Peer-reviewed

From Battlefield to Classroom: Leveraging Military Design Thinking for Enhanced Officer Training of Multi-Domain Operations

Z bojiště do učebny: využití vojenského designového myšlení pro kvalitnější výcvik důstojníků v multi-doménových operacích

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Abstract: In military operations, there is increasing emphasis on multi-domain operations (MDO) across land, sea, air, space and cyberspace, with technology and cognitive domain operations playing key roles. However, it remains unclear how NATO can optimally prepare officers for MDO. We applied a military design thinking method in an international setting, involving participants from diverse professional backgrounds (government, academia, industry, and military), all experts in Command

and Control, to design a blueprint for an operational-level MDO training program. This blueprint outlines the tasks, knowledge, skills and attitudes required for MDO, and describes the conditions for such a training program. Our findings provide valuable insights for developing MDO training programs for NATO officers.

Abstrakt: Ve vojenských operacích je kladen stále větší důraz na multi-doménové operace (MDO) v pozemní, námořní, vzdušné, vesmírné a kybernetické doméně, přičemž klíčovou roli hrají technologie a operace v kognitivní dimenzi. Stále však není jasné, jak může NATO optimálně připravit důstojníky pro MDO. Použili jsme metodu vojenského designového myšlení v mezinárodním prostředí a zapojili jsme účastníky z různých profesních prostředí (vlády, akademické obce, průmyslu a armády), ve všech případech odborníky na velení a řízení, abychom navrhli plán výcvikového programu MDO na operační úrovni. Tento plán nastiňuje úkoly, znalosti, dovednosti a postoje potřebné pro MDO a popisuje podmínky pro takový vzdělávací program. Naše zjištění poskytují cenné poznatky pro rozvoj výcvikových programů MDO pro důstojníky NATO.

Keywords: Education & Training; Preparedness; Military operations.

Klíčová slova: vzdělávání a výcvik; připravenost; vojenské operace.

INTRODUCTION

The term “Multi-Domain Operations” (MDO) is beginning to resemble a complex physical concept like dark matter: there is a vague idea what it means, and there is a mass of lay and specialist opinion that does little to clear the “conceptual clouds”. In this article we do not lift these conceptual clouds. Instead, we look at the concept from the viewpoint of decision-making in military operations, and propose a way to deal with the consequences of MDO. To do so, we sidestep the phenomenological discussion on MDO, and examine the consequences for decision-making. Theoretical hardliners may suggest that it is impossible to say meaningful things about the consequences of a concept when it is not fully understood or clear. We argue that if this were true, we would have to reject much of applied science since many meaningful applications rest upon fundaments that are not fully understood. For example, to remain in the field of physics for a moment longer, anyone turning on a light in a dark room may start wondering whether the light is a particle or a wave, but this person can also use the light to do something else.

In this paper MDO was considered from a decision-making perspective, and therefore the origins of MDO were explored. Within the military context, five domains of MDO are typically discerned: land, sea, air, space and cyberspace (Lund-Hansen and Reilly 2024).

NATO defined MDO as the coordination of military activities across various operational domains, where these activities are integrated with non-military actions, facilitating the ability to achieve specific military objectives at optimal times and locations (NATO 2023; Cannon 2024). Diaz de Léon (2021, 92) argued that MDO is a continuation of the 1980s concept of "Air-Land Battle", a challenge that rose from the need to "*…defeat an enemy of the scale of the Soviet Red Army by integrating itself into the joint fight across the traditional physical maneuvering domains of air and land*". To successfully combat the Soviet Union all possible fire-power was needed, irrespective of its origins on land or in the air. That means that at the heart of the problem there is the need to integrate traditionally separate spheres of operation and decision-making. Integration is thus the Achilles heel of MDO. People with vastly different trainings, specializations, paradigm and/or policy frames need to understand their unique differences and shortcomings as well as strengths. For a commander this poses a vexing problem: how to make decisions while knowing only part of the job - and being in command of people who do know that missing part?

The current MDO concept goes beyond the air-land integration challenge. Sea, space and cyberspace can be added, increasing but not fundamentally altering the integration problem. Added to this incremental problem there are two new challenges: technology and the cognitive domain. Regarding technology:

"Today, the MDO deals with the threat from the latest commercial technology and leveraging the same, as well as the most advanced technology, to improve command and control of forces" (Diaz de Léon 2021, 92). Technology, and the speed with which it develops, creates a fundamental challenge because it introduces new territory that no commander can hope to oversee without the input of specialists in the decision-making process. To a certain extent the modern battle cannot proceed without technology assessment of own forces and that of the enemy.

Cognitive domain operations, including psychology and public information operations, add another fundamental challenge. The battlefield is no longer the place where metal tries to destroy metal. The cognitive dimension greatly increases a commander's domain of responsibility. Cognitive warfare is

"…an unconventional form of warfare that uses cyber tools to alter enemy cognitive processes, exploit mental biases or reflexive thinking, and provoke thought distortions, influence decision making and hinder action, with negative effects, both at the individual and collective levels" (Claverie and du Cluzel 2022, 2).

Where technology and the cognitive domain meet, as in artificial intelligence and machine learning, the requisite knowledge extends far beyond anything taught at military academies and higher staff schools.

From the viewpoint of decision-making, depending on traditional command and control (C2) and traditional staff-procedures in which the commander is assumed to be the most knowledgeable soldier in the room, is insufficient. A commander must depend on

the inputs of many specialists whose knowledge he/she does not share, and in many cases does not understand. Educating officers to the point that they master all the necessary domains would be similar to clean the Augean stables, it would require enormous amounts of schooling in so many different disciplines that the time to create a philosopher-commander who understands everything is humanly impossible.

However, we believe that commanders can learn to make swift and appropriate decisions within MDO by consistently obtaining timely and accurate information from experts in various fields and by skillfully coordinating their operations with commanders from other domains, without needing to be subject matter experts in all specializations within all domains themselves. To ascertain the requisite knowledge, skills, and attitudes (KSA) that a commander must acquire for this challenging endeavor, and to elucidate the conditions that such a training program must fulfill, we engaged participants of the international NATO Command and Control Centre of Excellence (NATO C2COE) 2024 conference. Through the implementation of military design thinking (MDT) methodology, they collaboratively shaped a training program for MDO officers at operational level.

1 RESEARCH METHODOLOGY

We applied an MDT method in order to shape a NATO training program for MDO officers at operational level, in which the tasks to be performed and the KSA to be trained are specified. The conditions of this training program are defined as well.

1.1 Military design thinking method

Hornstra et al. (2024a) devised an innovative MDT method (refer to Appendix A) suitable for designing organizational innovation in the military setting, including shaping novel training programs for officers. We adapted this MDT approach to fit within the constraints of a conference setting.

The MDT method that was implemented for the challenges presented in this paper, incorporated the following modifications compared to the original method of Hornstra et al. (2024a, 2024b). The STARTEX and Design thinking retreat phases (i.e. Reconnaissance, Development and Consolidation phase) were all conducted in consecutive sessions on the same day. Therefore, the format and objectives of the MDT session were explained to the participants in the STARTEX instead of the Reconnaissance phase. Given the time constraints, we limited each of the Design thinking retreat phases from 90 to 60 minutes. For the same reason, we replaced the two one-hour presentations of senior officers, in both the Reconnaissance and Development phase, with a 10-minute presentation of a senior officer at the beginning of the Reconnaissance phase.

Additionally, we aimed to engage as many conference participants as possible in this session. However, due to the overwhelming interest, to maintain manageable oversight of the MDT process, we divided the participants into two groups of equal size: implementers and observers. Implementers were to engage in the MDT process. Observers, on the other hand, were to monitor the performance of the MDT process with the aim of providing feedback to implementers regarding the interim and final results during the plenary sessions. Each group (implementers and observers) was designed to have appropriate representation of both senior and junior members, while also ensuring a balanced inclusion of civilian and military personnel.

Furthermore, because this implementation of the MDT method was not conducted within the context of a military exercise, in the Reconnaissance phase, we did not associate the MDT process (performance reflection) with a military exercise (performance). Moreover, there was no necessity to differentiate among various types of learners in this context. Finally, there was no specific requirement for a transition from heterogeneous to homogeneous subgroups during the MDT process. Table 1 outlines the phases and corresponding key steps of the MDT method that we employed in this study.

Table 1: An MDT method to shape military training programs, derived from Hornstra et al.'s (2024a, 2024b) MDT method

Phase	Key steps per phase
STARTEX	1) Study available documents to determine the unperceived learning needs of the target learners (prior to session). 2) Explain format and objectives of MDT session to participants. 3) Conduct a survey among implementers to determine perceived learning needs of target learners, whereas observers only complete the personal background information questions of this survey. 4) Ask each implementer to interview one implementer with two informal questions about the intended training program.
Design thinking retreat: Reconnaissance	1) Provide a 10-minute relevant presentation of a senior officer. 2) Provide implementers with data generated in the STARTEX phase and ask them to study the data individually. 3) Ask implementers to review data and to brainstorm ideas in subgroups. 4) Ask implementers in subgroups to engage in divergent thinking and brainstorming about the data sources in order to generate as many ideas as possible about impediments and enablers for learners to attend the activities of the training program, where implementers per subgroup mark the ideas on sticky notes. 5) Let implementers plenarily inventory, thematically group and qualitatively assess the ideas. 6) Ask observers to provide feedback to implementers.
Design thinking retreat: Development	1) Ask implementers to break up into same subgroups and develop an optimal set of activities, based on generated, grouped and assessed ideas in Reconnaissance phase. 2) Ask implementers in the subgroups to present plenarily their suggested training program. 3) Ask observers to provide feedback to implementers. 4) Take notes and facilitate open discussion to clarify ideas. 5) Merge common themes from the several suggested training programs into an initial group of ideas for the training program.

Design thinking retreat: Consolidation	1) Ask implementers to break up into same subgroups to generate and refine solutions for the initial group of ideas for the training program. 2) Challenge ideas about solutions and provide feedback. 3) Ask implementers in subgroups to pitch plenarily their main solution. 4) Ask observers to provide feedback to implementers. 5) Ask implementers to refine their main solutions. 6) Compliment publicly the subgroup on best solution. 7) Plan further refinement and piloting of solutions.
Implementation	1) Implement solutions developed during design thinking retreat.

1.2 Participants

The MDT session participants constituted a subset of the attendees from the annual multi-day NATO C2COE 2024 conference on C2. This group consisted of junior and senior NATO officers as well as civilian and military scientists, all C2 experts. For further information regarding the participants, refer to Table 3 in the Results section.

1.3 Setting

The MDT session *Applying Military Design Thinking as a flexible C2 method to MDO: Shaping a training program for NATO officers* was conducted as part of NATO C2COE's 2024 conference program, which was titled that year *NATO Multi Domain Operations Synchronisation - C2 Implications: How to achieve converging effects in the continuum of competition?*. The MDT process was executed on November 19, 2024, at the military barracks *Majoor Jan Linzel Complex* in The Hague, the Netherlands.

1.4 Procedure

Three researchers (SH, JH, SN) supervised the execution of the MDT process. Table 2 displays the time table of the successive phases of this process. In the next sections, we described the proceedings of the STARTEX, Reconnaissance, Development and Consolidation phase in detail.

Table 2: Time table of the MDT process as executed during the NATO C2COE 2024 conference

Phase	Time (p.m.)
STARTEX	1.15 – 1.35
Break	1.35 – 1.45
Reconnaissance	1.45 – 2.45
Break	2.45 – 2.55
Development	3.05 – 4.05
Break	4.05 – 4.15
Consolidation	4.15 – 5.15

1.4.1 STARTEX phase

The session began with an overview of the format and a detailed explanation of the objectives of the MDT session. Adhering to the principle of just-in-time information, it was briefly noted that four immediately subsequent sessions would be conducted. The objectives of the MDT session were (1) experiencing the MDT process as an agile C2 method and (2) designing the blueprint of an innovative NATO training program for MDO officers at operational level.

Subsequently, we delineated the difference between unperceived and perceived learning needs of the target audience, meaning NATO officers conducting multi-domain operations (i.e. MDO officers). Unperceived learning needs are those of which participants may not be aware, whereas they are cognizant of perceived learning needs. To mitigate the possible unperceived learning needs, prior to the actual session, we described the contemporary MDO challenges, as set out in the Introduction section. Additionally, to address the perceived learning needs and to initiate the thinking process among implementers about the intended training program, we performed a five-minute needs assessment survey and a ten-minute peer interview. The survey (refer to Appendix B) comprised nine closed-ended questions and three multiple-choice questions. Subsequently, implementers were given two questions to facilitate informal peer interviews in pairs. The questions administered were *When you think about the preparation of MDO officers at operational level, what do you think we should definitely / definitely not include in a NATO training program*? On the contrary, observers only completed the personal background information questions of the survey.

1.4.2 Reconnaissance phase

To further stimulate the thinking process, a senior officer provided a presentation about NATO MDO. Implementers were then provided with data generated during the STARTEX phase, encompassing both unperceived and perceived learning needs. Initially, implementers were instructed to individually study these data sources. The implementers were then divided into two subgroups of equal size. Each subgroup was structured to ensure an adequate representation of both senior and junior members, as well as a balanced inclusion of civilian and military personnel. They were directed to review the data and brainstorm ideas. This activity involved divergent thinking and brainstorming to generate numerous ideas regarding the impediments and enablers for training MDO officers at operational level. Each idea was recorded on a sticky note by implementers. These notes were collected afterwards within each subgroup, yielding numerous distinct, though frequently ambiguous and disjointed, ideas. Following this, implementers were instructed to catalog and thematically categorize all the ideas during a plenary session, while observers provided feedback.

1.4.3 Development phase

Following the completion of the Reconnaissance phase, we transitioned to the Development phase. Implementers were instructed to reassemble into the same two

subgroups and utilize the ideas developed during the Reconnaissance phase to create an optimal set of training activities. To facilitate this process, and with the aid of a format provided in Appendix C, implementers were then assigned to identify the tasks of MDO officers at operational level; the necessary KSA for each task; and the components of the new training program for these MDO officers, which includes the KSA required for each MDO task. Next, each subgroup presented their proposed training program in a plenary session, while observers offered input again. The researchers documented the presentations and facilitated an open discussion to elucidate the ideas. The researchers then synthesized the common themes from both proposed training programs into an initial set of ideas for the training program.

1.4.4 Consolidation phase

Upon completing the Development phase, we advanced to the Consolidation phase. Implementers were directed to reorganize into the same two subgroups as in the prior phase. They enhanced and refined the initial set of ideas for the training program developed during the Development phase. The researchers circulated among the subgroups to critically evaluate the ideas and offer constructive feedback.

Thereafter, each subgroup of implementers presented their proposed training program in a plenary session, still adhering to the format outlined in Appendix C. During these presentations, both researchers and observers provided feedback, leading to the final revisions of the proposed training programs. The highest-ranking officer among the researchers publicly commended the subgroup of implementers with the best training program. Finally, participants were informed that the research team would consolidate the components (i.e. intended tasks to be performed and KSA to be trained) and conditions of all proposed training programs into a single comprehensive training program, which could serve as the blueprint for a NATO training program of MDO officers at operational level.

1.5 Data analysis

We utilized SPSS (version 28.0.0.0) to analyze the quantitative data of the survey.

2 RESULTS

From the MDT process, we present the following data: personal background information of participants, perceived learning needs, and components and conditions of a NATO training program for MDO officers at operational level. For all instruments in this study, the response rate was 100% (implementers: 18/18; observers: 18/18).

2.1 Personal background information of participants

To place the findings of this study in the appropriate context, personal background information of the implementers and the observers is first presented in Tables 3 and 4, respectively. This background information was gathered through the introductory nine closed-ended questions of the needs assessment survey. Several civilian participants reported having a military background. Nevertheless, we classified their professional status based solely on their current civilian roles.

Table 3: Personal background information of implementers

Question	N = 18
Country of origin	Denmark: 1 France: 1 Germany: 2 Greece: 1 Ireland: 1 Italy: 1 Norway: 2 Romania: 1 Sweden: 1 The Netherlands: 3 Turkey: 1 Ukraine: 1 USA: 2
Highest level of education completed	Bachelor: 3 Master: 14 PhD: 1
Age	30–39 year: 3 40–49 year: 5 50–59 year: 5 60–69 year: 5
Professional status	Civilian: 8 Military: 10
Military rank	OF-6: 1 OF-5: 4 OF-4: 1 O-5: 2 O-4: 1 OR-7: 1
Military branch	Air Force: 3 Army: 4 Navy: 3
Civilian expertise	Command and Control: 1 Data / AI / Cybersecurity: 5 Operations assessment: 2
Civilian position	Advisor / consultant: 3 IT architect: 2 Manager: 3

Organization	CMK Global Consultancy: 1 Danish Ministry of Defense: 1 Dutch National Cyber Security Centre: 1 Infodas: 1 Mandiant Google Cloud: 1 Microsoft: 2 NATO Allied Command Operations: 1

Table 4: Personal background information of observers

Question	**N = 18**
Country of origin	Canada: 1 Estonia: 1 France: 1 Germany: 1 Italy: 1 Norway: 1 Portugal: 1 Spain: 2 Sweden: 5 The Netherlands: 4
Highest level of education completed	Bachelor: 3 Master: 11 PhD: 4
Age	30–39 year: 0 40–49 year: 3 50–59 year: 10 60–69 year: 5
Professional status	Civilian: 9 Military: 9
Military rank	OF-5: 2 OF-4: 5 OF-3: 1 OF-2: 1
Military branch	Air Force: 2 Army: 4 Civil Guard: 1 Navy: 2
Civilian expertise	Business development: 1 Decision-making: 1 Command and Control & Operations: 3 Operation analysis: 2 Signal intelligence: 1 Technology and innovation: 1
Civilian position	Analyst: 2 Business developer: 1 Manager: 2 Scientist: 4
Organization	Canadian Joint Warfare Centre: 1 Helmut-Schmidt-University: 1 Lockheed Martin: 1 Netherlands Organisation for Applied Scientific Research (TNO): 1 Rohde & Schwartz: 1 Saab AB: 1 Swedish Armed Forces: 1 Swedish Defence University: 2

2.2 Perceived learning needs of implementers

The data of the perceived learning needs concerning MDO at operational level were gathered through a needs assessment survey and paired peer interviews. Table 5 presents the data from the needs assessment conducted among the implementers. These data were collected through the three multiple-choice questions of the needs assessment survey, in which multiple answers were possible for each question.

Table 5: Needs assessment - Perceived learning needs of implementers

Question	**N = 18**
What types of professional development are you currently spending time on to gain more insight into MDO at operational level?	Military exercises: 13 Education and Training: 6 Performing research: 7 Literature: 10 Conferences: 16 Podcasts: 5 Other: 1 (wargame)
What types of professional development do you need to gain more insight into MDO at operational level?	Military exercises: 15 Education and Training:11 Performing research: 6 Literature: 18 Conferences: 5 Podcasts: 2 Other: 1 (wargame)
What factors may prevent you from gaining more insight into MDO at operational level?	Lack of opportunities: 10 Lack of time: 10 Lack of motivation: 2 Lack of clear expectations from commander / organization: 6

In Table 6, the data from the implementers' paired peer interviews are displayed. The responses regarding the areas that require / do not require training were systematically categorized.

Table 6: Peer interviews - Perceived learning needs of implementers

Question	**N = 18**
When you think about the preparation of MDO officers at operational level, what do you think we should *definitely include* in a NATO training program?	1) Definition of MDO concepts. 2) Description of domains (including space, virtual and cognitive). 3) Synchronization / Interoperability / Interaction across NATO members and domains, including non-military actors. 4) Relationship between MDO and C2. 5) Effects thinking. 6) Data collection / Knowledge management / Information sharing. 7) Technology (e.g. AI) in support of MDO. 8) Cybersecurity. 9) Application of MDO to real-world operations. 10) Collective (i.e. cross-domain) training. 11) Cultural competencies (soft collaboration skills).
When you think about the preparation of MDO officers at operational level, what do you think we should *definitely not include* in a NATO training program?	1) Excessive emphasis on theoretical aspects. 2) Excessive emphasis on technical aspects. 3) Hierarchical structures and inflexible procedures. 4) Limitation to physical domains.

2.3 Components and conditions of NATO training program for MDO officers at operational level

As the final outcome of the MDT process, the implementers have formulated the components and conditions of a NATO training program for MDO officers at operational level. These findings are presented in Table 7. The implementers did not determine the required KSA for each task individually, but rather identified a comprehensive set of KSA that collectively enable the performance of the intended MDO tasks. Similarly, the conditions for the entire training program have been specified.

Table 7: Components and conditions of a NATO training program for MDO officers at operational level

Tasks to be performed	Knowledge / Skills / Attitudes to be trained	Conditions
1) Cross-domain stakeholder analysis 2) Cross-domain team building 3) Information sharing 4) Coordinating and enhancing the effects of one's own domain in relation to the effects of other domains, and reciprocally 5) Anticipating MDO of opponents	*Knowledge* - MDO concepts - Basics of all domains - Relevant military doctrines - Abilities of industry, governments and academia - Coherence of cross-domain effects - MDO of opponents *Skills* - Cultural soft skills - Collaborative soft skills - Team building soft skills - Interpersonal soft skills - Innovation management skills *Attitudes* - Trust in other experts and other domains - Open to innovation	- Cross-domain collective training - Not overly theoretical in orientation - Not overly technical in orientation - Clear connection to real-world operations

3 DISCUSSION

This study aimed to shape an innovative NATO training program for MDO officers at operational level by applying the MDT methodology tailored by Hornstra et al. (2024a, 2024b). MDO necessitates an effective orchestration and synchronization across domains and environments. Such an exhaustive approach requires multi-domain training and exercises. By employing MDT as a human-centric, collaborative process we explored ideas and narrowed them into viable training options.

The key findings are described in Table 7 as an overview of tasks, KSA and conditions for a MDO training program on a comprehensive level rather than task-specific. This is

in line with the cross-disciplinary perspective on MDO itself. Officers who are tasked in planning, conducting and evaluating MDO must be able to work cross-domain to be effective. Officers trained in a single-domain expertise need to make the shift to adapt to and adopt a multi-domain approach. As one participant aptly explained with a metaphor: "*How can you expect to win a chess match if you can only see two rows of chess pieces?*". In the next sections, we discuss the key findings: the KSA to be trained and the associated conditions for such a training program. Although participants stressed that the entirety of the KSA is necessary to perform adequately the entirety of the MDO tasks cohesively, for illustration purposes, we linked below each of the KSA to be trained to an acknowledged task (i.e. cross-domain stakeholder analysis, cross-domain team building, information sharing, coordinating and enhancing the effects of one's own domain in relation to the effects of other domains and reciprocally, and anticipating MDO of opponents).

3.1 Knowledge to be Trained

For MDO officer training, one of the key areas of knowledge to address is the establishment of a common understanding between cross-domain stakeholders of the basic MDO concepts: definitions, roles, rules and processes in combination with the use of interoperable technology. The goal is not to have individual interpretations but to build a clear, shared understanding that all officers can align with. This shared knowledge forms the foundation for effective C2 and action across all domains, ensuring that all officers work together with the same goals and approach in mind.

The participants of the MDT process underscored the importance of cross-domain stakeholder analysis, where officers must identify key actors across domains and understand their capabilities and influence on military operations. Understanding and coordinating the effects of one's own domain in relation to other domains is essential to guaranteeing that actions complement and reinforce each other rather than operate in isolation. However, we cannot expect a MDO officer to be a modern military variant of the Renaissance concept of the homo universalis. MDO officers do not need to be experts in every domain, but they must understand the foundational principles of each domain. For example, Air Force officers should be aware of both cyber threats and opportunities, even if their primary expertise is in air operations. After all, a cyberattack on enemy air defense systems can create vulnerabilities, making it easier for aircraft to strike ground targets. To effectively leverage such opportunities, officers must understand the harmony between domains through both technical enablement and a strategic mental framework for synchronization.

Another key area of knowledge is understanding relevant military doctrines. It is important to establish connections between these doctrines, ensuring that they align with MDO principles. Moreover, keeping doctrines up to date is crucial, as they provide the

framework for operations and guide decision-making. Officers must be familiar with both current doctrines and any updates, as this helps adaptability across different domains.

MDO is not limited to merely military domains but also involves the synchronization of actions and capabilities from non-military (i.e. civilian) sectors. By comprehending what actors such as tech companies, universities and defense contractors can contribute, officers can better leverage their strengths, synchronize efforts and influence them or be influenced by them. Insights into these abilities is important for effective cross-domain team building in order to enhance overall performance in MDO.

The results of the MDT application identified the task of anticipating the MDO of opponents, which is necessary for staying ahead of adversaries rather than losing the initiative. If officers only know their own side, it will likely lead to failure. Consequently, it is just as important to recognize and anticipate the opponent's MDO strategies, capabilities and potential actions. Without a comprehension of adversary MDO strengths and weaknesses, officers may fail to effectively counter threats and exploit opportunities.

3.2 Skills to be Trained

According to the results of the MDT application, the development of soft skills (e.g. cultural, collaborative, interpersonal and team building) is important to teach during a MDO course in order to foster adaptability, collaboration and innovation. Over the years, the military has cultivated a distinct culture. Even within the traditional three domains, cultural differences have posed significant challenges. These challenges are further complicated by the involvement of non-military actors and varying effects. MDO officers must be proficient in working with experts from diverse fields and domains to promote seamless cross-domain coordination. As the nature of MDO constantly evolves, agility in team structures is essential, allowing teams to quickly adapt to changing operational demands and maintain effectiveness in complex scenarios. While the chain of command remains important, the rigid command-and-obey model is not sufficient anymore with individuals from various backgrounds and perspectives. As a consequence, soft skills are essential for officers to acknowledge and navigate these differences, facilitating effective cooperation across military and civilian sectors.

Additionally, the participants highlighted the importance of innovation management skills for MDO, given the swiftly changing landscape of contemporary warfare that demands ongoing adaptation and the incorporation of novel technologies (Lund-Hansen and Reilly 2024). These skills empower military leaders to adeptly coordinate and exploit advancements across multiple domains (Armstrong et al. 2024). Furthermore, innovation management cultivates an environment of creativity and problem-solving, which is indispensable for tackling the intricate and unpredictable challenges encountered on the multi-domain battlefield (Lund-Hansen and Reilly 2024).

3.3 Attitudes to be Trained

In ongoing conflicts, we witness the rapid emergence of new weapons and unexpected technological advancements. New technologies, including the omnipresent application of drones, are increasingly shaping military operations. The speed with which such new technologies occur require a nimble and agile attitude, in both mindset and actions. MDO officers must therefore develop an open attitude towards innovation in order to stay ahead of trends, adapt to new tools and integrate them into MDO. Even with emerging technology, such as artificial intelligence and near real-time availability of data and communication from tactical to strategic commands, MDO remains fundamentally human-driven. As a result, trust among humans and trust in systems remains essential for mission success (Wrigley, Mosely and Mosely 2021). Nonetheless, traditional military training often fosters suspicion toward external expertise, as the instinct is to keep everything within the commander's control. In a rapidly changing environment, this approach is no longer feasible. Effective information sharing, along with trust and collaboration, is crucial for integrating insights from different stakeholders to achieve desired converging effects in MDO. While many younger officers may be familiar with and born into a world where innovation and emerging technologies are readily available, the ability to embrace and use new ideas and tools is crucial. Grounded in trust possibly beyond their comfort zones, today's military officers need to move past old-school approaches, and be willing to accept and capitalize upon new technologies.

3.4 Conditions of Training Program

The findings of the MDT session indicated that, contrary to what is often the military training practice, a MDO training program should be designed to address the needs of different branches collectively, rather than being tailored to specific branches. Only in this manner do officers from diverse backgrounds come to understand each other and each other's domains thoroughly. In other words, MDO experts should teach as they preach. Furthermore, there is a need to balance theory and practice. By avoiding overly theoretical or technical approaches, the MDO program should remain relevant to practical real-world endeavors. Wargaming using scenarios from stakeholders may help to develop interactive and experimental learning platforms that allow trust-building and cross-domain coordination and alignment.

3.5 Strengths and Limitations of this Study

This study has some strengths. The participants in the MDT session were all C2 experts. Moreover, they came from various nations, were at different stages of their careers and had diverse professional backgrounds (government, academia, industry, and

various branches of the military). This diversity in perspectives on MDO stimulated and facilitated discussions and idea development in the group process, thereby enriching the outcome of the MDT run. Additionally, previous research on the MDT method with the aim of creating training programs for officers was limited to a military exercise context (Hornstra et al. 2024b). This study demonstrated that the MDT method can also be decoupled from a military scenario and applied in the form of an expert meeting within, for example, a conference setting.

However, there were some limitations as well. The MDT run was conducted in a time-limited session at the NATO C2COE 2024 conference reducing the comprehensiveness of the discussion in each MDT phase. In addition to that, participation in the MDT session was voluntary and open to all conference attendees. This setup may have introduced selection bias.

3.6 Further Research

In this study, an innovative MDT method was used to collaboratively develop components and conditions for a training program for MDO officers at operational level. MDT is an iterative phased group process that combines brainstorming and divergent thinking to generate a broad range of ideas. These ideas are subsequently refined and systematically narrowed down to viable solutions that can be practically implemented. However, there are other methods that offer advantages in analyzing problems and finding solutions as well. For example, round-table Delphi methods likewise prioritize generating, testing and refining solutions. Future research could investigate whether understanding different aspects of and generating solutions for a training program for MDO officers through a Delphi method would offer new insights into shaping such a program. Future research could also examine through a retro analysis on a known training setting, assessed and addressed in a classical manner, whether the application of MDT could lead to a quicker and/or better outcome.

CONCLUSIONS

This study highlights the current paradigm shift in problem-solving approaches within the military context, emphasizing not only the search for solutions using known methods but also questioning which methods are best suited to achieve the desired outcomes. Moving away from typical military hierarchical decision trees, the study advocates for the inclusion of divergent thinking to contribute to solutions for complex and volatile problems. This approach aims to accelerate the decision-making process, enabling military organizations to stay ahead of evolving situations by employing a faster well-known Orientation, Observation, Decision and Action (OODA) loop. The MDT method provides a concrete framework to achieve these goals. However, it is crucial to recognize that at

some point, a decision must be made to implement the MDT method into the actual planning and execution processes. This raises the question of how much certainty of success for the execution of an MDT run is required to make such a decision. In any case, this study has demonstrated that the MDT method provides the opportunity to collaboratively design the blueprint of a military training program, in this instance for MDO officers at operational level, together with experts. Finally, NATO has not been idle in the development of MDO training programs. For instance, NATO School Oberammergau (2024) has scheduled new MDO courses in 2025 to improve operational readiness in the MDO field. We believe that the findings of this study can assist educators in further enhancing their MDO training programs, thereby better preparing NATO officers for their current duties within the MDO context.

The authors received no financial support for the research, authorship and/or publication of this article[1].

The authors declare that there is no conflict of interest in connection with the publication of this article and that all ethical standards required by the publisher were accepted during its preparation.

Disclaimer statement

The views expressed herein are those of the authors and not necessarily those of the Netherlands Ministry of Defence, the Turkish Ministry of National Defence, the US Government, the Uniformed Services University, or other Federal agencies.

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1 We thank COL (Ret) Mehmet Akif Morkaya of the Turkish Armed Forces for his presentation about NATO Multi-Domain Operations, and CPLAO Sam de Groot of the NATO C2COE for his support, both during the Military Design Thinking session at the NATO C2COE Conference in The Hague, the Netherlands, on November 19, 2024.

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Appendix A – Phases and corresponding key steps of the military design thinking method (2024a)

Phase	Key steps per phase
STARTEX	1) Study available documents to determine the unperceived learning needs of the target learners (prior to session). 2) Conduct a survey among the participants to determine the perceived learning needs of the target learners. 3) Ask each participant to interview one participant with two informal questions about the intended training program.

Design thinking retreat: Reconnaissance	1) Provide two one-hour relevant presentations of senior officers (immediately prior to session). 2) Inform the participants on design thinking retreat's format. 3) Link the military operation of the exercise (performance) to the MDT process (reflection on performance). 4) Provide the participants with the data generated in the STARTEX phase and ask them to study the data individually. 5) Ask the participants to review the data and to brainstorm ideas in heterogeneous subgroups. 6) Ask the participants in the subgroups to engage in divergent thinking and brainstorming about the data sources in order to generate as many ideas as possible about impediments and enablers for learners to attend the activities of the training program, where the participants per subgroup mark the ideas on sticky notes. 7) Let the participants plenarily inventory, thematically group and qualitatively assess the ideas.
Design thinking retreat: Development	1) Provide two one-hour relevant presentations of senior officers (immediately prior to session). 2) Ask the participants to break up into homogeneous subgroups and develop an optimal set of activities for different types of learners (e.g. learners from different units), based on the generated, grouped and assessed ideas in the Reconnaissance phase. 3) Ask participants in the subgroups to present plenarily their suggested training program for their type of learners. 4) Take notes and facilitate open discussion to clarify ideas. 5) Merge common themes from the several suggested training programs for the various types of learners into an initial group of ideas for the training program.
Design thinking retreat: Consolidation	1) Ask the participants to break up into the same homogeneous subgroups to generate and refine solutions for the initial group of ideas for the training program. 2) Challenge ideas about solutions and provide feedback. 3) Ask participants in subgroups to pitch plenarily their main solution. 4) Provide feedback on main solutions. 5) Ask participants to refine their main solutions. 6) Compliment publicly the subgroup on best solution. 7) Plan further refinement and piloting of solutions.
Implementation	1) Implement the solutions developed during the design thinking retreat.

Appendix B – Needs assessment survey (2024b)

12 questions.
Duration of maximum 5 minutes.

General

1) Country: ……..

2) Highest completed degree of education (cross out what does not apply): Bachelor / Master / PhD

3) Age (years): ……

4) Professional status (cross out what does not apply): Military / Civilian

Military (if applicable)

5) Military rank: ……

6) Military branch: ……

Civilian (if applicable)

7) Civilian expertise: ……..

8) Civilian position: ……..

9) Civilian organization: ……..

Professional development

10) What types of professional development are you currently spending time on to gain more insight into MDO at operational level? Please check what applies to you (multiple answers possible).

□ Military exercises
□ Education and Training
□ Performing research
□ Literature
□ Conferences
□ Podcasts
□ Other: ……

11) What types of professional development do you need to gain more insight into MDO at operational level? Please check what applies to you (multiple answers possible).
□ Military exercises
□ Education and Training
□ Performing research
□ Literature
□ Conferences
□ Podcasts
□ Other: ……

12) What factors may prevent you from gaining more insight into MDO at operational level? Please check what applies to you (multiple answers possible).
□ Lack of opportunities
□ Lack of time
□ Lack of motivation
□ Lack of clear expectations from commander / organization

Appendix C - Format for Development phase (2024b)

	Tasks: What should we perform?[1]	**Knowledge, Skills, Attitudes (KSA): What should we know and what should we be able to do (per task)?**	**Component NATO training program: What should we have to train for that?**
MDO at operational level	Task 1	Set 1 of KSA	Component 1 (Task 1 and KSA)
	Task 2	Set 2 of KSA	Component 2 (Task 2 and KSA)
	Task 3	Set 3 of KSA	Component 3 (Task 3 and KSA)
	Task 4	Set 4 of KSA	Component 4 (Task 4 and KSA)
	Task 5	Set 5 of KSA	Component 5 (Task 5 and KSA)

[1] Describe as many tasks as necessary (possibly more or less than 5).