic, operational, and tactical. The political level embraces all the others, which means that each action, right down to the tactical level, must be in harmony with the principal political objectives.

Figure 3 shows NATO's six-phase generic Crisis Response Process (NCRP) which facilitates strategic political decision-making through the North Atlantic Council (NAC) in an emerging crisis whether it corresponds to Article 5 or Non-Article 5. In the given circumstances the NAC will decide for each relevant crisis whether NATO is to act and, if so, in what way. Although each crisis is unique, the NCRP ensures that the Alliance is ready to perform the whole spectrum of Article 5 and Non-Article 5 missions encompassing all of the NATO core tasks.[9]

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7 *JDP 2-00.*

8 "Common Security and Defence Policy (CSDP) Structure, Instruments, Agencies," Text, EEAS – European External Action Service – European Commission, Accessed on 30 December 2021. https://eeas.europa.eu/topics/common-security-and-defence-policy-csdp/5392/common-security-and-defence-policy-csdp-structure-instruments-agencies_en

9 *COPD v3.0 – Comprehensive Operations Planning Directive.* 2021. Supreme Headquarters Allied Powers Europe.

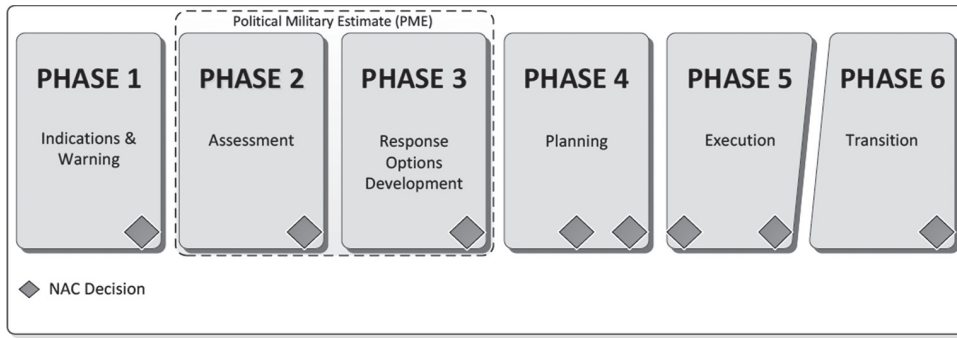

Figure 3 *NATO Crisis Response Process – Six-Phase Generic Process*[10]
Source: *COPD v3.0 COMPREHENSIVE OPERATIONS PLANNING DIRECTIVE*

NATO acknowledges that the military means alone cannot resolve a conflict. The Alliance's Strategic Concept states, "that the lessons learned from NATO operations, in particular in Afghanistan and the Western Balkans, make it clear that a comprehensive political, civilian and military approach is necessary for effective crisis management"[11].

MILITARY SOLUTIONS AND OPERATIONS PLANNING

The Design of Operations[12] process includes the graphical depiction of the linkages between end state, objectives, effects, lines of effort or operation (LoO), centres of gravity (CoG) etc. This provides the visualization of the plan, initially developed as a design framework from which options can be induced and once an initial operations framework has been agreed, it will become the operations design.

Since international crises are complex and change over time, at the outset it is likely that the stakeholders have different understanding of the problem and do not share the same view on how to react. Therefore, the International Design approach is unavoidable when consultations with the involvement of some stakeholders are carried out.

As the Alliance assessed the actual situation and declared it unacceptable, the desired end state is defined. The PMESII (Political, Military, Economic, Social, Infrastructure, Information) framework system analysis provides the basis for the assessment, and the flow of action moves toward the military and non-military measures, the Diplomatic, Information, Military, Economic (DIME) instruments of power (IoP).

[10] *COPD v3.0.*
[11] *COPD v3.0.*
[12] *COPD v3.0.*

Situational Awareness (SA)[13]

SA "is the human perception of all available elements of information relating to a specific situation that enables a holistic and informed interpretation of the operating environment". *Figure 4* depicts the main activities of Situational Awareness.

The Alliance continuously monitors and analyses the international environment to identify crises that could have an impact on NATO's security interests, and takes diplomatic, political and military measures to prevent them from evolving into larger conflicts. The NATO Strategic Concept outlines engagement with other international actors and the conduct of collaborative analysis.

Effective SA *(Figure 5)* requires continuous horizon scanning as a "collaborative effort involving all NATO political and military capabilities at all levels to assess potential risks and threats to NATO security interests".

The following should be considered as potential – but not exclusive – indicators:

1. Threats or acts of armed attack or aggression.
2. Proliferation and delivery of weapons of mass destruction (WMD).
3. International terrorism/extremism.
4. Instability from failed and failing states.
5. Environmental and humanitarian disasters.
6. Security of vital resources.
7. Organized/Transnational crime (for example human trafficking and narcotics).
8. Hostile communications and information activities targeted at NATO.
9. Cyber and hybrid threats.

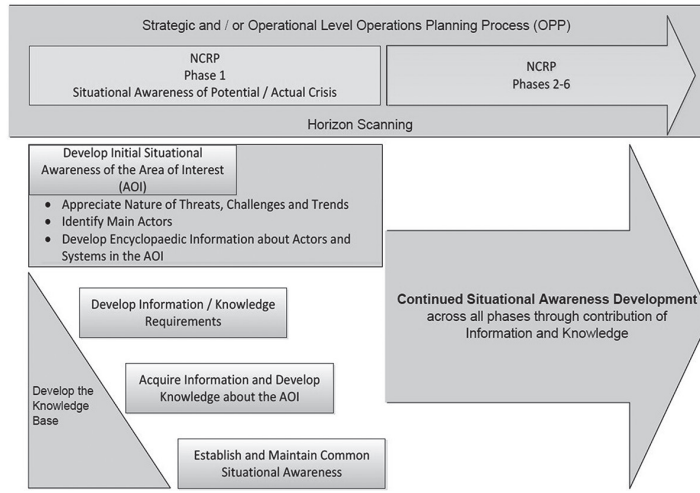

Figure 4 *Situational Awareness Main Activities*[14]
Source: *COPD v3.0 Comprehensive Operations Planning Directive*

[13] *COPD v3.0.*
[14] *COPD v3.0.*

The different levels of Situational Awareness include the Perception that involves the processes of monitoring and indicator detection; the Comprehension that requires the fusion of information to understand how it will influence the objectives; and the Projection that provides assessments of possible outcomes that potential actions may result in in the operating environment.

To develop initial SA of the Area of Interest (AOI) through information and intelligence related to the operating environment is a must to differing levels of SA understanding. This includes a comprehensive identification of indicators to be monitored over time to understand trends, and to identify the main actors in the area.

In order to develop information and knowledge requirements, to establish a Knowledge Base (KB), the staff acquire information about the designated area of interest, and establish and share common situational awareness.

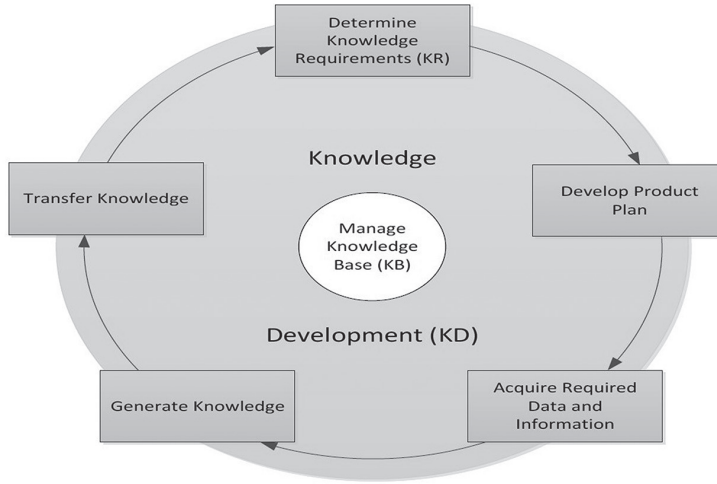

Figure 5 *The Knowledge Development Process*
Source: *COPD v3.0 COMPREHENSIVE OPERATIONS PLANNING DIRECTIVE*

The KD process covers "the acquisition, integration, analysis, and sharing of information and knowledge from relevant military and non-military sources" as it is shown in *Figure 5*. This process "includes analysis of the relationships and interactions between systems and actors considering different PMESII factors to enable a COM and staff to better understand the possible effects of DIME Instruments of Power (IoP) actions carried out."

Strategic-level planning[15]

The strategic level of the Operations Planning Process (OPP) is carried out by the Supreme Headquarters Allied Powers Europe (SHAPE) and directed and guided by the Supreme Allied Commander Europe (SACEUR). Here we summarize – without aiming to give an exhaustive list – the main elements of each phase in order to understand the objectives and

[15] *COPD v3.0.*

the course of the planning process, and also to understand the end-state which would bring about the desired solution for the crisis management.

The strategic OPLAN is "designed to develop strategic products for consideration by NATO military and political authorities to support their decision-making on the strategic level in response to a crisis on a Comprehensive Approach (CA) basis."

Strategic planning starts with an in-depth analysis of the crisis and the root causes as a result of the continuous situational awareness.[16] The analysis is basically an actors and factors analysis covering the different actors and systems in the operating environments. It includes the actors' identified objectives, modus operandi, strengths and weaknesses, interactions and interdependencies.

The Engagement Space is the part of the strategic environment concerning the crisis in which the Alliance has decided to engage. It is different from the operating environment that is defined as 'a composite of the conditions, circumstances and influences that affect the employment of capabilities and bear on the decisions of the commander (COM)'.[17]

Phase 1 – Initial Situational Awareness of potential crisis

The purpose of Phase 1 is to assist the NAC and/or NATO HQ staff in their NCRP Phase 1 activities with the identification of relevant emerging crises. Phase 1 main activities include continuing to monitor the actual crisis as part of Comprehensive Crisis and Operations Management Centre (CCOMC) scanning activity, direction may be given to build an initial understanding of the crisis and make an initial estimation and its possible implications to NATO.

Phase 2 – Strategic Assessment

Strategic Assessment aims "to develop and coordinate SACEUR's Strategic Assessment (SSA) of an emerging crisis and support the Political-Military Estimate (PME). A strategic assessment may also be conducted for an ongoing NATO operation and may lead to the revision of the OPLAN"[18]. Phase 2 will start on SACEUR's direction to develop a military assessment, having received the task from the NAC, and ends with SACEUR's submission of the SACEUR Strategic Assessment (SSA), which is the NATO Military Authorities' (NMA) advice for NAC consideration.

It is crucial to identify and analyse the principal actors and their role in the crisis and to determine and analyse the strategic Centre of Gravity (CoG). *Figure 6* describes the characteristics of Centres of Gravity.

[16] "New responses to new challenges: the comprehensive crisis response and operations at SHAPE." (in Hungarian) *Honvédségi Szemle,* 2017/6. http://real.mtak.hu/124824/1/HSZ_2017_145_6_Poloskei_Janos_Antal.pdf Accessed on 27 June 2022.

[17] *COPD v3.0.*

[18] *COPD v3.0.*

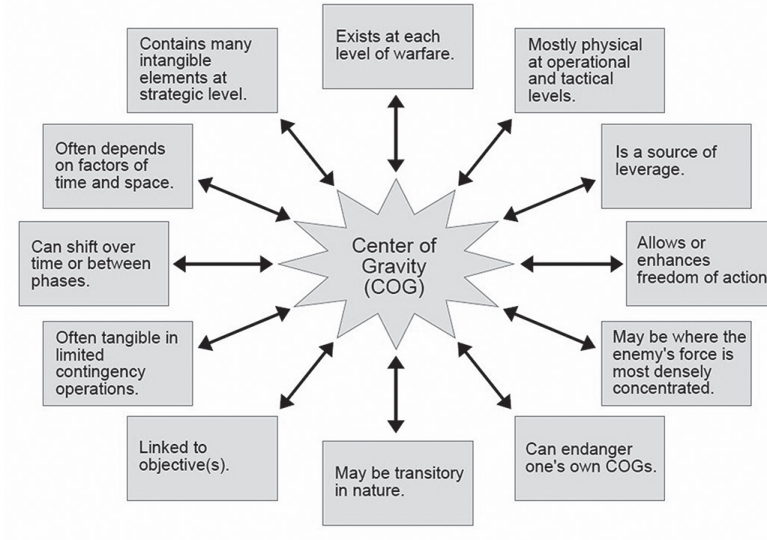

Figure 6 *Characteristics of Centres of Gravity*[19]
Source: *"JP 2-01.3," DINFOS Pavilion. Accessed on 16 December 2021. https://pavilion.dinfos.edu/Policy-Doctrine/Article/2131656/jp-2-013/*

Phase 2 evaluates potential strategic ends – the desired NATO end-state; NATO strategic objectives and strategic effects, ways and means considering that not all the desired elements of the end-state may be achieved by only military means.

Phase 3 – Military Response Options Development

The purpose of NCRP Phase 3 is to finalize the desired NATO end-state and further develop the potential strategic, political and military response strategy for the Alliance. At the military strategic level, Phase 3 develops military options for NAC to consider, supporting their Political Military Estimate (PME) process. Phase 3 reviews and analyses the political direction and guidance, determines military and non-military strategic objectives, selects and develops Military Response Options (MROs). In the end, a Strategic Risk Evaluation Matrix is developed with a mitigation strategy and conclusion of which risks are unacceptable, conditionally acceptable, and acceptable, where no risk mitigation actions required.

[19] "JP 2-01.3," *Pavilion – Dinfos Online Learning.* https://pavilion.dinfos.edu/Policy-Doctrine/Article/2131656/jp-2-013/ Accessed on 16 December 2021.

Phase 4 – Strategic Plan Development

Phase 4a – Strategic Concept of Operations (CONOPS) Development

The Strategic Plan Development is divided into two parts: Phase 4a – the development of a Strategic Planning Directive (SPD) and CONOPS; and Phase 4b – the development of a strategic OPLAN. The purpose of Phase 4a is to "describe SACEUR's concept for the conduct of the NATO-led military operation, in accordance with other non-military and non-NATO efforts, to achieve the NATO MSOs and establish conditions required to assist in the achievement of the desired NATO end state. It also includes the development and issuing of the Strategic Planning Directive (SPD) to provide authoritative direction to SHAPE, the designated HQ(s), Allied Command Operations (ACO) subordinate commands and other supporting NATO agencies".

Phase 4b – Strategic OPLAN Development and Force Generation

The purpose of Phase 4b is to identify and activate the forces and capabilities required to implement the strategic CONOPS and accomplish the mission within acceptable risks. It also specifies the sequence of the strategic activities and operations, including the deployment, employment, sustainment, and C2 of NATO-led forces, for the accomplishment of the agreed NATO military mission, as well as the possible necessary interaction with cooperating non-NATO entities. The international legal provisions are put in place during this Phase, the military and non-military activities are synchronized in a Comprehensive Approach in Phase 4b. The employment of strategic resources, the StratCom considerations are also important parts of the plan. Phase 4b activity includes planning for C2, the main components of the command structure, and the definition of the Theatre of Operations (TOO) and the Joint Operations Area (JOA).

Phase 5 − Execution

The purpose of Phase 5 is to provide strategic advice, direction, and guidance to achieve MSOs to reach the NATO end-state. The main activities of Phase 5 "include the coordinating actions necessary to initiate an operation, the implementation of the strategic OPLAN, monitoring and facilitating the operation, identifying and managing strategic risks, and the continued generation of resources for success"[20]. The execution phase involves the coordination, de-confliction and synchronization of the subordinate commands via a Strategic Capabilities Office (SCO). It also assesses the relevance of current plans and directives with stakeholders, and if required a plan review (using Phase 2-4 process).

Phase 6 – Transition

Phase 6 contains the transition and termination of a NATO military operation. This involves the "handover of responsibility to proper authority (UN, other IOs, EU or homeland actor, etc.) in the crisis area and the withdrawal of NATO forces"[21]. It is done in a controlled manner to avoid this action being a destabilizing effect on the whole mission. Apparently,

[20] *COPD v3.0.*
[21] *COPD v3.0.*

this is the most difficult part, and obviously, it failed in the case of the withdrawal from Afghanistan in 2020.

Phase 6 activities include the conduct of transition planning, strategic assessment of MROs, preparing strategic transition CONOPS and/or OPLAN, the coordination and collaboration between SHAPE, NATO HQ, NATO Agencies and relevant actors.

The termination of the operation "must be in accordance with the StratCom. The Comprehensive Crisis and Operations Management Centre CCOMC executes and manages all the post operation termination activities, like end of mission reports, archiving information, completing lessons learned post operation analysis."[22]

THE DIME/PMESII/ASCOPE/ICR2 FRAMEWORK

The strategic and operational planning requires the in-depth understanding of the Operational Environment (OE). To understand the environment, it has to be divided into domains where the actors can be identified, the processes can be analysed and understood, the influencers and decision-makers can be identified. Without proper understanding of these factors and actors a definition of the end-state can even fail and the result is an unachievable objective. One of the OE analysing approaches is the PMESII methodology. Military operations are planned and prepared in the DIME/PMESII/ASCOPE/ICR2 framework, which are key tools to understanding the operational environment. An ex-ante evaluation of the expected impact of operations is of primary importance for defining the content and process of the operations (COA–Course of Action). Analysing the expected impacts of these action plans is paramount to success.

DIME implies the application of four Instruments of Power of Diplomacy, Information, Military and Economy. PMESII examines the operational environment in six domains: Political, Military, Economic, Social, Information and Infrastructure. The ASCOPE approach is used primarily in counter-insurgency operations to analyse Areas, Structures, Capabilities, Organizations, People, and Events, whereas ICR2 stands for assessing both Information-Collection Requirements (ICR) and Information-Capabilities Requirements (ICR).[23]

Understanding the operational environment means that the actors have to tackle the challenges of operating in the human domain in general.[24]

By covering the PMESII domains, this approach is going further on the traditional focus on military matters only.[25] The Joint Intelligence Preparation of the Operational Environment (JIPOE) makes the planning staff capable of assessing the potential impact of the operational environment on the accomplishment of the mission. The COM and the staff develop a holistic view of the operational environment with regard to the causes and background of the crisis and the specific dynamics.

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22 *COPD v3.0.*

23 Szabadföldi, I. "Military Operation Planning (OPLAN) Supported by Artificial Intelligence." Presentation, *In the Service of the Nation Conference 2021* - 2021. 70.

24 *Operating in the Human Domain.* US SOC, 2015. https://nsiteam.com/social/wp-content/uploads/2017/01/SOF-OHD-Concept-V1.0-3-Aug-15.pdf

25 *AJP-5 Allied Joint Doctrine for the Planning of Operations with UK National Elements.* NATO Standardization Office: 2019.

The PMESII domains

In the PMESII framework, the OE is often considered and therefore consists of six plus two, that is to say, eight operational variables. The application of these operational variables to a specific operational environment by the developers, in cooperation with subject matter experts, gains a holistic and detailed understanding of that OE via the analysis continued systemically. The additional two operational variables, often framed with the acronym PMESII-PT,[26] are the Physical terrain and Time.

In order to get a deeper understanding of the operational environment, the COPD introduces the term Comprehensive Preparation of the Operational Environment (CPOE), and declares that NATO utilizes the PMESII model for the CPOE. The CPOE is a "cross-headquarters process, supported by the various functional and special staff areas", and it considers "the assessments of non-military and non-governmental organizations, the JIPOE and the Joint Intelligence Estimate support".[27]

The identification of the Centre of Gravity (CoG) in the specific domains is key to carrying out an Effect-based Operation (EBO). Intelligence plays a crucial role in collecting the information regarding the PMESII domains on all three levels of intelligence.[28] Strategic-level intelligence serves both for senior military and civilian leaders and combatant commanders *(Figure 7).*

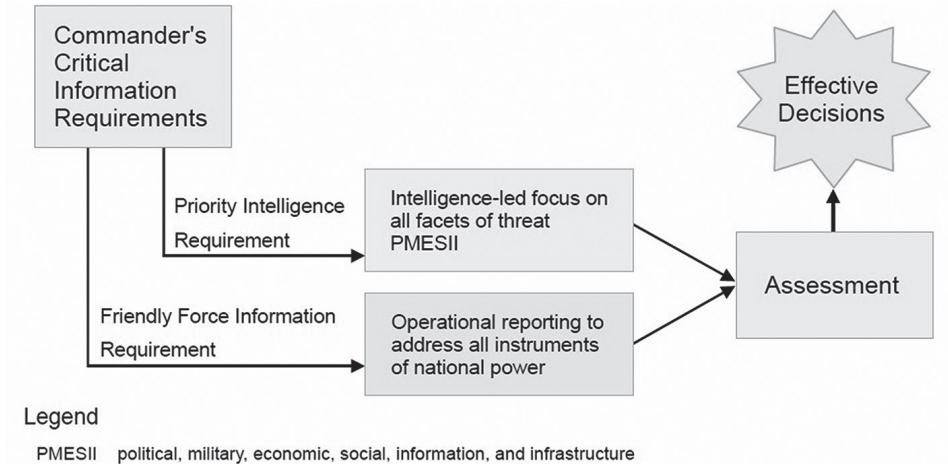

Figure 7 *Commander's Critical Information Requirements and Assessments*[29]
Source: *JP 2-0, Joint Intelligence*

[26] *TC 7-102 – Operational Environment and Army Learning.* Washington DC.: HQ Dept of the Army, 2014. https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/tc7_102.pdf Accessed on 23 November 2021.
[27] *AJP-5.*
[28] *JP 2-0.* 144.
[29] *JP 2-0.*

AI SUPPORTING THE OPERATIONS PLANNING

The US Congress appointed the National Security Commission on AI, which after two years of work submitted a Final Report in 2021. One of the Report statements was that "a new warfighting paradigm is emerging because of AI". Substantial investments are being poured into AI development projects and in the military domain extreme secrecy surrounds the cutting-edge solutions, very few details are public of the actual results. The AI-influenced warfighting idea is often called "algorithmic" or "mosaic" warfare. These phrases outline that a new era of conflicts is emerging that will be dominated by AI, and algorithms will fight against algorithms. The winning part will be determined by the amount and quality of military data, the algorithms developed, the AI-enabled networks that are connected, the AI-enabled weapons deployed, and the AI-supported operational concepts applied to wage new ways of war.[30]

The DoD outlined an ambitious strategy to be "AI-ready" by 2025. *Figure 8* depicts the strategic goals.

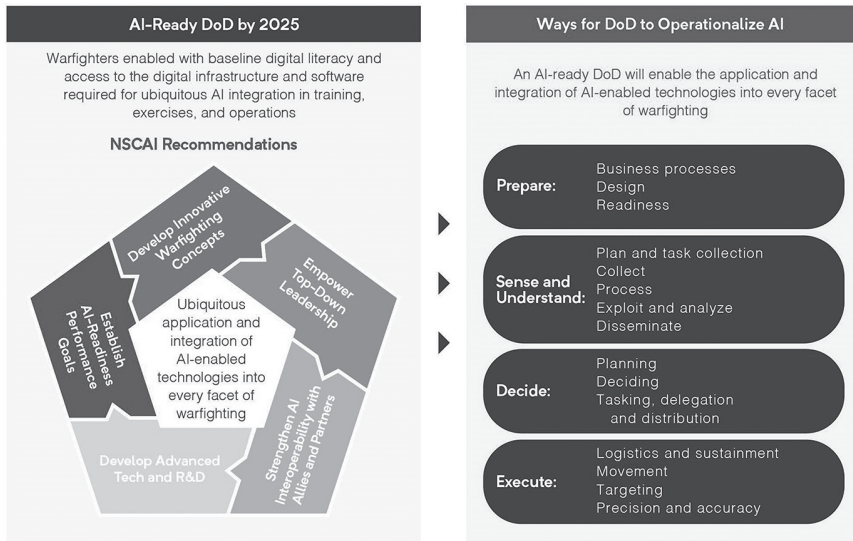

Figure 8 *An AI-Ready DoD by 202531*
Source: *National Security Commission on AI – Final Report*

There are both possibilities and challenges for AI in military applications[32]. In the military domain, the potential for AI is present in all domains (land, sea, air, space and cyber) and at all levels of warfare (political/strategic, operational, tactical). At the political and strategical levels, AI can be used to destabilize an opponent state's social and political stability by producing and disseminating large amount of fake information. And *vice versa,* AI would

[30] Final Report. (Arlington: National Security Commission on Artificial Intelligence, 2021) https://www.nscai.gov/wp-content/uploads/2021/03/Full-Report-Digital-1.pdf Accessed on 17 January 2022.

[31] *Final Report.*

[32] Svenmarck, P. et al., "Possibilities and Challenges for Artificial Intelligence in Military Applications." Researchgate, 2018. https://www.researchgate.net/publication/326774966_Possibilities_and_Challenges_for_Artificial_Intelligence_in_Military_Applications. Accessed on 17 January 2022.

also be the best instrument to defend against such attacks. Below strategic level, at operational level AI can be an efficient tool to select the optimum COA, and at tactical level, AI can improve autonomous control in unmanned systems in order to operate them more efficiently and increase battlefield impact.

Essentially, AI is expected to provide support in efficient military decision-making concerning both time and information constraints. Military decision-making will benefit from human-AI synergy[33] and the main reasons to employ AI systems to support the decision-making of military commanders are the following:

1. the vulnerabilities of human decision-making,
2. the diversity and complexity of conflict situations,
3. the information and technology means employed in warfare,
4. the amount of information needed to be processed in real time.

AI-based military decision support models can be based on neural networks (NN), Bayesian belief networks (BBN), Fuzzy Logic (FL), Genetic Algorithms (GA) and Expert Systems (ES).[34]

NN is based on the concept of a neuron as a unit for information storage, and mapping input to output. NNs are composed of processing elements called nodes, where a weight is associated with each connection between nodes. Weights are given randomly at the beginning, and change during the network's learning process. The neuron gets a numerical input vector and each element of the input vector is scaled by a weighting constant assigning the importance to each input.

Fuzzy Logic is a form of many-valued logic in which the truth value of variables may be any real number between 0 and 1. It is employed to handle the concept of partial truth, where the truth value may range between completely true and completely false.

Genetic Algorithms are used to generate high-quality solutions to optimization and search problems by relying on biological models like mutation, crossover and selection for tackling complex problems. GA applications include optimizing decision trees for better performance, automatically solve sudoku puzzles, hyperparameter optimization. GA repeatedly modifies a population of structures in order to choose an appropriate structure for a particular problem.

Expert systems (ES) use a knowledge base including a set of rules represented mainly as if–then rules and an inference engine that provides computer reasoning through inductive, deductive, or both inductive-deductive reasoning.

The various AI techniques to boost Decision Support Systems (DSS) in CoAs selection tackle the description of the event, the development of possible CoAs, the identification of criteria for the CoA's evaluation process, the evaluation of the CoAs in accordance with the criteria, analysis and comparison of these CoAs, and post-execution analysis being executed either sequentially or simultaneously.

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[33] Bosch K. and Bronkhorst, A. "Human-AI Cooperation to Benefit Military Decision Making." NATO STO, 2018. https://www.sto.nato.int/publications/STO%20Meeting%20Proceedings/STO-MP-IST-160/MP-IST-160-S3-1.pdf

[34] Prelipcean, G., Boscoianu, M. and Moisescu, F. "New Ideas on the Artificial Intelligence Support in Military Applications," Recent Advances in Artificial Intelligence, Knowledge Engineering and Data Bases. https://www.wseas.org/multimedia/books/2010/Cambridge/AIKED.pdf Accessed on 17 January 2022.

AI support for the DIME/PMESII framework model

As discussed previously, the DIME/PMESII framework model assists in enabling effects-based planning to consider a broader set of options and a broader understanding of their potential impacts. The problem is the understanding of the cause-effect relationships among their variables, and modelling these relationships and using them to forecast outcomes is a real challenge. One of the solutions to tackle this challenge was the design and development of the Probative Rapid Interactive Modelling Environment (PRIME)[35] software tool for effects forecasting. The objective of PRIME was to support analysts and strategy planners by exploring the full range of consequences associated with the considered courses of action (COAs) and to allow teams of analysts to collaboratively develop forecasts for planned actions. PRIME has two main functions: the first is to provide support for the development of generic DIME/PMESII models that forecast direct or indirect PMESII effects given a type of DIME action on a given type of entity. The second function is to leverage these generic models to produce specific forecasts about the combined effects of a specific COA.

Such solutions' effectiveness and efficiency can be extended with wider application of AI techniques, like machine learning using DNN (deep neural network) technology. The DIME/PMESII/ASCOPE framework can be considered as a multidimensional matrix of variables with cross-effects. With properly designed algorithms, those variables/parameters changes will trigger effects on others that can be forecast.

Challenges and expectations of AI application

The U.S. DOD established five ethical principles for the development and use of AI: "the systems need to be responsible, equitable, traceable, reliable, and governable and it is stated that efforts have to be done to minimize bias in data on which AI operates".[36]

Since AI systems need to be trained with a large volume of data sets (Big Data), the use of AI for military strategic planning means additional challenges, namely that AI may augment threats, "change their nature and characteristics, and also pose new security concerns. An exercise of integration of AI with nuclear C2 systems showed that such systems were vulnerable to malicious manipulation that can seriously decrease strategic stability, coming from the risk of the intervention of adversarial AI actors using techniques to deceive or disrupt C2 systems".[37]

Additional challenge is the "battlefield singularity" when AI may accelerate the warfare so much that humans cannot follow the developments, leading to lost control over the COA resulting in strategic errors, or leading to accidents and conflict escalation.

Another type of challenge is the mental challenge, when commanders and staff could be "technology-dependent", and the classical art of warfare features of intuitive, adaptive aspects of military command and decision-making are diminishing.

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[35] Lawrence, J. D. and Murdock, J. L. *Political, Military, Economic, Social, Infrastructure, Information (PMESII) Effects Forecasting for Course of Action (COA) Evaluation.* Ft. Belvoir: DTEC, 2090.

[36] Vestner, T. "From Strategy to Orders: Preparing and Conducting Military Operations with Artificial Intelligence." GCSP, 17 February 2023. https://www.gcsp.ch/publications/military-operations-and-artificial-intelligence. Accessed on 27 February 2023.

[37] "From Strategy to Orders."

A further challenge is that AI systems would provide fast and complex recommendations for human decision-making that the military staff may have no time or capacity to assess. Additionally, in the case of the application of multilayer neural network technology, due to its complex operational mode, they do not understand how the system has reached its conclusions (AI black box effect).

CONCLUSION

We can conclude that if sufficient quantity and quality of data are available, AI solutions boost data analytics processing at an incomparably higher speed than human computing. That would break down operations into specific tasks of allocating resources, predicting enemy actions or mitigating risks with an improved accuracy and higher velocity of decision-making.

The different models applied in the course of the military operations planning process, like DIME/PMESII/ASCOPE/ICR2 frameworks are key tools to understand the operational environment, and the evaluation of the expected impact of the operations has primary importance for defining the optimum COA.

Analysing the expected impacts of these action plans is paramount to success in which AI technologies may provide an efficient tool in terms of speedy decision support and accurate predictions as well. ASCOPE factors are dimensions in which the PMESII operational variables (systems and sub-systems) are identified, and behind this structure, a plethora of structured and unstructured data exists providing the basis for a properly designed algorithm for operations planning support.

Considering the high-level autonomy of AI systems, it may result in developing a specific doctrine for the armed forces to clarify if AI is regarded as a technical tool with a mathematical and computing system, or as an agent with cognitive abilities, an autonomous influencer.

The military operations planning process is data intensive, time sensitive and effective, and efficient result oriented. AI technologies and their military applications have only emerged recently, and the integration of AI into the armed forces will definitely transform the design and execution of military operations.

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