The use of Wargaming as a Naval Concept Exploration Tool

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INTRODUCTION

This paper describes the work conducted so far by the NATO Specialist Team on Naval Ship Systems Engineering in exploring the use of wargaming as a concept exploration, analysis and assessment tool. Working closely with wargaming specialists at University College London, ST/NSSE has used wargaming to explore aspects of a current area of NATO capability enhancement through a series of wargames which explored the concept, assessed its benefits and drawbacks, and indicated other areas where capability creation and enhancement was likely to benefit NATO naval operations.

THE NATO SPECIALIST TEAM ON NAVAL SHIP SYSTEMS ENGINEERING

The Specialist Team on Naval Ship Systems Engineering (ST/NSSE) is a sub group under the NATO Ship Design Capability Group. It is tasked with developing methods of assessment and processes in naval ship design. In recent years it has worked extensively in the area of Mission Modularity, working closely with the Specialist Teams on Mission Modularity (ST/MM) and Ship Costing (ST/SC) developing interface standards and proving the case for mission modularity in naval ships. Part of this work included a 2 day wargame in the UK to explore the mission modularity concept as it could be applied to a series of low end naval missions (disaster relief, counter piracy and non-combatant evacuation operations). This wargaming activity showed promise in its ability to explore concepts and hence ST/NSSE's current programme of work is going further, considering more high-end warfighting roles and, if successful, with a view to creating formal guidance within SDCG's suite of standards and guidance on the conduct of wargaming for concept analysis and assessment.

WHAT IS WARGAMING?

Professional wargaming is a structured and systematic method of simulating and analysing military, political, economic, or other strategic scenarios in a controlled environment. It is often used by military organizations, government agencies, and other entities to test and develop strategies, train personnel, and explore potential outcomes of complex situations. The term "wargame" is used to cover a very wide range of activities and as such it is virtually impossible to find a single standard definition, but Peter Perla, one of the leading lights of modern professional wargaming uses the following definition which is widely, if not universally, accepted within the professional wargaming field [Perla, 2011]:

> *"A wargame is a warfare model or simulation whose operation does not involve the activities of actual military forces, and whose sequence of events affects and is, in turn, affected by the decisions made by players representing the opposing sides."*

Professional wargaming typically involves the following key elements:

- Scenario Development: Wargames begin with the creation of a detailed and realistic scenario that reflects the specific context or problem being addressed. This scenario can range from military conflicts and geopolitical crises to disaster response and business strategy.
- Participants: Wargaming typically involves a diverse group of participants, including subject matter experts, military personnel, policymakers, analysts, and other stakeholders. These individuals take on various roles and positions relevant to the scenario, such as military commanders, diplomats, or business leaders.
- Simulation Tools: Wargames can be conducted using a variety of tools and techniques, ranging from tabletop exercises and computer-based simulations to more elaborate war rooms and models. The choice of tools depends on the objectives and complexity of the wargame.
- Rules and Adjudication: Wargames have established rules and procedures that govern how actions and decisions are made within the simulation. Adjudicators or facilitators ensure that the rules are followed and that the game progresses according to the scenario.
- Analysis and After-Action Review: One of the primary purposes of professional wargaming is to analyse the outcomes and consequences of various actions and decisions. After the wargame concludes, participants often engage in an in-depth after-action review (AAR) to assess the results, identify lessons learned, and develop insights for real-world application.
- Training and Strategy Development: Wargaming is often used for training military and civilian personnel in decision-making, crisis management, and strategy development. It allows participants to practice their skills in a risk-free environment.
- Policy and Strategy Development: Wargaming can inform the development of policies, strategies, and plans by providing insights into potential challenges and opportunities in various scenarios. It can help decision-makers refine their approaches and mitigate risks.

Overall, professional wargaming is a valuable tool for exploring complex and uncertain situations, fostering collaboration among stakeholders, and improving decision-making processes in a wide range of fields beyond the military, including government, business, and academia.

Professional wargaming has a long and illustrious path stretching back over centuries. In ancient times leaders and military commanders used tabletop games and simulations to strategize and teach tactics. For example, the Chinese game of "Wei-Hai," which dates back to the 5th century BC, involved the use of pieces representing military units. IIn the early 19th century, the Prussian military developed a wargame called "Kriegsspiel" (literally "war game" in German). Kriegsspiel used detailed rules, maps, and miniatures to simulate warfare scenarios. It was designed to train Prussian officers in tactics and decision-making. Kriegsspiel's influence spread to other European militaries.

In the late 19th century, naval wargaming gained prominence, particularly in the United Kingdom. The Royal Navy used wargames to develop and test naval strategies, which were critical during World War I. The US Navy also adopted similar practices. Both World War I and World War II saw the use of wargaming to plan and analyse military operations. The US Navy wargamed extensively in the interwar period, in particular covering operations against the

Japanese in the Pacific. So extensive were the scope of these games that Admiral Chester Nimitz is quoted as saying:

> *'The war with Japan had been re-enacted in the game room here by so many people and in so many different ways that nothing that happened during the war was a surprise – absolutely nothing except the Kamikaze tactics towards the end of the war; we had not visualised those'.*

[UK MOD Wargaming Handbook, 2023]. In the UK the Western Approaches Tactical Unit, also known as WATU, made a significant contribution to the fight against German U-boats during World War II. Established in Liverpool, in 1941, WATU was a training and research facility that played a crucial role in improving the effectiveness of Allied anti-submarine warfare. WATU used wargaming to develop and test innovative tactics, techniques, and technologies for countering U-boats in the treacherous waters of the North Atlantic.

Figure 1 – ASW wargaming at the Western Approaches Tactical Unit

Using realistic simulations, WATU trained naval officers and escort ship crews, helping them better understand U-boat tactics and develop strategies to counter them. The unit's work in improving convoy escort tactics and coordination, as well as developing anti-submarine warfare tactics, contributed significantly to the eventual Allied victory in the Battle of the Atlantic. Their efforts helped reduce the devastating impact of U-boat attacks on Allied convoys, ensuring the flow of vital supplies and reinforcements to Europe during the war.

Today, professional wargaming is used in a wide range of fields for training, strategy development, and policy analysis. It continues to evolve with advances in technology, incorporating computer modelling, virtual reality, and other innovative approaches. Professional wargaming has proven to be a valuable tool for decision-makers, helping them anticipate challenges, test strategies, and develop effective responses to complex and dynamic situations. Its rich history reflects its enduring relevance in addressing a variety of strategic and operational challenges.

WARGAMING AS A CONCEPT ANALYSIS TOOL

Senior proponents of wargaming are keen to stress that wargaming is not an operational analysis tool [Downs-Martin. 2023]. However, the technique can be used as a precursor to OA work in that it can allow concepts and ideas to be explored in a "safe to fail" environment and, depending on the methods used, at relatively low cost. The Naval Architecture and Marine Engineering team at University College London (UCL) has used wargaming in this way for nearly a decade to support its students in their ship design activities [Bradbeer, 2022, Manley, 2023]. Wargaming is used in a number of ways:

- As a training aid – whilst students have a good understanding of the basics of ship design they are usually unfamiliar with the ways that navies and warships operate. A selection of wargames are available that are used to demonstrate the roles of different ship types and other assets (for example land based aircraft and space assets) in the conduct of naval operations. Other games illustrate the value of particular aspects of combat system design choice in close quarter battles, benefits or otherwise of detailed ship system architectures or missile exchanges against peer threat navies.
- As "operational analysis" in the Ship Design Exercise. Having said that wargaming is not OA, it is used as a rapid substitute in the UCL Ship Design Exercise (SDX). In this mode the UCL tools are used to allow the students to explore aspects of their designs, for example the design of offensive and defensive weapon systems and the impact of signature control. For some design project, bespoke games are constructed by the academic staff to analyse niche areas of warfare and design. A recent example is UCL's "Cobalt Rocks" seabed warfare game which was developed to support a design project that was centred on the protection of Critical Undersea Infrastructure (CUI) [Manley, 2023]
- Perr-on-peer performance assessment. At the conclusion of the SDX the student designs are tested in a fleet level operational wargame with their opponents based on real world threats and/or successful student designs from previous years.

Since developing these tools for the educational environment, UCL has extended their use into other training sectors. For example, the training and detailed design games have been used for team and domain training in the UK MOD and defence contractors in the EU, whilst the game focussing on close quarter combat has been used as the basis for a training game at the Royal Navy's Maritime Warfare Centre.

THE NATO SPECIALIST TEAM'S WARGAMING PROJECT

The work of ST/MM and ST/NSSE in 2016 demonstrated the initial value of wargaming as a concept assessment tool in low end naval operations. Discussions within the team and with SDCG members in Delft (NL) in 2018 indicated that there was scope to push the method to high end warfighting areas. This discussion sat within concerns that full blown operational analysis was, in many cases, conducted in an initially unstructured way that had the potential to drive in cost and time into a programme. It was felt that wargaming has the potential to act as a precursor activity, allowing faster assessment and initial analysis of new and developing concepts, potentially allowing a down-selection of ideas and providing the much-

needed focus for more comprehensive but expensive OA work. These discussions led to wargaming forming part of ST/NSSE's current programme of work.

The next step was to consider how this could be undertaken. It was apparent from an early consideration of available tools and access to specialists that the UCL suite of wargaming tools would be a suitable basis with which to conduct the study. UCL's "A Balanced Fleet" (ABF) wargame was already used in that mode for student projects and it was assessed that the core game could be augmented as necessary to cover whatever specialist areas were to be part of the NATO study.

NATO Naval Ship Systems Engineering

A new product or service can only become successful if it meets customer expectations. This is true not only for consumer products and services such as cars and web stores, but also for warships. In the case of a warship*, 'customer' means 'all persons who will be involved in the life cycle stages** of the new warship', for example for building the ship, conducting maritime operations, maintaining the ship's systems, and training the crew. These persons can be divided into groups of stakeholders, for example builders, operators, maintainers, and trainers. Each stakeholder group will have a unique view on what is needed for a new warship to become successful. For example, for Navy HQ a new warship can only become successful if she will be effective in battle; for maintainers she can only become successful if she was designed with low maintenance in mind.

The main objective of naval ship design is to create a warship that will meet stakeholder expectations: only then will the new warship be effective in battle. Naval ship design is more than designing a ship that satisfies a set of requirements and that can be acquired (operated, maintained) within budget. Requirements may be technically infeasible, or they may contradict each other. Also, the budget may be too low to satisfy the requirements. It is known from past experience that designing a naval ship will not succeed at the first attempt, because of the aforementioned reasons. A proper design process will lead to advice on how to modify the set of requirements and/or the budget.

Designing a ship to a set of requirements and a budget is mainly the work of naval architects and cost engineers (people who can estimate the cost of a ship design). This design activity is only one part of the naval ship design process. Figure 1 shows a model of the concept stage of the naval ship design process. This is the life cycle stage that should be completed by the Navy (or government) because both the expectations of the stakeholders and the design artefacts have to change a few times before a ship concept design can be delivered. The diagram shows where stakeholders and ship designers have to work together and exchange information (orange boxes) in order to deliver a successful concept design.

The concept stage starts with capturing the expectations of all stakeholder groups in a set of requirements and a budget. Next, an attempt is made to design a ship that satisfies the set of requirements and that can be acquired (operated, maintained) within budget. The design is tested, which means (a) requirements satisfaction is measured and (b) the cost of the ship design is estimated. Measuring requirements satisfaction requires the definition of metrics for each requirement. Cost should be life cycle cost but the budget may be only for the acquisition of the new ship. Test results are then discussed with the stakeholders. If the test results are disappointing, the set of requirements and/or the budget has to be modified. It is

important that requirements and/or budget modifications are made as a result of a dialog between the stakeholders and the system designers: stakeholders may have to lower their expectations. If the test results are good, the naval ship design process can proceed to the next stage. The outcome of the model shown in Figure 1 is a coherent set of requirements, budget and ship concept design. That data set is the starting point for the next stage, the development stage, which may be done by or in cooperation with an external organisation (e.g., a naval architecture and marine engineering firm).

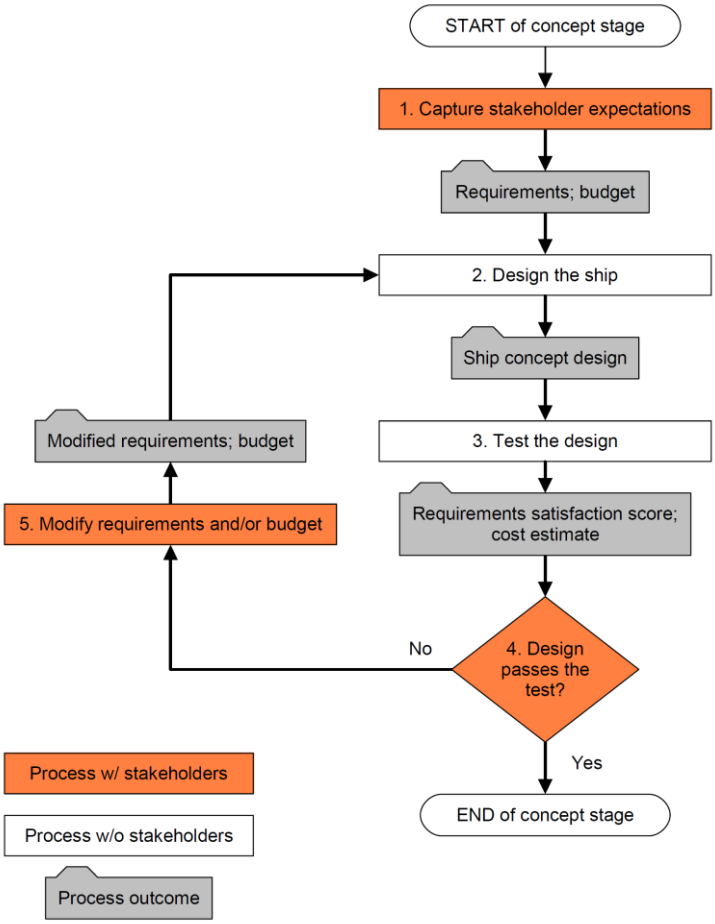

Figure 2 - Model of the naval ship design process

Capturing stakeholder expectations and controlling the requirements and/or budget modification process are matters of critical importance to the battle effectiveness of a new warship. In fact, they are matters of critical importance to the success of any new product or service. The international standard on systems engineering is built upon this observation [1]. The standard defines a framework of concepts and processes. Application of the framework should guarantee the delivery of a product that will be successful in its post-development life cycle stages (utilization, support, retirement). A logical conclusion is that proper naval ship design is in fact the application of systems engineering to the domain of naval ship design. A conclusion drawn by the NATO Ship Design Capability Group (SDCG) more than fifteen years ago, when the group established the Specialist Team on Naval Ship Systems Engineering (ST-NSSE). ST-NSSE recommended in a working paper published in 2011 that NATO nations should apply systems engineering in the concept stage of a project or programme aimed at acquiring a new warship [2]. Applying systems engineering to naval ship design leads to

activities, artefacts and tools that are specific to the naval ship design domain. ST-NSSE currently is writing a new NATO standard on naval ship systems engineering in order to capture these domain-specific things.

Designing a ship to a set of requirements and a budget usually is supported by powerful software tools. There is however limited support for the other parts of the naval ship design process (Fig 1). The work of the design activity may be excellent; unfortunately if the other activities are not done properly, the end product is likely to become unsuccessful. For warships this means: ineffective in battle. Wargaming has the potential to improve this situation. Wargaming seems to be an important tool for both capturing stakeholder expectations and controlling the requirements and/or budget modification process. Wargaming brings stakeholders and system designers (such as naval architects and system engineers) together and creates an environment in which the two groups can exchange relevant information. In order to test this theory, ST-NSSE requested support from University College London (UCL): without the support from experienced wargamers a proper test is impossible. Next, ST-NSSE and UCL developed an operational setting relevant to both most NATO nations and the NATO organisation as a whole. The operational setting was created to answer an important and relevant question:

Is it possible to protect an amphibious task group against enemy submarines using only offboard maritime unmanned systems instead of traditional anti-submarine warfare frigates?

THE ASW BARRIER WARGAME

A meaningful and realistic subject for analysis was required that was relevant to current NATO interests so as to ensure that the relevance of the subject was clear. It was decided to look at the use of offboard systems for anti-submarine warfare. (ASW). This is an area of considerable interest to NATO and many of its member nations, and an area where a project under the NATO Strategic Defence Initiative (SD) programme currently exists to consider “real world” concepts. Due to limitations on information sharing and participants the NSSE wargame study would have to be conducted as an unclassified study, but it was felt that, despite this the study would be able to generate meaningful results and insights that would be of benefit to the ASW community as well as serving as a test bed for the validity of wargaming concept assessment.

The core ABF wargame system required additional development to cover the capabilities explored in the proposed wargame series. This focussed on the creation of an ASW model (ABF had, until 2023, been used primarily for surface warfare gaming), and consideration of offboard systems and their characteristics such as environmental and performance limitations, performance characteristics, and launch and recovery.

Figure 3 – BAE Systems T-650 Drone carrying a lightweight anti submarine torpedo [BAE SYSTEMS}

Figure 4 – SEABER Small modular UUV, REPMUS 2023 trials

Introduction to the ASW Barrier Wargame Series

The operational setting of that exercise was selected to be the deployment, sustainment and recovery of an ASW barrier, or more precisely:

> *Exploring the use of offboard autonomous systems for the defence of an amphibious task group against enemy submarines during the deployment, sustainment and recovery phases of an operation.*

During the wargaming exercise the performance of an "offboard enabled" future force would be compared with the performance of traditional ASW assets. Several scenarios would be played. After each scenario the effectiveness of the ASW barrier would be evaluated and changes to the composition of the offboard autonomous systems mix would be proposed, in order to improve barrier effectiveness (without adding a huge amount of extra cost).

The wargame series was conducted as follows:

- A training scenario to bring participants up to speed with the game mechanics
- Initial wargaming of the scenario using existing ASW platforms and tactics
- At least two games replacing those existing capabilities in whole or in part with offboard equivalents

The game setting was the conduct of a Non-combatant Evacuation Operation (NEO) in the face of a potentially hostile submarine and surface threat. The setting for the wargame campaign was the fictional countries of Florin and Guilder, the former beset by civil war and natural disaster, the latter with territorial aims on Florin and supporting rebel factions in the

civil war. Blue Force was to conduct a NEO from Florin, Red Force (Guilder) sought to frustrate the evacuation, primarily through the use of small conventional submarines. Blue Force (referred to hereon as “Blue”) therefore contained the ASW forces protecting the NEO.

Figure 5 – Playing area and pieces for the NATO ASW Wargame

Initial Forces

Blue initially comprised a conventional force of three ASW frigates, similar in capability to the RN Type 23, with low frequency active towed array sonar, ASW helicopters, and ship and helicopter launched light-weight torpedoes. The NEO force comprised four large commercial vessels which were required to remain offshore whilst evacuees were ferried from the local port.

Red comprised a force of one medium and two small conventional submarines (SSK), broadly analogous to the Kilo and Sang-O classes. Red was supported by irregular forces in small boats, covert commercial shipping, and (in the initial ingress phase) medium sized Fast Attack Craft (FAC), analogous to the Tarantul III class of vessels.

Game Management

The campaign was divided into a series of scenarios designed to test different elements of the campaign and the various force mix options. Five games plus a training game were developed:

- Game 0 – training game for all participants
- Game 1 – Approach phase- Traditional fleet vs. Emplaced SSKs.
- Game 2 – Evacuation Phase - Conventional Force as ASW Barrier, NEO underway
- Game 3 – Evacuation Phase - Modular Force as ASW Barrier, NEO underway
- Game 4 – Evacuation Phase, Modular Force as ASW Barrier (player-selected force mix), NEO underway
- Game 5 - Exfiltration phase, HVUs (high-value units: the large commercial vessels) depart the OA.

Once players felt familiar with the rules and game mechanics games would be run twice, simultaneously to increase learning benefit and generation of insight into the forces and capabilities represented in the games.

Participants were divided into three teams, or cells. The competing teams were the Red and Blue cells, game control was performed by the White Cell. Each cell was located in a separate room to ensure security of information ('double blind'). There was a fourth team, Green Cell, which covered commercial and neutral shipping. The Green Cell acted as an adjunct to the White Cell in this game.

White Cell participants comprised the following:

Game Controller: the game "umpire", controlling the flow of the game, managing game progression, "injects", environment and overall game play. One of the Game Controller's key roles was to resolve situations that the game rules do not explicitly cover. An important activity is to determine whether a particular result should be reversed or ignored[1].

Adjudicators : The adjudicators (also called 'runners') were the primary liaison between the White Cell and the Red and Blue Cells. There was at least one adjudicator dedicated to each of Red and Blue. The adjudicators received orders and other transmissions from their Red or Blue team, brought to the White Cell's room for resolution, and returned to their teams with results and other information relevant to that team. The adjudicators usually conducted die rolling for their respective teams, for example, to determine if a Blue ASW frigate detects a Red submarine.

Red and Blue Cell participants comprised two to three players dedicated solely to the actions of their side in the game.

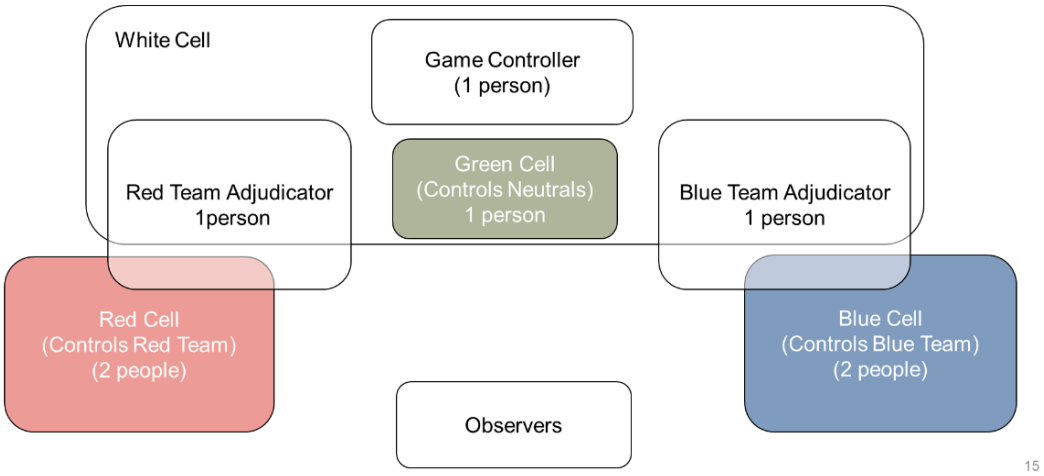

Figure 6 – ASW Game Team/Cell Organisation

[1] If an unexpected or extreme event occurs that would end a game prematurely the Game Controller may reverse that decision to allow game play, learning and analysis to continue. The situation is recorded and included in the end of game analysis. For example, in one game covered here a key Red submarine was sunk at the outset of the game. Its loss would have made the rest of the game largely redundant, hence the submarine was reinstated and it was noted that early detection of submarines at long range could considerably ease the burden on the ASW team.

Order of Play

Each game was made up of the following phases:

Scenario Briefing – An overall brief to all participants on the scenario to be played, followed by briefings to each team. Weather conditions for the next 7 days were determined by the White Cell, and forecasts for the next 3 days were briefed to Red and Blue.

Initial Planning Phase – Blue made their initial plans, for the steady-state deployment of offboard assets, ship patrol lines etc. taking into account the roulement, or duty cycle, for offboard assets (both crewed and uncrewed), launch and recovery times, transit times and time for rearming/refuelling/recharging. Red planned submarine ingress/egress routes and other activities (in some scenarios Red wished to land special forces at observation points, or make use of covert teams in commercial vessels).

Game Start – the game comprised a number of turns :

- Teams write orders and submit to their adjudicators
- Adjudicators brief Game Controller on their teams actions
- White cell determines results of encounters, detections, attacks and vessel damage (this may involve adjudicators returning to the teams for in-turn briefings, decision making and reporting back to the White Cell, particularly during detection and attack)
- Adjudicators record results of actions in the turn, and return to their teams to read out results of which their team is aware. Care needs to be taken at this point as the adjudicators for each team are likely to know the locations and actions of BOTH teams; discretion and confidentiality is required.

Game turns continue until either side achieves its victory conditions or the Game Controller judges that further play is nugatory.

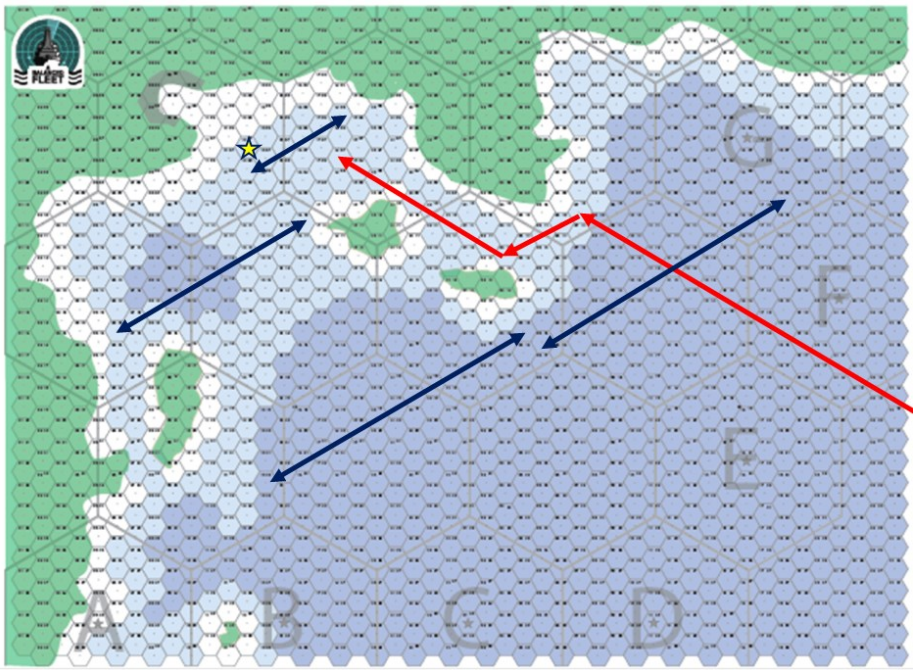

Figure 7 – Wargame playing area showing ASW patrol routes (blue), SSK approach routes (red) and HVU anchorage (yellow star)

Game Execution

The wargaming exercise was conducted over three days. Each day comprised two sessions, one morning, one afternoon. In each session the assembled players were briefed on the scenario to be played, following which they split into their respective teams or cells. Team/cell specific briefs were delivered by the White Cell and then the games commenced. Games were fought to a conclusion, with all participants responsible for recording their actions, rationale behind those actions, and observations on their own aspects of the game (both in terms of the game events and also the game execution). At the conclusion of each game the players were brought back together in plenary to discuss the conduct and outcomes of the game, and to identify and record any learning points that arose.

Games 1 and 2 were played singly so that all could participate and concentrate on learning the game mechanics. Once the experienced members of the White Cell were satisfied that the players had a good understanding the players were split so that each subsequent scenario could be played twice, simultaneously. This increased the involvement and hence the engagement or "agency" of each participant and also doubled the opportunity for learning and observation.

With each game, participants were encouraged to move between teams and cells. For example a participant may have played in the Red Team for game 1, moved to the Blue Team for game 2, thence the Red Cell for game 3 and the Blue Cell for game 4. White Cell members were an exception and generally remained constant throughout the process. This was doe to ensure continuity and consistency in game execution and adjudication.

Each day concluded with an additional "hot wash" session to capture higher level observations and to allow modifications to the game plan for the following day. This allowed new capabilities to be proposed, considered and agreed, and for the game design team to then generate game material to reflect the new capabilities. For example, a deployable seabed acoustic monitoring system was proposed and agreed; the design team developed the characteristics of the system in game terms after discussion with relevant subject matter experts and created the required game components overnight for use in the games the following day.

Figure 8 – Playing area, ship and capability cards

Capabilities Explored

As discussed previously, Blue's initial forces were based on existing conventional ASW capabilities such as ASW frigates, hull mounted and towed array sonars and torpedoes delivered by helicopter or (in extremis) the frigates themselves. Throughout the series of games the offboard capabilities available to the Blue Team were reviewed and enhanced where capability gaps were identified. The range of planned enhancements included:

- Uncrewed Surface Vehicles (USV) using thin line towed arrays for submarine detection. These had the benefit of speed and the opportunity for constant communications but were considered to be sea state limited, easily detectable and relatively vulnerable to attack
- Uncrewed Undersea Vehicles (UUV) using similar thin line towed arrays. These had the benefit of operating in the same medium as the target, were quiet and hard to detect but were slow, and in the absence of a subsea communications network, required to operate on planned routes with pre-plotted reporting cycles
- Uncrewed Aerial Vehicles (UAV) deploying sonobuoys and lightweight torpedoes. Payload considerations, in particular when carrying torpedoes, would limit their speed and endurance so the Blue teams usually chose to operate them in concert with traditional ASW helicopters

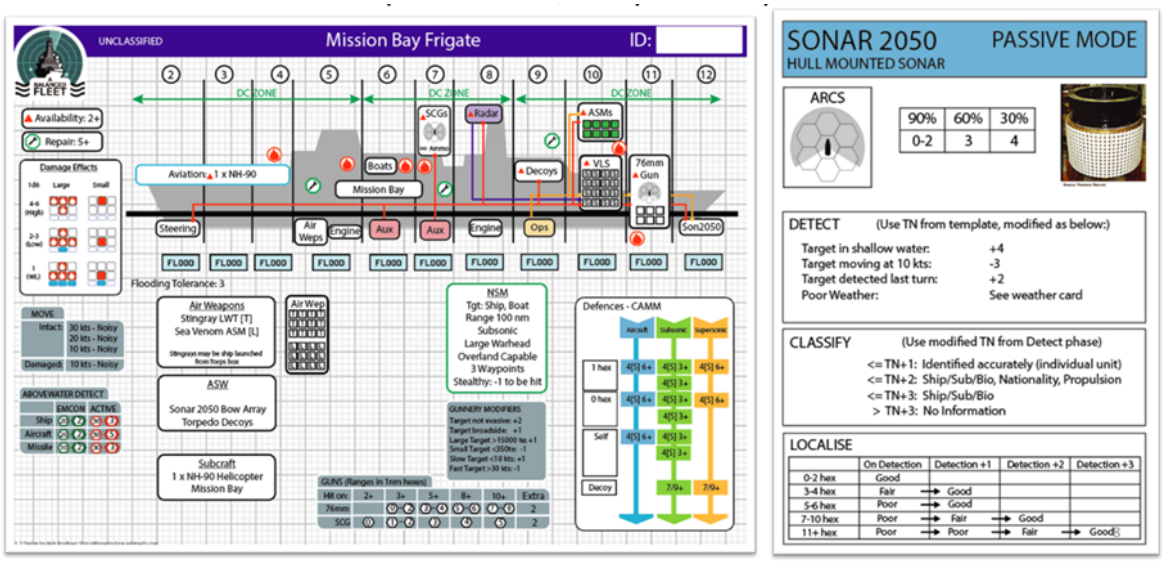

Figure 9 – "A Balanced Fleet" Ship and System Capability Cards

As the games progressed, capability gaps were identified and proposals made for new systems to fill those. These included:

- Seabed communications infrastructure – this was discussed but was not deployed in the games. Had this happened the utility of the UUVs would have been enhanced, and whilst this would have given a clear benefit in the defensive situation of the HVUs at anchor it would have been difficult to deploy to support open ocean ASW.

- Deployable passive sonar system – a “spoke and hub” array of seabed sensors with wired links to an active central communications buoy that allowed real time communications and data sharing with controlling sites in ships or ashore. This created a near-impenetrable barrier for the defended HVUs (so much so that the Red submarine commanders declined to seek to pass through it), but it took time to deploy and recover, meaning that in the exfiltration phase most of these assets were abandoned (recovery would have exposed the recovering ships to the submarine threat over a considerable period)
- USV-based torpedo defence system. The scenario required the ASW barrier and the frigates sustaining it to be operating at some distance from the anchorage in which the HVUs were operating. This meant that a hostile submarine could penetrate the barrier and achieve a firing solution, even at long range, against the noisy HVUs so that they could launch a spread of homing torpedoes that were then unlikely to be countered. A torpedo hard kill system was already featured for the frigates and it was suggested that the same system cold be deployed on a USV to protect the anchorage. This was developed as a capability enhancement and deployed in the games on Day 3, where it was successful in providing an effective defence.

CONCLUSIONS FROM THE WARGAME SERIES

At the end of three days the players assembled to discuss their thoughts, observations and conclusions as to the effectiveness of the game, and to expand on learning points and observations concerning the ASW barrier project. This discussion extended into a following day involving the members of ST/NSSE who were present. Conclusions drawn were as follows:

Concept and Capability Assessment

1. The games revealed capability benefits, development paths and demonstration of concepts that are in line with “real world” trajectories, despite the event being run using only unclassified open source data.
2. SMEs engaged constructively and remained involved throughout. There was a concern that SMEs would focus on elements of limited realism arising from open source information, but this did not happen.
3. Wargaming acted as “Design validation” for some of the advanced platform, system and operating concepts under consideration.
4. Wargaming provides a framework that assists designers and others in knowing what questions to ask. It provides a “birds eye view” of a problem or capability gap before launching in to more extensive analysis.
5. Wargaming can be used to investigate a broad range of options and then focus in on options that show the greater potential benefit. This can focus limited resource in follow-on operational analysis work.
6. The agility of the process was well demonstrated. New elements were introduced and tested quickly, whilst capability effectiveness can be varied easily for sensitivity analysis. This was aided by SME involvement, with experts giving their opinions on

capability performance (based on their experience) that could rapidly be turned into more realistic game mechanics, units etc.

7. The process allowed the effect of disruptive technologies to be investigated quickly.
8. Wargaming can identify areas that appear promising but which deliver little benefit. Within the campaign the use of UUVs was seen as of little benefit – but the reason why (and potential future mitigation paths) were also identified.
9. The ability to quickly consider and create future capabilities brings with it the ability to quickly consider how they may be countered. It allows for a virtual "arms race".
10. Understanding of the context within which a capability or concept exists allows the interfaces and interactions with other capabilities to be explored. It can uncover (higher order) effects that are not obvious from simply discussing the concept in a traditional environment.
11. It can provide assistance in informing decisions, forming a framework for explaining why a concept may or may not be worth pursuing.

Game Execution

1. Post game washups after each game are essential in understanding interaction between red/blue actions. Capture insights/feedback whilst the debrief is happening.
2. White cell insights come from an overarching perspective. The adjudicators are critical, and should be writing down their thoughts as they happen. Consider having at least one dedicated rapporteur for a game, and ideally one for each of the Red, Blue and White Cells/Teams.
3. Consider where outcomes were "lucky" or were robust. These should be noted as insights.
4. Importance of establishing clarity in desired outcomes, capability needs, etc. Everyone should be aware of the aims and objectives of the game. That should not prevent insights and observations of other aspects being recorded.
5. Losing isn't bad – its where you learn. Wargames should be a "safe place to fail". If a player feels bad then that is a good thing, they achieved good investment in their role.
6. The game was relatively quick to construct (speed depends on pre-existing material and the basis UCL ABF system was already established). This game took roughly 1 month of effort to prepare. The game design process established that a new variant could be up and running in a week or so.
7. Iteration – and hence speed – is critical for this kind of game to succeed.
8. Repetition – players may tend to overcompensate in some areas, but may then iterate down to a sensible medium. Benefit of overall experience shows.
9. Player engagement is essential. Players should be kept occupied, but take care to balance workload, especially in Red and Blue teams.
10. Managing player numbers – too many players in a team results in "decision paralysis"
11. Rotation of players through the various cells worked well, different insights obtained from different perspectives were valuable, especially in later games where players had been in different roles.
12. Running multiple games allowed for the concept to be quite well explored. Had this exercise been a real concept analysis task rather than a "proof of principle" we would probably want more iterations, e.g. variation on modular frigate mission bay size.

Hence more time would be needed – perhaps a week – with options for more parallel games.

13. "Misson Creep" is a risk, hence the game controllers need to be strict on the scope for the range of studies / variables. Be careful not to stifle innovation though.
14. Be wary of the "Psychology of Red", suicidal tendencies and "last turn" frenzy. Unexpected game endings should mitigate.
15. Perceived attractiveness of sides was apparent, Red was thought of as having "fun stuff to play with".
16. The game was developed and run successfully at UNCLASS. There is an obvious ability to run at higher classification for specific studies within suitable environments.
17. Including engagement (besides detection, tracking, classification and identification) is essential to player involvement and agency and would increase the generation of learning, discussion points and insight into force capabilities.
18. A future iteration could have two teams each playing Red to the other's Blue – this would help balance out workloads, mitigate "Psychology of Red" issues, and give everyone insights into both sides.

Training and Other Benefits

1. The game demonstrated a clear training and familiarisation benefit across non-engineering personnel. It was felt that participation in events such as this, either as analysis events or training events would be of significant benefit to those outside engineering and operations. For example, commercial/finance personnel would gain insights into the impact of decisions in their areas, and gain an understanding as to why "military" requirements are important.
2. The game has given non-specialists in ASW a significantly better appreciation of ASW tactics, procedures, and systems. For specialists in other areas it provided a good vehicle to understand design and operations in context – how does your aspect feed in to the greater whole (e.g. survivability, noise, manoeuvrability, acceleration, flight deck ops, lean crewing, automated systems).
3. The games showed the benefit of engaging seniors / decision makers in physical games. Wargames promote interaction, personal investment and an opportunity for seniors to gain wider insights into their projects and capability areas.

Conclusions Drawn by the NATO Team

ST-NSSE members were involved in various roles in the wargame. They observed how stakeholders and system designers exchanged information. The stakeholders are subject matter experts: persons who have experience with anti-submarine warfare, and who have a unique view on what is needed for the new system of offboard maritime unmanned systems to become successful. In general terms it was observed how the system designers learned important lessons on how systems are deployed and operated in the predefined operational setting. The subject matter experts learned about the potential capabilities and limitations of new technology. It was concluded that the information exchange was important and relevant, of critical importance to designing an effective new anti-submarine warfare capability. In summary, both the test and the test results are considered to be a great success. So ST-NSSE is going to include wargaming as an essential domain-specific activity in the new naval ship design NATO standard.

ST/NSSE's primary objective was to demonstrate and explore the role of wargaming to support design and concept analysis. It is felt that this was achieved. The games demonstrated (within the unclassified restrictions):

- the potential effectiveness of an ASW barrier system using offboard assets compared with a traditional arrangement,
- the benefits and drawbacks of various elements of such a system,
- capability gaps in the proposed concepts and potential solutions,
- wargaming is a very powerful method for discovering which components and characteristics of a system composed of many components, such as the deployable ASW barrier system, are actually essential,
- wargaming includes many relevant factors such as the complexity of sensor and weapon modelling, environmental effects, system capabilities and limitations, probability modelling, rules of engagement, etc.
- wargaming is an activity that needs support from experienced wargamers (e.g., from UCL) to make sure that the learning points, including those with negative experience on what actually does not work, are relevant,
- wargaming and modelling and simulation (M&S) serve different purposes: wargaming looks at the whole picture and therefore cannot be used for studying many variations of the operational problem (it would take far too much time); M&S can be used to study an operational problem in great detail with many variations, with a much smaller problem scope compared with wargaming,
- the results of M&S can be used to develop the wargaming model.

It was considered by the game development team that the event has successfully demonstrated the benefit and worth of using wargaming as a concept analysis tool.

Future Work

It was the opinion of the NSSE members, NATO Subject Matter Experts and other participants that the wargames met the objective of investigating and analysing novel concepts. As a result, formal guidance on the use of wargaming in this role will be included in ST/NSSE's forthcoming Allied Naval Engineering Publication (ANEP) on ship and system design.

Members of the NATO Maritime Unmanned Systems Initiative SD 1.1271 ASW Barrier Project Team took part in and observed the wargames and requested a brief to the wider group which was conducted in Lisbon in Summer 2023. As a result it is intended to re-run the wargame as a classified event using system concepts and operating concepts/scenarios developed by that team.

The games were also witnessed by members of the UK and NE MODs engaged in joint future programmes who similarly concluded that wargaming was a valid tool for concept assessment. As a result a major joint programme is conducting similar wargaming events to inform its development.

CONCLUSION

The study successfully demonstrated the ability of wargaming to be used as a concept analysis tool. The speed with which a series of wargames can be developed was shown, as

was the ability to make rapid changes to the came and its constituent elements to take advantage of developing ideas and concepts within the wargaming event. Finally, the extension of the approach from a NATO study into its real-world application in significant naval projects has been shown.

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Authors’ Biographies

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