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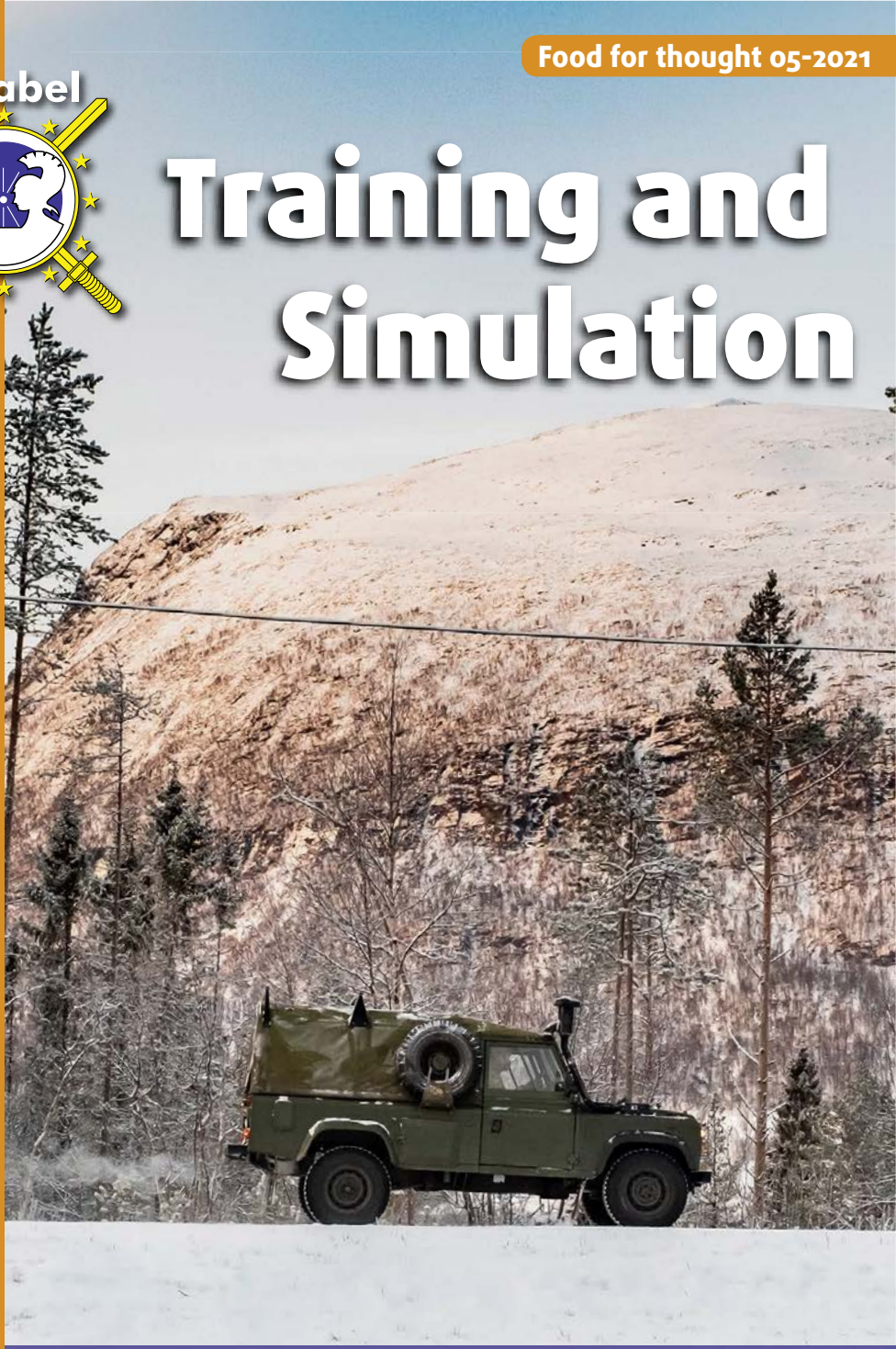
Training and Simulation



AN EXPERTISE FORUM CONTRIBUTING TO EUROPEAN ARMIES INTEROPERABILITY SINCE 1953

FINABEL
European Army Interoperability Center

Written by
the Research team of Finabel

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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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INTRODUCTION

Existing structures have outgrown our existence and our means of living and evolving together. Still, we organise ourselves in such a way as to meet our interests, but bigger questions remain, especially regarding defence issues. Overtaken between the cleavages of history , the nations, with their heritage and interests, have acquired huge importance and empirical strength. So much so that today, within the European Union, we are asking ourselves the question of mutual help in our internal defence, emphasising the strategic concerns over continental and Mediterranean security.[1] How could this emerge? As Finabel, we believe that this can only be done through interoperability and mutual trust, enabling us to deal with what we describe as the surrounding and upcoming threats. Indeed, often positioning themselves as international mediators and stabilisers with regard to their values, European nations have a role to play in terms of a shared and ethical defence.[2] A *topos* of the European community has been making more and more headlines in recent years within the European Union and its institutions: Europe is seeking strategic autonomy in defence.[3] In contrast to a new *Fouchet* plan reminiscent of the De Gaulle years,[4] Emmanuel Macron has repeatedly presented this autonomy as a Europe of defence linked to an assertive and determined Atlanticism.[5] Indeed, for the French leader, this transatlantic partnership would not be asymmetrical but balanced. In the second "*Grundsatzrede*", on 17 November 2020, German Defence Minister Annegret Kramp-Karrenbauer agreed with French considerations regarding Europe's own defence.[6] The Franco-German couple agrees on the usefulness of NATO given the illusion of the end of the Cold War, but also due to the prominence of the terrorist threat and the return to authoritarianism in the European Union. Beyond these recent political elements, the interoperability between European armies lies in the very essence of the creation of the *Common Security and Defence Policy*.[7] Indeed, how can such a policy be successfully developed without interoperability and intelligibility of the tactics, techniques and practices between European armies? It cannot be done without permanent bridges between European armies, whether institutional or political. These aspects underline the importance of European armies' interoperability and the European political ideal of achieving it through its defence policy. This focus on a common defence has been growing year after year since the publication of the *Global strat-*

1. OSCE Network, European Security - Challenges at the Societal Level, December 2016. Available at: https://osce-network.net/file-OSCE-Network/documents/European_Security-OSCE_WEB.pdf
2. Fiott, Daniel. 2020. *"Covid-19 should mean more European defence cooperation"*. EDA, European Defense Matters, Issue #19, p.12. Available at: https://eda.europa.eu/docs/default-source/eda-magazine/edm19_web
3. Fiott, Daniel. Keohane, Daniel. Maulny, Jean-Pierre et al. 2020. *"The Quest for European Strategic Autonomy – A Collective Reflection"*. Istituto Affari Internazionali. Issue 20|22. Available at: https://www.iai.it/en/pubblicazioni/quest-european-strategic-autonomy-collective-reflection
4. Teasdale, Anthony. 2016 *"The Fouchet Plan: De Gaulle's Intergovernmental Design for Europe"*. LSE, LEQS Paper No. 117/2016. Available at: https://www.lse.ac.uk/european-institute/Assets/Documents/LEQS-Discussion-Papers/LEQSPaper117.pdf
5. Voskopoulos, George. 2006. *"European Integration: From Gaullism to Atlanticism and Europeanism"*. Conference: European Union. Volume: 45, Book 4. Available at: https://www.researchgate.net/publication/259005070_European_Integration_From_Gaullism_to_Atlanticism_and_Europeanism
6. DW. 2020. *"German defense minister: Europe still depends on US for security"*. Available at: https://www.dw.com/en/german-defense-minister-europe-still-depends-on-us-for-security/a-55626599
7. EEAS, The Common Security and Defence Policy (CSDP). Available at: https://eeas.europa.eu/topics/common-security-and-defence-policy-csdp_en#:~:text=The%20Common%20Security%20and%20Defence%20Policy%20(CSDP)%20enables%20the%20Union,on%20civilian%20and%20military%20assets.

egy for the foreign and security policy of the European Union in 2016, which emphasised defence cooperation between Member States.[8] More recently, the resources provided by the European Defence Fund and the national defence budgets are substantial (despite cuts triggered by the COVID-19 crisis), allowing us to observe an upward institutional and community dynamic concerning defence.[9]

Through this study, the Finabel research team has analysed and investigated three key areas of training and simulation (T&S) through the lens of armies' interoperability, to technically feed its essence. The three key areas analysed here are cultural interoperability, European defence industry, and data interoperability. It is not the purpose of this study to give an exhaustive overview of all the areas of interoperability between European armies. The main goal of this research is narrowed down to training and simulation systems across the three chosen domains, to identifying processes and structures that work, those that could be improved, and the factors hindering progress, especially regarding full acquisition, industrial integration and data sharing . At the end of each thematic analysis, we propose a general critical assessment followed by recommendations.

CULTURAL INTEROPERABILITY

Introduction

This section of the Training & Simulation study seeks to assess the incidence of military culture vis-à-vis the deployment and the implications of simulation-based training (SBT). Firstly, it is deemed appropriate to investigate the deterrent and geopolitical function of military exercises in the contemporary era, providing concrete evidence for the theories introduced. Likewise, the specificity of joint military exercises will be dealt with, underlining their rationale and significance for allies, partners and opponents respectively. Under certain circumstances, we argue that armies would make greater use of integrated and standardised SBT systems to avoid unintended escalation in unstable regions.

At this point, the current trends in SBT will be analysed through a comprehensive outline of the features and the drawbacks of the three different categories of simulated training: live, constructive and virtual. Benefits and further developments, both technological (geo-pairing, logistics) and necessity-driven (cyber threats, peace-keeping operations), will be considered, as well as the most widely used types and brands of simulation systems.

Thereafter, the cultural challenges affecting the use of simulators in military environments will be addressed. First, the traditional military resistance to innovation will be re-

8. EEAS. 2016. *"A Global Strategy for the European Union's Foreign and Security Policy"*. Available at: https://eeas.europa.eu/topics/eu-global-strategy/17304/global-strategy-european-unions-foreign-and-security-policy_en
9. Emmott, Robin. 2020. *"EU keeps defence fund alive with 8 billion euro proposal"*. Reuters. Available at: https://www.reuters.com/article/us-eu-budget-defence-idUSKBN23328S

ported, identifying the roots in military history and doctrine, while examining whether it is still present and outspoken. Secondly, a scrutiny of the current military culture resistance will be brought forward, looking over the sectors involved and the training objectives envisaged.

In light of the matters covered in this section, a series of recommendations from the Finabel Permanent Secretariat will be submitted to encourage its Member States to take action towards cultural interoperability in SBT.

1. Exercises as Means to Deter Opposition

Over the last decades, military exercises, in addition to their purely practical and preparatory scope, also had geopolitical functions. These are usually made explicit by the decisions taken during the planning phase of the exercise, which include the scale and the venue of the training drill. Other relevant variables are the types of weaponry employed and, if applicable, the countries involved.

Evidence shows that beyond their importance in terms of strategic posture and readiness to counter threats, military exercises are oftentimes used as leverage for political change or as a bargaining chip in negotiations. The latter is clearly displayed by the decision of the Trump Administration to cancel major military exercises (Key Resolve and Foal Eagle) with South Korea in the wake of the two summits with North Korean leader Kim-Jong-Un, aimed at stimulating the country's denuclearisation[10].

Moreover, the suspension of joint military exercises can be a signal of geopolitical intentions, trying to advocate for a posture adjustment. This is evident in the case of the US suspension of the Bright Star military exercise with Egypt in the aftermath of the military takeover in 2013. A similar scenario led to the US suspension of the Malabar exercise with India because of New Delhi's nuclear tests. In a different fashion, disinviting a country from a joint military exercise conveys a geopolitical statement as well; this, for instance, occurred in the event of the US-led RIMPAC (Rim of the Pacific) naval exercise in 2018 where the US discarded the participation of the China's People's Liberation Army (PLA) due to Beijing's militarisation of certain disputed islands in the South China Sea.

More frequently, military exercises are being used to exert certain rights and to oppose States' claims. This is the case of Freedom of Navigation (FON) operations that are increasingly performed in the above-mentioned South China Sea and the Black Sea. These exercises serve mostly to reinforce the status of international waters, expressed by the enjoyment of the internationally recognised rights and freedoms, against the allegedly unlawful and expansionist claims of certain States.

Political contentious relations may likewise lead to an increased frequency of military exercises. This happens as the arising tensions push for the deployment of more troops to the frontier. Thus, as Clem puts it: "military exercises involving these forward-deployed units are an inevitable consequence of their placement"[11]; indeed, the placement itself normally generates the imperative of train-

10. Axelrod, Joshua. 2019. *"Trump administration to end major military exercises with South Korea: report"*. MilitaryTimes . Available at: https://www.militarytimes.com/news/pentagon-congress/2019/03/01/trump-admin-to-end-major-military-exercises-with-south-korea-report/

11. Clem, Ralph. 2018. *"Military Exercises as Geopolitical Messaging in the NATO-Russia Dynamic: Reassurance, Deterrence and (In)Stability"*. Texas National Security Review. The Strategist. Vol. 2, Iss. 1.

ing troops on the ground on which they are based. A suitable example of this situation can be drawn from the heightened friction between NATO and Russia since Moscow's annexation of Crimea in 2014. This act spawned concerns from the NATO Member States bordering Russia and was followed by the decision to deploy battalion-sized battlegroups on the Alliance's Eastern flank. In response, the Kremlin launched its largest exercise since the end of the Cold War, Zapad ("West") 17[12], followed up by NATO Trident Juncture 2018[13].

As a matter of fact, military exercises carry out a broad range of functions. Their most observable purpose is to rehearse procedures and therefore to enhance the readiness and interoperability among different forces and services. However, from a geopolitical standpoint, another manifest effect of military exercises is to demonstrate the ability to sustain a potential armed conflict by showing off capabilities, especially defensive ones. Thereby, the intended outcome of military exercises could be the deterrence of eventual aggression from a designed opponent.

Nevertheless, while there is an evident desire for deterrence and stability when practicing military exercises, it is argued that the unintended consequence may be instability. Indeed, exercises usually design a target (a State or alliance from which the army should be ready to defend its territory) which, at the same time, can be prompted to fuel the frenzy of possible preparation for an attack on its territory. The target of an exercise can also be implicit depending on the chosen location of an exercise or the countries involved in it. This might generate in the target State the perception of a prelude of military engagement as the power balance could be modified to its detriment[14]. Such a scenario was not only prominent during the Cold War era, whose most indicative episode was the Soviet perception of the 1983 NATO Able Archer exercise as a potential nuclear first strike threat[15], but it is still present in more recent times, as shown by the concerns following the Russian Zapad 17 exercise[16].

It is undeniable that armies all over the world have legitimate reasons to maintain readiness, exercise command and control and bolster their defence posture against potential threats. It is also true that interoperability and deterrence are both better achieved when operations take place on the ground where they hypothetically should be performed. However, to reduce the risk of regional destabilisation, armies could either conduct exercises in areas distant from geopolitical tensions (although morphologically comparable) or make greater use of simulation-based training, carrying out more frequent drills at the tactical and strategic level. As will be discussed later, state-of-the-art simulators have reached a very advanced stage, being able to reproduce seamlessly real-word conditions. In this way, States would be able to practice their defence readiness without raising concerns from opponents and, by making efforts to standardise systems

12. Giles, Keir. 2018. *"Russia Hit Multiple Targets with Zapad-2017"*. Carnegie Endowment for International Peace. U.S.-Russia Insight. Available at: https://carnegieendowment.org/2018/01/25/russia-hit-multiple-targets-with-zapad-2017-pub-75278
13. Martinho, Lara. 2019. *"NATO Exercises - Evolution and Lessons Learned"*. NATO Parliamentary Assembly. Defence and Security Committee. Sub-Committee on Future Security and Defence Capabilities. Report.
14. Blankenship, Brian, and Kuo, Raymond. 2020. "*Deterrence and Restraint: Do Joint Military Exercises Escalate Conflict?"*. University of Miami
15. Heuser, Beatrice. 2016. *"The Virtual World of Exercises and Deterrence"*. Sciences Po. War Games and Deterrence 15 IV.
16. Clem, Ralph. 2018.

and interfaces, allies would be able to achieve a high degree of interoperability.

1.1 The Rationale Behind Joint Military Exercises

Most military exercises see the involvement of more than one State's units. Indeed, the benefits of joint military exercises are manifold. Army officers that train together tend to build more extensive relations with each other through military-to-military contact. Moreover, they can drill with more advanced and sophisticated systems, which in turn might stimulate inputs for innovation and transformation of their equipment. Most importantly, joint military exercises increase the interoperability between forces involved and, within the context of an alliance, ensure the integration of capabilities and troops at all levels[17].

Typically, joint military exercises are carried out within a very accurate framework, featuring clear structures and operational bounds. These are usually established in a Memorandum of Understanding (MoU), signed between the participants, that specifies: a list of personnel and equipment deployed by each State, the purpose of the exercise, its command structure, the terms (including parameters and restrictions) and the responsibilities. At the same time, from a geopolitical perspective, the execution of joint military exercises stems from a precise rationale that encompasses multiple aspects. Commonly, a shared

17. Di Pane, James. 2017. "*Major NATO Exercise With Sweden Highlights Ability to Deter Russian Aggression*". The Heritage Foundation. Commentary Europe. Available at: https://www.heritage.org/europe/commentary/major-nato-exercise-sweden-highlights-ability-deter-russian-aggression

sense of threat would bring two or more States to conduct joint training of their forces to stand against a potential attack. Similarly, a major power would provide support and training to States that are under threat by another rival major power. The objective, as for individual exercises, remains that of deterring the opponent but the risk of instability is substantial.

Essentially, the strict requirements of the MoU do not prevent from producing unintended strategic effects, namely in the form of concerns or boosts about the change in the balance of forces. These can occur both for the target of the exercise and the participants (usually the host State). The former can be bothered by the establishment of a coalition of opponents, which could eventually lead to an upgrade of its military capabilities or a quest for allies. The latter instead, could develop enhanced confidence in its capacity to seek military solutions to foreign policy challenges. This happens not only due to the upgrade in its defence, but also because it perceives a sort of commitment from the other participants of the exercise (usually major powers) to support its cause against the target. Joint military exercises can therefore encourage adventurism. This is shown in the case of the Sea Breeze exercise of 2008, held by the US in the Black Sea. Georgia, taking part in the joint exercise, assumed it had Western support to re-obtain the breakaway provinces of Abkhazia and South Ossetia; however, it ended up prompting the Russo-Georgian War, lost by Tbilisi without any backup from its presumed supporters.

A trade-off can be highlighted between deterrence and support resulting from the decision to undertake joint military exercises. On the one hand, joint training may enable partners to better defend themselves from threats and deter the target State from carrying out reckless operations. On the other hand, partners might feel reassured by the commitment to collective defence and are therefore likely to take on provocative actions, possibly leading to conflict escalation. The dilemma comes as "supporting partners risks escalation, but that in turn augments deterrence. Restraining partners prevents adventurism, but potentially weakens deterrence. Either choice generates strategic problems"[18].

In this context, the key to get through the security conundrum might be embedding joint military exercises into formal military/defensive pacts i.e., alliances. A clear-cut security relationship between states can therefore give rise, complementarily, to joint military exercises as means to flexibly respond to modifications in strategic needs. Accordingly, the alliance could provide political and cooperative limitations by establishing parameters and constraints; those include the scope of cooperation, the conditions for invocation and a privileged communication channel that would reduce any chance of misperception of allied stances. Moreover, the long-term value of the alliance would prevent partners from embarking on escalation measures as they attribute more significance to the mechanisms in place within the alliance. By contrast, joint military exercises may be held to restore the trust and confidence in the alliance commitments (addressing internal weakness) or to immediately counter upcoming security chal-

18. Blankenship Brian, and Kuo Raymond. 2020.

lenges.

These factors do not apply to joint military exercises taking place outside of the framework of an alliance. While there is still the deterrent element and the enhancement of defence capabilities, the commitment to intervene in case of aggression is more questionable, as it is not made explicit by a formal alliance. Still, one of the primary goals of conducting joint training is the achievement of interoperability between forces, even lacking an overarching structure[19]. There exist however, other kinds of bonds with partners: NATO, for instance, established in 2014 the Partnership Interoperability Initiative (PII) to maintain and deepen interoperability between Members and partners of the Alliance. A further consolidation of this policy is represented by the Enhanced Opportunities Partners (EOP) i.e., States that enjoy a closer association with the Alliance in terms of consultation, information sharing and access to interoperability programmes. Furthermore, partners that benefit from the EOP status may also happen to take a consistent part to the Alliance's exercises; this is the case of Sweden, that in addition to the involvement of NATO members in the massive Aurora 17 exercise, partly hosted the Trident Juncture 2018 exercise along with Finland, another EOP State, and Norway, a NATO Member State.

Whilst States/alliances are not treaty-bound to defend partners in case of aggression, the involvement in exercises and their location certainly counts. These actions signal a form of commitment both to the partner and to the target. Promoting and improving interoperability would be a vain act if not accompanied by its implementation when necessary. Nevertheless, the use of integrated and comprehensive SBTs, standardised among allies and partners, might be an initial step towards overcoming the diffidence and risks revolving around large-scale joint military exercises in geopolitically torn regions.

2. Current Trends in SBT

Due to the prominent increase in military exercises, it is crucial for armed forces to be prepared to operate in a wide spectrum of scenarios and for commanders to issue orders in a timely fashion. However, as seen above, military exercises, especially when conducted jointly with partners, not only deter the opponents but are also liable to trigger escalation. Therefore, although military exercises are very unlikely to be fully replaced for countless factors, including military culture, resorting to simulation-based training might be, for starters, an efficient way to reduce geopolitical risks.

Furthermore, given the fact that simulators are now able to reproduce in a model real-world conditions and implications, they represent a very useful tool to test military doctrines, train forces (individually and collectively), analyse data to improve the performances and optimise the decision-making processes. Indeed, SBT's most common utilisation is that of support in all the cycles of training, increasing the safety of the personnel involved and stimulating their skills.

The guiding principle for training through simulation is "train as you fight, fight as you train", that requires coincidence between

19. Clem, Ralph. 2018.

training techniques and implementation of war operations, both defensive and offensive, in case of necessity. The definition and application of standards during simulations (and for simulators) is therefore paramount to practice military procedures among forces pertaining to different domains as well as within alliances or partnerships.

2.1 Types of Simulations: Characteristics and Drawbacks

The types of simulations covered by this study do not encompass the whole spectrum of military simulated exercises. Firstly, we solely take into consideration the simulations that involve a prominent, and in some cases exclusive, use of digital/artificial means for the enhancement of personnel's critical combat skills, both on an individual and team level. Secondly, although these simulations can be operated across all the domains of the military, the systems examined mostly refer to the training of land forces. Indeed, insofar as the mission of Finabel concerns the interoperability of Europe's land forces, our exposition is primarily focused on their peculiarities.

In this respect, depending on factors such as the environment in which the simulation takes place or the ranks and the systems involved, it is possible to distinguish between live, constructive, and virtual simulations, whose respective characteristics and drawbacks are going to be dealt with below.

2.1.1 Live Simulations

The drills that mostly resemble real combat are live simulations as they imply the deployment of real personnel, usually infantry/regiments, and real weaponry systems (Hardware in the Loop – HWIL) in a precisely designated geographical area characterised by elements of nature. This sort of training is also operated during military exercises. On the field, two opposing sides engage with designed equipment, on which are installed systems simulating the effects of real weapons. This is done through the emission of eye-safe lasers that can replicate the trajectory and the ballistic performance of firing, while soldiers and vehicles are geo-referenced and equipped with passive sensors that interact with the laser signals, detecting where the strikes hit and their intensity. When substantial damage is inflicted, the relative procedures to clear the field are activated[20].

The conduct of the operations is constantly overseen and coordinated by the Exercise Control board (EXCON), which, together with controlling personnel on the ground, gathers all kinds of data to carry out a revision at the end of the simulation (After Action Review – AAR). This aims to correct, improve and strengthen operational aspects. The EXCON is indeed the cornerstone of the entire simulation, around which all the activities take place: the board regularly receives information on the outcome of the engagements, the live position of the single soldiers, the radio communication within the units as well as the consumption of ammunition and fuel. Thereafter, the EXCON can assess in real-time the tactical and operational performance of the participants and can therefore stimulate the command-and-control (C2) functions of the commanders of the units.

The integration of all the data and indications

20. Boccasino Andrea Ten. Col., Travaglio Carlo Magg., et al., 2015. *"Il Modelling & Simulation nell'addestramento militare. Le esperienze delle principali forze armate mondiali e possibile modello per la Difesa"*. Centro Alti Studi per la Difesa. 17° Corso Superiore di Stato Maggiore Interforze. 2° Sezione - 5° GdL

produced constitutes material for the AAR, which is beneficial for both the individual soldiers and the commanders. After collecting information centrally, the review is conducted through specific software, produced by companies such as the American Cubic Corporation or the Swedish SAAB.

One of the major downsides of live simulation is the limited interoperability of the various software. It is in fact desirable for these systems to apply the same set of standards, especially when it comes to joint training. For this reason, NATO, in the wake of the Modelling and Simulation (M&S) Master Plan, created the Modelling & Simulation Group (NMSG) and the Simulation Interoperability Standards Organization (SISO). More explicitly for live training, NATO designed a forum, the Urban Combat Advanced Training Technologies (UCATT), to identify the requirements of the instrumentation to be employed during multinational live simulations but, for the time being, more work needs to be done.

Another drawback of live training is represented by the burden and the costs of bringing a significant amount of personnel to the same area (especially in the case of joint exercises involving many forces). The location itself inevitably has a limited set of training i.e., it necessarily presents restrictions regarding the morphological characteristics of the scenario (not certainly a vast array of theatres). This in turn constrains the training output of the simulation, limiting how and what troops can practice[21].

Moreover, laser systems employed in live training have some limitations in accuracy, range hazard and mismatch in obscurant specific bullet-versus-pulse propagation that may affect the real-time casualty assessment of the exercise. To overcome this problem, geo-pairing[22] systems using GPS positions are under development. This technology would entail, beyond the higher accuracy at longer ranges compared to lasers, the possibility to calculate the incidence of natural obstacles like fog, rain, or foliage for firing scores. Plus, adding terrain knowledge (natural elements like hills or trees), commensurately with the weapons systems effects, would determine the most conceivably akin trajectory to that of an actual battlefield. However, while progress has been substantial, geo-pairing remains defective in certain areas[23], thus it is not fully operational yet.

2.1.2 Constructive Simulations

Constructive simulations involve simulated personnel, guided by real officers, operating through a digitalised system. These are command post exercises, tailored for the enhancement of the C2 functions of the higher echelons. The commanders practice the planning phase of the conflict and the issuance of orders during the engagement. Higher controllers (HICON), in the command structure, receive a constant flow of information from lower controllers (LOWCON), that directly operate through the system and apply the orders given by their superiors. In this context,

21. Hagman, Per. 2021. Interview with Mr Hagman on the Swedish simulation programs and the Swedish participation in multinational training, focusing on the impact of new technologies. 5 January, 2021.
22. Baer Wolfgang, Baer Nikolaus., Powell D. William, and Zografos James. 2005. *"Advances in Terrain Augmented Geometric Pairing Algorithms for Operational Test"*. Naval Postgraduate School. Department of Information Science. Modeling and Simulation Workshop
23. At this point in time, terrain models are not satisfactory enough to allow geo-pairing technology to accurately reproduce real engagements. Additionally, these systems increase both the costs and the complexity of the training. Therefore, further time will be necessary to conform geo-pairing to live simulations.

the software simulates the outcome of the confrontation in near real-time[24].

Due to their easy-to-manage nature, constructive simulations are the most common on a multinational level. They usually take place in simulation centres such as that of Enköping in Sweden. Some of the most advanced software, used in the NATO framework, are Joint Conflict and Tactical Simulation (JCATS) and Joint Theatre Level Simulation (JTLS). While the former is used for training at the tactical level, the latter serves for support in operational and strategic exercises.

As for live simulations, EXCON structures collect all the data stemming from the exercise, including the communication between HICON and LOWCON, with the purpose of reviewing the activities in the AAR and identifying possible gaps. However, in constructive simulations it is possible to effortlessly repeat the exercise to adjust eventual mistakes/shortcomings, upgrade the scenario by increasing the adversities or experiment different tactics to prevail or contain.

It is important to note that "the main objectives for this type of exercise is the simulation of decision-making process and the end state that needs to be achieved is the capability to efficiently predict future courses of action".[25] However, there might be a sort of path dependency present in military structures, whereby the organisation unconsciously keeps repeating certain activities along established paths or past experiences. Hence, for constructive simulators, it is possible that military officials are reluctant to embrace new technology or tend to channel the simulation always along the same lines, without taking advantage of experimentation. Other drawbacks include the quickness of the simulation and the lack of the possibility to make smaller-scale decisions.

2.1.3 Virtual Simulations

Lastly, it is critical to consider virtual simulations. These involve real personnel operating with simulated equipment in an artificial battlefield, designed to reproduce real environments' features. Against these selected backgrounds, individual soldiers can train their skills, increase their knowledge of weapons systems, and adapt their behaviour in the face of different situations. Indeed, virtual simulators also envisage the possibility to interact with other players, both virtual and real, that perform different functions in the scenario.

Virtual exercises take place across the whole military career as they are useful not only for individual abilities but also for collaborative tasks. Moreover, as they occur in an indoor environment, virtual simulations minimise the dangers to soldiers and can involve more personnel (usually situated in classrooms inside simulation centres). Simulators are designed to replicate real world conditions and hardships in a 3D virtual reality where other players represent real opponents, reacting to inputs and applying their cognitive mechanisms. Among the most advanced virtual simulators there are those produced by Northrop Grumman and Thales Group as well as the VBS systems made by Bohemia Interactive Simulations, recently upgraded from the VBS3 to the VBS4 version.

24. Boccasino Andrea Ten. Col., and Travaglio Carlo Magg., et al., 2015.
25. Zinca Diana-Ioana, and Barsan Ghita, 2018. "*Constructive Simulation Programs and NATO Functional Area Services Applied In Computer Assisted Exercises*". De Gruyter. Land Forces Academy Review Vol. XXIII N. 2(90)

It is important to underline a trend that concerns virtual simulations which is that of "gamification" i.e., the utilisation of cutting-edge video games for military training. This is usually done to extend the simulation to different terrains and to involve more personnel without increasing the relative costs. Games are in fact likely to boost the competitiveness between soldiers and therefore enhance trainings' appeal. Nonetheless, they can alter soldiers' perspective of the real battlefield by making them behave as they would in a game.

2.2 Benefits

One of the major benefits of resorting to simulation-based training is that it allows for cutting costs down while also improving the performances. Indeed, especially for command post exercises and battalion-level skills, it is largely convenient to undertake operations in a simulated scenario rather than a real one. Mobilising units and massive amounts of equipment around the territory is considerably expensive (considering the costs of manoeuvring and maintenance), and entails the risk of damaging local landowners. Moreover, it is hardly affordable to change plans, perhaps to explore a different strategy, when the process is already underway. For these reasons, reliance on simulators reduces the expenses of training[26] and improves its efficiency in certain aspects. Thus, the possibility to repeat various times the same exercise without wasting time and resources, allows soldiers to determine the most suitable strategy to accomplish their mission and then put it into practice. Additionally, the evolution of the scenario improves their decision-making and adaptability with no concerns over safety or costs[27].

Virtual training facilitates multinational training in a safer and securer operational environment, as it does not require physical presence, which simultaneously minimises the danger to soldiers' health and life while bringing more people together[28]. Moreover, it offers an effective possibility to test and improve soldiers' communication and cognitive skills, whereas constructed simulators increase their overall preparedness for a potential attack from a more theoretical point of view[29].

Remarkable advantages can be drawn from merging the three types of simulation together[30]. In doing so, the competitive, evolutionary, and reviewing aspects can be combined with real combat elements. It is just a matter of technological progress, and therefore time, to achieve a feasible integration of the three as the benefits outweigh by far the efforts needed.

Alongside their role in training, simulators may widen their scope across the military domain. Indeed, they can play a significant part in refining the supply chain and logistics of the army during the operations. Simulations could focus on the entire network of the supply chain, taking as variables vehicles, routes, and facilities to manage the delivery of equipment to the battlefield (or goods to the population) safely (through a risk-assessment calculation) and within the shortest amount

26. Lahger B., 2021. Interview with Mr Lahger regarding constructive training and simulation, multinational training and interoperability and generational gap. January 18, 2021.
27. Jakobsson, 2021. Interview with Mr Jakobsson regarding the VBS simulator and constructive and virtual training, January 15, 2021..
28. Hagman P., 2021.
29. Jakobsson, 2021.
30. Hagman P., 2021.

of time possible.

Furthermore, distributed simulations[31], based on high-level architecture (HLA), can reproduce the challenges stemming from certain disruptive technologies. These would impact the preparedness of the army in facing cyber-attacks and train the commanders against potential hybrid warfare. Cyber-attacks, even from non-State actors, are likely to occur more frequently in the near future; the army's security measures to counter cyber threats would be better evaluated and rehearsed constantly to ensure networks' stability. Simulators take a cross-cutting approach addressing human-system integration, maturation of cyber-security skills, effective decision-making and opportunities for automation[32]. Similarly, simulation may reproduce the dynamics of hybrid warfare to identify the shortfalls and weaknesses of the organisation in a complex scenario. This may help grasp the human/cognitive aspects of hybrid threats, improving the decision-making procedures.

In the same vein, simulations may not only be intended to train for warfare but also for the multidimensionality of peace-keeping operations to meet the challenges and complexity of modern peace processes. These tools could also be used by civilian peacekeepers as they would be intended to enhance soldiers' critical thinking and conflict-resolution skills[33]. However, such systems are not accessible yet, as they are still under development.

3. Cultural Challenges

As shown in the previous section, the benefits of simulation-based training clearly outweigh its downsides. Yet, as with the adoption of every new technology, the introduction of SBT is met with a lot of resistance by military stakeholders.

The implementation of SBT is of crucial importance for a number of reasons. Firstly, the resistance to new technologies bears the risk of falling behind in the technological race. Secondly, the interoperability between the armed forces and the implementation of joint multinational training exercises suffer greatly if countries refuse to implement SBT.

The following section will therefore explore the various sources of this resistance to change and provide an overview over the challenges to interoperability in SBT.

Three main forms of resistance to change are identified: institutional inertia and path dependency, military culture, and the age gap inside the armed forces.

Furthermore, this section also highlights the various cultural challenges to interoperability that stem from the different army cultures across states as well as the language barriers that hamper successful cross-country simulation-based exercises.

3.1. Institutional Inertia and the Resistance to Change

The obstacle of institutional inertia and the resistance to change is by no means a unique feature of the military but a problem that per-

31. Decentralised, event-driven simulations executed across multiple systems characterised by asynchronous parallelism.
32. Veksler D. Vladislav, Buchler Norbou., et al. 2018. *"Simulations in Cyber-Security: A Review of Cognitive Modeling of Network Attackers, Defenders, and Users"*. Frontiers in Psychology. Mastering Cyberpower. Vol.9.
33. Dorn A. Walter, Webb Stewart, and Paquet Sylvian. 2020. *"From Wargaming to Peacegaming: Digital Simulations with Peacekeeper Roles Needed"*. International Peacekeeping. Vol. 27 Iss.. 2.

sists in various branches of public administration. One of the main reasons for the hesitancy to adopt new innovations is that public and military administrations are highly complex organisations that represent institutional stability and continuity.[34] As these bureaucracies are dealing with recurring problems in a familiar environment, they thrive on consistent and standardised approaches to resolving these problems.[35] Innovation and the introduction of new technologies, procedures and methods subvert this standardisation and consistency and risks to meet substantial resistance from stakeholders within an organisation.[36] To enact change in large organisations that are embedded in well-developed cultures and hierarchical bureaucracies is therefore remarkably difficult, as the mere existence of a complex organisational system with a multi-layered bureaucracy tends to resist change.[37] Or, to put it in the words of former U.S. President Woodrow Wilson: "If you want to make enemies, try to change something."[38]

However, this hesitancy in adopting and implementing new procedures, technological solutions and methods in the military area is not necessarily detrimental. As the military provides for one of the most crucial tasks of the modern state – national security – the stakes are high, and there is little room for error.[39] Retaining functioning organisational systems provides for stability and the reduction of the sources of potential error. Resistance to change of stakeholders inside the military can, in this respect, also have positive implications. While inter-institutional resistance might prevent negative developments, [40] it also provides for a degree of legitimacy and acceptance by stakeholders inside the institution.[41] Some scholars define these patterns of resistance as an "organisational immune system" where organisations erect barriers to change in the form of people, policies, procedures and culture.[42]

However, this organisational path dependency and the resistance to change can also have severe repercussions. If dominant patterns get fixed and gain a quasi-deterministic character, the military is endangered to fall behind in the technological race vis-à-vis other military powers.[43] A prominent example of these negative effects is the introduction of radio communication into the U.S. Navy. While the Navy attempted to introduce the new technology to its ships in 1899, it took roughly fifteen years to fully integrate the radio into U.S. naval operations due to organisational and political resistance to the new technology, which left the U.S. Navy lagging far behind its British and German counterparts.[44]

Defence innovation evokes in this respect the dilemma to choose between stability (security) and change (transformation). However, in a world where technology is developing at

34. Grunow, Dieter. 2014. *"Innovationen in der Öffentlichen Verwaltung"*. Manfred Mai, Ed. Handbuch Innovationen: Interdisziplinäre Grundlagen und Anwendungsfelder, Wiesbaden: Springer Verlag, pp. 209-232: 211.
35. Hill, Andrew. 2015. *"Military Innovation and Military Culture"*. Parameters, Vol. 45, No. 1, pp. 85-98: 85.
36. Ibid.
37. Pape, M. Jason. 2009. *"How the Army resists Change"*. Leavenworth: School of Advanced Military Studies. Available at: https://apps.dtic.mil/sti/pdfs/ADA506189.pdf. : 11.
38. Wilson, Woodrow. 1916. *"Addresses to Salesmanship Congress in Detroit, MI and to Luncheon Sponsored by the Salesmanship Congress in Toledo"*. Cary T. Grayson Papers, Staunton, Virgina: Woodrow Wilson Presidential Library. Available at: http://presidentwilson.org/items/show/22045 10 March 2021.
39. Galvin, Tom. 2018. *"Leading Change in Military Organizations: Primer for Senior Leaders"*. Carlisle: US Army War College Press. Available at: https://publications.armywarcollege.edu/pubs/3556.pdf 10 March 2021: 4.
40. Ibid.: 3.
41. Schreyögg Georg, and Sydow Jörg. 2010. *"Understanding Institutional and Organizational Path Dependencies"*. The Hidden Dynamics of Path Dependence: Institutions and Organizations, New York: Palgrave Macmillan, pp. 3-14: p. 7.
42. Galvin, Tom. 2018: 103.
43. Schreyögg and Sydow, 2010: p. 7.
44. Zachary, M. Taylor. 2016. *"The Politics of Innovation: Why some Countries are Better than Others at Science and Technology"*. Oxford: Oxford University Press: p. 192.

an ever-increasing pace, resistance to change jeopardizes the actor's position in favour of those who are less hesitant to implement new technological solutions.[45]

Exogenous events outside the control of policymakers and military officials have been specified as one of the important drivers for change.[46] While the military is not affected by competitive market pressures in the same way as private companies that operate in the free market,[47] there are nonetheless a number of external pressures that constitute a driving force for change.[48] Holmberg and Alvinius identify three different forms of external pressure: structural, normative and functional. Structural pressures are the result of the change of the international environment, where the use of military means is expanded to new areas.[49] Normative pressures, on the other hand, are deriving from changes in value sets, norms and discourses in (inter)national society, like gender equality or liberal interventionism.[50] Functional pressure is probably the most important driver for change, as it resembles the adaptation of new technologies in the military and enables it to keep up with foreign military powers in the technological race.[51]

However, there is also an internal dimension that determines the adoption of change. Firstly, tight budgets and the procedures of the allocation of resources within the military might hinder the introduction of new and costly technologies.[52] Secondly, buy-in and support of stakeholders within the military are crucial, as they reduce resistance and increase the acceptance rate for the envisioned change.[53] However the variable that has the biggest impact on whether resistance to change occurs is military culture. As B. H. Liddell Hart once pointed out: "The only thing harder than getting a new idea into the military mind is to get an old one out."[54]

3.2. Cultural Resistance to Change in the Military

Culture is the central element that permeates the entire structure of the army and helps explain its conservative nature. It adds to the traditional obstacles of bureaucracy and allows us to understand the resistance that the army opposes to change. This is due to the peculiar characteristics of the functioning of complex organisational systems and integrated processes that tend to resist innovation. Indeed, the root of this difficulty of change is organisational culture, namely, a set of long-standing beliefs, values, expectations and practices shared by a group.

The culture of the army with its traditions, ideals, customs and rules of conduct is the product of centuries of evolution. Order, obedience, hierarchy and division of functions characterise the culture of the most effective military institutions. This is the main reason

45. Korba, Rod. 2016. *"The Dilemma of Defense Innovation and Adaptation"*. Small Wars Journal. Available at: https://smallwarsjournal.com/jrnl/art/the-dilemma-of-defense-innovation-and-adaptation . 10 March 2021
46. Falkner, Gerda. 2016. *"The EU's current crisis and its policy effects: research design and comparative findings"*. Journal of European Integration, Vol. 38, No. 3, pp. 219-235: p. 221.
47. Krause, v. Ulf. 2014. *"Innovationen im Militär"*, Manfred Mai, Ed. Handbuch Innovationen: Interdisziplinäre Grundlagen und Anwendungsfelder, Wiesbaden: Springer Verlag, pp. 299-318: p. 300.
48. Ross, L. Andrew. 2010. *"On Military Innovation: Towards an Analytical Framework"*. Study of Innovation and Technology in China, Policy Brief No. 1, 1-4: 2.
49. Holmberg Arita, and Alvinius Aida. 2019. *"How Pressure for Change Challenge Military Organizational Characteristics"*, Defence Studies. Vol. 19, No. 2, pp. 130-148: p. 136.
50. Ibid. 136-137.
51. Ibid. 138-139.
52. Dowdy John, and Chinn David. 2014. *"Five Principles to Manage Change in the Military"*. McKinsey and Company, Ed. Available at: https://www.mckinsey.com/industries/public-and-social-sector/our-insights/five-principles-to-manage-change-in-the-military
53. Galvin, Tom. 2018: 100.
54. Quoted from: Dowdy John, and Chinn David 2014.

why it is extremely difficult to succeed in changing large organisations with well-developed cultures, such as the military.

Discipline-based organisations are characterised by what Williamson Murray calls the "conservative culture hypothesis" – their reluctance to attach importance to new and previously untried ideas, concepts and innovations.[55] According to this hypothesis, the classic military virtues of self-sacrifice, obedience, collectivism and knowledge of history are strengths in preparing for struggle and war, but they become great hurdles when the organisation seeks change. For the military environment, in particular, the hypothesis postulates that its cultural content stifles innovation. Indeed, it is true that the military stresses the importance of collectivism and therefore of the good of the group over the individual, appreciate uniformity over diversity, where the latter must be suppressed in an environment where personnel has to be easily replaceable, and prefer task-oriented and converging norms over idea-oriented and divergent ones. However, the conservative culture hypothesis suggests that all of these characteristics militate against effective innovation in military organisations.[56]

Another major obstacle to cultural change in the military environment is the size and complexity of the army. Indeed, the many levels and ramifications of the organisation and large staffing can translate into broad resistance to change from within. Furthermore, when people join an organisation such as the military, voluntarily adopting its culture as their own, the change in organisational culture presents a dilemma of membership as a whole. This ties back directly to the emotional aspect of changing beliefs, as altering what people have come to consider to be true and right is both an intellectual and emotional event that requires an incredible effort. Besides, the greater the changes and innovations that lie ahead, the more likely it is that emotions are stronger and undermine the process of change.[57]

Jason M. Pape (2009) also identified another challenge in the army's cultural change effort: finding patterns and obtaining examples of desired attitudes and behaviours. This is due, in particular, to the fact that unlike civilian companies where people with the required leadership values are recruited and employed, in the military, these values are internally grown. Also, leaders must internalise core values and principles and set an example for others to make the rest of the military change. This determines that any approach to innovation in the military field passes through present and future leadership figures. At the same time, the author points out a rather interesting paradox: the strategic leaders of the army are expected to propose a cultural change when they themselves are a product of the army culture.

It should then not be overlooked the strong link with the past of the various military organisations. They look at history as the primary source from which to draw the most important lessons to develop principles and concepts and further strengthen military culture. The past is also the foundation upon which the various ceremonies and traditions of the military are built, and this allows or-

55. Hill, Andrew. 2015: 87.
56. Ibid. 88.
57. Pape, M. Jason. 2009: 144.

ganisations to instil a greater sense of belonging and community to their members.[58]

Moreover, according to Andrew Hill (2015), it is essential to analyse the relationship between innovation and culture to better understand what the military reaction to innovation will be. The author defines this relationship as "the cultural concept of the ideal fighter", which allows us to understand how innovation aligns with the current cultural assumptions of honour, tolerance for variation, delegation of authority and with the organisational concept of the ideal fighter. It also shows how innovation affects the way commanders command, subordinates obey, and fighters prepare to fight.

Indeed, Hill states that innovation involving a reversal of the principles of honourable warfare and altering the calculation of courage will produce strong resistance from the military environment. It is also possible to see the conditions of change in a fighter's susceptibility to violence, as innovations often alter the very nature of the courage required.

Much more ambiguous will be the response of the military to those innovations that directly affect the offensive and defensive risk. The main consideration will concern whether or not they have an advantage in warfare. Indeed, it is much more likely that the military with favourable offensive capabilities will oppose those innovations, such as machine guns, that increase the risk in the offensive exponentially. But at the same time, various technological inventions bring about a shift in collateral damage considerations and procedures for determining acceptable civilian casualties during military operations. Guided ammunition, for example, is one of the most easily adopted inventions because it allows the military to limit civilian casualties. On the other hand, the military can oppose the adoption of those innovations that reduce military control over collateral damage.

The military could exert strong resistance to technological innovations as these could make significant changes to established strategic doctrines or tactics on the battlefield. The introduction of new technologies can potentially favour a branch or a mission, triggering an internal rivalry and creating new promotion paths to the detriment of more traditional services, directly affecting the prestige of some tasks by altering and reducing the dangers of combat. All of this could lead the military to exert further resistance to innovation that could not only create career paths for other more risk-averse military personnel but also alter and even interrupt their careers.[59]

Innovations can also upset the balance with which the organisation delegates or centralises the various decisions regarding the use of force, the modification of a plan or the request for support resources, etc. Those changes, that are at the basis of a shift in the balance in favour of more direct control of forces and greater transparency, risk being viewed more favourably by leaders than by those who entrust greater responsibilities to subordinates. Similarly, military organisations will try to resist all those innovations that involve a decentralisation of the decision-making process and a reduction in the uniformity and substitutability of military resources.[60]

58. Hill, Andrew. 2015: 87.
59. Taylor 2016: 191. 1
A60. Hill, Andrew. 2015: 91-92.

Ultimately, armies are conservative organisations that adapt very slowly to changes and innovations. Without a compelling reason or a crisis that induces to change army culture, it will most likely resist the change. Today we are facing a new era of warfare in which understanding army culture is far more important than understanding how to change it, as this change is a very long and challenging process.

3.3. Generational Gap

Finabel had the opportunity to study first-hand how the troops carry out military drills in virtual environments thanks to the Försvarsmakten (Swedish Armed Forces), which facilitated the interviews with some service members, including Mr Gustafsson, Mr Hagman, Mr Jakobsson and Mr Lahger. The Swedish officials supported Finabel's study regarding the cultural challenges the armed forces may encounter while performing such training, including the eventual resistance to SBT. Moreover, they shed light on how virtual drills affect multinational training and interoperability between armed forces.

The interviewees concurred that one of the challenges that might hinder the smooth development of Training & Simulation programs is the generational gap within the armed forces.

The Swedish experts recognise that, on the one hand, older commanders are usually more comfortable with traditional equipment than technologically advanced gears. On the other hand, the youngest soldiers are typically more accustomed to new technologies such as headphones and smartphones that they use to communicate. Besides, many of them have already experience with computers and gaming platforms. However, it is not uncommon also for young service members to be inexperienced with such devices.[61]

Furthermore, Mr Hagman highlighted that the Swedish Armed Forces (SAF) lack officers between 25 and 50 years old due to defence budget cuts over the past few years.[62]

To remedy the current status, the Swedish parliament recently approved a 40% increase in the defence expenditure for the 2021-2025 period. The investment should lead to service members' increase from 55,000 to 90,000 by 2030.[63]

Mr Hagman asserted that the issue is not insurmountable, and it can be solved by training the existing officers and giving them the time to get familiar with the new tech equipment. In this respect, Mr Lahger stated that senior officers, as younger soldiers, are willing to learn how simulators operate. Although the younger generation may be accustomed to gaming technologies, training is essential for every rank or age group as everyone needs to get used to this new simulation equipment.[64]

Furthermore, Mr Jakobsson and Mr Lahger stated that, despite initial resistance to virtual training from younger and older generations (as they are used to real-world drills using physical equipment), soldiers and officers quickly realised the importance of this way of

61. Jakobsson. 2021. Interview with Mr Jakobsson regarding the VBS simulator and constructive and virtual training. January 15, 2021.
62. Hagman, Per. 2021. Interview with Mr Hagman on the Swedish simulation programs and the Swedish participation in multinational training, focusing on the impact of new technologies. 5 January, 2021.
63. The Associated Press. 2020. *"Sweden ups defense budget 40% due to regional tensions"*. Defense News. Available at: https://www.defensenews.com/global/europe/2020/12/15/sweden-ups-defense-budget-40-due-to-regional-tensions/
64. Lahger, Björn. 2021. Interview with Mr Lahger regarding constructive training and simulation, multinational training and interoperability and generational gap. January 18, 2021.

training.[65] Moreover, Mr Lahger noted that, albeit senior commanders do not train much, they guide the training, acting as mentors for the youngest troops and being considerably involved in the virtual drills.[66]

Eventually, both age groups gradually commit to the simulation as they realise its potential in becoming as effective as real-life drills. Virtual training has several benefits, but as Mr Jakobsson indicated, the servicemembers need to have a positive attitude towards simulations.[67]

3.4. Multinational Training and Interoperability

The Swedish officials further discussed with the Finabel team how Training & Simulation affects multinational training and interoperability with other armed forces.

The experts concurred that common geopolitical interests could support the employment of standard software, which can enhance multinational training. In this regard, Mr Hagman mentioned how the SAF had undergone massive budget cuts in the past 20-35 years. However, following the Ukraine crisis, Sweden committed to restoring the traditional army policies, and restarting major exercises.[68] Mr Jakobsson also supported the argument that the incidents in Crimea awakened European defence practices and policies. In this regard, the Swedish government has promoted transnational training to confront the new geopolitical challenges.[69]

The circumstances accentuate the importance of virtual training as a significant resource

65. Jakobsson. 2021.

66. Lahger. 2021.
67. Jakobsson. 2021. A
68. Hagman, Per. 2021.
69. Jakobsson. 2021.

to enhance multinational exercises. Virtual simulators have several benefits, and the idea behind them is to connect different armies even if they are not using the same software. The troops can then perform joint exercises without actually meeting, reducing the overall costs of the drills. Moreover, the cooperation allows the militaries to learn different doctrines, improve communications and reach a new international interoperability level before performing real-life exercises.[70]

However, as there are challenges within a country's armed forces (for instance, a generational gap and lack of experience with simulators), there are also issues in the international domain.

Cultural differences play a significant role in influencing multinational training. Although Mr Hagman asserted that, regardless of the nationality, the ultimate armies' goal is to vanquish the enemy[71], some issues might hinder its achievement, including linguistic barriers.

The SAF has already performed several drills with the Finnish armed forces. Usually, at the highest levels of command, officers are used to communicating using a *lingua franca*, typically English. Besides, it is not infrequent for them to exchange information and plan the military exercises either in Swedish or Finnish.[72]

In multinational training, national armies usually remain separate during the exercises, and the merge only occurs at the very tops of the hierarchical chain of command. However, once the troops are moving, soldiers communicate in their native language. On a practical level, sometimes, the linguistic barrier can be problematic and hinder interoperability because battalions are rarely mixed during the drills. If they were to be merged, the soldiers would need to use a common language to understand and pass the orders.[73]

Besides, the experts state that it takes time to get used to virtual simulators and the challenges that come with them. However, there are already examples that these drills can enhance interoperability between national armies. The German and Dutch armed forces managed to intertwine their armies, from the highest to the lowest levels of command. Soldiers can communicate in English but can also interact with each other in German and Dutch.[74] Once the troops overcome the linguistic barrier, it is easier to carry out complete drills and enhance multinational training and interoperability.

Further challenges can interfere with the accomplishment of multinational training or interoperability, including traditional military resistance to innovation. As Mr Hagman emphasises, national doctrines play a significant role as every country seeks to pursue its own military convictions. However, he acknowledges that there should be more convergence between the national directives in order to enhance interoperability through multinational training.[75]

Despite the several cultural issues that might affect interoperability, the Swedish experts agree that multinational training through simulators can be achieved at a constructive level. However, European countries need to

70. Ibid.
71. Hagman, Per. 2021.
72. Gustafsson. 2021. Interview with Mr Gustafsson on live simulation, multinational training, and data. January 20, 2021..
73. Jakobsson. 2021.
74. Ibid.
75. Hagman, Per. 2021.

provide their armed forces with the necessary equipment to perform these special drills.

Currently, VBS technology is mostly used in central and northern European countries (notably Scandinavia). In contrast, States with larger armed forces, for instance, Spain, France, and Germany, only have few licences.[76]

Overall, the generational gap and the linguistic barrier are not insurmountable issues. If addressed correctly, they can be overcome and become an asset for multinational training. The youngest generation will be responsible for promoting SBT, which will enlarge and make more effective international drills. At the same time, the oldest generation will have to support the training evolution with the experience and knowledge gained during the military career.

Conclusions

This chapter analysed the role of military culture during deployment and simulation-based training. It outlined the advantages and disadvantages of cultural challenges on Training & Simulation and, more generally, on interoperability during multinational drills.

The first section investigated the deterrent and geopolitical function of military exercises in the contemporary era, providing concrete evidence for their influence on reducing the risk of regional destabilisation. Afterwards, we examined in detail the main reasons and conditions in which joint military exercises unfold, making practical examples of international cooperation between armed forces.

The study continued by analysing how simulation-based training benefits multinational drills and the current trends in SBT through a comprehensive outline of the features and drawbacks pertaining the three different categories of simulated training: live, constructive, and virtual. Subsequently, we examined how cultural resistance to change in the military may hinder armed forces' interoperability through SBT, presenting the perspective of field experts and discussing the different schools of thought that address the implications and outcomes of the opposition to new technologies in the military domain.

The analysis provided us with the ground to study how the Swedish Armed Forces respond to cultural challenges from different perspectives. Thanks to the direct participation of Swedish military personnel, we analysed the several difficulties that service members have to overcome, from a micro to a macro level, to become internationally interoperable through drills performed in virtual simulators.

From our research, we can infer that the benefits stemming from the usage of simulators for military training exceed, by far, the costs. This is not only based on geopolitical reasons, but also on performance-based grounds and necessity-driven purposes. However, as a matter of fact, certain cultural challenges, specific to military environments, arise from their deployment, especially with regard to generational gaps and multinational exercises. Nevertheless, certain barriers are hopefully going to be overcome as technological progress and international competition are poised to accelerate the reception/integration process within the armed forces.

76. Jakobsson. 2021.

Recommendations

In accordance with our analysis, Finabel suggests the following recommendations:

- Increase the frequency of joint SBT to avoid the potential concerns generated by military exercises in unstable regions;
- Invest more in Research & Development of breakthrough technology (geo-pairing) and cutting-edge simulators for military purposes other than warfare (logistics, peace-keeping, cyber threats);
- Implement English classes in the troops training, allowing the soldiers to get familiar with the basic vocabulary needed to perform multinational training;
- Mix the battalions even at the lowest level, allowing the soldiers to make the acquaintance of different doctrines and ways of command, and therefore being fully interoperable with transnational armies;
- Address resistance to innovation embedded within military culture, especially with regard to path dependency;
- Head towards the merge of the three categories of simulations (live, constructive and virtual) in order to add reviewing, evolutionary, and competitive factors to real combat elements.
- Integrate and encourage military wargaming as part of the military's daily life. Organise competitions between sections and units to increase the motivation of using these simulation tools.
- During this COVID-19 pandemic, where teleworking is the norm in most Member States, we should dare to encourage "hybrid engagement" where virtual and physical engagement should be running in parallel.

MILITARY TRAINING & SIMULATION: A DEFENCE INDUSTRY OUTLOOK

Introduction

The following study analyses the military training and simulation market from the perspective of the much fragmented industrial sector within the European Union. By doing so, we aim to investigate whether industries can be seen as drivers for interoperability. To answer this question the study is structured as follows. The first section gives an overview of the industry market, mentioning the most prominent enterprises, and it discloses their main products. The second section examines the role of defence industries, the products present on the market as well as highlighting factors that hinder the standardisation process. The third section provides an overview of the current state of affairs with the training and simulation sector, identifying the benefits of VR/AR-aided training and simulation, and assessing the latest trends and technological developments. The fourth section pays specific attention to the limitations within the European defence market. The empirical com-

ponent starts in the fifth section, which takes the Swedish approach to training and simulation as an example. Accordingly, the purpose of the study is to assess the impact of industry on fostering innovative solutions within the EU's military training and simulation market, provide recommendations, and motivate further investigation in this field.

4. Industries and Products

Armed forces have always looked for new solutions to increase their soldiers' readiness during ground operations. Advanced weapons and brand-new equipment are essential to enhance soldiers' capabilities. However, it is equally vital to develop the correct approach towards the environment and the challenges presented during the mission. The development of efficient preparation goes through intensive training; as warfare is evolving, so do military practices. In this regard, advanced technologies are becoming an integral part of armed forces' exercises thanks to the so-called "Training & Simulation" programs, consisting of virtual training and exercise simulations in live and virtual environments.

Several industries worldwide can supply the necessary tools to implement virtual training, including Northrop Grumman Corporation, Cubic Corporation, CAE, Aai Corporation, Lockheed Martin Corporation, L3 Link Training & Simulation and Rockwell Collins Inc. In Europe, the leading providers are (and not limited to) Saab (Sweden), Thales Group (France), BAE Systems (United Kingdom), Bohemia Interactive Simulations (Czechia), Leonardo (Italy) and Rheinmetall (Germany).[77]

These enterprises have an extensive range of products that cover several armed forces' areas, including naval, land and aircraft division, giving the purchasers a vast choice to meet their troops' needs. Their products have several benefits for the governments, as they allow them to reduce the cost of military exercises (notably raw materials) and the risks involved in the drills.[78]

In regard to the land domain, the manufacturers offer different solutions that allow the service members to test live training environments thanks to the latest gaming technologies, which integrate interactive headsets and gloves.[79] Moreover, more products are available to the armed forces, allowing them to have a thorough assortment of the latest technology applied to the military domain. The list includes small arms training and armoured fighting vehicles simulators that mimic real-life scenarios in controlled environments.[80] The most common is the Virtual Battlespace (VBS), of which there are different versions available. As the name suggests, the VBS is a platform based on commercial game technologies which combine multiplayer virtual environments with several different scenarios that allow the soldiers to experience the most realistic virtual training.[81]

Training & Simulation programs are not limited to indoor exercises, as the industries offer

77. Grand View Research. 2018. "*Military Simulation & Virtual Training Market Report, 2018-2025*". 17 February 2021. Available at: https://www.grandviewresearch.com/industry-analysis/military-simulation-and-virtual-training-market.
78. Ibid.
79. BAE Systems. 2017. Gaming technology and F1™ set to transform the future of cockpit development and military training. 17 February 2021. Available at: https://www.baesystems.com/en/article/gaming-technology-and-f1--set-to-transform-the-future-of-cockpit-development-and-military-training-at-bae-systems.
80. Thales Group. 2021. Land | Thales Group. Thalesgroup.com. 18 February 2021. Available at: https://www.thalesgroup.com/en/land.
81. Bohemia Interactive Simulations. 2021. VBS3 | BISim. Bohemia Interactive Simulations. 22 February 2021. Available at: https://bisimulations.com/products/vbs3.

solutions for live outdoor drills. In this regard, soldiers can use geo-localisation devices and firing simulating systems, operating through lasers, that mimic any real weapon. Moreover, the servicemembers can dispose of precision scoring systems that provide automatic and instant feedback of hit location and dispersion of rounds.[82]

Several countries in Europe rely on these products to train their troops, as they allow the command centre to monitor the simulations continuously while performing unique drills. Moreover, it is possible to gather data and analyse the overall performances of the service members to improve their readiness and capabilities on the battlefield. For instance, Thales Group supplies the French, German, Dutch and British armies[83]. However, it is more relevant to emphasise how different armed forces that share the same technology are able to carry out bilateral live training based on regional and cultural proximity. In this respect, during a Finabel interview with Mr Per Hagman from the Swedish Defence Materiel Administration (FMV), it was highlighted that Sweden had lots of exercises with Finland, Norway, Denmark, the U.S., and the UK seamlessly interacting with them.

The available products allow the users to train similarly to other soldiers using the same items, enhancing interoperability between armed forces. However, as it happens with standard weaponry and equipment, questions related to the standardisation process and its feasibility arise.

5. The Standardisation Process

The NATO guidelines define standardisation as "*the development and implementation of concepts, doctrines and procedures to achieve and maintain the required levels of compatibility, interchangeability or commonality needed to achieve interoperability.*"[84] Furthermore, they add that standardisation affects distinct fields, including *materials*, and "*it permits NATO countries to work together, as well as with their partners, preventing duplication and promoting better use of economic resources.*"[85]

On this matter, the European Parliament commissioned an extensive study regarding European armaments standardisation; the analysis, among other things, examines industries' standards and the impact of training on interoperability.[86] The study makes the distinction between "arms" and "armaments"; the former refers to the gears and weapons, whereas the latter is more inclusive as it also concerns technical and administrative factors of standardisation.[87]

The standardisation of weaponry is an important process that allows to avoid the duplication of products, which is not limited to the arms themselves but also includes systems and platforms. It brings considerable economic benefits as the homogenisation of the products reduces their costs. Therefore, the budget can divert to other projects that would bring innovations and promote the armaments' modernisation process. Moreover, standardi-

82. Saab. 2021. Live Fire Training. Saab. 18 February 2021. Available at: https://www.saab.com/products/live-fire-training.
83. Thales Group. 2021. Land | Thales Group. Thalesgroup.com. 18 February 2021. Available at: https://www.thalesgroup.com/en/land.
84. NATO. 2017. Standardization. NATO. 18 February 2021. Available at: https://www.nato.int/cps/en/natolive/topics_69269.htm.
85. Ibid.
86. Fiott, Daniel. 2018. *"European Armaments Standardisation"*. Europarl.Europa.Eu. Available at: https://www.europarl.europa.eu/thinktank/en/document.html?reference=EXPO_STU(2018)603872#:~:text=Standardisation%20is%20a%20method%20of,enhance%20armaments%20standardisation%20in%20Europe.
87. Ibid.

sation can improve interoperability between armed forces and upgrade the armies' operational capabilities and encourage competitiveness between the defence industries.[88]

Many elements drive the duplication of armaments, ranging from modernisation programs and legacy platforms to national industrial protectionism.[89] Despite the certified benefits, often the defence sector prefers to keep the production of the goods differentiated, as the diversity would guarantee a significant "*strategic effect for deterrence and during military operations.*"[90] Moreover, a not fully standardised technology allows governments and armed forces to safeguard the national defence industries interest and maintain strategic autonomy.

The European Parliament's study indicates that additional elements could hinder the standardisation process, including the global defence market. In the past, several technologies developed for the military sector (for instance, the Global Positioning System) have been used for civilian purposes (the so-called "spin-off"). However, the experts state that, nowadays, the tendency goes the other way around since several technologies are either originated or manufactured in the civilian sector (the so-called "spin-in").[91] For instance, that is the case of the VBS simulators, which take inspiration from commercial game technologies. The distinction between the defence equipment and capabilities, and civilian commodities and technologies, increases and makes it more challenging to differentiate them. Hence, it makes standardisation harder to achieve.[92]

However, the experts indicate that the standardisation process has a voluntary nature, meaning it needs the willingness between various stakeholders, including industries and governments.[93] Therefore, the first step states have to do to reach standardisation is to identify shared military requirements. They would allow creating a pattern, supporting the goods' customisation and preventing a degree of duplication, hence enhancing military interoperability.[94]

6. The Current State of Affairs

The nature of warfare is rapidly transforming from "being weapon-centric to technology- and information-centric".[95] On the one hand, the technologies of the Fourth Industrial Revolution such as AI, AR/VR, Blockchain, Robotics, Cloud Computing, and Autonomous Vehicles significantly increase the degree of military autonomy. On the other hand, however, they ultimately alter the way we can now conduct war and have simultaneously created new defence challenges in how to confront hybrid warfare in a coordinated way. Therefore, it is of crucial importance to transform traditional military training exercises into computer-based training by combining live training with simulators in order to enhance the situational awareness and the overall pre-

88. Ibid.
89. Ibid.
90. Ibid.
91. Ibid.
92. Ibid.
93. Ibid.
94. Ibid.
95. Market Reports World. 2018. "Global Military Simulation and Virtual Training Market Research Report – Forecast Till 2023,". Available at: https://www.marketreportsworld.com/global-military-simulation-and-virtual-training-market-12430642.

paredness of the armed forces for future joint operations. Virtual training and simulation in particular are an integral part of this approach for a new era that has a great potential to increase the interoperability of the air, sea, and land-based armed forces.

6.1 Trends and Latest Technological Developments

New technology-based training has already been used for many years. Yet, the advances made within commercially developed technologies – virtual, augmented reality, and gaming – have notably increased the demand for those virtual systems within the defence industry, aerospace sector and armed forces. As the quality of large-scale simulations improves and their benefits outgrow the costs, the industry and Ministries of Defence (MoDs) are actively seeking for possibilities to make a greater use of virtual and constructive simulations by merging live training with simulations to create a Live Virtual Constructive-Integrative Architecture (LVC-IA) to conduct interoperable distance training at the battlefield, air and maritime levels.

According to the Global Military Simulation and Virtual Training Market Research report (2018), the simulators within "synthetic training environments and [the development of] the interoperable capabilities for virtual training are some of the key trends in this market"[96] with external factors like great power competition, electronic and asymmetric warfare encouraging its further rapid growth. Countering drones, for instance, which is hard to train in live training and easy in virtual training, has especially driven up the demand for investment and innovation in the C-UAV simulation and training system.[97]

Thus, according to the *Global Military Simulation and Virtual Training Market 2017-2027* report (2018), the global military simulation and virtual training market is expected to grow by approximately 7% in 2023. North America is still holding a dominant regional position in the military simulation and virtual training market (33.5% share of the market's revenue in 2027), followed by the Asia-Pacific region[98] (30.5%) and Europe, whose share is anticipated to decrease from 24.31% in 2018 to 21.9% in 2027.[99] With the "growing emphasis on maritime security and the subsequent focus on virtual solutions for naval training and the increased use of flight simulators for training combat aircraft pilots,"[100] flight simulators will prospectively lead the simulation and virtual training market by making 59.3% of the market in 2027, followed by maritime and combat simulators, which will constitute a share of 22.8% and 17.9%, respectively.[101]

Despite declining defence expenditure among the majority of the EU MS, the adoption of flight and maritime simulators is on the rise as new adversaries and security challenges develop, e.g., nuclear-powered underwater drones and hypersonic missile weapons. Examples of such approaches are set by the *Royal Navy's Maritime Composite Training System*

96. Ibid.
97. Jakobsson. 2021.
98. Notably, this trend is particularly characterised for such technologically advanced countries as China, India, Japan, South Korea, and Australia (ibid.).
99. MarketReports. 2018.
100. Ibid.
101. GlobalData. 2017. "Global Military Simulation and Virtual Training Market 2017-2027,". Available at: https://store.globaldata.com/report/gd-df0118sr--global-military-simulation-and-virtual-training-market-2017-2027/#tab-table-of-contents.

(MCTS), and the *Royal Swedish Navy's Naval Warfare Training System* (NWTS), which authorise "teams and sub-teams such as EW, sonar and anti-air warfare to operate together in a unified environment [and offer] constructive training to enable the training of senior staff officers and commanders".[102] The report by the Global Military Simulator Systems Market to 2030, however, anticipates the land simulators to become a key sector of the simulation and virtual training market in 2030 by representing 47.9% of the market's total share.[103] Hence, rising demand for land simulators is anticipated to be affected by the procurement of various land platforms, such as China's T-15 Light Tank, Russia's T-14 Armata, the US's Joint Light Tactical Vehicles (JLTVs), the UK's Athena C2.[104] Consequently, the "procurement of simulators is primarily dependent on the acquisition of other military equipment such as aircraft, submarines, helicopters, armoured vehicles, unmanned aerial vehicles (UAVs), and naval ships".[105] It can therefore be concluded that the defence market, defence industry, and global arms race are interdependent, inseparable, and co-constitutive.

7. Limitations Within the European Defence Market

Despite this, however, there is no single defence market in Europe. In fact, the EU market is hugely complex and internally fragmented as it is jeopardised by "a range of private, semi-private and public primes, midcaps and small and medium enterprises (SMEs)" with its own unique legal, administrative, cultural and language specifics.[106] Furthermore, as defence procurement is mostly concentrated in relatively few countries – France, Germany, Italy, Spain, Sweden and the United Kingdom – SMEs are facing challenges in overcoming national prime companies' monopoly.[107] Another issue is that governments tend to prioritise national supply-chain companies, who are regulated by the governments who have ownership shares in those respective companies such as, for instance, Italian state-controlled defence contractor Leonardo. Furthermore, the EU export control regime largely "limits the options for cross-border defence sales if importing countries have more liberal defence export rules" (2018).[108] Therefore, if SMEs were to ship their products to another European country, which is exporting military equipment to third countries, the national export control regime of the latter comes into effect. The Netherlands and Germany have particularly strict national export laws.

Another protective option available to the EU Member States is to invoke the Article 346 TFEU, which allows Member States to "take measures as it considers necessary for the protection of the essential interests of its security which are connected with the production of or trade in arms, munitions and war material;

102. Nash, Trevor. 2020. *"The Changing Face of Naval Simulation & Training"*. Imdex Asia. 17 November. Available at: https://www.imdexasia.com/the-changing-face-of-naval-simulation-training/.
103. ReportLinker. 2020. "The Global Military Simulator Systems Market to 2030,". Available at: https://www.reportlinker.com/p05994287/The-Global-Military-Simulator-Systems-Market-to.html?utm_source=GNW.
104. Ibid.
105. GlobalData. 2017. "Global Military Simulation and Virtual Training Market 2017-2027,". Available at: https://store.globaldata.com/report/gd-df0118sr--global-military-simulation-and-virtual-training-market-2017-2027/#tab-table-of-contents.
106. Fiott, Daniel. 2018. *"European Defence Markets and Industries: New Initiatives, New Challenges"*, Nação e Defesa (150), p.82.
107. Ibid: 77.
108. Drent Margriet and Zande Dick. 2018. *"More European Defence Cooperation: The Road to a European Defence Industry?"*. Clingendael Policy Brief. 5 June. Available at: https://www.clingendael.org/sites/default/files/2018-06/PB_European_Defence_Cooperation_European_Defence_Industry_0.pdf.

such measures shall not adversely affect the conditions of competition in the common market regarding products" (2019).[109] Furthermore, as Fiott (2018) mentions, cultural and language barriers further strengthen the gap between SMEs and larger defence companies that govern the cross-border competition and the defence market as such.[110]

As a result, the overall trend remains that Member States "continue to procure the large majority of their military equipment on a national basis [and cannot] achieve the collective benchmark of spending 35% of their total equipment procurement" by reaching only 20% in 2019.[111] Likewise, the defence R&T falls short of the collectively agreed 2% goal. In fact, the defence expenditure on R&T has risen on the whole by 0,1% thereby by hitting only 0.9%.[112] As the defence spending remains predominantly national, unnecessary duplicates across MS' defence capabilities emerge. Thus, for instance, in comparison to 30 weapon systems in the U.S., the EU possesses 178.[113] Similarly, the EU uses 17 different types of main battle tanks (MBT), whereas the US has a single version of (MBT) in the US – M1 Abrams.[114]

Therefore, the standardisation of military equipment is urgently needed, which would reduce the costs of duplication, encourage cross-national cooperation, and improve the interoperability between European forces. As a result, the lack of cooperation between the EU Member States, i.e., the focus on national defence industry, leads to structural problems such as the fragmentation of the EU defence market. Moreover, it creates redundancy and costly duplications in the national R&T, further complicates interoperability issues, and weakens the EU strategically, reinforcing its reliance on the US. An enhanced industrial integration would, in turn, considerably increase the interoperability of European military forces as it implies the harmonisation of military capabilities, including strategic enablers.

Nevertheless, there are multiple possibilities to overcome the fragmentation of the European defence market and enhance Intra-defence-industrial cooperation. In a long-term perspective, Coordinated Annual Review on Defence (CARD)and Permanent Structured Cooperation (PESCO) projects can potentially provide a positive impact on the fragmentation of the European defence market due to a closer defence industrial cooperation within a multilateral framework, which is aimed to promote the synergy among European defence companies and reduce costly duplications of national military capabilities (NATO, 2017; Drent and Zandee, 2018). PESCO's *Integrated European Joint Training and Simulation Center* (EUROSIM) project is of particular interest to the field of simulation-based training solution. EUROSIM aims to create "a tactical training and simulation hub, which through decentralised governance involving multi-national training

109. Treaty on the Functioning of the European Union. 2016. "Article 346 (1b)". Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A12016E346.
110. Fiott, Daniel. 2018. "*European Defence Markets and Industries: New Initiatives, New Challenges*". Nação e Defesa(150), pp.76-84.
111. European Defence Agency. 2021. "Defence Data 2018-2019/ Key Findings and Analysis". Available at: https://eda.europa.eu/docs/default-source/brochures/2019-eda-defence-data-report.pdf, p.12.
112. Ibid.:10.
113. European Commission. 2019. "Towards a European Defence Union". Available at: https://ec.europa.eu/commission/sites/beta-political/files/euco-sibiu-towards_a_european_defence_union_0.pdf, p.2.
114. European Commission. 2017. "Reflection Paper on the Future of European Defence". Available at: https://ec.europa.eu/commission/sites/beta-political/files/reflection-paper-_-defence_en.pdf.

capacities could integrate tactical training and simulation sites in Europe into a real-time, networked, connected system" (2021).[115] Furthermore, the exclusive membership of the project simultaneously facilitates the higher degree of cooperation and contribution that five participating MS – France, Germany, Poland, Slovenia, Hungary – are willing to provide due to pre-existing forms of defence cooperation.

From the organisational point of view, European countries may greatly benefit from the newly created *European Defence Standardisation Committee* (EDSC), which will provide assistance and coordination to European Defence Agency's (EDA) participating MS and their industries "to move towards enhanced European defence standardisation with the aim of facilitating CSDP missions & operations and strengthening the European Defence Technological and Industrial Base (EDTIB)"[116] by drawing attention to the already developed and developing defence standards. Outside formal organisations, the *European Training and Simulation Association* (ETSA), for instance, provides a platform for "European training and simulation community and provides an environment for users and suppliers to exchange opportunities, ideas, information and strategies on training and simulation technology and methodology" (2021)[117] which is essential to staying ahead of the competition as technology rapidly evolves.

Accordingly, there is a very well established institutional background present within which respective national defence companies can operate. The existing institutions attempt to encourage multilateral defence procurement and training. Similarly, the industry is interested in the achievement of a unified European defence market and standardised military equipment. Yet, it is a long-term two-level game that calls for legal, political, and economic changes in the national governments' approach to EU defence and multilateral defence-industrial cooperation. Governments heavily invest in new technologies. Yet, when it comes to cooperation, a choice is always guided by structural and economic factors, which would favour buying a new MBT rather than a new training system; and so far, military equipment like MBT was the priority.[118] Therefore, as the result of nationalised defence market, there are no signals yet in establishing an open market and using a common simulation software tool.

8. Sweden as a Case Study

Finabel had the opportunity to study how virtual training impacts military drills thanks to the Swedish Armed Forces. Since Sweden took over the presidency for Finabel in June 2020, the European Army Interoperability Centre's team was given the chance to contact and interview some of the key people involved in this project, including Mr Hagman and Mr Jakobsson. Their statements enabled Finabel to understand how "Training & Simulation" works, its benefits and disadvantages. Moreover, their active involvement helped

115. PESCO. 2021. "Integrated European Joint Training and Simulation Center". Available at: https://pesco.europa.eu/project/integrated-european-joint-training-and-simulation-centre-eurosim/.
116. European Defence Agency. 2020. "New European Defence Standardisation Committee launched AA" 24 November 2020. Available at: https://eda.europa.eu/news-and-events/news/2020/11/24/new-european-defence-standardisation-committee-launched-aa.
117. DefenceIQ. 2021. "ETSA" Available at: https://www.defenceiq.com/events-landforcestraining-online/mediapartners/etsa-1.
118. Hagman, Per. 2021.

Finabel's team comprehend how these special drills may affect the interoperability of armed forces and the industries' role.

Sweden facilitated the interviews with some experts allowing Finabel's team to gain a deeper understanding of Training & Simulation exercises. Moreover, Finabel had the opportunity to attend a presentation by SAAB: the manufacturer supplies the Swedish Armed Forces with the necessary technologies to perform virtual training.

During the presentation, Saab showed the products supplied to the SAF, including laser simulator, geo-pairing and VBS, (e.g., vehicle simulators and ATW simulators), which support infantry training.[119] Furthermore, the Swedish company extensively explained how the armed forces use its technology and its benefits to the training.

The Swedish Armed Forces are not Saab's only buyer; the Swedish company has 18 Training & Simulation sites located in eleven countries. The primary purchasers include (and are not limited to) the UK, the Netherlands, Norway, Slovenia, Czechia, France and Germany.

To better comprehend virtual reality simulators' impact on military training, Mr Hagman's supported Finabel's team in understanding how industries practically impact interoperability between the armed forces.

Mr Hagman gave Finabel an overview regarding the products the SAF use to train, explaining more about lasers and their impact on drills.

Finabel's focus was drawn toward the feasibility of multinational training; the team wondered if countries needed to use the same laser software or they could train together even in case they owned different products. Mr Hagman stated that, on a theoretical level, having the same supplier is not a requirement to be interoperable. In this regard, he added that the 2016 standardisation of laser code – U-Lace – made it possible for different laser equipment from different vendors to work together.

Moreover, he added that it is easier to carry out joint exercises with countries that share the same provider. For instance, Sweden performs drills with Finland, Norway, Denmark, Britain and the Netherlands as they share the same systems.

However, from a practical standpoint, Mr Hagman stated that only the Dutch and the German army do joint exercises without sharing the same systems.[120]

Currently, the products available on the market do not all have standard profiles; hence, interoperability is limited to those that share the same platforms. However, according to Mr Hagman, as there are not so many systems available on the military market, the standardisation process presumably should not be demanding.[121]

In Training & Simulation, the civilian and defence industry merge, combining video games and military training; hence, it becomes vital to understand how their coexistence may impact standardisation, and therefore interoperability. When asked if the military's reliance on civilian industry may be a problem in the future or if they can work together, Mr Jakobsson replied that both options are valid. He continued pointing out that in the past, military technologies became integrated into

119. Saab. 2021. PowerPoint presentation to Finabel Virtual reality technologies rank fifth among Saab's total expenditures, preceded by Barracuda, Underwater Systems, Missile Systems and Ground Combat equipment.
120. Ibid.
121. Ibid.

civilian systems.[122] However, nowadays, the civilian market (in terms of gaming technologies) is much bigger; hence, the military has to adapt to these new products.

Mr Jakobsson mentioned that further issues might arise. On the one hand, the civilian industry moves faster than the military; new versions of virtual realities are frequently released, making their life span shorter. On the other hand, Mr Jakobsson stated that when the armed forces invest in any products, they want to work with them long-termly. The approval processes require a longer time, as the military needs to understand the interest of particular new technology before deciding to use it. The consequence is that the most recent items may become obsolete in 10 years.[123] Therefore, according to Mr Hagman's expert opinion, industries alone could not drive the commodities' standardisation but need the states' support. In this regard, many efforts have been made to create convergence; Germany has been a key player in promoting standardisation. Nevertheless, it is NATO's frameworks to be considered the driving force that can favour standardisation.[124]

Conclusions

This study has focused on the Training & Simulation programs within European market. By doing so, it researched the leading manufacturers present on the EU market, their products, the duality of the industry (civilian and military) and focused on the issue of standardisation. As the study aimed to answer the research question of whether the industries function as the drivers for interoperability, we examined the current market's trends to comprehend the benefits and disadvantages of virtual training, analysed legal limitation within the European defence market, as well as the interplay between national governments, EU institutions and industry's output to foster standardisation and interoperability between different military simulation systems and training plans. Furthermore, thanks to the direct participation of Swedish military personnel and industries' representatives in our study, we were able to shed light on industries' participation in the challenging path that leads to interoperability. Its findings imply that EU defence industries cannot be seen as a driver for standardisation and interoperability due to certain legal hurdles and the fragmentation within the EU Member States' military simulation and training market.

The land forces are specifically characterised by the diversity of the simulator training programs because procurement is largely done in separate areas, e.g., each military equipment requires a corresponding simulator that would exclusively fit to that particular equipment.[125] The standardisation of interfaces, in this sense, is the best solution, which should be taken into account during the procurement process. However, the industry would not do it by itself and would possibly resist the urge to merge and change.[126] The same goes for the national governments', who tend to outsource their resources to international organisations. The EU member states need to take leader-

122. Jakobsson. 2021. Interview with Mr. Jakobsson regarding the VBS simulator and constructive and virtual training, January 15.
123. Ibid.
124. Hagman, Per. 2021.
A125. Ibid.
126. Ibid.

ship in transforming military education, procurement and supply chain management to increase the Union's competitiveness, autonomy, interoperability of the defence sector, as well as industries' armament collaboration.

Recommendations

Therefore, to foster the rapid adoption and adaption of LVC training, Finabel suggest the following recommendations:

- Increase the investment flow into the R&D of the VR/AR-based training simulations to foster their ability to mimic operational environment even more realistically;
- Introduce mandatory virtual training classes, in contrast to the existing practice of unit commanders setting loose teaching plans in accordance with their personal preferences;
- Offer training courses that teach how to use operative systems that are different from the domestic ones in order to enhance interoperability with allied countries that use dissimilar platforms;
- Identify standard military requirements that improve communication between buyers and vendors (industry and armed forces) in order to customise products and overcome the challenges that hinder interoperability.
- There is an urgent need for dialogue through the consultation platforms with the defence industry in order to start discussions on standardisation.
- Through the European Defence Agency and the European Military Staff, it should be investigated how a European political consensus can be reached within the framework of national legislation in this field.

DATA UTILISATION, THE NEED FOR STANDARDISATION AND OBSTACLES

Introduction

The following sections analyse what data interoperability between European armies entails and the forms it can take and could take. The aim of this study is to inform about the importance of the process of data interoperability in order to achieve a relevant European defence structure. What we are not doing in this study is providing a list of the different processes of interoperability regarding data. Such a list, in fact, would simply not be relevant, as its forms are multiple and always new. What will be discussed in this study are the common obstacles to data interoperability between European armies. Instead, it will explain why and how data interoperability is not yet systematic regarding political and technical aspects. Finally, our organisation will give different proposals to improve exchanges and practices between European armies regarding data. Firstly, the study will observe what "data" means as well as their uses and importance

within the military domain. Then, we will observe how interoperability is conditioned by national interests. Finally, we will analyse the technical forms taken by interoperability.

9. What is Data?

Data means "information". Data provides information on a specific subject and as such, is always used for a specific goal.[127] The usefulness of data is related to its relevance for a structure. When we talk about data interoperability within European armies, we are therefore talking about the share of relevant information between army structures in order to achieve a common objective.[128]

Data interoperability is key in the process which gathers systems and services to work together, to obtain the same clear and shared expectations and explanations of the same content. Interoperability can be broadly defined as any activity that connects actors, such as forums or research workshops. When it comes to data interoperability between armies, the question is how and why it happens.[129] [130] It is often linked to sharing the same procedures and using the same database in a joint operation.[131]

10. Political Aspects: National Interests vs. Interoperability

The degree of data interoperability achieved is primarily related to national interests, which imply policy and context considerations. NATO defines interoperability as « the ability to operate in synergy in the execution of assigned tasks ».[132] But why should several Member States come to cooperate together in the long-term? Indeed, the EU military interoperability seems to confront itself against a big challenge which is the sovereign nature of states over their strategic information (which implies a reluctance to share sensitive data related to their Defence). Moreover, this military interoperability seems difficult to sustain over the long term, as joint operations are often limited in their duration.[133]

Military interoperability among EU Member States is effective when several military organisations of member states conduct military operations together. But this interoperability can only be achieved with relevance and efficiency thanks to common national interests. Indeed, it is no coincidence that the most notorious examples of interoperability took place during armed conflicts, wars, or within a politico-military organisation such as NATO. During the Cold War, NATO saw Member States exchanging data and developing common tactical and strategic frameworks because they had the same national interests. Thus, we see the relevance of observing the interoperability of EU armies with regard to data through intergovernmentalism, i.e. why certain Member States are grouping together in order to function and act together on specific subjects. The exchange of data between

127. Cambridge English Dictionary. *"Data"*. Available at: https://dictionary.cambridge.org/dictionary/english/data
128. Data Interoperability Standards Consortium. *"What is data interoperability?"*. Available at: https://datainteroperability.org/
129. Tanner, E. Patrick. 1987. *"Potential Data Exchange Between Various Army Systems Using the Data Traffic Management System"*. Available at: https://core.ac.uk/display/109049417
130. European Data Protection Supervisors. 2020. *"Interoperability"*. Available at: https://edps.europa.eu/data-protection/our-work/subjects/interoperability_en
131. Lichtblau E. Dale, and Bleach D. Richard. 2010. *"US and Coalition Forces Data (Semantic) Interoperability Study"*. Institute for Defense Analyses. Available at: https://apps.dtic.mil/dtic/tr/fulltext/u2/a522325.pdf
132. Derleth, James. 2015. *"Enhancing interoperability: the foundation for effective NATO operations"*. NATO. Available at: https://www.nato.int/docu/review/articles/2015/06/16/enhancing-interoperability-the-foundation-for-effective-nato-operations/index.html
133. NATO. 2006. *"Interoperability for joint operations"*. Available at: https://www.nato.int/nato_static/assets/pdf/pdf_publications/20120116_interoperability-en.pdf

the military structures of the member states is conditioned by the emergence of new threats and common objectives. With regard to these aspects, standardisation processes are of real importance in order to promote opportunities for military interoperability as well as being a common base upon which EU Member States can build. It is in that sense that agreements such as the NATO Standardization Agreements were created in order to foster interoperability between European states.[134] These aspects are also highlighted by various PESCO projects such as the EU Collaborative Warfare Capabilities (ECOWAR), which aims to « increase the ability of the armed forces within the EU to face collectively and efficiently the upcoming threats that are more and more diffuse, rapid, and hard to detect and to neutralize ».[135]

The point we want to stress here is that EU Member States (MS) that are not members of international organisations in which other MS are also members, will find it more difficult to develop joint operations. The same conclusion can be drawn for such MS with regard to promoting a fruitful framework that promotes the interoperability of their armed forces with other European armed forces. Indeed, it is through common goals that the value of interoperability emerges, these are more identifiable through membership in the same international organisations or forums, especially for military interoperability and the share of sensitive data.

Moreover, the general difficulty in achieving interoperability between armies should also be highlighted because of the different military policies that have been pursued in the field of defence innovation and research. A second reason may be the budget earmarked for defence within the member states, which is not the same from one European state to another. Such differences in these budgets, which are crucial to the defence of any Member State, imply different technological advances to be taken into account when exchanging data. The result is an additional difficulty due to national interests and the choices they have hitherto implied for the defence sector.[136]

Beyond these political aspects, EU Member States data interoperability is conditioned by technical and procedural obstacles, such as classification, and need to establish a common frameworks of action, such as common Tactics, Techniques and Procedures (TTP).

10.1 What Are the Implications of Using Data?

Using data implies controlling their origin, having permission to use them and being assured of their relevance. However, when this interoperability of data encounters the military domain, it is also a matter of controlling which data is shared, checking its sensitivity.[137]

Regarding these aspects, Finabel wanted to stress the importance of data classification. Indeed, this aspect is linked to the decisions of a structure, whether military or otherwise, to decide whether it will be shared and to

134. Finabel. 2021. "*EU law and military interoperability. Assessing the European defense initiatives of 2009 and 2016*". Available at: https://finabel.org/eu-law-and-military-interoperability-assessing-the-european-defence-initiatives-of-2009-and-2016/

135. PESCO. "*EU COLLABORATIVE WARFARE CAPABILITIES (ECOWAR)*". Available at: https://pesco.europa.eu/project/eu-collaborative-warfare-capabilities-ecowar/

136. Senat (FR). 2019. "*European Defense: The Challenge of Strategic Autonomy*". Rapport d'information n° 626 (2018-2019) de M. Ronan LE GLEUT et Mme Hélène CONWAY-MOURET, fait au nom de la commission des affaires étrangères, de la défense et des forces armées, déposé le 3 juillet 2019. Available at: http://www.senat.fr/rap/r18-626-2/r18-626-2_mono.html

137. Williamson, R. Marlene. 2019. "*Data interoperability: a case study in complex systems engineering*". New England Complex Systems Institute. Available at: https://necsi.edu/data-interoperability-a-case-study-in-complex-systems-engineering

whom. This process can be defined as the importance of "categorizing data in order to use them at their highest level of effectiveness and efficiency" (2020).[138] This is used to perform complex and varied actions in many different fields of operation when it comes to common operation between armies.

Real interoperability between European armies comes through a relevant and sufficient data share. Indeed, concerning the party that receives shared data, it is always necessary to have access to a relevant amount of data in order to be able to create the information we are interested in producing. How relevant is an information if half of it (and the most important part) is missing?

Moreover, these data must correspond to technical standards that allow them to be read, i.e., no encryption impossible for the recipient to decrypt.[139] The importance of TTPs (Tactics, Techniques and Procedures) must be stressed here and will be further developed in this paper. What is the purpose of this tool? In order to accomplish certain tactics, there is a need for specified techniques to achieve this, which are framed by procedures to be followed. The interoperability of data between armies therefore requires a set of TTPs to be defined, both technically and in terms of the procedures to be followed for these exchanges.[140]

138. De Groot, Juliana. 2020. *"What is Data Classification? A Data Classification Definition"*. Digital Guardian. Available at: https://digitalguardian.com/blog/what-data-classification-data-classification-definition

139. National Academies of Sciences, Engineering, and Medicine. 2017. *"Cryptographic Agility and Interoperability: Proceedings of a Workshop"*. Washington, DC: The National Academies Press. Available at: https://www.nap.edu/read/24636/chapter/3

140. Winchester, Robby. 2017. *"What's in a name? TTPs in Info Sec"*. Specterops. Available at: https://posts.specterops.io/whats-in-a-name-ttps-in-info-sec-14f24480ddcc

11. Data Interoperability in Training and Simulation

Using the same training models and simulation, data can improve the ability of European armies to train together, operate together and simulate joint operations.[141]

We believe that European armies cannot ignore the development of a methodology drawn from the evaluation processes of the different Member States taken from simulators, in order to move towards common evaluation practices. This method could provide training system developers with the information they need to promote future joint operations between member states.[142]

Regarding training and simulation in the army and data interoperability, there is a need to develop a unified methodology to measure warfighters performances within simulation systems. These metrics could be generated using the data simulators currently in use to derive the training curriculum they provide. Currently, these metrics are largely overlooked, mostly because training systems developers are not required to do so. In addition, there is no guidance for these developers with regard to how to identify the appropriate metrics for use in these systems.

The amount of digital information that gets produced is expanding exponentially, which is also true for defence matters. The vast majority of the data that is produced by virtual training and simulation obliges defence to look at possible solutions to process that data. One of the possible outcomes could be the use of Artificial Intelligence (AI) and Machine learning to process, interpret and analyse that data. The term AI was first coined in 1956 by John McCarthy, now AI can be described as 'a sub-field of computer science and how machines can imitate human intelligence (being human-like rather than becoming human)'.[143] Machine learning on the other hand is an application of artificial intelligence that 'provides systems the ability to automatically learn and improve from experience without being explicitly programmed'. Modern forms of warfare are relying more heavily than ever on AI and machine learning. It has been stated that states investing in AI and big data might have an upper hand in warfare.[144] The recent interest towards AI within defence matters is underlined by a tendency to allocate growing parts of the defence budget into the development of AI. [145] Also The European Defence Agency has shifted part of its focus towards AI and supports Research and Development of the EU states in the field of AI.

However, the relation between the military and AI applications is not that straightforward as it seems. As mentioned, AI could prove to be a solution to manage the vast amount of data gathered through military structures. Certain tasks can be carried out more efficiently, as humans are unable to process the amount of data produced by training. Machine learning however may be able to do

141. Army Technology. 2019. *"Doing more with simulation-based military training"*. Available at: https://www.army-technology.com/features/doing-more-with-simulation-based-military-training/

142. Modern Military Training. 2016. *"4 steps to achieve greater interoperability for training effectiveness"*. Available at: https://modernmilitarytraining.com/training-effectiveness/4-steps-to-achieve-greater-interoperability-for-training-effectiveness/

143. Marr, Bernard. 2018. *"The Key Definitions Of Artificial Intelligence (AI) That Explain Its Importance"*. Forbes. Available at: https://www.forbes.com/sites/bernardmarr/2018/02/14/the-key-definitions-of-artificial-intelligence-ai-that-explain-its-importance/?sh=371e577b4f5d

144. Meserole, Chris. 2018. *"Wars of None: AI, Big Data, and the Future of Insurgency"*. LawfareBlog. Available at: https://www.lawfareblog.com/wars-none-ai-big-data-and-future-insurgency

145. A recent example includes the UK investing in AI capabilities as part of a strategy to adapt to the newest forms of warfare. Lomas, Natasha. 2020. *"UK to invest in AI and cyber as part of major defense spending hike"*. Available at: https://techcrunch.com/2020/11/19/uk-to-invest-in-ai-and-cyber-as-part-of-major-defense-spending-hike/

so, at considerable speeds as well. Not only will we be able to interpret the data we will be able to analyse it and look for possible solutions when using machine learning or other viable forms of AI. The flipside of the coin however is that for AI to be developed in a proper way, data is needed. To create AI applications, the industry needs to gain access to a large amount of data, which are currently retained due to security reasons. Because of the national security concerns linked with sharing military information, the EDA has expressed the idea of creating a 'data lake' composed of data with a low classification level, possibly anonymized.[146] Access to such a pooling database of military information, would enable systems based on machine learning to improve themselves, while at the same time allowing Member states and the industry to develop new AI solutions and software. Such a 'data lake' therefore could be beneficial for both parties. AI and algorithms could be created to process and analyse training data, look for patterns and for possible answers, but to create them a minimum level of data needs to be available. Therefore, in the end, it is in the interest of both parties, armies and the industry, to make available at least a certain minimum of training and simulation data. However, as will be shown in the next paragraph, classification may be one of the issues impeding the creation of the aforementioned 'data lake'.

11.1 The Classification Obstacle

The system of classification within defence matters has been around for a long time. Recent societal changes however might shed a new light on classification and might reveal some difficulties with the current approaches towards data and the classification thereof. In recent years, and especially since the advent of the internet, information as such has become an important value in all parts of society. Information has been described as the new form of currency.[147] What makes classification interesting and relevant is the fact that it balances national security concerns and the right to access the information needed to set out training goals. This equilibrium can be difficult to find and maintain. Security measures that are too strict or severe could result in having negative consequences, such as minimising the potential of setting training goals, reduce the effectiveness of training, induce irrelevant training resulting in real life harm when conducting wartime operations, and also the costs of classification also need to be taken into account.[148]

One may ask why classify data in the first place. When looking at military and security related data, the answer may be straightforward. When conducting training with virtual reality systems, the data collected contains both the strengths and the weaknesses of the battalions and of the army in itself. It is without any doubt, states want to avoid exposing their weaknesses to other states, and the easiest way to do that is to make the data confidential, classifying it as secret. The consequence is however that a lot of potentially useful data may or can not be used and shared, hamper-

146. European Defence Agency. 2020. *"European Defence Matters: Enhancing interoperability Train together, deploy together"*. Available at: https://eda.europa.eu/docs/default-source/eda-magazine/edm19_web.pdf

147. Evans, Michelle. 2018. *"Why data is the most important currency used in commerce today?"*. Forbes. Available at: https://www.forbes.com/sites/michelleevans1/2018/03/12/why-data-is-the-most-important-currency-used-in-commerce-today/

148. Wichamasekora, Suranfa. Webinar.

ing interoperability between states. The end goal of multinational exercises is that data and information will be shared with participating states. The problem that arises is one of policy and authority, for which different systems of data management and different levels of command hinder that process. States most often operate on their own, national network[149]. Therefore, the problem is whether such a network can be released to partners of a certain mission.

The results of classification do not only affect international exchange of data between states (as a result of a multinational exercise for example) but are also visible within the state itself. Taking Sweden as an example, it is shown that the uncertainty about the classification of the data of simulation and training impeded the experts from using that data and more importantly from analysing it. There are some advantages to make training data public.[150] Firstly, like already said, it helps to enhance the technical development of the training systems used by the army. Open information and the sharing of data may have a deterring effect on enemy forces. This shows how well land forces might be operating in certain situations. The UK for example has moved part of its exercises from Canada to Europe, partly motivated by the deterring effect of these trainings.

Most countries have enacted a certain act to protect different types of information. The UK for example has drawn up a document on 'government security classifications'.[151] Most of the time the rules on national secrecy and classification however are drawn up in a legislative document. Most classification regulations incorporate a tier system. There are different kinds of classification levels, linked to the sensitivity of the data. [152] Most of the systems have similar categories for classification: Top Secret, Secret, Confidential, Sensitive, and Unclassified.[153] An alternative way of looking at it is often suggested, differentiating between Restricted, Confidential, Internal, Public. The fact that different systems of classifications are being used between states (and also international organisations[154]), hampers the interoperability between states and might prove to be a problem when analysing the data of multinational exercises.

Finally, data interoperability between different European armies appears indispensable and useful when it comes to common Tactics, Techniques and Procedures (TTPs).[155] Indeed, a prior understanding of the means of action of the actors working together allows the harmonisation of the interoperability of the armies during simulations but also during operations. Through this sharing of data, a European TTP could be set up: a procedure to be followed during joint operations, taking into account the functioning, strengths

149. The US for example is using SIPRNET. Williams, Lauren. 2019. *"Army seeks new paths to network interoperability"*. Defense Systems. Available at: https://defensesystems.com/articles/2019/10/23/army-network-policy-change-williams.aspx?m=1

150. Hagman, Per. 2021. Interview with Mr. Hagman on the Swedish simulation programs and the Swedish participation in multinational training, focusing on the impact of new technologies. 5 January.

151. UK Government. 2018. *"Government Security Classifications"*. Available at: https://www.gov.uk/government/publications/government-security-classifications

152. Fields, Jeffrey. 2017. *"What is classified information, and who gets to decide?"*. The Conversation. Available at: https://theconversation.com/what-is-classified-information-and-who-gets-to-decide-77832

153. The UK for example differentiates between: 1) Official data, some of which could have damaging consequences if lost, stolen or published in the media, but are not subject to a heightened threat profile, 2) Secret, very sensitive information that justifies heightened protective measures to defend against determined and highly capable threat actors, 3) Top Secret most sensitive information requiring the highest levels of protection from the most serious threats. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/715778/May-2018_Government-Security-Classifications-2.pdf and: https://www.packetlabs.net/data-classification/#:~:text=Data%20Classification%20Levels,%2C%20Confidential%2C%20Internal%2C%20Public

154. NATO and the EU both have a system of classification of security and defence information of the organisations.

155. National Institute of Standards and Technology (NIST). 2021. Available at: https://csrc.nist.gov/glossary/term/Tactics_Techniques_and_Procedures

and weaknesses of each of the actors involved. Indeed, knowing the techniques, tactics and procedures of allies, would enable them to anticipate their actions, to harmonise intervention plans, and to predict their reactions and functioning during joint interventions.

Conclusions

As regards interoperability between European armies, particularly with regard to shared data, there was no point in being nostalgic about the supposedly greater efficiency of Europe of six. Today the European Union has 26 Member States and still faces the same obstacles: national interest before shared interests, especially in the field of defence. Today it is only by taking account of common threats and repeated dialogue between Member States that data sharing between armies can evolve. This should concern both the political aspect - with the increasing number of institutionalized dialogues between armies, particularly thanks to PESCO missions - and the technical aspect - for example with regard to the classification systems of each of the Member States and shared data, or joint simulation programmes between the armies of the Member States.

Recommendations

In the light of these observations, Finabel draws up a list of recommendations for EU Member States with regard to data interoperability:

- Information between European armies should not only be shared for communication purposes and be episodic, but there should be multiple channels for sharing it in order to work towards a European defence on a daily basis. The institutional creation of more communication channels between the structures responsible for each army should be encouraged.
- As national interests can only be brought together through the consideration of common threats, Finabel recommends that the heads of European armies should participate jointly and repeatedly in forums dedicated to recent threats to the European continent. Even if a threat does not particularly affect a European state directly, opening the door to a threat on European soil means letting it evolve inside our nations, who knows which door it will come knocking at next?
- One idea EDA has proposed to its members is to create a repository, or 'data lake', of less sensitive but anonymous military operational data on vehicles, air platforms and so on. By giving research and technology organisations, SMEs and large industry access to it, these players could devise new AI solutions such as platform-specific smart software.
- We come from a world where we throw away most of the data just to find certain signal characteristics, to a future where we will be able to squeeze so much more information out of the data that our sensors gather.
- The combination of big data and AI can be hugely beneficial for the military and the improvement of training itself.
- The military mindset in data sharing should change from the need to share

to the dare to share principle. There is far too much over-classification of data, which permanently bottlenecks interoperability through data sharing.

- In view of the speed of technological developments, current procurement procedures in many Member States are too cumbersome and unwieldy. These, often Kafkaesque, procedures lead to excessive time lapses between the writing of the requirements, the procurement procedure and the final delivery. In the process, the technology is often already out of date on delivery.
- There is an urgent need for appropriate procurement procedures that enable technology to be purchased at very short notice.
- Knowledge of available technology and systems should increase off the shelf purchase. We need to build good consultation platforms where industry and armed forces can better exchange knowledge, experience and technology.

Conclusive Remarks

The achievement of higher degrees of interoperability and standardisation of armaments between the European armies' land forces is the longstanding mission of Finabel. As advanced digital technologies are increasingly becoming an integral part of troops training, this study was conceived with the purpose to analyse the current state of their utilisation and the future developments which might be achieved by their deeper integration into military drills and simulated operations.

Prompted by the initiative of the Swedish Chief of Staff, chair of Finabel for the year 2020, the study benefited from the crucial contributions of experts directly involved with the process of adoption of simulation technologies within the SAF, and has examined specifically the case of Sweden as an "early adopter" of these solutions. The research has been hence focused on three strategically relevant areas: the dimensions of cultural interoperability, an overview of the defence industry, and the issues concerning data and cooperation between member states.

The first chapter proposed a thorough analysis of those aspects related to the human technology interaction, with particular regard to the areas of the geopolitical significance in adopting simulation-based techniques for training, both on the national and international cooperative levels, and of the cultural challenges military structures face in adapting to these technologies. Key findings were the positive effect T&S have proven to provide in reducing the risks associated with destabilisation and the security dilemma, as well as the cost-effectiveness of the employment of simulations for military training. However, the research has also exposed the presence of a systemic resistance to SBT systems, mainly due to institutional, cultural, and generational elements typical of military structures.

The second chapter of the study looked into the main actors present in the EU market and their contribution to the offer of civilian and military products. The most compelling question to answer, in this case, has been whether enterprises could be considered as a driving force in the development of an interoperable range of solutions for training or not. The major takeaway of this section has been that of identifying a twofold hindrance to the standardisation of simulation technologies for training at a continental level: both the governments and the industry, in fact, are currently not in the position to be seen as proactively engaging in an effort of homogenisation. Legal limitations, specificity of requirements, and outsourcing, are currently hindering the development of a unified European defence market, resulting in a fragmented picture of varied national interests met by equally diversified industry outputs.

In the last part of the paper, the study has delved into the examination of data and their sharing for interoperability purposes. More than in any other previously analysed aspect, it is especially for the partaking of military data that national security interests become essential to understand the reluctance in creating a common defence T&S sector. Excluding some proposals and the existence of limited scope multinational initiatives of cooperation in this sense, access to data is currently widely restricted from the lack of institutionalised procedures and technical standards, much limiting the opportunities for a large-scale employment of AI and machine learning solutions.

The study hereby presented has by no mean the pretension of being all encompassing, nor exhaustive. Given the newness and sensitivity of the topic, at present, sources are still scarce, and a greater effort of research must be done to understand how to fully exploit the potential of training and simulation to foster interoperability among Finabel's member states. There is the need for EU institutions and member states to take action and

transform the military educational system, its procurement strategies, and supply chain management, to achieve coherence in their action, not to be left behind in a key defence sector. A more concerted engagement at EU level would undoubtedly have spill-over effects in different sectors, boosting the Union's competitiveness and autonomy. In the future, technological progress and international competition, are likely to act as drivers to facilitate the adoption from armed forces of simulator-based systems, hence the implementation of a wider cooperation, transversal to the EU military-industrial complex and finalised to obtain higher degree of interoperability of platforms, is in the best interest of all Finabel's member states.

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- Contributing to a common European understanding of land defence issues. Finabel focuses on doctrines, trainings, and the joint environment.

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Finabel contributes to reinforce interoperability among its member states in the framework of the North Atlantic Treaty Organisation (NATO), the EU, and *ad hoc* coalition; Finabel neither competes nor duplicates NATO or EU military structures but contributes to these organisations in its unique way. Initially focused on cooperation in armament's programmes, Finabel quickly shifted to the harmonisation of land doctrines. Consequently, before hoping to reach a shared capability approach and common equipment, a shared vision of force-engagement on the terrain should be obtained.

In the current setting, Finabel allows its member states to form Expert Task Groups for situations that require short-term solutions. In addition, Finabel is also a think tank that elaborates on current events concerning the operations of the land forces and provides comments by creating "Food for Thought papers" to address the topics. Finabel studies and Food for Thoughts are recommendations freely applied by its member, whose aim is to facilitate interoperability and improve the daily tasks of preparation, training, exercises, and engagement.

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