

LINES AND WEBS: A WARGAME ON SUSTAINMENT IN LARGE-SCALE COMBAT OPERATIONS

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MASTER OF MILITARY ART AND SCIENCE
Wargame Design

by

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ABSTRACT

LINES AND WEBS: A WARGAME ON SUSTAINMENT IN LARGE-SCALE COMBAT OPERATIONS, by Major Catherine Renee Deeter, 184 pages.

In its recent update to Field Manual 3-0, Operations, the United States Army codified its focus on preparing for large-scale combat operations with peer/near-peer enemies. This adjustment, while a doctrinal change, also affects a change in thinking how to conduct sustainment against an enemy that can match fire power and range the battlefield. The United States Army is still developing concepts and best practices for success in contested logistics environments, learning from both historical examples and the recent conflict between Ukraine and Russia.

This thesis identifies relevant aspects of large-scale combat, emerging theories on sustainment, and current logistics requirements of the Army and models them in a competitive wargame. Modern logistics is highly vulnerable and minimally flexible. An emerging theory for near-future conflict attempts to solve this problem with a web system. *Lines and Webs* is a wargame that allows players to learn by pitting the modern logistics system against a proposed web system and can help military professionals investigate sustainment strategies for large-scale combat in the absence of real-world experience. This thesis details the research methodology and design process for *Lines and Webs* and concludes with a replicable, playable wargame. See an overview video of this thesis at https://youtu.be/_cUBr4Jht04.

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ACRONYMS

A2/AD	Anti-Access, Area Denial
C2	Command and Control
CONUS	Continental United States
DoD	Department of Defense
FM	Field Manual
FOB	Forward Operating Base
LOC	Line of Communication
LOGSTAT	Logistics Status Report
LSCO	Large-Scale Combat Operations
MDO	Multi-Domain Operations
MSR	Main Supply Route
NMC	Non-Mission Capable
RSOI	Reception, Staging, Onward Movement, and Integration
SPIDERWEB	Self-sufficient units, Precision logistics, Interoperability with partners, Distribution, Expeditionary sustainment, Regional resources, Widely dispersed, Enabled mission command with enterprise resource planning, and Brigade-focused

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CHAPTER 1

INTRODUCTION

Background

At midnight on 30 August 2021, the last of the United States military pulled out of Afghanistan, ending a twenty-year effort in this Central Asian country.¹ Almost a year later, 24 February 2022, Russia invaded Ukraine, underscoring a truth the US military had been contemplating for years that the US military needs to be good at more forms of war than just counterinsurgency (COIN).² This recognition, coupled with President Biden identifying both Russia and the People's Republic of China (PRC) as threats in the 2022 National Security Strategy, led the military to focus on large-scale combat operations (LSCO) and develop their supporting doctrine for multi-domain operations (MDO). Shifting between such differing types of war creates a need to maintain different skills for each.

The warfighting functions of movement and maneuver (from now on, referred to as 'maneuver') and sustainment are particularly impacted by this shift in warfare types and are the focus of this wargame design thesis. In COIN operations, both maneuver and sustainment missions operate linearly, moving from secure staging areas such as forward operating bases (FOBs) to delivery locations. During the most recent example of COIN, the Global War on Terror, theater operations took on a steady state nature and much of logistics was outsourced,

¹ US President, "Remarks by President Biden on the Drawdown of U.S. Forces in Afghanistan," The White House (April 6, 2023), <https://www.whitehouse.gov/?s=afghanistan>.

² Sam Fishburne et al., "Field Manual 3-0: Doctrine Addressing Today's Fight," *Military Review*, 99, no. 1 (January-February 2019): 8.

degraded the military's overall sustainment capabilities.³ In this form of warfare, the US controlled multiple domains, creating a safe operating space.⁴ However, in large-scale combat operations this is not the case. In this type of warfare, maneuver elements often operate within anti-access, area denial (A2/AD) zones where communications, navigation, and protection may all be compromised.⁵ This requires maneuver to operate in a distributed, non-linear fashion. Likewise, sustainment must adapt, adjusting from supply issued along Main Supply Routes (MSRs), to multiple distributed nodes and lines of communication.

The adaptations required by multi-domain and large-scale combat operations create unique problems within the sustainment and protection realms. The modern context of these problems is not well understood. This paper will discuss the theoretical underpinnings of maneuver and sustainment in large-scale combat and how they supported the design of a useful and playable wargame that allows players to explore competing sustainment strategies of linear versus distributed logistics. This paper is divided into five chapters: the introduction, a literary review, a research methodology, an explanation of the modeling mechanisms used to create a wargame effectively modeling the topic, and a conclusion. Also enclosed are the rules, playing pieces and supplemental material, and the map.

³ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

⁴ Sam Fishburne et al., "Field Manual 3-0: Doctrine Addressing Today's Fight," *Military Review*, 99, no. 1 (January-February 2019): 11-12.

⁵ Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 130-131.

Problem Statement

This project will address the lack of a wargame that enables players to understand the complexities of managing concurrent division maneuver and sustainment at the operational level by comparing sustainment strategies, and to gain insights into decision making in a large-scale combat operations (LSCO) environment.

Purpose of the Study

The conclusion of the research will result in the creation of a wargame that models theories for sustainment in a large-scale combat operations environment. This wargame will provide players with the chance to practice sustainment strategies to understand the complexities of its management and to practice decision making for LSCO.

Research Questions

This problem led to the foundational question of this research project: How can the complexity of large-scale combat maneuver and sustainment operations in near-future combat be represented effectively in a competitive wargame in order to teach the importance of flexible, self-correcting sustainment systems? This includes two secondary questions addressed in chapters two and four.

Secondary Question 1: What aspects of reality must be modeled to demonstrate the complexities of sustainment in LSCO in a competitive wargame? This question forms the core of the player's experience during the wargame. Only by understanding the challenges commanders will face when planning operations in a LSCO environment could the researcher design a wargame that highlights the complex difficulties of sustainment in a multi-domain (MDO) and large-scale combat operations environment. Military doctrine and professional journals highlight the necessary change in thinking from counterinsurgency (COIN) sustainment to MDO/LSCO

sustainment. These differences are central to the wargame, creating the core decisions of players and ensuring the focus remains on conducting consistently sustained maneuver operations. When answering this question, the researcher assessed the key factors needed to model the wargame's key dilemma while discarding factors that, while interesting, create unnecessary and distracting complexity.

Secondary Question 2: How can the relevant aspects of reality be effectively modeled in a competitive wargame? This supporting question considers the key aspects identified by the first supporting question and develops methods to effectively model them in ways that are simple enough to be useful, but not so simple that the model loses the importance of the core dilemma. The wargame models the lack of a secure rear area where sustainment can mass with relative safety, the need for spider-web sustainment, and amassing logistics effects to facilitate battlefield convergence.⁶ These wargame mechanics are further explained in chapter four.

Assumptions

This project makes several key assumptions. The first assumption is that the central dilemma of sustainment in a LSCO environment can be modeled in a wargame and will achieve a useful model at the completion of the project. The second assumption is that wargames can be distilled into seven necessary features to achieve functionality: objectives, a scenario, a database, models, rules, players, and an analysis.⁷ The third assumption is that the players do not have a strong sustainment background in either large-scale combat operations, or counterinsurgency

⁶ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 6-8.

⁷ Peter Perla, *Peter Perla's The Art of Wargaming: A Guide for Professionals and Hobbyists*, ed. John Curry (Annapolis, MD: United States Naval Institute Press, 2011), 158.

operations and will benefit from a safe-to-fail environment this wargame intends to provide. The fourth assumption is that the players have no previous experience in wargames and will need instruction in wargame specific terms, common interactions, and use of physical features such as the game board, unit tokens, and dice.

The final assumption that no other wargame provides the instructional value to the players that this wargame does. Numerous wargames informed the design of this wargame, notably including *Thor's Hammer*, *1944: Race to the Rhine*, *Battle for Moscow*, and *Nevsky: Teutons and Rus in Collision 1240-1242*. These games feature sustainment driven operations or operations executed with undefined borders between players. The scope and delimitations section of this chapter discusses the decisions leading to these assumptions.

Definition of Terms

The following terms are necessary to understand this research project:

Wargame: a “representation of conflict or competition in a synthetic environment in which people make decisions and respond to the consequences of those decisions.”⁸

Safe-to-Fail Environment: an environment which allows players to apply out of the box thinking without threat of judgement or consequence.

Step Loss: in wargaming, when a piece loses health points at a standard set amount.

SPIDERWEB Sustainment: Self-sufficient units, Precision logistics, Interoperability with partners, Distribution, Expeditionary sustainment, Regional resources, Widely dispersed,

⁸ Chairman of the Joint Chiefs of Staff, *Joint Planning*, Joint Publication 5-0, Washington DC: Joint Chiefs of Staff, 2020, III-45.

Enabled mission command with enterprise resource planning, and Brigade-focused.⁹ In this usage, enterprise refers to the computer or web-based systems used to enable sustainment operations.

Scope and Delimitations

To focus on the unique challenges facing maneuver and sustainment in the unpracticed LSCO environment, the scope of this research project is on the operational and strategic levels of war. In a similar fashion, the wargame orients primarily on the land domain with limited overlap in other domains of air, sea, space, and cyber. This delimitation intends to reduce the complexity placed on players and keep the focus of the wargame on the sustainment challenge within the land domain.

Although the wargame incorporates elements of combat and logistics, it does not replicate the details of tactical orders and resupply operations. Players can engage units in combat and resupply but will not decide specifics on formations or use of weapon types. Terrain, combat, and resupply are simulated in broad detail. Geography is simulated by diverse types of terrain to create ease of movement and distance effects on players for both maneuver and sustainment.

Players will employ army units during the wargame. While special cards will allow the replication of effects on the battlefield - normally provided by air, sea, space, or cyber units - those units are not physically portrayed in the game.

⁹ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 6.

Limitations

During the development of this wargame, three limitations arose. First, the Master in Military Art and Sciences program is nine months long rather than the usual 18–24-month programs seen at civilian universities. This limitation resulted in fewer iterations of the wargame prototype and fewer opportunities to "break" the game and identify any design gaps that may exist. An additional limitation is that the testing pool available was primarily military officers, and family and friends of the author. While playtesting from a pool of military personnel provides useful feedback to a military wargame, this research would also have benefited from the feedback of board game "superusers". Superusers are those individuals who professionally play and review board games in both the prototype and final versions.

A third limitation is the very nature of a wargame. Wargames are reflections of reality which attempt to model warfare in an artificial setting. However, it is impossible to truly model every aspect of war and some features required simplification to feature the focus of the game usefully.

Significance of the Study

By playing this wargame, players will confront the challenges of sustaining operations in a large-scale combat and multi domain environment. This is significant because the US Army currently sits in a position of transition to LSCO/MDO.¹⁰ Players maneuver and sustain operations while dealing with both the inherent complexities of, and threats to, their respective logistics systems.

¹⁰ Sam Fishburne et al., "Field Manual 3-0: Doctrine Addressing Today's Fight," *Military Review*, 99, no. 1 (January-February 2019): 12.

Wargames "help human beings investigate the processes of combat."¹¹ They set "players in specific situations and [give] them a context for their decision making."¹² Wargames simulate theoretical situations and as Peter Perla states in *The Art of Wargaming*, "we may never know the right answers, but gaming can sometimes help us learn to ask the right questions."¹³ Wargames are a useful tool for learning and experimentation.

Summary

This introduction chapter detailed the purpose, scope, assumptions, and limitation of this project and described the conduct of research. The next two chapters answer the research question: How can the complexity of large-scale combat maneuver and sustainment operations in near-future combat be represented effectively in a competitive wargame in order to teach the importance of flexible, self-correcting sustainment systems? This next chapter reviews the relevant literature and wargames investigated during this project.

¹¹ Peter Perla, *Peter Perla's The Art of Wargaming: A Guide for Professionals and Hobbyists*, ed. John Curry (Annapolis, MD: United States Naval Institute Press, 2011), 169.

¹² Ibid., 158.

¹³ Ibid., 45.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this thesis is to answer the question: How can the complexity of large-scale combat maneuver and sustainment operations in near-future combat be represented effectively in a competitive wargame in order to teach the importance of flexible, self-correcting sustainment systems? Creating a wargame to answer this question requires a thorough investigation of how sustainment must change to support large-scale combat operations (LSCO) environment, an understanding of the elements of wargame design, and a review of existing sustainment related wargames. This provides a framework for understanding the data that is relevant and necessary to designing this wargame. This investigation also identifies the methods for usefully depicting the data within the game.

This chapter is organized into seven sections. These sections explore how the US military has conducted sustainment in its most recent competition (counterinsurgency); warfare in a LSCO environment; why sustainment presents a limitation in LSCO; the SPIDERWEB/Adaptive Sustainment theory as a mitigation; a theoretical framework for wargame design; a review of relevant board games; and finally, a “so what”. The sustainment in counterinsurgency (COIN) sections addresses where the US military is currently situated for both its sustainment strategies and the organization of sustainment units. The warfare in LSCO section reviews the key changes in the US military operations regulations. The section addressing why sustainment presents a limitation in LSCO looks at the capability and operational gaps created by the shift in focus from COIN to LSCO. The section on the SPIDERWEB/Adaptive Sustainment theory reviews recommendations and concepts for successful sustainment in LSCO. The two sections on

wargaming address theory, wargame development, and sustainment modeling techniques.

Finally, the “so what” section interprets how the key lessons from the literature review should be modeled in the wargame. Together, these sections allow the exploration of methods for sustainment in large-scale combat operations.

Sustainment in Counterinsurgency

For the past twenty years, the US military has fought primarily in the sands of the Middle East. And after those twenty years, the United States has developed those sands into a mature theater. During that time, operations in the Middle East have shifted along the Competition Continuum to settle on counterinsurgency and stability operations. Sustainment in this counterinsurgency relied heavily on theater contracts for everything from strategic air and sea lift to food, water, and cleaning services on forward operating bases (FOBs). Soldiers spent time in theater on predictable rotational deployments while sustainment occurred over established lines of communications (LOCs).¹⁴

"Iron Mountains" supported the various operations occurring across multiple countries. These resulted from the United States' standard strategy, "employ[ing] expeditionary (initial entry) forces to enable larger, follow-on forces to secure lines of communications and exploit initial success for greater operational objectives."¹⁵ Iron mountains are the "sprawling supply

¹⁴ Michael D. Lundy, "Meeting the Challenge of Large-Scale Combat Operations Today and Tomorrow," *Military Review 100 Years* 98, no. 5 (September-October, 2018): 233; Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 132.

¹⁵ Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 130.

dumps" built on bases dotted throughout the theater.¹⁶ Large supply convoys would travel from iron mountains to FOBs and back, their only possible interaction with the enemy occurring during transit before they return to safety in the rear area. These methods "focused on the efficient delivery of supplies and services."¹⁷

Over the past twenty years of war, multiple efforts "reduce[d] sustainment force structure in pursuit of efficiency."¹⁸ The War on Terror dragged on. Public sentiment faded, leading Americans to question the large Department of Defense (DoD) budget. As the DoD budget shrank in response, efforts were made to create efficiencies and "run the department like a 'lean' business disproportionately impact[ing] logistics."¹⁹ This reduced the size of sustainment units (moving several from active duty to reserve or national guard), "caused heavy reductions in EAB headquarters," and contracted many sustainment efforts (cooking, maintenance, etc.).²⁰ The DoD attempted to reduce the tooth (one combat soldier) to tail (number of soldiers providing support)

¹⁶ Sydney J. Freedberg Jr., "No More Iron Mountains: Lighter Logistics Key to Multi-Domain Battle," *Breaking Defense*, May 3, 2017, <https://breakingdefense.sites.breakingmedia.com/2017/05/no-more-iron-mountains-streamlined-logistics-key-to-multi-domain-battle/>.

¹⁷ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

¹⁸ Michael D. Lundy, Richard Creed, and Scott Pence, "Feeding the Forge: Sustaining Large-Scale Combat Operations," US Army, July 18, 2019, https://www.army.mil/article/223833/feeding_the_forge_sustaining_large_scale_combat_operations.

¹⁹ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

²⁰ Michael D. Lundy, "Meeting the Challenge of Large-Scale Combat Operations Today and Tomorrow," *Military Review 100 Years* 98, no. 5 (September-October, 2018): 234.

ratio as much as possible. This is additionally complicated by the time it takes for the military to gain and implement a new technology as it struggles to keep up with civilian logistics.²¹ As a result, there is a capability gap between logistics and the pace of the operational organization it supports.²² While the decisions made during operations in the Middle East created efficiencies in logistics, they also led to leaning of the active duty sustainment units and over-reliance on contractors. This weakens sustainment in a contested environment. How the military has been conducting sustainment will not prevail when the joint force is operating in a much less permissible environment anywhere in the world and at a moment's notice.

Warfare in a Large-Scale Combat Operations Environment

In October 2022, the United States Army published its new Field Manual (FM) for Operations, 3-0. Field Manual 3-0 addresses both large-scale combat operations (LSCO) and multi-domain operations (MDO).²³ LSCO is the major focus of the US Army's new operations manual, in which greater levels of force are employed.²⁴ Often, the unit employed will enter a theater directly into a fight, requiring them to "fight while uncoiling."²⁵ According to FM 3-0, MDO is "the combined arms employment of joint and Army capabilities to create and exploit

²¹ Paul Christian van Fenema et al., "Sustaining Relevance: Repositioning Strategic Logistics Innovation in the Military," *Joint Force Quarterly* 101 (April 2021): 63, <https://ndupress.ndu.edu/Media/News/News-Article-View/Article/2553714/sustaining-relevance-repositioning-strategic-logistics-innovation-in-the-milita/>.

²² Ibid.

²³ Headquarters, Department of the Army, *Operations*, Field Manual 3-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 1-2.

²⁴ Ibid.

²⁵ Jesse L. Skates, "Multi-Domain Operations at Division and Below," *Military Review* 101, no. 1 (January-February 2021): 69.

relative advantages that achieve objectives, defeat enemy forces, and consolidate gains on behalf of joint force commander."²⁶ Multi-domain requires units operate in "a mobile, dispersed manner" to counteract a panopticon battlefield in which units are easily found.²⁷

The supporting field manual for logistics (FM 4-0) recognizes that LSCO "require[s] a volume of reinforcements, material, and equipment significantly greater than other types of operations."²⁸ Peer and near-peer adversaries can create unique challenges for the United States military across all domains. Specifically, challenges related to logistics include: "preparing forward-stationed forces to fight and win while outnumbered and isolated; protecting forward-positioned forces and those moving into theater; [and] maintain C2 [command and control] and sustainment of units distributed across vast distances in noncontiguous areas and outside supporting ranges and distances."²⁹ LSCO warfare comes with a higher tempo than COIN. It often causes friendly and enemy forces to intermingle and bypass, requiring support units to protect themselves in their own rear area as a part of consolidating gains.³⁰

FM 3-0 identifies multi-domain operations (MDO) as the Army's operational concept.³¹ It provides four tenets of operations as aspects to include in plans and operations: agility,

²⁶ Headquarters, Department of the Army, *Operations*, Field Manual 3-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 1-2.

²⁷ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 6.

²⁸ Headquarters, Department of the Army, *Sustainment Operations*, Field Manual 4-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 5-1.

²⁹ *Ibid.*, 1-4.

³⁰ *Ibid.*, 1-5.

³¹ Headquarters, Department of the Army, *Operations*, Field Manual 3-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 3-1.

convergence, endurance, and depth.³² These tenets provide the broad over-arching framework for the logistics struggle modeled in the proposed wargame. FM 3-0 defines these tenets as:

Agility is the ability to move forces and adjust their dispositions and activities more rapidly than the enemy...*Convergence* is an outcome created by concerted employment of capabilities from multiple domains and echelons against combinations of decisive points in any domain to create effects against a system, formation, decision maker, or in a specific geographic area...*Endurance* is the ability to persevere over time throughout the depth of an operational environment...[and] *Depth* is the extension of operations in time, space, or purpose to achieve definitive results.³³

Convergence is an important tenet of MDO from the sustainment perspective. In an operation, convergence integrates strikes across all domains to penetrate and disintegrate enemy defenses.³⁴ Understanding when those convergence windows are planned allows logistics to mass supply in concert to support the operational effort. For MDO, the division is the unit of employment.³⁵

FM 4-0 recognizes that LSCO has a high tempo, creating gaps and seams that require "a flexible and tailorable distribution system."³⁶ Concurrent with a high tempo is a likelihood of operating in anti-access/area denial (A2/AD), expanding contested logistic environments with longer lines of communications and increased vulnerability for logistics units.³⁷ The field manual

³² Headquarters, Department of the Army, *Operations*, Field Manual 3-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 3-1.

³³ Ibid., 3-3 thru 3-7.

³⁴ Jesse L. Skates, "Multi-Domain Operations at Division and Below," *Military Review* 101, no. 1 (January-February 2021): 72.

³⁵ Ibid., 74.

³⁶ Headquarters, Department of the Army, *Sustainment Operations*, Field Manual 4-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 5-11.

³⁷ Matthew Powers and Brian O'Flynn, "Contested Logistics Simulation Output Analysis with Approximate Dynamic Programming: A Proposed Methodology," *Journal of Defense Analytics and Logistics* 6, no. 2 (2022): 120-121, <https://doi.org/10.1108/JDAL-07-2022-0004>.

includes considerations for planning. For maneuver units, a loss of tempo and operations also results in a large degradation "in supplies, communications, and equipment readiness," a key issue to model in the wargame.³⁸ Fatality and non-mission capable (NMC) flow from a point of injury/failure under contested conditions is also an issue sustainment faces in LSCO.³⁹ Both casualty and inoperable equipment flow challenges should be modeled in this research's intended wargame. Sustainment is important in LSCO as "it directly enables tempo, extends operational reach, and prevents early culmination."⁴⁰ This relies on "adequate transportation, maintenance, logistics, and medical support."⁴¹

Sustainment as a Limitation in Large-Scale Combat

The sustainment in counterinsurgency section of this chapter discussed how the logistics assets and units were reduced and outsourced to improve efficiency during the War on Terror. Second-and-third-order effects of these actions affected the Army's perception of logistics compared to combat troops.⁴² With logistics deploying from secure FOBs and providing perfectly packaged supply drops, the problem set of sustaining the soldier became solely the

³⁸ Headquarters, Department of the Army, *Sustainment Operations*, Field Manual 4-0, Fort Belvoir, VA: Army Publishing Directorate, 2022, 5-12.

³⁹ Ibid.

⁴⁰ Michael D. Lundy, Richard Creed, and Scott Pence, "Feeding the Forge: Sustaining Large-Scale Combat Operations," US Army, July 18, 2019, https://www.army.mil/article/223833/feeding_the_forge_sustaining_large_scale_combat_operations.

⁴¹ Ibid.

⁴² Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

purview of the logistics branch.⁴³ The expeditionary logistics skills necessary for non-commissioned officers, First Sergeants, and company grade officers (tracking and preserving supply, rearm, refuel, and fix under fire or out of support, etc.) have atrophied.⁴⁴ The military is used to entering a mature theater with sustainment and infrastructure already in place, but in a coming LSCO fight, a mature theater is unlikely.⁴⁵ This creates a limitation that can be solved through a change in training and technology.

Training

Expeditionary skills such as foraging, innovative maintenance, and other problem-solving skills necessary for success in a LSCO environment are one method for overcoming the limitation of past COIN style sustainment practices. These skills must be developed across the force, not just within sustainment, to "support the force in an every-changing, degraded, and lethal environment."⁴⁶ With contracted support in LSCO less likely to exist, and an enemy able and willing to target large supply convoys, maneuver units will have to stretch their on hand supplies until resupply is possible.⁴⁷ Supply units must keep moving to maintain security, therefore requiring accurate and timely reporting up and down the chain to ensure logistics

⁴³ David Crozier, "Decisive Action: How to Fight and Sustain in the Army's Future Battles," *NCO Journal*, (May 2013), <https://www.armyupress.army.mil/Journals/NCO-Journal/Archives/2013/May/05-28-Decisive/>.

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 8.

⁴⁷ David Crozier, "Decisive Action: How to Fight and Sustain in the Army's Future Battles," *NCO Journal*, (May 2013), <https://www.armyupress.army.mil/Journals/NCO-Journal/Archives/2013/May/05-28-Decisive/>.

effects are massed when and where they are needed.⁴⁸ Similar retraining and execution are required for Reception, Staging, Onward-movement, and Integration (RSOI). Many locations, including allied and partner nation airports and seaports, are within the threat rings of peer and near-peer opponents.⁴⁹ This means the US military will have to conduct RSOI either contested or in the Continental United States (CONUS) before transit into theater.

Technology

Technology is both an additional limitation to sustainment in LSCO and a possible method to bridge capability gaps. LSCO will probably include operations in nonlinear and noncontiguous environments requiring a transformation of the technology equipped to logistics organizations.⁵⁰ Emerging technologies such as drones or artificial intelligence may provide ways to ensure continuity and responsive sustainment, but these come with their own supply requirements and are untested under wartime conditions.⁵¹ However, even if the scalability and reliability of such technologies can be assured, supplies will continue to move primarily along

⁴⁸ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 8.

⁴⁹ Michael D. Lundy, Richard Creed, and Scott Pence, "Feeding the Forge: Sustaining Large-Scale Combat Operations," US Army, July 18, 2019, https://www.army.mil/article/223833/feeding_the_forge_sustaining_large_scale_combat_operations.

⁵⁰ James K. Greer, "LSCO Lessons: What the Army Should Be Learning About Large-Scale Combat Operations from Ukraine War," Modern War Institute, July 24, 2022, <https://mwi.westpoint.edu/lSCO-lessons-what-the-army-should-be-learning-about-large-scale-combat-operations-from-the-ukraine-war/>.

⁵¹ Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 132.

ground lines for the foreseeable future.⁵² The wargame should include drones and a system for predictive planning.

Transitioning Sustainment from COIN to LSCO

An effective transition of sustainment operations, from a focus on COIN to one focused on LSCO, requires five key things. First, the military must change how they classify "correct" sustainment. Although efficiency is an important metric to strive for, being able to adjust "in response to threats, operational demands, and available information" ensures sustainment units are effective and resilient.⁵³ Instead of measuring sustainment by efficiency of delivery, it should be measured by how adaptive sustainment is to the changing situations occurring in large-scale combat operations.⁵⁴ Second, leaders must consider sustainment when coordinating their cross-domain operations to ensure sustainment is not a limitation when converging effects on the enemy.⁵⁵ Third, large logistics convoys or footprints are easy targets for enemy fires. During the battle for Baghdad 2003, the heaviest casualties came from attacks on flammable, unarmored

⁵² Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 132.

⁵³ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, last modified April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>; Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 132.

⁵⁴ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, last modified April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

⁵⁵ Bryan J. Quinn, "Sustaining Multidomain Operations: The Logistical Challenge Facing the Army's Operating Concept," *Military Review* 103, no. 2 (March-April 2023): 130.

fuel trucks.⁵⁶ These fuel trucks were often in large convoys, making them easily identifiable targets. In the war between Russia and Ukraine that began on February 22, 2022, Russian logistics convoys were stalled on the roads for days, vulnerable to attacks and unable to deliver supplies.⁵⁷ During the Global War on Terror, the Army modernized combat units before logistics units, leaving fuel trucks as vulnerable, high-payoff targets.⁵⁸ To increase the survivability of sustainment units, their personnel and capabilities should be minimized (more, smaller elements, not reduced in total number), distributed and semi-autonomous.⁵⁹ Fourth, Army sustainment has dual competing purposes: sustain an Army in wartime and maintain a level of readiness during peacetime. With the efforts to run the DoD like a business, US armed forces are stretched thin just to support *peacetime* operations.⁶⁰ To transition to a force ready for a fight against Russia or China, the success metric must change from cost effectiveness in peacetime to readiness in

⁵⁶ Sydney J. Freedberg Jr., "No More Iron Mountains: Lighter Logistics Key to Multi-Domain Battle," *Breaking Defense*, May 3, 2017, <https://breakingdefense.sites.breakingmedia.com/2017/05/no-more-iron-mountains-streamlined-logistics-key-to-multi-domain-battle/>.

⁵⁷ Bradley Martin, D. Sean Barnett, and Devin McCarthy, *Russian Logistics and Sustainment Failures in the Ukraine Conflict: Status as of January 1, 2023* (Santa Monica, CA: RAND Corporation, 2023), https://www.rand.org/pubs/research_reports/RRA2033-1.html.

⁵⁸ US Government Accountability Office (GAO), *Defense Logistics: Several Factors Limited the Production and Installation of Army Truck Armor during Current Wartime Operations*, GAO-06-160, Report to Congressional Committees, Washington, DC: GAO, 2006, <https://www.gao.gov/products/gao-06-160>.

⁵⁹ John Sattely, "Sustainment of the Stand in Force," *War on the Rocks*, September 12, 2022, <https://warontherocks.com/2022/09/sustainment-of-the-stand-in-force/>; Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 5.

⁶⁰ Ibid.

wartime.⁶¹ Finally, the Army must develop or reorganize units so they can subsist on Spartan amounts of supply.⁶² Fuel is still the commodity with the highest battlefield demand and until the equipment that requires that consumption is modernized, ground resupply is a necessity.⁶³ Therefore, the game must model both the high demand and high volume of fuel in combat and how that demand drives sustainment decisions.

SPIDERWEB/Adaptive Sustainment Theory as a Mitigation

The previous sections addressed the issues with sustainment as it transitions its focus along the Competition Continuum. The ideas recommended in those sections were broad and strategically oriented. This research aims at developing a wargame that leaders can use to explore methods of sustainment in LSCO at the operational level. To understand how to model those methods, this thesis adopts a proposed model: SPIDERWEB Sustainment, also known as Adaptive Sustainment.

SPIDERWEB Sustainment is an acronym that stands for Self-sufficient units, Precision logistics, Interoperability with partners, Distribution, Expeditionary sustainment, Regional resources, Widely dispersed, Enabled mission command with enterprise resource planning, and

⁶¹ Paul Christian van Fenema et al., "Sustaining Relevance: Repositioning Strategic Logistics Innovation in the Military," *Joint Force Quarterly* 101 (April 2021): 61, <https://ndupress.ndu.edu/Media/News/News-Article-View/Article/2553714/sustaining-relevance-repositioning-strategic-logistics-innovation-in-the-milita/>.

⁶² Sydney J. Freedberg Jr., "No More Iron Mountains: Lighter Logistics Key to Multi-Domain Battle," *Breaking Defense*, May 3, 2017, <https://breakingdefense.sites.breakingmedia.com/2017/05/no-more-iron-mountains-streamlined-logistics-key-to-multi-domain-battle/>.

⁶³ Ibid.

Brigade-focused.⁶⁴ It is a theory being explored across both the Army and the Marine Corps.⁶⁵ SPIDERWEB Sustainment proposes a "web" of nodes, routes, and suppliers run by logistics units that are "light, flexible, responsive, resilient, and redundant."⁶⁶

An example of this is seen in conflict between Ukraine and Russia, in which Ukraine has experimented with drones to support logistics by collecting wounded soldiers and making supply drops.⁶⁷ To be successful, this web requires data to ensure accurate delivery of the correct amount of supplies and equipment where and when they are needed.⁶⁸ The web allows sustainment to have the adaptability to be mobile, redundant, and dispersed in a contested

⁶⁴ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 6.

⁶⁵ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 6; John Sattely, "Sustainment of the Stand in Force," *War on the Rocks*, September 12, 2022, <https://warontherocks.com/2022/09/sustainment-of-the-stand-in-force/>.

⁶⁶ Ibid.

⁶⁷ Paul Christian van Fenema et al., "Sustaining Relevance: Repositioning Strategic Logistics Innovation in the Military," *Joint Force Quarterly* 101 (April 2021): 61, <https://ndupress.ndu.edu/Media/News/News-Article-View/Article/2553714/sustaining-relevance-repositioning-strategic-logistics-innovation-in-the-milita/>.

⁶⁸ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 7-8.

environment.⁶⁹ This idea supports the small units needed for Multi-Domain Battle, which are dispersing, hiding, and staying on the move and cannot be tethered to traditional supply lines.⁷⁰

This theory is also known as Adaptive Logistics. Adaptive Logistics and SPIDERWEB Sustainment differ from current sustainment methods in two ways. First, is a transition away from the depot model in which supplies move from the rear area over a line of communication to the tactical user linearly.⁷¹ Instead, the model is user-oriented, in which these three zones are interconnected, sometimes working independently from each other to focus combat power, especially in the critical period of theater opening.⁷² The second difference is a focus on information as the currency of logistics through either accurate reporting or artificial intelligence algorithms.⁷³ Currently, if a unit's logistics status report (LOGSTAT) is late, inaccurate, or nonexistent, logisticians are expected, in the depot model, to project requirements based on historical data. However, in a fight against a near-peer enemy where the front lines may constantly shift, historical data is less dependable. Accurate data ensures logistical supply meets

⁶⁹ Mikayla Easley, "Army Exploring New Tech to Charge up Troops on the Go," *National Defense*, May 27, 2022, <https://www.nationaldefensemagazine.org/articles/2022/5/27/army-exploring-new-tech-to-charge-up-troops-on-the-go>; Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 7.

⁷⁰ Sydney J. Freedberg Jr., "No More Iron Mountains: Lighter Logistics Key to Multi-Domain Battle," *Breaking Defense*, May 3, 2017, <https://breakingdefense.sites.breakingmedia.com/2017/05/no-more-iron-mountains-streamlined-logistics-key-to-multi-domain-battle/>.

⁷¹ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

⁷² Ibid.

⁷³ Ibid.

demand and does not under perform or breakdown.⁷⁴ Using flexible sustainment units and accurate data, adaptive logistics can shift from efficient "pull" models (forces request support) to resilient and effective "push" models (forward positioned supply based on predictive logistics).⁷⁵ Therefore, the game must model logistics units that players can employ across time and distance to bolster, and not anchor, operations.

The key to both the Adaptative Logistics and SPIDERWEB models is in keeping supply commodities mobile and therefore survivable.⁷⁶ This requires, in part, a change in the attitude (at all levels to include the DoD), of logistics as a critical function instead of a menial peripheral function that can be outsourced.⁷⁷ The wargame must model this by making sustainment the central focus. Additionally, the design of organizations and training for sustainers should be focused on situations when logistics units are "out-manned, out-gunned, decentralized without connectivity, in an expeditionary environment, moving against a peer competitor, and holding temporary or periodic domain superiority."⁷⁸

⁷⁴ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

⁷⁵ Ibid.

⁷⁶ Michael D. Lundy, Richard Creed, and Scott Pence, "Feeding the Forge: Sustaining Large-Scale Combat Operations," US Army, July 18, 2019, https://www.army.mil/article/223833/feeding_the_forge_sustaining_large_scale_combat_operations.

⁷⁷ Chris Dougherty, "Buying Time: Logistics for a New American Way of War," Center for a New American Security, April 13, 2023, <https://www.cnas.org/publications/reports/buying-time>.

⁷⁸ Paul C. Hurley, Tracie M. Henry-Neill, and Rebecca S. Brashears, "Sustainment Innovation for Multi-Domain Battle," *Army Sustainment* (January-February 2018): 5.

Wargames

While the literature on wargame design is not deep, there are several texts for reference recommending principles for design. This thesis reviews several key texts on wargame design in both the civilian and military arenas, as well as various models featuring sustainment challenges.

The most comprehensive text on wargaming is Peter Perla's *The Art of Wargaming*. This book covers an in-depth history, examples, and design. Perla traces the history of wargaming from its earliest iterations such as Chess and Go, to the version of Kriegsspiel used by the Germans as early as 1812, and in WWII to respond accurately and quickly to American attacks on the German Siegfried Line prior to the Battle of the Bulge.⁷⁹ Wargames are also a central teaching method used in American, German, French, British, and Japanese (to name a few) military academies.⁸⁰ From this review of history, Perla synthesizes key lessons gained by using games: balancing logistics and combat elements, the importance of learning over winning, and providing an avenue to ask the right questions.⁸¹ Perla argues wargaming is not intended to provide a quantitative analysis of a problem, feature reality, or be duplicable.⁸² In fact, his definition is: "a model or simulation...whose sequence of events affects and is, in turn, affected by the decisions made by players representing the opposing sides."⁸³ He summarizes the seven elements of a wargame as objectives, a scenario, a database, models, rules, players, and

⁷⁹ Peter Perla, *Peter Perla's The Art of Wargaming: A Guide for Professionals and Hobbyists*, ed. John Curry (Annapolis, MD: United States Naval Institute Press, 2011), 54.

⁸⁰ Ibid., 17-27.

⁸¹ Ibid., 34 & 45.

⁸² Ibid., 157.

⁸³ Ibid.

analysis.⁸⁴ Perla's seven elements provides a framework for the development of this wargame. This framework drives the research conducted to identify the dynamics to model in the wargame before rules and game development.

The Theory of Fun for Game Design by Raph Koster is a review of the usefulness that games provide for learning and understanding complex problems. According to Koster, games "are iconic depictions of patterns in the world. They have more in common with how our brain visualizes things than they do with how reality is actually formed."⁸⁵ Koster emphasizes the best scenario for learning is when fun is involved. To avoid boredom, a game design has just enough, but not too much complexity as "it is the act of solving puzzles that makes games fun."⁸⁶ As Koster underscores that while wargames must model reality, they must also positively engage players, or players may quit after a few rounds. Therefore, the wargame designed for this thesis must balance creating a sustainment dilemma for players to resolve without discouraging due to irrelevant or excessive detail. This is especially important to maintain the attention of maneuver officers. The wargame should balance between the combat and logistics systems so that maneuver officers do not leave the game thinking it does not apply to their specialty.

The British Ministry of Defence produced the *Wargaming Handbook*, a reference for developing and using wargames in a military setting. This handbook also includes a summary of the history of wargames, geared specifically towards their military context. The Ministry of Defence provides its own definition of a wargame: "a scenario based warfare model in which the

⁸⁴ Peter Perla, *Peter Perla's The Art of Wargaming: A Guide for Professionals and Hobbyists*, ed. John Curry (Annapolis, MD: United States Naval Institute Press, 2011), 158.

⁸⁵ Raph Koster, *A Theory of Fun for Game Design*, 2nd ed. (Sebastopol: O'Reilly Media, Inc., 2014), 34.

⁸⁶ *Ibid.*, 40-42.

outcome and sequence of events affect, and are affected by, the decisions made by the players."⁸⁷

This handbook makes a key argument about why wargames are a necessary and useful tool for any military, namely that they provide a safe-to-fail environment.⁸⁸ This handbook covers elements, applications, techniques, and fundamentals of wargames used for investigating military operations. With the subject of this research focused on sustainment in an unfamiliar operational environment, the British Ministry of Defence provides a compelling argument for using a wargame to model the developed theory. This wargame is exploring the challenges of sustainment in near-future combat. The Ministry of Defence's valuation of wargames as safe-to-fail environments allows players to experiment and learn how best to meet those challenges.

Several board games include logistics as a central challenge. *1944: Race to the Rhine* is one of the most well-known. Using a spoke and node model, throughput of supplies is the central limitation players must overcome. Players operate in a semi-cooperative manner where the enemy is abstracted and not controlled by a player.⁸⁹ While players are on the same side, their interests are not always aligned.⁹⁰ They secure nodes along their lines of communication (LOCs) while advancing toward the aim at the other end of the board.⁹¹ They must balance movement

⁸⁷ Ministry of Defence Shrivenham, *Wargaming Handbook*, Wiltshire, UK: Development, Concepts and Doctrine Centre, August, 2017, 5.

⁸⁸ Ibid.

⁸⁹ Jaro Andruszkiewicz and Waldek Gumienny, *1944: Race to the Rhine*, PHALANX, 2014, Art by Piotr Staby.

⁹⁰ Ibid.

⁹¹ Ibid.

toward their aim with maintaining LOCs and not outrunning their supply.⁹² This game provides an excellent example of throughput as a limitation, by regulating movement between nodes and depicting supplies using cubes. While this game only allows movement along the pre-built LOCs, those LOCs are designed in a web-like fashion. This game shows that modeling throughput relies not just on the number of cubes that must be moved but also on the range or volume to which each unit is limited.

Thor's Hammer is another excellent board game featuring logistics and designed by students at Georgetown University alongside the Department of Sustainment and Force Management at the Army's Command and General Staff College.⁹³ This game also uses a spoke and node map, but unlike *1944: Race to the Rhine*, does not limit movement to only along the spokes.⁹⁴ In another similarity, this game also has a maneuver objective limited by logistics requirements; however, in this game, control of key logistics nodes is one condition for winning the game.⁹⁵ While *1944: Race to the Rhine* was oriented toward World War II, *Thor's Hammer* depicts modern operations, with key nodes for logistics being sea or airports.⁹⁶ The ability for units to move off the spoke and node lines on the map better reflects potential sustainment operations in a LSCO environment. However, the advantages of moving along the spoke (speed) encourages logistics units not to stray onto other parts of the map.

⁹² Jaro Andruszkiewicz and Waldek Gumienny, *1944: Race to the Rhine*, PHALANX, 2014, Art by Piotr Staby.

⁹³ Jonathan Abshire, Jamie Hood, and Zack Watson, *Thor's Hammer*, Georgetown University, 2022.

⁹⁴ Ibid.

⁹⁵ Ibid.

⁹⁶ Ibid.

Nevsky: Teutons and Rus in Collision 1240-1242 is a medieval era board game with interesting logistics challenges. Conceptualizing the clash between the Teutonic and Russian powers, *Nevsky* forces players to raise and equip armies with the aim of controlling as much of the board as possible.⁹⁷ Players must balance timing of armies in service through the lords that raise them, choosing whether mass or endurance is more useful at each point in the operation.⁹⁸ In addition, prior to their turn, players must sequence what order each lord (and therefore unit) is played.⁹⁹ This creates an effect of operational planning in the game that is immediately complicated by "contact with the enemy" since players alternate playing their cards in sequence.¹⁰⁰ This idea offers opportunities to both replicate planning and communications issues that may be seen in MDO.

Finally, *Battle for Moscow* pits the Soviet Union against the German Army during Germany's attempt to take Moscow in 1941.¹⁰¹ The game uses a hex map where the goal to win is to control the city of Moscow.¹⁰² This wargame demonstrates the use of easy-to-follow retreat rules. In *Battle for Moscow*, combat is assessed through a combat results table, where the roll of

⁹⁷ Volko Ruhnke, *Nevsky: Teutons and Rus in Collision 1240-1242*, GMT Games, 2019, art by Charles Kibler, Rodger B. MacGowan, Chechu Nieto, and Mark Simonitch.

⁹⁸ Ibid.

⁹⁹ Ibid.

¹⁰⁰ Board Game Geek, "Nevsky: Teutons and Rus in Collision 1240-1242," accessed October 15, 2023, <https://boardgamegeek.com/boardgame/249590/nevsky-teutons-and-rus-collision-1240-1242>.

¹⁰¹ Frank Chadwick, *Battle for Moscow*, Oberlabs, 2009, art by Victory Point Games.

¹⁰² Ibid.

the dice is compared to a results table that determines the outcome.¹⁰³ Combat can be resolved in six possibilities, two of which involved the defender retreating.¹⁰⁴ This wargame provides a template for how to design retreat rules in a complicated wargame without overcomplicating combat.

So What?

Investigating the realm of sustainment, where it is coming from and where it is likely headed, provides insight into what must be included in the wargame. The intent of this research is to create a wargame to allow officers of all branches to explore the challenges of maintaining operational reach and tempo in a large-scale combat fight. With the intent in mind, the literature review suggests including the following features in the final wargame.

The most significant thing to model is the disconnect between how sustainment systems currently operate and how theories like SPIDERWEB and adaptive sustainment suggest they should operate in the future. To model this, each side will play using a different sustainment system. One player will use the traditional system with big logistics units that can carry substantial amounts of supply. This system will manage sustainment in the traditional linear manner, large and inflexible. The other player will use a theoretical system where the logistics units are smaller, more numerous and carry less supply. This player will utilize a web-like system that allows for flexibility, responsiveness, and redundancy. Finally, both players will have the option to balance support operations with actions that will increase survivability.

¹⁰³ Frank Chadwick, *Battle for Moscow*, Oberlabs, 2009, art by Victory Point Games.

¹⁰⁴ Ibid.

The next important aspect to model is how logistics will be contested in large-scale combat. Sustainment units will have no safe area to operate within. Like combat units, they are always in contact from either direct or indirect fires. To model this the wargame will include multiple ways to target sustainment units and infrastructure with both direct and indirect fires. Additionally, the sustainment units' strength will reflect their vulnerability to such attacks. With a LSCO theater under constant threat, operations such as packaging of supplies, and the reorganization/integration of units occurs in the continental United States rather than at the theater port. This will also be reflected in the wargame.

A key theme that arose from this literature review is that information is currency in combat. As mentioned above, LSCO will likely be complicated by anti-access/ area denial efforts, creating communications and global positioning blackouts. To replicate this, the wargame will model players issuing commands to move their pieces as well as a feature to disrupt that process. Other information key to successful combat operations is the amount and location of supplies between units and ports. For this, the wargame will feature a tracker system utilizing supply tokens to indicate which units have supply and which units need supply. Since it is well documented that fuel is the most tempo affecting class of supply (followed by ammo), at a minimum, the tokens will signify CLIII(B) (fuel) and CLV (ammunition).

Finally, technology is emerging as a key piece to combat in large-scale operations. Both in use in the Russia-Ukraine War and in research by the United States Military, drones are being used to decentralize many aspects of combat. In the Russia-Ukraine War, drones are used to find enemy units to call for fire on their positions. In the wargame, drones will be modeled by how easily units can be found on the battlefield as well as by the system to call for fire. The United States is researching the use of larger drones to evacuate wounded soldiers or deliver supplies.

The wargame will model this through special cards that provide alternative delivery of replacements or resupply.

Summary

This chapter reviewed relevant literature and wargame models necessary to develop a method to model sustainment in a large-scale combat operation through a wargame as a useful learning implement. This included a review of literature covering current sustainment practices, large-scale combat, and multi-domain operations as the Army's new operational model, why sustainment presents a limitation and theories for how sustainment can be successful in war against a peer or near-peer enemy. This chapter also reviewed literature on competitive wargaming uses, design and valuable models to provide ways to model sustainment challenges. These concepts create the basis for the research conducted in this thesis. Each of the wargame models reviewed in this chapter demonstrates distinct aspects of sustainment as a challenge or limitation to combat. The various pieces of these wargames build the foundation of a game to show the unique challenge of sustainment in LSCO. The next chapter will address the research method for collecting the data required to develop the ideas presented in the literature review.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

This chapter explains the methodologies used to research the suitability of sustainment in LSCO as an educational wargame model for professional development. This research combined two methodologies to understand sustainment operations in LSCO. The first was to identify which aspects of sustainment are most important to include in a wargame, and the second was to determine a useful model with relevant mechanics for those aspects. Peter Perla's *Art of Wargaming* provides a model for wargame development, which was paired with *Grounded Theory* to collect, code, and categorize data to design the proposed wargame. These methodologies were integrated step by step, as shown in Figure 1.

Method: Wargame Development Integrated with Grounded Theory

Integrating Wargame Development with the Grounded Theory method allows refinement of the wargame design through an iterative process. This inductive approach develops a theory (presented as a wargame) that both reflects the data researched and the experiences of play-testers, and thereby depicts and employs that data.¹⁰⁵ This process calls for an initial investigation of data to develop a prototype wargame. However, it requires an iterative analysis of the data, incorporating the results into each refined prototype of the game design. The initial investigation allowed for the amalgamation of the sustainment principles, unique characteristics of large-scale combat operations (LSCO), and recent history, into something that allows for the

¹⁰⁵ Shawn Blaydes, "Return to Twilight: A Model of Great Power Rivalry," (Master's thesis, U.S. Army Command and General Staff College, 2022), 31, <https://cgsc.contentdm.oclc.org/digital/collection/p4013coll2/id/4062/rec/3>.

quick understanding of playtesters. Research and data collection informed how to model key aspects of sustainment operations in LSCO and develop rule sets to guide players through exploring the topic. Playtester feedback resulted in an additional analysis of sustainment operations in LSCO while suggesting new, novel modeling approaches.

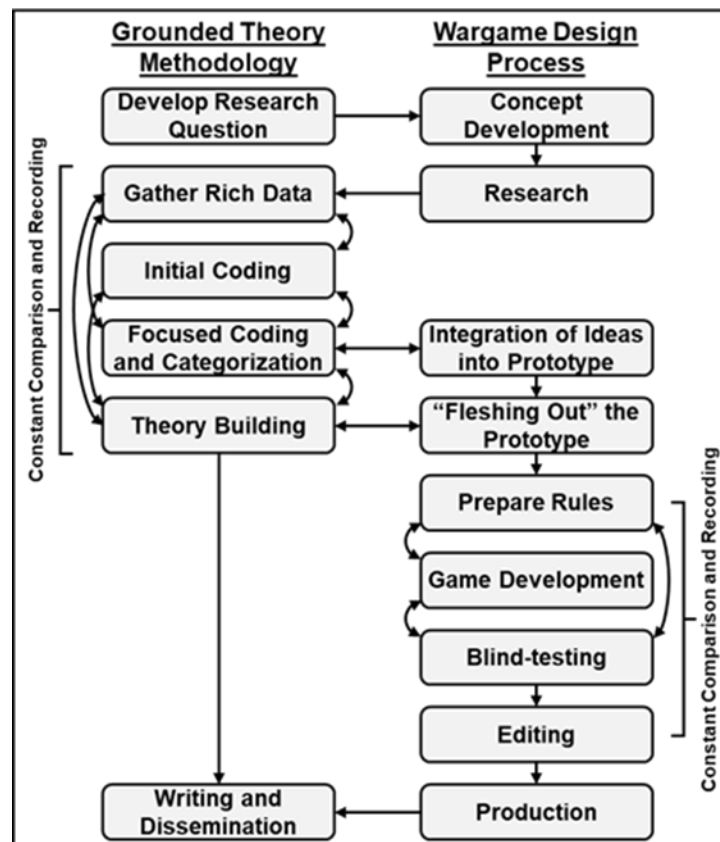


Figure 1. Integrated Wargame Design and Grounded Theory Methodology

Source: Shawn Blaydes, "Return to Twilight: A Model of Great Power Rivalry," (Master's thesis, U.S. Army Command and General Staff College, 2022), 32, <https://cgsc.contentdm.oclc.org/digital/collection/p4013coll2/id/4062/rec/3>.

Developing the research questions in this thesis completed the first step for both Wargame Development and Grounded Theory method. These research questions satisfy both the

"develop research question" for step 1 of Grounded Theory, and the "Concept Development" for step 1 of Wargame Development. To satisfy the second step of Wargame Development in Figure 1 - "Research", Grounded Theory guided the literature review and initial data collection. The remaining steps were conducted iteratively. However, this thesis did not include 'human subjects' research and so amended the process to remove the "blind testing" step.

Data Collection

Grounded Theory uses theoretical sampling to conduct a constant comparative analysis of data.¹⁰⁶ According to grounded theorist Kathy Charmaz, "theoretical sampling involves starting with data, constructing tentative ideas about the data, and then examining these ideas through further empirical inquiry."¹⁰⁷ In this process, the research seeks the best sources of data, then refines those sources of data based on the results of the comparative analysis.¹⁰⁸ This data collection begins with an initial conceptual theory and the data needed to support that theory. Through constant analysis of the collected data, the researcher reviews and refines the emerging theory. From this emerging theory, the researcher assesses what additional sources of data are required and updates the data collection plan.

Although the data collection methods described above are fluid, in this case, these began by reviewing the US Army's new doctrine developed to employ forces in large-scale combat operations (LSCO). From there, various articles on sustainment in future operations and in

¹⁰⁶ Dale Spurlin, "Grounded Theory Research Methodology," U.S. Army Command and General Staff College, Fort Leavenworth, KS, March 3, 2023, https://cgsc.blackboard.com/ultra/courses/_14000_1/cl/outline.

¹⁰⁷ Kathy Charmaz, *Constructing Grounded Theory*, 2nd ed., (Los Angeles, CA: SAGE Publications Ltd., 2014), 199.

¹⁰⁸ Ibid.

historical examples were used to identify an initial listing of the core features necessary to model in the proposed wargame that would communicate the reality of the difficulty of conducting sustainment in LSCO. These core features serve as the initial, broad categories around which the theoretical sampling is structured: SPIDERWEB sustainment, logistics on the move, and smaller footprints are better. Through this process, this research will "check, qualify, and elaborate the boundaries of [the] categories and to specify the relations among categories."¹⁰⁹

To determine how the core features of sustainment in LSCO would be modeled, existing wargames were investigated to analyze and evaluate dynamics and determine their viability for adoption. These dynamics and other novel approaches used in the wargame underwent extensive testing by volunteer play-testers to understand their effective integration. Adjustments based on playtester feedback occurred until the model achieved the desired effect. These other novel approaches are covered in Chapter 4.

Data Analysis

In Grounded Theory, "coding is the pivotal link between collecting data and developing an emergent theory to explain these data."¹¹⁰ For this research, data was coded to identify trends and gaps. Initial coding was completed by naming each paragraph of text to gather as many codes as possible for consideration.¹¹¹ After this initial phase, the codes were assessed for the "most significant or frequent initial codes" to draw from the data themes that should be

¹⁰⁹ Kathy Charmaz, *Constructing Grounded Theory*, 2nd ed., (Los Angeles, CA: SAGE Publications Ltd., 2014), 205.

¹¹⁰ Ibid., 113.

¹¹¹ Ibid.

incorporated into the wargame.¹¹² The initial coding phase was conducted unscripted; however, text sources were considered for relevance.¹¹³ Initial coding included US Army doctrine on operations and sustainment in large-scale-combat and references to the challenges of sustainment against a modern, near peer enemy.

In this research, the theory was developed as a wargame, incorporating the core features that emerged as themes throughout coding and categorization. With the initial and subsequent coding described above, the wargame was prototyped with written rules, then play-tested and edited cyclically. This cycle allowed each edited prototype to incorporate data from play-testers, adjust the theory (the wargame), and further refine how to conduct sustainment in LSCO. Each iteration of playtesting and prototyping allowed the researcher to reconsider data from new perspectives, address unexpected or unintended outcomes, and find gaps in understanding. Because this process was cyclical, each iteration of data collection and analysis allowed for additional data collection and analysis. Likewise, with each cycle, the edited wargame prototype resulted in a progressively a richer model.

Summary

After a lengthy focus on counter-insurgency operations in the Middle East, working knowledge of how to conduct sustainment operations in large-scale combat is scarce within the US Army. Experience is even scarcer. Advances in technology during World War I demanded the development of artillery doctrine. Without a LSCO war to develop sustainment doctrine,

¹¹² Kathy Charmaz, *Constructing Grounded Theory*, 2nd ed., (Los Angeles, CA: SAGE Publications Ltd., 2014), 113.

¹¹³ Shawn Blaydes, "Return to Twilight: A Model of Great Power Rivalry," (Master's thesis, U.S. Army Command and General Staff College, 2022), 45, <https://cgsc.contentdm.oclc.org/digital/collection/p4013coll2/id/4062/rec/3>.

experience must be gathered through alternate means such as lessons learned during major training exercises. A conceptual wargame is another such means. Grounded Theory method allowed for a qualitative approach of data collection and analysis to develop this wargame. This approach provided the means to adjust the research and incorporate emerging data and sources to create a refined and useful model. The wargame development model incorporated the data codes and categories of the Grounded Theory method into a model that features the themes of sustainment in LSCO. The features incorporated, as well as how features were modeled, are discussed in the following chapters.

CHAPTER 4

ANALYSIS

Introduction

Modeling sustainment in a large-scale combat environment begins with an exploration of the systems which either facilitate or threaten the successful execution of logistics. Analysis of the theories and strategies to employ sustainment in a LSCO environment provide the key traits to model in this wargame to answer the primary research question: How can the complexity of large-scale combat maneuver and sustainment operations in near-future combat be represented effectively in a competitive wargame in order to teach the importance of flexible, self-correcting sustainment systems?

Secondary research question one is: What aspects of reality must be modeled to demonstrate the complexities of sustainment support maneuver in a competitive wargame? This question is answered in this chapter through the identification of sustainment and combat operations which reflect the flavor and challenge of reality into a competitive wargame. This also provides the scope of the game and informs the actions of the players in the model. Known factors include the size of logistics units, cyberattacks on communications, indirect fire, fuel, and ammo as sustainment centers of gravity, and the amount of flexibility in the sustainment system.

Secondary research question two is: How can the relevant aspects of reality be effectively modeled in a competitive wargame? This question is answered through design choices of the game and how closely those design choices reflect reality to model the central challenges or are divorced from reality for the game to work or the player to remain engaged. Answering the secondary research questions supports answering the primary research question. Chapter 5 concludes with insights and recommendations developed during the creation of this wargame.

This chapter is organized into two parts. Part I provides an overview of the final wargame design. Part II addresses how the wargame approached modeling the central dilemmas of the primary research question. The full game rules can be found in Appendix B.

Part I: Overview of *Lines and Webs*

Scenario and Number of Players

The wargame is set in near-future fictional combat between opposing peer sides. *Lines and Webs* is designed as a two-player wargame. Players take on the role of either the Gamma or Delta division commander as they lead their respective forces to conquer the map. Both players begin with a foothold on the map and the opportunity to bring in additional supplies, units, or higher assets.

Timescale and Victory Conditions

Each turn of the wargame represents one day in the campaign. Turns continue until either one player achieves victory conditions or at the end of the fifteenth turn. Victory in this game is achieved when one player controls all ports (airports and seaports) for an entire turn. For example, if a player gains control of all ports during the combat phase in turn six, that player wins the game at the end of turn seven, unless control of any port is lost before the end of turn seven. If no player controls all four ports by the end of turn fifteen, then the player with the most ports in their control wins. If players each control two ports, then the player with the higher remaining combat power wins.

Game Map, Board, and Tracker Cards

Most of the player interaction occurs on the game map (see figure 2). Players start on opposite sides of the map, with a seaport of debarkation (SPOD) in their bottom right corner.

Both players also control an airport of debarkation (APOD) located to the player's left and halfway between the end of the map and the middle of the board. Two gray dotted lines indicate the initial limit of units for both players. No unit blocks will be placed between those two lines during the initial game set up.

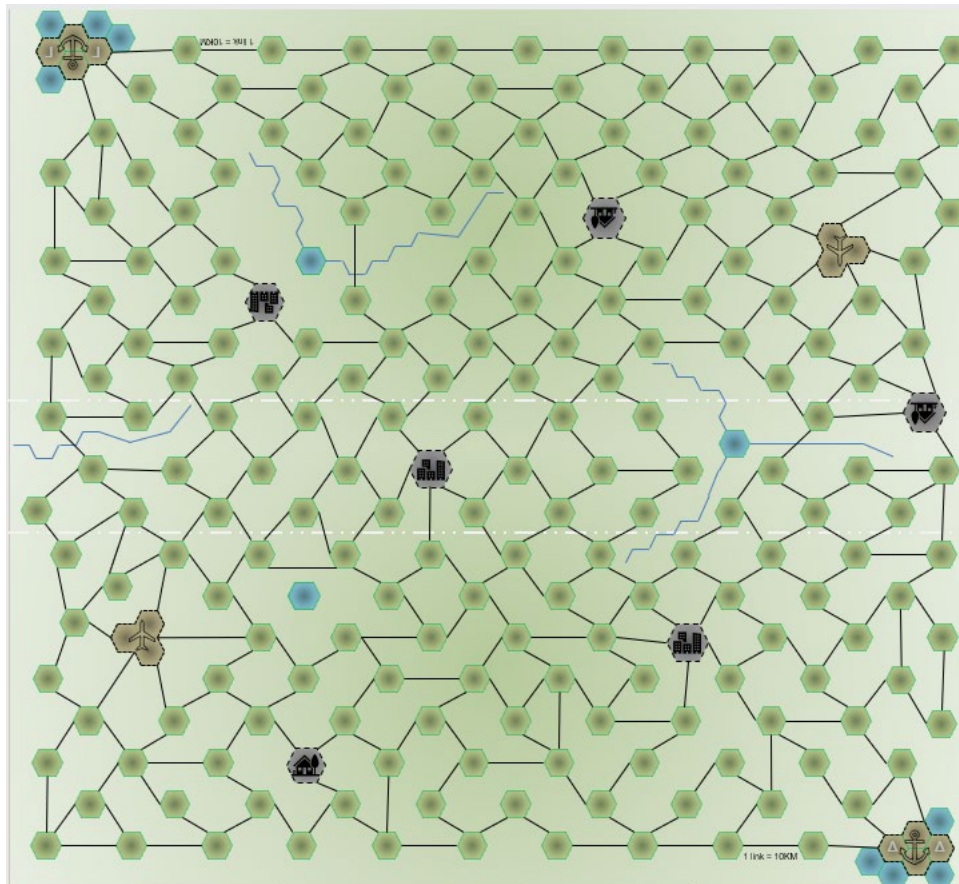


Figure 2. Game Map

Source: Created by Author.

Scale

Lines and Webs uses a node and link system to model terrain, where each link (black line) represents 10km. The unit block's position on the node indicates it controls halfway down each connected link. The total size of the map board is approximately 140km by 110km.

According to Field Manual (FM) 3-94, a division area spans 28km by 48km.¹¹⁴ The scale of the map in this wargame is much larger than that. Although this seems to be a failure in representing reality, through multiple playtests this map size best supported real world unit movement ranges and weapons ranges, balanced with providing players space to move.

Terrain

Types of terrain are reflected by the color of the hexagon tiles and their borders as referenced in the map legend (see figure 3 below). The iterations of this game tested several versions of terrain, starting with more variation and a continuous hexagonal pattern rather than node and link. Through testing, it was determined the large variation in terrain weighted gameplay toward combat operations and away from the logistical challenges. To solve this, terrain was simplified to the game map's final version of primarily steppes (grassland plains mostly devoid of forest) with terrain modifiers to create maneuver challenges. These terrain modifiers include infrastructure such as ports, towns, and cities, and water features such as ocean, lakes, and rivers with limited crossing points.

¹¹⁴ Headquarters, Department of the Army, *Armies, Corps, and Division Operations*, Field Manual 3-94, Fort Belvoir, VA: Army Publishing Directorate, 2022, C-12.

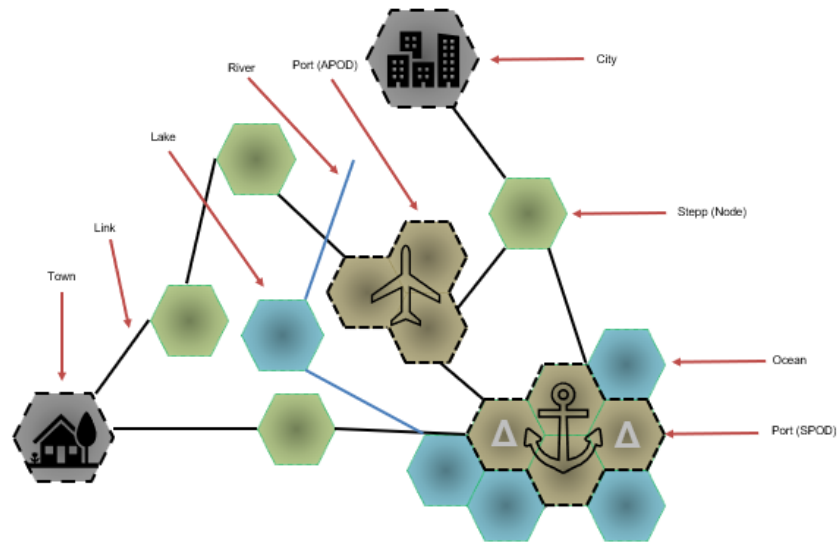


Figure 3. Map Legend.

Source: Created by Author.

Nodes

Nodes are indicated by hexagons. Most hexagons are colored green, indicating they are the base terrain of steppe, unless they include a terrain modifier discussed below. Each node can hold only one unit at a time (unless the port terrain modifier applies). This decision came after several iterations of playtesting of the stacking of different types of units. Limiting the number of units per node is another strategy to balance the focus of the game away from combat operations and toward logistical challenges.

Links

Links are indicated by the black lines stretching between nodes. Links abstract the various highways, roads, and trails which connect one piece of terrain (a node) with another. Units may only move between nodes along links. Units may not move to an adjacent node if no link connects them even if those nodes look close together on the map. Links also define the movement of supplies between nodes or units.

Terrain Modifiers

Terrain modifiers apply additional effects to a hex. Terrain modifiers include (1) ports; (2) towns; (3) cities; (4) rivers; (5) lakes; and (6) oceans. The terrain modifiers are explained briefly below:

Ports

Ports include both SPODs and APODs. SPODs are seaports of debarkation. APODs are airports of debarkation. Each player controls one APOD and one SPOD at the start of the game. Ports provide players with logistical capabilities to bring in supplies and units, as well as defensive capabilities to the occupying unit. Unlike other nodes, ports can hold more than one unit at a time. SPODs can hold up to four units. APODs can hold up to three units. The number of hexagons that make up the ports are a visual cue to the number of units that port can hold. Ports are treated like cities and provide the occupant with an advantage in combat by increasing the number on which they can receive damage by two when rolling a d12 die. Ports have an organic capacity to hold supplies and receive damage as indicated by their tracker card (discussed in detail below). Supply storage is increased by the carrying capacity of any unit occupying the port. Ports are the key terrain players must control to achieve victory conditions.

Town

Towns provide the occupying unit a defensive capability by increasing the number on which they can receive damage by one when rolling a d12 die. This advantage only applies when the unit occupies the town node. When attacking, a unit must move down the link toward the target node, thereby leaving their occupied node and losing any defensive advantage it may provide.

Cities

Cities provide the occupying unit a defensive capability by increasing the number on which they can receive damage by two when rolling a d12 die. This advantage only applies when the unit occupies the city node. When attacking, a unit must move down the link toward the target node, thereby leaving their occupied node and losing any defensive advantage it may provide.

Rivers

Blue lines between links and nodes indicate rivers. If a link crosses a blue line, it is considered an approved crossing point such as a bridge or ford. If no link crosses a blue line, units cannot move across the river for either movement or combat. This does not affect distance attacks by field artillery units. A distance attack is defined as any attack initiated from two or more nodes away. An attack initiated from an adjacent node is considered a direct attack.

Lakes

Blue hexes not connected to an SPOD indicate the presence of a lake. Lakes may also be connected to rivers. Lakes are impassable. No units may cross a lake to an adjacent hex. Field artillery units firing from a distance (two or more nodes away) may fire over a lake but must include the lake in their distance estimation.

Ocean

Blue hexes connected to an SPOD indicate the start of the ocean on that side of the map. Ocean is impassable. Ocean cannot be fired over.

Summary of Terrain Effects

Figure 4 summarizes all terrain effects on movement, combat, and supply.


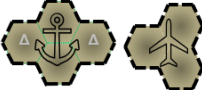



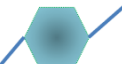

Terrain	Movement	Supply	Combat	Artillery
Steppe 	Unrestricted movement	Unrestricted movement. Can hold up to three supply tokens not stored with a unit as indicated by unit tracker card).	No advantage.	No advantage.
Ports 	Unrestricted movement	Unrestricted movement. Can hold up to twelve supply tokens as indicated by the port tracker card. SPOD can hold up to four units. APOD can hold up to three units.	Provides occupant with a defensive advantage. Defender's damage hit increased by two (2). Ex. damage is scored on a 9 instead of a 7.	Field Artillery units occupying a port and attacked from two or more links away receive a defensive advantage. Defender's damage hit increased by two (2). Ex. damage is scored on a 8 instead of a 7. Ports can also be attacked in lieu of attacking the occupying unit. In this case, no defensive advantage applies.
Towns 	Unrestricted movement	Unrestricted movement. Can hold up to three supply tokens not stored with a unit as indicated by unit tracker card).	Provides occupant with a defensive advantage. Defender's damage hit increased by one (1). Ex. damage is scored on a 8 instead of a 7.	Field Artillery units occupying a town and attacked from two or more links away receive a defensive advantage. Defender's damage hit increased by one (1). Ex. damage is scored on a 8 instead of a 7.
Cities 	Unrestricted movement	Unrestricted movement. Can hold up to three supply tokens not stored with a unit as indicated by unit tracker card).	Provides occupant with a defensive advantage. Damage hit increased by two (2). Ex. damage is scored on a 9 instead of a 7.	Field Artillery units occupying a city and attacked from two or more links away receive a defensive advantage. Defender's damage hit increased by two (2). Ex. damage is scored on a 8 instead of a 7.
Rivers 	Cannot be crossed unless a link already bisects the river.	Cannot be crossed unless a link already bisects the river. Cannot store supply.	No advantage.	No advantage.
Lakes 	Impassable.	Impassable. Cannot store supply.	No advantage.	No advantage. When firing over a lake, field artillery must include the lake in their distance calculation.
Ocean 	Impassable.	Impassable. Cannot store supply.	No advantage.	No advantage.

Figure 4. Terrain Effects

Source: Created by Author.

Game Board

On the player's edge of the map, at both ends, is a reference key, spaces for various card decks used in the game, and the offshore delivery queue (see figure 5). The reference key provides reminders about how to read tracker cards and unit block stickers. The spaces for the card decks provide the player with an organization tool to keep track of which cards are in play and which are out of play. These cards are discussed later in this section and the next. The delivery queue, discussed in more detail below, provides the player with a system to track assets coming into the operational theater.

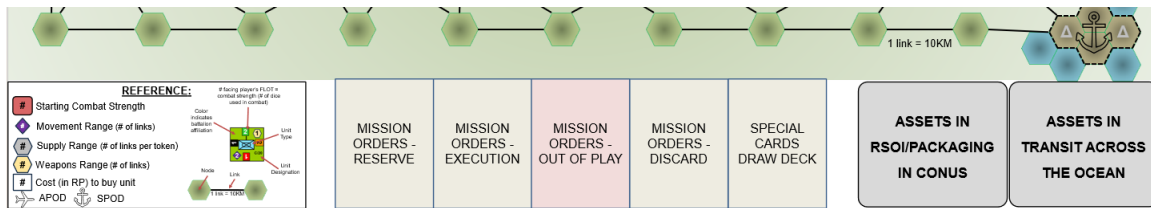


Figure 5. Player Game Board.

Source: Created by Author.

Tracker Cards

Each unit and SPOD/APOD has an associated tracker card (see figures 6, 7, 8). These cards provide the player with a method of tracking each unit's on-hand quantities. Limiting both combat units and sustainment units to a specific amount of supply that can be carried requires the player to consider what supplies a unit must move and attack with and where resupply can come from. Unlike combat-oriented wargames, this forces *Lines and Webs* players to consider logistics as it impacts their combat operations. Damage to the combat and sustainment units is tracked by turning the unit block (described in the next section). However, players can also target SPODs and APODs, causing infrastructure damage. This damage is tracked on the SPOD/APOD tracker card.

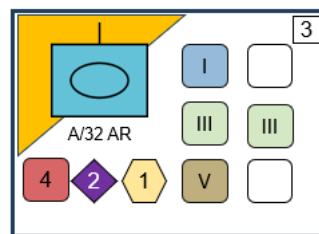


Figure 6. Delta Faction Unit Tracker Card.

Source: Created by Author.

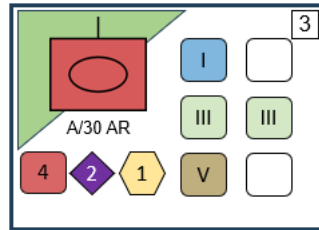


Figure 7. Gamma Faction Unit Tracker Card.

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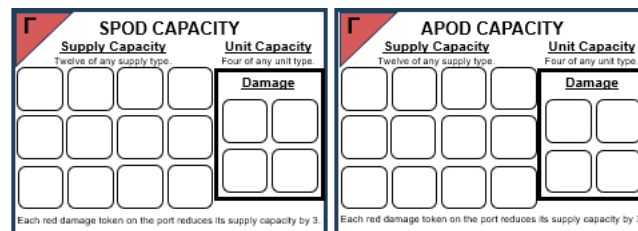


Figure 8. SPOD/APOD Tracker Card.

Source: Created by Author.

Unit Design

Figure 9 illustrates how to read information on unit blocks in *Lines and Webs*. The overall condition of the unit, which reflects various factors including its personnel strength and combat readiness, is represented by its step count. This corresponds to the colored square and number on the border of the unit's block. Each unit has four steps. The green square indicates the unit still has all four steps; the yellow square shows it has lost a single step; red that it has lost two steps; and black that it has lost three steps. If a unit takes another step loss when degraded to the black square, the unit is “destroyed” and removed from the board.

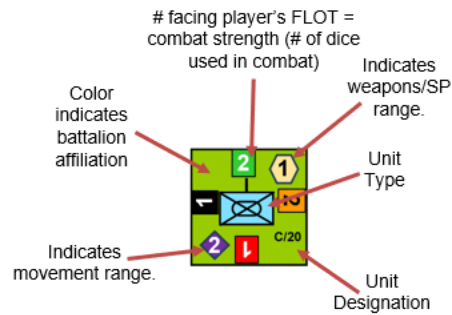


Figure 9. Unit Block Guide.

Source: Created by Author.

The numbers in each step square indicate the current combat strength of that unit and translate to the number of dice that unit can use in combat. The icon positioned away from the player's side of the board (toward the front line of troops or FLOT) indicates the unit's current combat strength. The icon in the center of the block indicates the unit type, described below. The letters and numbers on bottom right indicate the unit designation and corresponds to the unit's tracker card. The background of the unit block indicates battalion affiliation and allows players to quickly match combat and support units. The number in the hexagon indicates that unit's weapons range if the hexagon is tan, and the unit's supply range if the hexagon is grey. Finally, the number in the purple diamond indicates the unit's movement range.

Unit Types

Figure 10 details the seven types of units in the game. Since this wargame is designed to reflect near-future combat, the number and types of units are informed by the Army 2030 proposed design for an Armor Division.¹¹⁵

¹¹⁵ "U.S. Army's Way Forward: 5 New Division Organizations," Battle Order, last modified April 11, 2023, <https://www.battleorder.org/post/waypoint-divisions>.

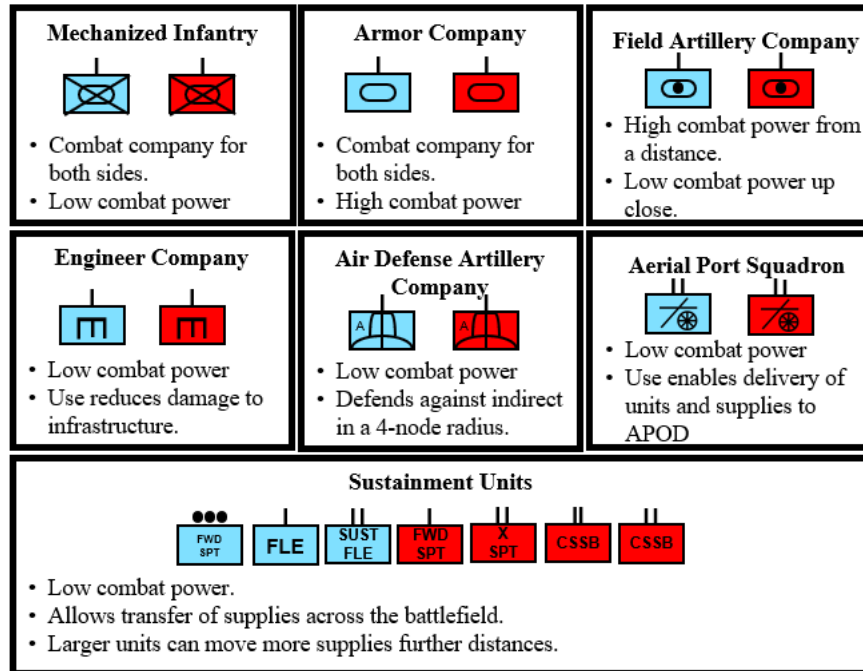


Figure 10. Unit Types.

Source: Created by Author.

The unit types in the wargame were simplified to reflect the major capabilities of a division and keep the game playable. To support the opposing sustainment systems used in the game, each players' combat units are matched, but their sustainment units are designed differently. For combat units, the number of units available to each player reflects two brigades consisting of armor, mechanized infantry, field artillery, sustainment, and key enablers. Each brigade consists of four combined arms battalions represented by their maneuver units: two battalions of two armor companies and one mechanized infantry company; one battalion of one armor company and two mechanized infantry company; one battalion of three field artillery companies. For sustainment units, each player has the same capacity to conduct sustainment, however, the gamma player's sustainment units are represented by one forward support company for each battalion, and one brigade support battalion per brigade. The delta player also has one forward

support company per battalion, but each company is broken into three platoon sized elements. Similarly, each brigade has a brigade support battalion, but that battalion is broken into four company sized elements. Both players have a division support brigade broken into two battalion sized elements. Enablers for both players include two air defense artillery companies, two engineer companies, etc. Figure 11. below depicts the units for each player.

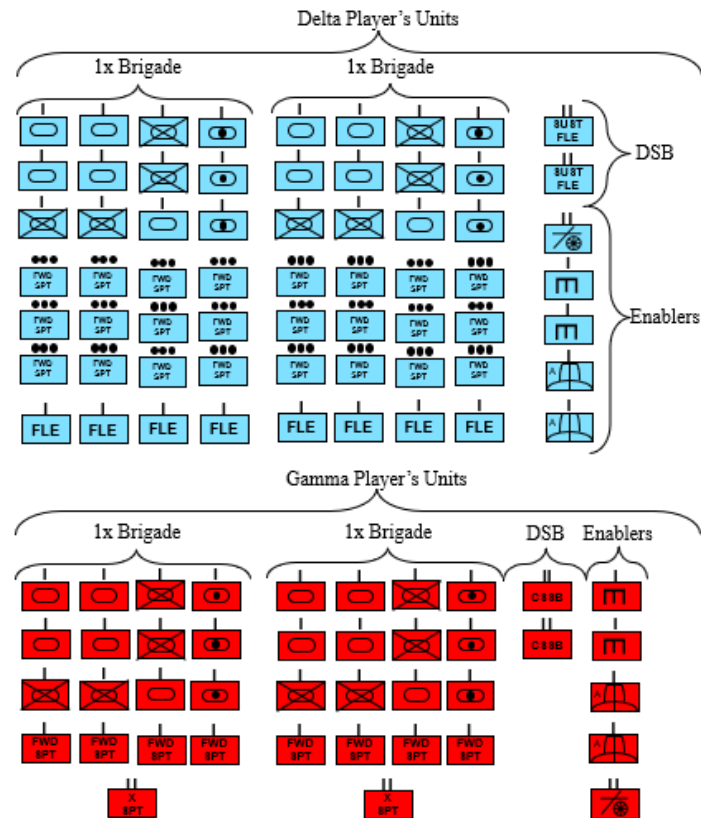


Figure 11. Units Available to Each Player.

Source: Created by Author.

Special Cards

Special cards are used in the game to provide effects players are expected to encounter in large-scale combat operations. This wargame utilizes ten special cards which will be discussed in depth in Part II of this chapter, according to what feature that card supports. Figure 12 depicts the

design of special cards, where each card has an title, a descriptive slogan, details on how the card is used, and the cost of the card in resource points (RP). The cards indicate if they should be discarded after use. In this case, a discarded card is returned to the special card deck and is available for purchase again in a future turn.

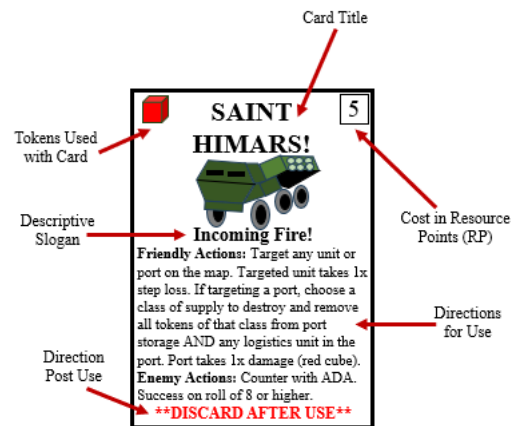


Figure 12. Special Card Example.

Source: Created by Author.

Mission Orders Cards

The Mission Orders Cards provide players with a method to plan the flow of combat (see figure 13). Only combat units have mission orders cards. Players will place these cards in the order in which they want to move their units. The use of mission orders cards represents the headquarters elements which are not represented by individual unit blocks.

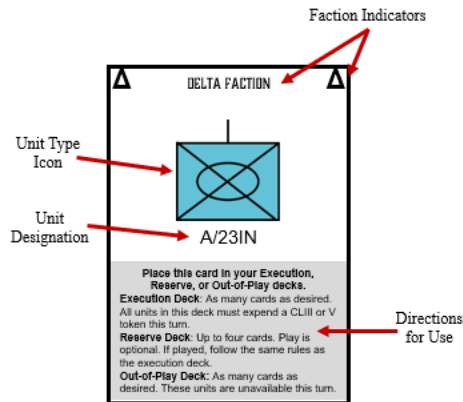


Figure 13. Mission Orders Card.

Source: Created by Author.

Tokens

This wargame utilizes several different plastic cubes, referred to as tokens, to represent different types of physical elements in the game (see figure 14). These tokens represent supply (food/water, fuel, and ammunition), suppression, degradation, and damage to infrastructure. Tokens are the main method players use to track logistics requirements and simulate moving supplies across the battlefield.

Players collect unit blocks, unit tracker cards, and unit mission orders cards for the starting units. Players place unit blocks onto the game map anywhere between their side of the board and the closest grey dotted line. A recommended starting deployment of units can be found in each player's reference card (see Appendix C), but players may deploy their units in any manner. Unit mission order cards are collected into a deck and placed in the "Mission Orders – Out of Play" box on the game board. Unit tracker cards are arranged below or to the side of the game board. The tracker cards allow the player to array their cards in the same manner as their units are arrayed on the game map for easy identification.

Each unit in play begins with a basic load of supplies, recorded on the unit tracker cards. For combat units a basic load equals the shaded boxes depicted on the associated unit tracker cards. Place a supply cube matching the color of the shaded box in each box. Blue cubes are class one (CL I, food, and water) and are placed in the blue shaded box. Green cubes are class three (CL III, fuel) and are placed in the green shaded box. Brown cubes are class five (CL V, ammunition) and are placed in the brown shaded box. For sustainment units a basic load equals all storage boxes on the tracker card filled. The shaded boxes indicate that unit's basic load and are the only boxes which must match the color of box to the color of the cube. All other boxes may be filled with supply cubes in any manner the player desires. Finally, players place their Aerial Port Squadron unit, four (4) green tokens, four (4) blue tokens, and four (4) brown tokens onto the "Assets in Packaging/RSOI" space of the SPOD queue on the game board.

Turn Sequence

After game setup is complete, the game progresses in phases and turns. Each turn consists of seven phases: (1) deploy; (2) spend resources; (3) transport supplies; (4) issue orders; (5) roll for initiative; (6) execute orders; and (7) CL I Consumption/Reset.

Phase 1: Deploy

In this phase, units and supplies move from the offshore delivery queue forward one space, moving from packaging/RSOI in CONUS (continental United States) to transit across the ocean onto the game map via an SPOD or APOD (see figure 16). All units arriving at a port start with a full basic load of supplies. Units and supplies may always be delivered to the SPOD and maybe delivered to the APOD when it is controlled by the Aerial Port Squadron (control requires occupation). Once units are deployed to an SPOD or APOD, their tracker card is placed with the player's other in use tracker cards and the unit's mission card is placed in the "Out of Play" deck on the game board. SPODs/APODs cannot receive supplies or units exceeding their storage capacity.

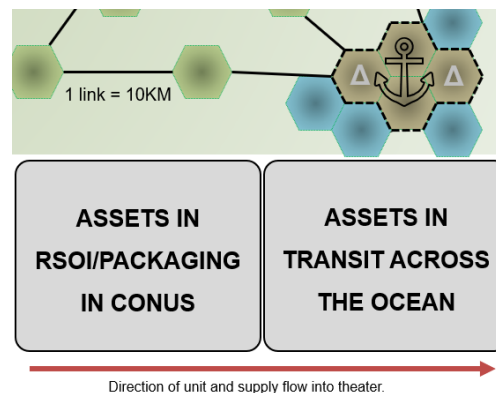


Figure 16. Offshore Delivery Queue.

Source: Created by Author.

Phase 2: Spend Resources

During this phase, players may acquire supply tokens, special cards, or new units by spending Resource Points (RP). Each player receives 25RP each turn. Resource points do not roll over. Supply tokens each cost one RP. Each new unit costs RP according to the number in the hexagon in the top right corner of the unit's tracker card. Each Special Card costs RP according

to the number in the hexagon in the top right corner of the card. Purchased supply tokens and units are placed in the player's delivery queue in the space marked "Assets in Packaging/RSOI". When an APOD is not controlled by an Aerial Port Squadron (APS), supplies, not units, may be delivered directly to the APOD at a cost of 2xRP per supply token. This represents the cost of strategic air lift. When an APOD is controlled by an APS, players can deliver units and supplies to the APOD at no additional cost, not to exceed the APOD's storage capacity. This allows the player to bypass the delivery queue wait time.

Phase 3: Transport Supplies

During this phase, players conduct resupply operations simultaneously. This phase is limited to five minutes. For the first turn, players should conduct resupply from the player's front line of troops (FLOT), or forward most units, back toward the SPOD. This enforces the habit of pushing supplies forward to combat units. Units located in the same node (only allowed in the SPOD and APOD) may cross-level supplies except when both units are combat units. Combat units may only cross-level CL I (food and water) and CL III (fuel). If both combat units are the same type, they may cross-level CL V (ammunition).

Each sustainment unit has a Sustainment Point (SP) limit, defining the distance that unit can move each supply token. At the beginning of the phase, all sustainment units are placed on their edge so that the sticker is facing the owning player. When the player completes all resupply actions a unit is allowed, the sustainment unit block is tipped back down with the sticker facing up. This provides the players with a method of tracking which units are still able to conduct resupply, and which are exhausted.

Players have three resupply methods available in this phase. First is MOVE SUPPLIES. In this method, any supplies in theater (on the game map) may be moved. Each sustainment unit

may move half its total storage capacity (number of boxes on the tracker card; round up), moving each token the number of links of that unit's SP. Supplies may only be moved into an open storage space on the receiving unit's tracker card. If no space is open, up to three tokens can be delivered directly to the node. However, these tokens are not carried with the unit when it moves and are lost if not picked up by the end of the turn, Phase 7.

The second resupply method is MOVE AND RESUPPLY. In this method, sustainment units may first move by expending a CLIII (fuel) token, then conduct resupply according to the rules in the MOVE SUPPLIES method. Movement of the sustainment unit is limited by that unit's movement points. This method requires the expenditure of a CLIII token to utilize.

The third option sustainment units have in this phase is DISPLACE. Sustainment units can displace by placing their unit block face down. A displaced unit cannot be targeted by fires, but also cannot deliver or receive supplies. This method reflects the need for sustainment units to balance logistics operations with survivability concerns. This does not expend a CLIII token. Displacement only lasts until the end of the turn.

Phase 4: Issue Orders

In this phase, players plan out their sequence of orders for execution in Phase 6 using mission orders cards. This represents the need to sequence of events and movements to achieve objectives while operating in the expected communications degraded environment of multi-domain operations. Mission orders cards represent an order issued to a unit to either move or engage in combat. Only combat units have mission orders cards since sustainment units receive their orders during Phase 3.

To issue orders, players collect mission orders cards for all combat units on the map. These cards can be organized into three decks: execution, reserve, and out-of-play. Players can

place as many or as few cards into the execution deck as desired. However, each unit with a card in the execution deck must at least expend a CLIII (fuel) token whether the player moves that unit on the game map or not. This rule was added after multiple playtests revealed a habit of players to give all their units an order, monotonously extending Phase 6 with no actual moves by any players. The only exception to expending a CLIII (fuel) token is for field artillery units, which may choose to expend either CLIII and move or CLV (ammunition) and fire on an enemy unit from afar.

Players may place up to four units' mission cards into the reserve deck. These cards allow a player to optionally use those units based on the flow of play. The reserve deck simulates a commander's ability to react to battle. Units in the reserve deck may be played at any point during Phase 4 as long as one player still has cards to play from their execution deck. Any units given orders from the reserve deck must follow the same rules of supply expenditure as those from the execution deck. If both players have exhausted their execution deck, then only one additional reserve card may be played by each.

For both the execution and reserve deck, the cards are placed so that when the deck is face down, the top card is the first card the player wishes to play. Any cards not placed in the execution or reserve decks are placed in the out-of-play deck and cannot be used at all during this phase. During this phase, players may include special cards placed in their executions deck. The position of the card in the deck dictates when they can be played.

Phase 5: Roll for Initiative

In this phase players roll for initiative for the next phase. This simulates the unpredictable nature of war. Each player rolls a d12 die. Initiative goes to the player with the higher roll.

In this phase, players can move units and engage in combat. This phase is conducted sequentially, starting with the player who has initiative. Players turn over a card from their execution or reserve decks to move or attack with the revealed unit. Players continue in turn until all cards from the execution deck are exhausted and each player has an opportunity to play one more card from their reserve deck.

Diagram illustrating the movement and engagement rules for a unit. A unit (represented by a green hexagon) moves from its starting position to a new position (represented by a green hexagon). The movement is divided into two segments: Movement Point 1 and Movement Point 2. The unit must engage in combat if it moves into an adjacent node (represented by a green hexagon) that is already occupied by another unit (represented by a green hexagon).

Source: Created by Author.

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expend CLIII to move to a port and expend additional CLIII to make repairs to that port. Repairs remove one token of damage from the port. Only one token per port may be removed per turn.

Phase 7: CLI Consumption/Reset

During this phase, units consume food and water and reset for the next turn. CLI (food and water) is consumed every third turn, representing the standard carry capacity of a combat unit of three days. Units that cannot consume CLI are considered degraded and marked with a red token on the unit block. Degraded units cannot move or attack and remain degraded until they can receive and consume a CLI token. If a unit cannot remove its degraded token by the next time CLI consumption is required, it takes a step loss.

During this phase, in all turns, reset actions are taken before the next turn. Any displaced units are turned face up and any suppressed units (indicated with a yellow block) are unsuppressed.

Combat Rules

Although this wargame is focused on the logistics challenges of LSCO, the combat interactions between players drives those logistics requirements and forces players to consider how they want to engage in combat when they are planning their resupply operations. The following sections describe the various aspects of combat in this wargame.

Combat Sequence

Combat is initiated when one unit moves onto a node adjacent to a node occupied by an enemy unit. Attacking players indicate combat by moving down the link to the adjacent node. When combat is initiated, it must be resolved. Units do not have the choice to move out of contact. As mentioned in the section about the unit block stickers, the number on the edge of the

block indicates the current combat strength of that unit, and how many dice that unit can be used in combat. The field artillery (FA) unit is the only type which does not follow this system. See the FA specific rules in the sub-section below.

When engaging in combat, both units must expend a CLV (ammunition) token. Armor units must expend both CLIII and CLV. This rule replicates the high cost of fuel associated with tanks in real life. If a unit cannot expend the requisite supply tokens it may not initiate combat. If a unit challenged to combat cannot expend the requisite supply tokens, it endures an attack without fighting back. The defending unit rolls their dice first, representing that a unit in defense would identify a unit moving into contact. Players can change this by using the Scout's Out Special Card, discussed in a subsection below. The defending unit scores a hit on a roll of seven or better on a d12 die. The first scored hit by either the defending or attacking unit sends the receiving unit into suppression (marked with a yellow token). Each hit after results in a step loss on the receiving unit. The attacking unit then rolls dice based on the resultant combat power. The attacking unit also scores a hit on a seven or better unless the defending unit occupies a town, city, or port. These locations provide the defending unit with an advantage. A town increases the attacking unit's required roll for a hit from seven to eight (+1) while a city or port increases it from a seven to a nine (+2).

The unit dealing out the higher number of hits wins the engagement. The winner of the engagement retains control of the node on which combat occurs. Whoever loses the engagement retreats from the node according to the retreat rules discussed in the next section. If the number of hits scored is equal, the attacking unit returns to its original node and the defending unit retains control of its current node. When hits scored are equal, neither player has won the engagement. When hits are unequal, the player with the most hits scored against their opponent

is considered the winner, regardless of their position as the attacking or defending unit. At this point, the winner of the engagement can choose to engage in another attack by expending additional CLV and/or CLIII. If a unit receives enough hits to run out of step loss options (for a full-strength unit, suppression plus four hits) it is destroyed, and the unit is removed from the board.

Field Artillery Specific Combat Rules

Field artillery (FA) units can enter either a direct fight (attacking a unit in an adjacent node) or an indirect fight (attacking a unit from a distance of two or three nodes). If an FA unit engages in a direct fight, it follows the rules of combat like any other unit but is limited to a single die. FA unit engaging in an indirect fight can increase its dice by expending additional CLV tokens to target an enemy unit that is two or three nodes away from its position. In this scenario, the FA unit identifies its intended target and expends CLV (ammunition) to attack. FA units can expend up to three CLV tokens and roll a die for each token. This simulates the high expenditure of specialized ammunition field artillery units incur in real life. Hits are scored on a seven or better unless modified by defensive positions as discussed above. Unless the FA unit is attacking another FA unit, the opposing unit cannot counterattack. Field artillery units fire rockets which fire too many shots from too short a distance for air defense artillery units to intercept the rockets, so players cannot use ADA to defend against FA attacks.

Scouts Out Special Card

The Scouts Out Special Card replicates the use of battalion scouts being prioritized to the company in combat (see figure 18). This card allows the attacker to “identify enemy positions and attack first” by rolling their dice and scoring hits first. This card costs 1x RP and is discarded after use.

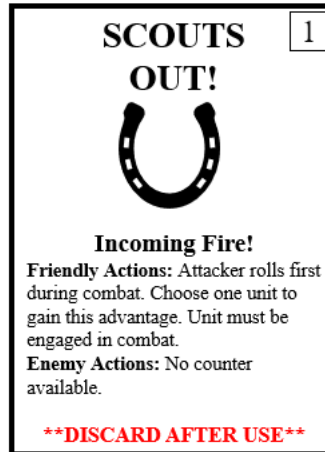


Figure 18. Scouts Out Special Card.

Source: Created by Author.

Retreat Rules

When combat is conducted and it does not end in a draw, the losing unit must retreat. In this instance, the winning unit retreats the losing unit two nodes in whatever direction they prefer. This moves them out of combat range and allows the winner to organize the battlefield to their advantage. If nodes are occupied in such a way that the losing unit cannot retreat two nodes without stacking with another unit, the loser takes an additional step-loss instead. This represents the reality that a unit with nowhere to retreat would continue to take casualties from enemy fire.

Suppression

When units engage in combat, the first hit taken results in suppression of that unit rather than a step loss. This suppression represents the dual reality that enemy units would immediately take cover upon receiving fire and that initial attacks are less accurate than follow-on fire. Suppression is indicated by a yellow token and lasts for the entire turn. Suppressed units can fight, but not move. For field artillery units, rolling a twelve on any die models that the first shot

was also a lucky accurate shot. In this instance, a die roll of twelve counts for both a suppression and a step loss on the enemy unit. This only applies to field artillery units.

Part II: Modeling Key Dilemmas

The literature review established the key dilemmas of sustainment in large-scale combat operations that should be modeled in *Lines and Webs*. They were sustaining across lines versus webs; contested logistics; the battlefield as a panopticon; and the innovative use of technology.

Lines Versus Webs

The core design of this wargame rests on the opposing sustainment systems used by each player and informs the name of the wargame. The Gamma Faction (using the red blocks) utilizes a traditional sustainment system that military players are familiar with from how sustainment is currently conducted in the United States Army (see figure 19). This traditional system has assigned sustainment units for each combat battalion, brigade, and division. These units are larger entities with the capability to move substantial amounts of supply quickly. However, their line like design of sustainment means that lines of communication (LOCs or routes of supply) to the frontlines are easily disrupted.

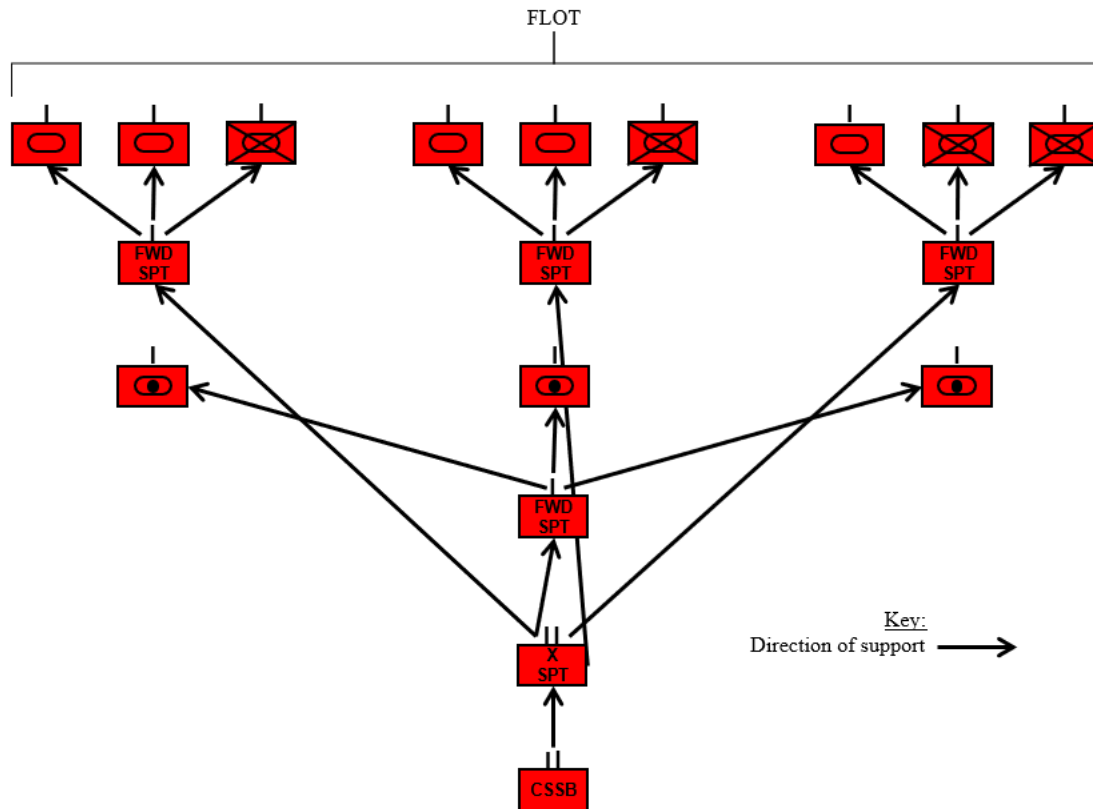


Figure 19. Line Sustainment System (Gamma Faction)

Source: Created by Author.

The Delta Faction (using the blue blocks) utilizes a weblike system of sustainment developed from the SPIDERWEB and Adaptive Logistics theories discussed in Chapter 2 (see figure 20). This system has the same amount of sustainment as the Gamma Faction, but each unit is broken into smaller elements: Forward Support Company (FSC) into three FSC platoons; Brigade Support Battalion (BSB) into four company sized Forward Logistics Elements; Division Sustainment Brigade (DSB) into two Combat Service Support Battalions (CSSB). These more numerous, smaller elements allow the player to design a web-like sustainment system that is more resilient to attack, but it takes longer to move the same amount of supply to the frontlines. The juxtaposition of these two sustainment systems allows players to experiment with the

differing challenges of logistics in large-scale combat operations and consider possible mitigating strategies.

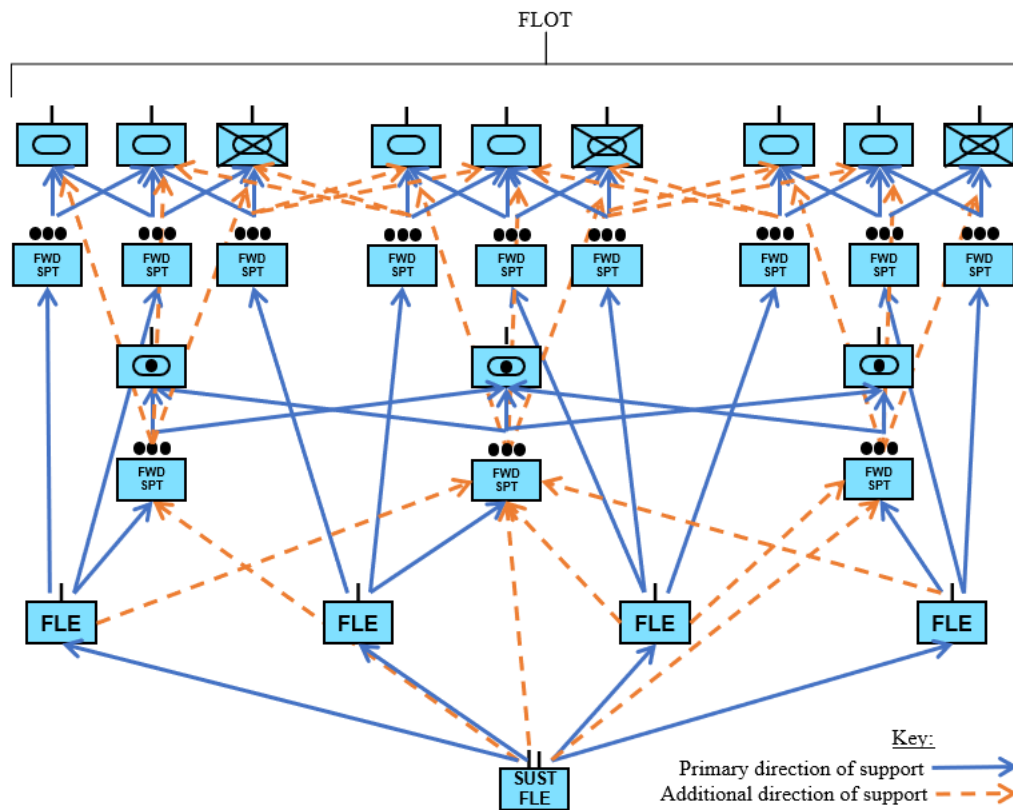


Figure 20. Web Sustainment System (Delta Faction)

Source: Created by Author.

Contested Logistics

In large-scale combat operations, sustainment nodes and lines of communication will be critical targets to affect the flow of combat. The following features demonstrate the vulnerability of sustainment in the wargame. First, are several special cards: (1) Saint HIMARS; (2) Close Air Support; (3) SF in the Rear Area; (4) 9-Line Recovery; and (5) Massive Casualties. Second, there is no true rear area and logistics depots at SPODs and APODs are easily targeted. Third,

divisions include limited air defense support, represented in the wargame by the two Avenger Air Defense Artillery companies which provide limited protection against indirect fire.

Saint HIMARS

The Saint HIMARS special card allows a player to target indirect fires onto any unit or port on the board (see figure 21). The longest range of a High Mobility Artillery Rocket System (HIMARS) is 300km, reaching well beyond the size of the game map.¹¹⁶ This coupled with the likelihood that all units will be easily found in a large-scale combat operation, makes the HIMARS a particularly lethal and effective asset. This asset is modeled as a special card with a high cost to buy (five RP) and must be discarded immediately after use. This design reflects the reality that the HIMARS has limited ammo (1-6 rounds depending on type) and is an asset reserved to corps or higher elements.¹¹⁷

¹¹⁶ Lockheed Martin, “HIMARS,” accessed March 16, 2024, <https://www.lockheedmartin.com/en-us/products/himars.html>.

¹¹⁷ Ibid.

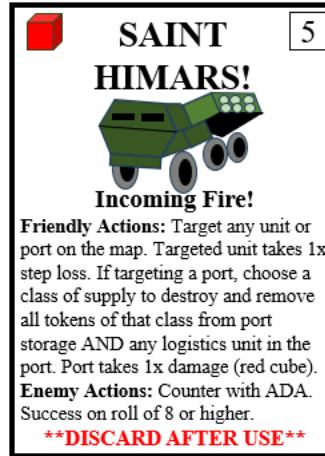


Figure 21. SAINT HIMARS Special Card.

Source: Created by Author.

Close Air Support

The Close Air Support card simulates the reality that units in combat will have air support at key times during combat (see figure 22). Unlike the Saint HIMARS card, this card cannot target infrastructure and must be used in relation to a friendly unit. This represents the reality of how air support is employed in combat: when air support is available, units call in strikes on enemy targets identified in their vicinity.¹¹⁸ Because close air support is not always apportioned to a unit, this card has a higher cost (3 RP) and must be discarded after use. This card simulates the notion of joint integration between ground and air forces and threatens vulnerable sustainment units.

¹¹⁸ “Close air support (CAS) is air action by aircraft against hostile targets that are in close proximity to friendly forces and that require detailed integration of each air mission with the fire and movement of those forces.” Chairman of the Joint Chiefs of Staff, *Joint Close Air Support*, Joint Publication 3-09.3, Washington, DC: Joint Chiefs of Staff, 2021, I-1.

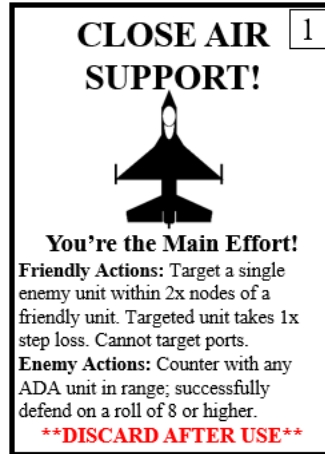


Figure 22. Close Air Support Special Card.

Source: Created by Author.

SOF in the Area

The SOF in the Area special card reflects the reality that special forces are a consistent element operating in combat locations often long before ground forces arrive. Special forces are often operating in the deep area (beyond the frontline of troops).¹¹⁹ The enemy's deep area, therefore, is the friendly's rear area (behind the combat units where sustainment forces operate). Although these forces are not large, they can create problems through guerrilla attacks. The special card represents this by allowing a player to restrict movement of units or supplies through a single node for one turn (see figure 23). Since special forces units are less numerous than conventional units, this asset is reflected as a card and not a unit block and has a higher cost to buy (3 RP).

¹¹⁹ Robert Toguchi and Michael Krivdo, ed, *The Competitive Advantage: Special Operations Forces in Large-Scale Combat Operations*, Large-Scale Combat Operations Series (Fort Leavenworth, KS: Army University Press, 2019): 254.

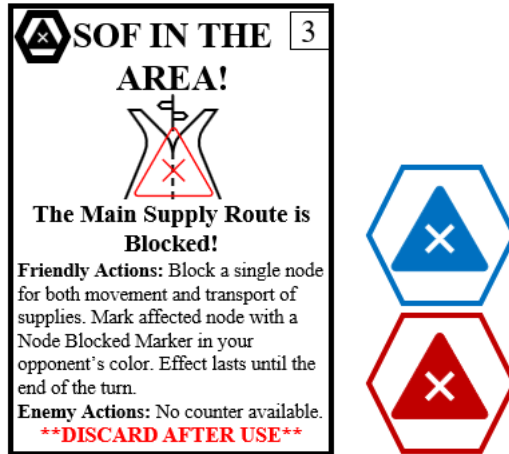


Figure 23. SOF in the Area Special Card and Node Blocked Marker.

Source: Created by Author.

9-Line Recovery

The 9-Line Recovery special card reflects the reality that units take equipment damage during combat as well as suffer regular maintenance faults during operations (see figure 24). A player uses this card to induce maintenance issues on one of their opponent's units, preventing that unit from movement or combat until those faults are "fixed" through the delivery of an orange cube. This card introduces an aspect of chaos found on the battlefield.



Figure 24. 9-Line Recovery Special Card

Source: Created by Author.

Massive Casualties

The Massive Casualties special card reflects the likelihood that the losing unit in a combat engagement would also have to deal with numerous casualties (see figure 25). As indicated this card can only be used by the successful player of a combat engagement against the opponent's losing unit. The targeted unit takes an additional step loss. This card replicates the impact of combat on personnel, a core aspect of sustainment.

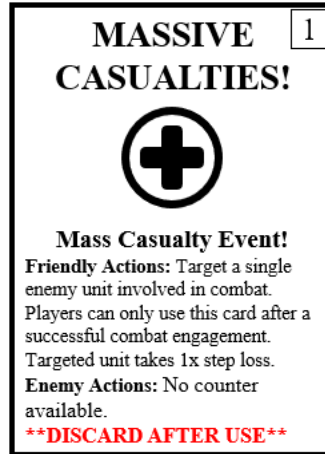


Figure 25. Massive Casualties Special Card

Source: Created by Author.

No True Rear Area

A rear area is the space behind the combat units, in friendly territory which has, in theory, been cleared of enemy combatants. In large-scale combat operations, however, most if not all units are easily found on the battlefield. This results in an increased threat to not only sustainment units in the rear, but also the depots built at ports like the APOD and SPOD. To replicate this in the wargame, players use the Saint HIMARS special card to target the ports and, when successful, remove all of one type of supply stored in that location. This replicates like items being stored together and that large volumes of supplies are easily identifiable.

Protection Against Indirect Fire

Although all units are easily found and targeted in large-scale combat operations, divisions do have limited assets to protect against indirect fire, the air defense artillery (ADA) battalion represented as two ADA companies (see figure 26). These companies each host twelve

Avenger systems using Stinger missiles which each have a range of about 8km.¹²⁰ The unit block provides coverage for four links in any direction, simulating the avenger units arrayed in concentric circles from the location of the unit block's node. While the ADA companies cannot cover the entire battlespace, players can employ them strategically to cover their most vulnerable locations.



Figure 26. ADA Company Unit Block.

Source: Created by Author.

The Battlefield as a Panopticon

Several design choices replicate the aspect that all units are easily findable in a LSCO environment. The first design choice is to play the wargame with the unit blocks laid face-up and visible by both players. The second design choice is the inclusion of the special cards Drone Recon and Command Post.

Unit Block Face-Up

As discussed in the literature review in Chapter 2, one of the major challenges of large-scale combat is the difficulty in masking unit movement or positions. To replicate this high findability in the wargame, all the unit blocks are placed face-up and visible to both players (see figure 27). Several factors contribute to the ease with which units can be found in LSCO. First,

¹²⁰ Federation of American Scientists, “FIM-92A Stinger Weapons System: RMP & Basic,” Military Analysis Network, accessed March 17, 2024, <https://man.fas.org/dod-101/sys/land/stinger.htm>.

the use of mini drones to find and target enemy units in the Russia-Ukraine war also contributes to the panopticon effect of the battlefield. Second, the use of competent special forces by both the U.S. Army and peer/near-peer armies. The ability to see all unit blocks and their information abstracts special forces in the wargame.

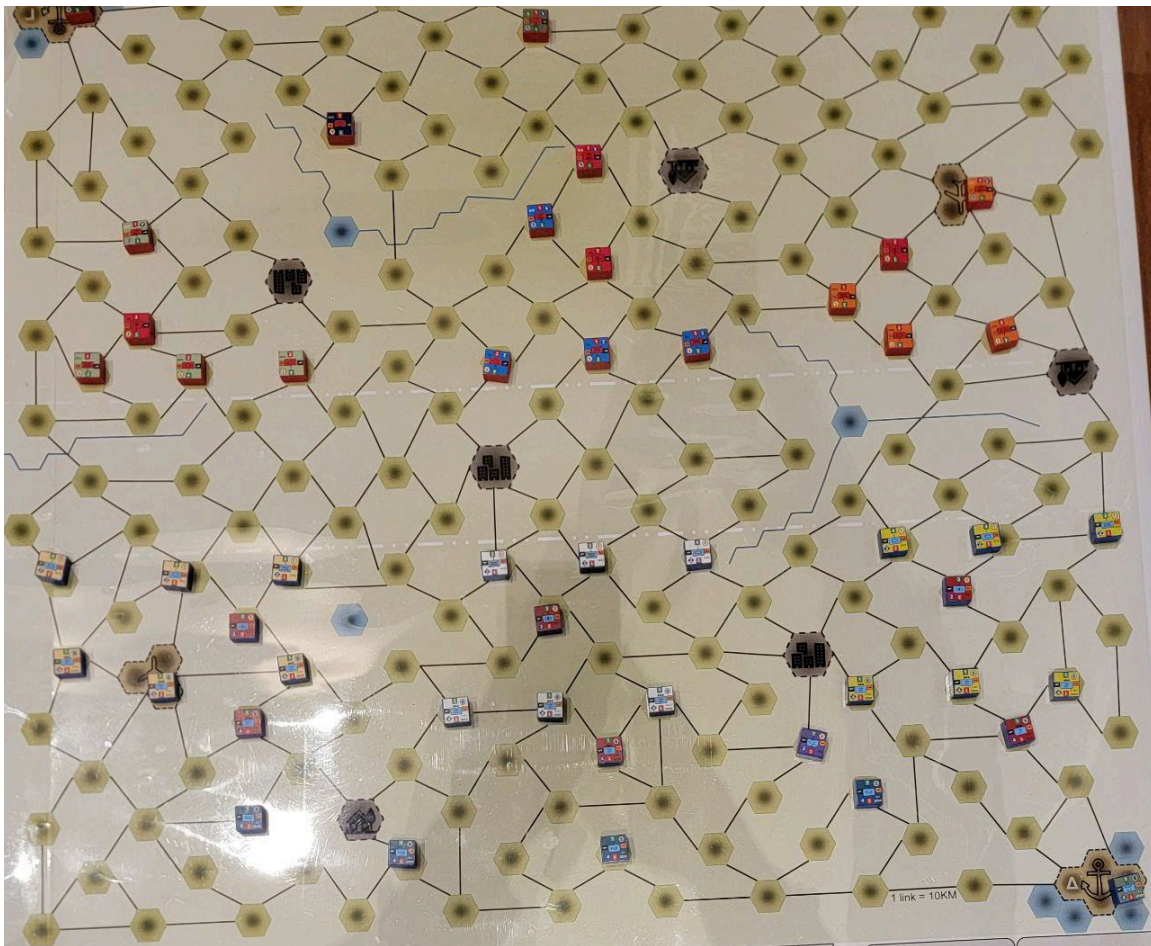


Figure 27. Example of Unit Placement.

Source: Photo by Author.

Drone Recon

The Drone Recon Special Card reflects the use of drones to find and target enemy formations that is currently occurring in the Russia-Ukraine War as was discussed in Chapter 2 (see figure 28). Since all unit blocks are visible to both players, the drone recon card is not used

in the obvious manner: to identify enemy units. Rather, this card counters another specific card in the special card deck, the Command Post Special Card. The Command Post Special Card is discussed in the next section. The Drone Recon card allows a player to “see” that their opponent is planning to conduct a concerted attack with multiple units and negate that ability by “attacking” the command post organizing the attack.

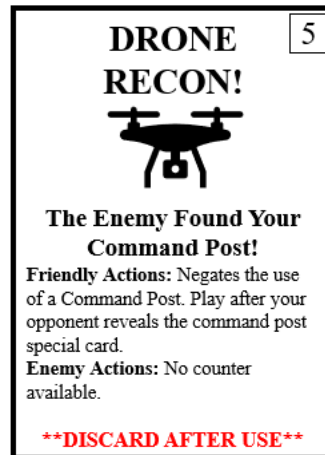


Figure 28. Drone Recon Special Card.

Source: Created by Author.

Command Post

Battalion headquarters are not replicated in the unit blocks for this wargame, providing the player with more freedom of maneuver utilizing company elements. Headquarters units are mostly abstracted into the mission orders cards aspect of the game. Within the design of the game, stacking units into one node overpowers the combat aspect of the game and encourages devaluation of the logistics planning, which defeats the purpose of this research. However, this part of the design precludes the players’ ability to conduct concerted attacks. To return this capability to the game, the Command Post Special Card allows a player to move three unit-blocks in a single move, instead of one by one (see figure 29). This card is placed in the Mission

Card Execution Deck so that it is played prior to the three units the player wishes to move in concert and is discarded after use.



Figure 29. Command Post Special Card.

Source: Created by Author.

Innovative Use of Technology in Multi-Domain Operations

To replicate the near-future aspect of this wargame, several features represent the use of innovative technology, a key feature of future LSCO fights. These near-future technologies are represented through special cards: (1) Drone Recon; (2) Air Drop Inbound; (3) Cyber Attack.

Drone Recon

The Drone Recon card was discussed in the last section as it contributes to the panopticon nature of the battlefield. It also represents a novel use of mini drones.

Air Drop Inbound

Chapter 2 discussed the development of drones with the capability to carry larger amounts of weight (250+ pounds). The Air Drop Inbound card replicates the possibility of this technology by allowing a player to deliver one supply token (blue, green, or brown) or one

replacements token (orange) directly to a single unit (see figure 30). This card answers the MASCAL (mass casualty) special card and the 9-Line Recovery special card. When not used in response to a special card, this card removes one step loss from a single unit. This card is discarded after use.



Figure 30. Air Drop Inbound Special Card.

Source: Created by Author.

Cyber Attack

The Cyber Attack Special Card replicates the possibility of having to operate in anti-access/area denial conditions (see figure 31). Using this card allows players to disrupt their opponents tactical plan. As was described in the previous section, players use mission cards to determine the flow of their combat plan. The Cyber Attack card allows a player to shuffle their opponent's mission card deck and place it in any order they wish. This simulates the real-world scenario that communications are disrupted, and units will act on their last given orders.

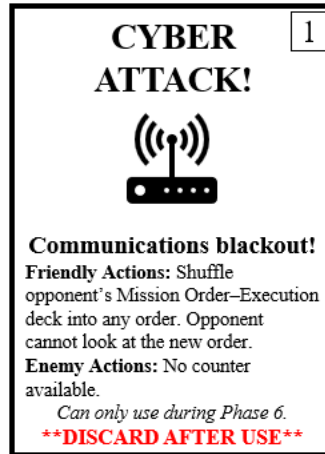


Figure 31. Cyber Attack Special Card.

Source: Created by Author.

Summary

This chapter addressed the secondary research question 1 and 2: What aspects of reality must be modeled and how can they be effectively modeled in a useful wargame? Part I described the foundations of the wargame design. Part II addressed how the wargame design approached modeling the themes identified in Chapter 2. The next chapter will discuss insights made during development and playtesting of the wargame as well as recommendations for future research.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This thesis has addressed the primary research question of how to model the challenges of logistics into a competitive wargame that supports the exploration of decision-making for logistics in near-future large-scale combat operations. The final wargame, *Lines and Webs*, is suitable for military professionals at the company grade level and above. This chapter addresses a summary of insights made during the development of the wargame as well as recommendations for future research and utilization of the wargame.

Insights

A Valuable Tool and A Tradeoff of Choice

The first insight is how the wargame will be a valuable tool to provide players an understanding of the challenges they will face keeping operations in supply when operating in large-scale combat. Playtesting led to the discovery that conducting successful logistics in a LSCO environment will force commanders to confront a choice: short term efficiency or long-term resilience. During playtesting, the most common observation was the effect the juxtaposed sustainment systems communicated. Specifically, players using the traditional system (red blocks; Gamma Faction) remarked how vulnerable they felt their logistics assets were, while the players using the web-like system (blue blocks; Delta Faction) commented their logistics capability felt sluggish. This prompted the players to discuss the tradeoff between the systems. Using the traditional method could push large amounts of supply very quickly but was easily broken if attacked. This suggests that in LSCO this method is reliable for only short periods of time and represents a potential risk for commanders to underwrite. However, discussions

revealed that the answer was not as simple as adjusting to the web-like method. The web system, while more resilient, took much longer to move supplies to the target units. It also presents several challenges to tracking requirements. Commanders using this method would underwrite a different kind of risk. Considering these competing types of risk, it is apparent that successful divisions in a LSCO fight will need to adjust between traditional and web-like sustainment systems.

The juxtaposition of the traditional sustainment system to the proposed web-like system also invites military officers to consider various implications at both the tactical and operational levels. At both levels, officers must consider how to adjust training to support the survivability of sustainment units and lines of communication. At the tactical level, officers must consider reorganizing their logistics elements to allow operating in the flexible web-like manner. At the operational level, military leaders must consider what organizational, equipment, and technology changes are needed to support the web-like system. Sustainment units operating in this system need additional communications and mission command infrastructures to be successful.

Sustainment Sets the Tempo

The second insight results from another observation made by play-testers. Army logisticians, of whom this researcher is one, are familiar with the adversarial push and pull between maneuver and sustainment. Maneuver officers often express frustration that logistics holds back their combat operations. However, one Army officer noted this is a common feature of combat, stating “1) intel drives fires; 2) fires drives maneuver; 3) and sustainment sets the tempo.”¹²¹ By turn 3, playtesters of *Lines and Webs* consistently recognized the importance of

¹²¹ Dallas Cheatham, LTC, email message to author, February 12, 2024.

managing their sustainment system. Considering what survivability actions they should use to maintain their lines of communication, as discussed in the previous section, was only one aspect of this management. In addition to this, players had to consider their combat and supporting resupply actions multiple steps ahead to ensure they could meet their objectives.

Balancing Reality with Enjoyment

The third insight is how important it was to find the line between modeling reality and retaining enjoyment when playing the wargame. War is often compared with chaos and while it is useful to model the complex nature of a battlefield, there is a point at which that complexity takes a toll on the players. This wargame is intended as a learning tool in which players make multiple attempts to expand their understanding and refine their strategies. A game which confers a large mental toll on the players is unlikely to encourage those players to play a second time.

Early in the playtests, several players commented on the complicated aspect of the supply tracking system. To reduce the amount of information players had to keep at the front of their mind, the researcher made several changes to the design. One example is the rule to stand up sustainment units at the beginning of the resupply phase and lay them back down once that unit has completed all resupply options. This created a visual marker of progress through the supply phase and removed the requirement for the players to remember which units' supply capabilities had been exhausted. Another example is making the tracker cards separate items instead of printing them on a single piece of paper. This allowed players to organize the tracker cards in a similar layout to how their units were arrayed on the map board. This reduced players' need to translate data on position between map board layout and tracker card layout.

Reducing cognitive load on players increases the likelihood of subsequent attempts at the wargame. Playtesters in later versions of the wargame, who were able to play with the design changes, expressed interest in playing again - often because they felt they could do better the next time. This shows the wargame design weighted enough towards enjoyment to increase the wargame's worth as a valuable tool while not impacting the core purpose to expose players to multiple sustainment systems.

Recommendations

The wargame *Lines and Webs* was developed to address the challenges of conducting sustainment in large-scale combat operations. The final product achieved this objective and can be employed as a useful tool for military professionals to explore different systems of sustainment against a near future, peer/near-peer threat. This section includes several recommendations for use of the wargame, potential expansions, and future research.

Professional Military Development

Replicating the likely environment of large-scale combat is difficult in training exercises. These exercises place officers in the middle of the conflict, making it difficult to understand what actions have what consequences. A wargame, on the other hand, allows officers to experiment with different strategies in a safe-to-fail environment. *Lines and Webs* provides the perfect venue for officers at all levels to explore different logistical strategies with a broad view of the battlefield. This wargame encourages discussions on how to translate the proposed sustainment systems, actions, and reactions into real life. Brigade support commanders can play this game with their forward support commanders, division support commanders with their brigade support commanders, and use it as a medium to discuss the insights the game encourages. *Lines and*

Webs can be used as a leadership development product in Army formations as well as during both maneuver and sustainment career education.

Expansions

This wargame represents the basic version developed from the research. However, it has the potential for several expansions to support specific goals of the players.

Additional Special Cards

Including new special cards in the game can provide unique challenges for army leaders to consider. One special card that can be added is one that affects entire areas of the game map. This can be done with a chemical or nuclear special card. Both cards would allow players to deny sections of the map to their opponents and create unique logistics problems to solve.

A New Game Map

Utilizing the same hex and node system, but with different terrain features can change the challenges that players must address. Other game maps can focus objectives on tactical scenarios that military professionals often address in training exercises. An alternative game map might create a wet gap crossing obstacle that forces players to rely on non-traditional resupply methods that encourages a more strategic use of the air-drop special card and the echelon of logistics units onto key terrain.

Mis-matched Opponents

Although in a peer/near-peer conflict opponents are likely to be evenly matched, it is possible peer opponents meet on the battlefield with different sizes of military forces. Starting the wargame with one player who has significantly more combat assets at the start of the conflict than the other can help players investigate how that affects managing the logistics systems. In

this expansion, both the overpowered and the underpowered side can switch between the traditional and web-like sustainment systems. Players can then see how each system holds up under this new predicament.

Further Research

During the development and playtesting of this wargame, several ideas for further research presented themselves. This research includes assessing what equipment units in LSCO might require and forays into artificial intelligence (AI).

Logistics Equipment for LSCO

First is a procurement study to address the infrastructure requirements to support different logistics systems. When playtesting the game, players remarked how the web-like system, while resilient, could not be executed with the communications, life support, and mission command system currently available within logistics units. This research can also include commercial technology that can be used innovatively in a LSCO fight in a comparable manner to the various drones already under review. Research into the specific equipment to support logistics units shifting between the traditional and web-like systems is the first step to initiating a procurement process to field that equipment to Army support elements. Expanding and creatively thinking about how current technologies can be incorporated into Army logistics will be key to success in future conflicts.

Logistics AI

Further research should center around artificial intelligence, the admittedly hot topic of the mid-2020s. In a combat environment where a lack of communications is more likely than not, systems that can estimate supply and maintenance requirements with a high level of

accuracy will bridge the gap to receiving updates from the units themselves. Historical data and experience can provide significant ability to make estimates without AI, but these estimates lose accuracy when logisticians have no reference for the intensity or type of combat that is occurring.

AI can also help assess the most efficient route or expedite orders to resupply units. With the data of unit locations, on-hand supply, and requirements, AI could match logistics units with the right assets to combat units in need in a way that maximizes support while minimizing threats to vulnerable units. Doing this requires collecting data in a digital manner that is currently collected by analog systems. Research in this arena should focus on both the input (digital collections systems), analysis (AI), and output (how the plan is communicated to the users). Cracking the code on a secure logistics AI will provide significant advantage in an environment with innumerable weapons systems to exploit.

Summary and Conclusion

This research attempted to develop a learning tool investigating the challenges of sustainment in large-scale combat operations. It did this by answering the primary research question: How can the complexity of large-scale combat maneuver and sustainment operations in near-future combat be represented effectively in a competitive wargame in order to teach the importance of flexible, self-correcting sustainment systems?

This primary research question was divided into two secondary research questions that were answered in chapters two through four. Chapter 2 investigated the key systems, dilemmas, and dynamics of the reality of sustainment in LSCO that should be modeled in the wargame and answered secondary question 1 and focused the wargame on the competing lines versus webs sustainment systems. Chapter 3 addresses the research methodology and how the wargame

design was incorporated with grounded theory to develop a game as an answer to the primary research question. Chapter 4 answered secondary question 2 through an iterative development process and detailed the design choices of the game map, lines versus webs sustainment systems, contested logistics, the battlefield as a panopticon, and the innovative use of technology resulting in an effective wargame.

Wargames provide a safe-to-fail environment that encourages players to experiment with strategies that can lead to creative ideas and out-of-the-box solutions. Wargames allow players to investigate complex situations and better understand causal relationships, which might be overlooked in the chaos of real life. *Lines and Webs* replicates major themes found in large-scale combat operations and provides a sandbox for players to test alternative sustainment systems which each have advantages and disadvantages. This researcher anticipates this wargame will find a home in professional leader development and military education as a method for exploring the unique predicaments expected in large-scale combat operations.

APPENDIX A

WARGAME PARTS LIST

Table 1 below describes a complete list of parts required for the wargame *Lines and Webs*.

Parts list for <i>Lines and Webs</i> .			
No.	Category	Item	Qty.
1	Maps	Game Map	1
2	Game Aids	12-sided Die	10
3		10-sided Die	1
4		Dice Tower (recommended)	2
5		Timer or Stopwatch	1
6	References	Rule Book	2
7		Delta Player Card	1
8		Gamma Player Card	1
9	Tokens	Food Cube (Blue)	300
10		Fuel Cube (Green)	300
11		Ammunition Cube (Brown)	300
12		Damage Cube (Red)	50
13		Suppression Cube (Yellow)	50
14		Repair/Replacements Cube (Orange)	50
15		Degraded Cube (Black)	50
16		Delta Node Blocked Marker (Blue)	6
17		Gamma Node Blocked Marker (Red)	6
18	Special Cards (3 of each for each player)	Saint HIMARS!	6
19		Close Air Support!	6
20		Scouts Out!	6
21		9-Line Recovery!	6
22		Drone Recon!	6
23		SF in the Area!	6
24		Command Post!	6
25		Cyber Attack!	6
26		MASS CAL!	6
27		Air Drop Inbound!	6

Delta (Blue Player) Starting Package			
28	Unit Blocks	Forward Support Platoon	12
29		Forward Logistics Element (Company)	4
30		Forward Logistics Element (Battalion)	1
31		Armor Company	5
32		Mechanized Infantry Company	4
33		Field Artillery Company	3
34		Aerial Port Squadron	1
35		Air Defense Artillery Company	1
36	Cards	Unit Tracker Cards	31
37		Sea Port of Debarkation (SPOD) Tracker Card	1
38		Airport of Debarkation (APOD) Tracker Card	1
39		Mission Order Cards	13
Delta (Blue Player) Expansion Package			
40	Unit Blocks	Forward Support Platoon	12
41		Forward Logistics Element (Company)	4
42		Forward Logistics Element (Battalion)	1
43		Armor Company	5
44		Mechanized Infantry Company	4
45		Field Artillery Company	3
46		Engineer Company	2
47		Air Defense Artillery Company	1
48	Cards	Unit Tracker Cards	32
49		Mission Order Cards	15
Gamma (Red Player) Starting Package			
50	Unit Blocks	Mechanized Infantry Company	4
51		Armor Company	5
52		Field Artillery Company	3
53		Forward Support Company	4
54		Brigade Support Battalion	1
55		Air Defense Artillery Company	1
56		Aerial Port Squadron	1
57		Division Service Support Battalion	1
58	Cards	Unit Tracker Cards	20
59		Sea Port of Debarkation (SPOD) Tracker Card	1
60		Airport of Debarkation (APOD) Tracker Card	1
61		Mission Order Cards	13

Gamma (Red Player) Expansion Package			
62	Unit Blocks	Mechanized Infantry Company	4
63		Armor Company	5
64		Field Artillery Company	3
65		Forward Support Company	4
66		Brigade Support Battalion	1
67		Air Defense Artillery Company	1
68		Engineer Company	2
69		Combat Service Support Battalion	1
70	Cards	Unit Tracker Cards	21
71		Mission Order Cards	15

Table 1. Parts List.

Source: Created by Author.

APPENDIX B

WARGAME RULE BOOK FOR *LINES AND WEBS*

Introduction

Scenario

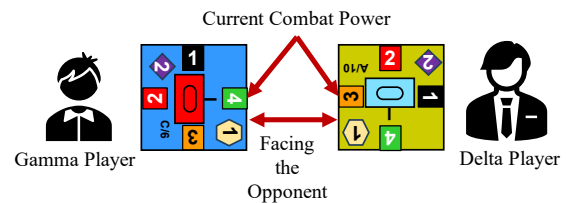
Lines and Webs is a near-future fictional wargame. Players take on the role of either the Gamma or Delta division commander as they lead their respective forces to conquer the map. Both players begin with a foothold on the map and the opportunity to bring in additional supplies, units, or higher assets. The map represents the theater of operations for both players. Success is defined by the player's ability to control operations in theater, represented by control of the ports.

Timescale and Victory Conditions

Each turn of the wargame represents a day of fighting. Turns are tracked using a 10-sided die; the side facing up indicates the current turn. Play continues until victory is achieved or the end of the fifteenth turn.

Victory: One player controls all ports (airports and seaports) for an entire turn. Ex. Gamma player gains control of all four ports during phase 6 (see Turn Sequence section) on turn 7. If the Gamma player still controls all ports at the end of phase 7 on turn 8, then the Gamma player wins, and the game is over.

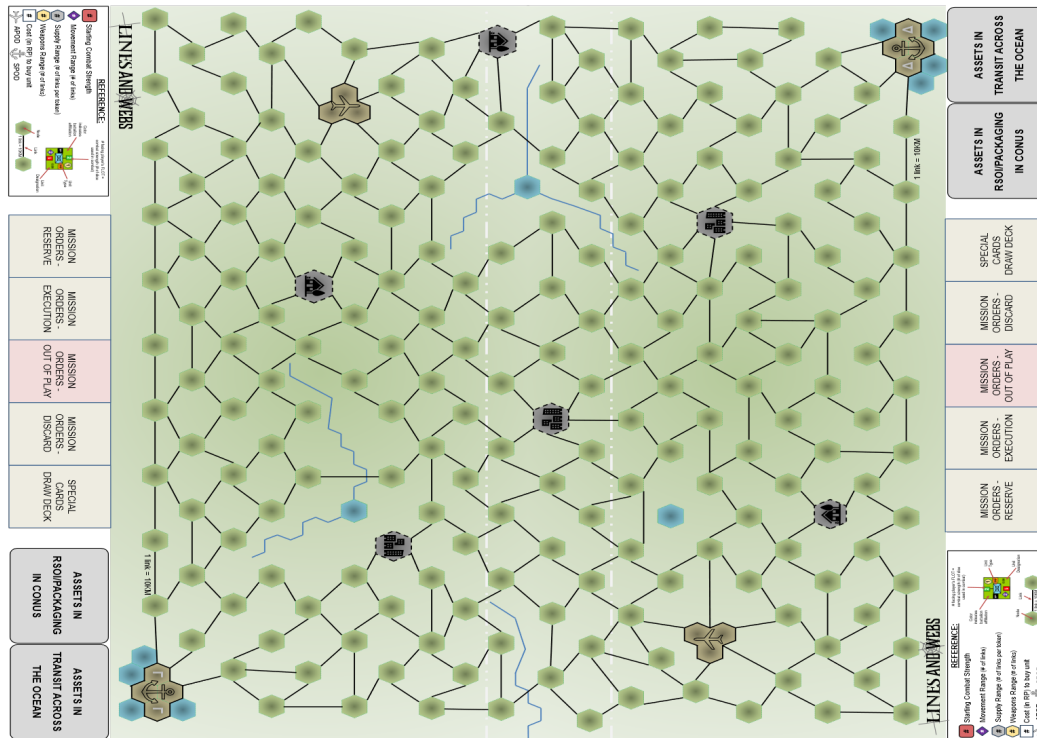
Determining Victory on Turn Fifteen: If neither player controls all four ports by the end of turn fifteen, then the player with the most ports in their control wins. If players each control two ports, then the player with the higher remaining combat power wins. To calculate the total remaining combat power, players add up the combat power number for each unit still on the map (the number in the box facing the enemy on the unit block).



Number of Players and Game Variations

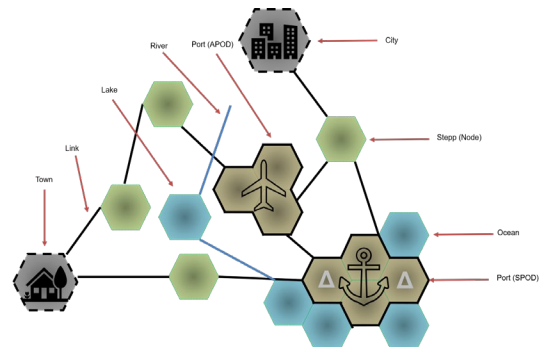
Lines and Webs is designed as a two-player wargame. The game may be played by four players. When playing with four players, players are divided evenly between sides. Each side can divide up responsibilities between combat and logistics.

The Playing Board *The Game Map*



Most of player interaction occurs on the game map. Players start on opposite sides of the map, with a seaport of debarkation (SPOD) in their bottom right corner. Both players also control an airport of debarkation (APOD) located to the player's left and halfway between the end of the map and the middle of the board. Two gray dotted lines indicate the initial limit of units for both players. No unit blocks may be placed between those two lines during the initial game set up. See the Setup Section for more information.

Terrain



Types of terrain are reflected by the color of the hexagon tiles and their borders. The base terrain of the map is steppes (grassland plains mostly devoid of forest). Terrain is modified to become lakes or infrastructure.

Base Terrain

- **Nodes** are indicated by hexagons. Most hexagons are colored green, indicating the base terrain of steppe. Nodes can include a terrain modifier as discussed below. Each node can hold only one unit at a time (unless the port terrain modifier applies).
- **Links** are indicated by the black lines stretching between nodes. *Each link represents 10km.* Links abstract the various highways, roads, and trails which connect one piece of terrain (a node) with another. Units may only move between nodes along links. Units may not move between nodes if no link connects them. Links also define the movement of supplies between nodes or units.

Terrain Modifiers

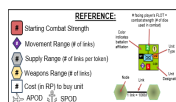
Terrain modifiers apply additional effects to a hex. Terrain modifiers include ports, towns, cities, rivers, lakes, and oceans.

- **Ports** include both SPODs and APODs. SPODs are seaports of debarkation. APODs are airports of debarkation. Ports provide players with logistical capabilities to bring in supplies and units, as well as defensive capabilities to the occupying unit. Unlike other nodes, ports can hold more than one unit at a time. SPODs can hold up to four units. APODs can hold up to three units. Ports have an organic capacity to hold supplies and receive damage. Ports are key terrain players must control to achieve victory conditions.
- **Towns** provide the occupying unit with a defensive capability.

This advantage applies only when the unit occupies the town node, in defense, and not when attacking out of a town.

- **Cities** provide the occupying unit with a higher defensive capability than towns. This advantage applies only when the unit occupies the city node, in defense, and not when attacking out of a city.
- **Rivers** are indicated by the blue lines between links and nodes. If a link crosses a blue line, it is considered an approved crossing point such as a bridge or ford. If no link crosses a blue line, units cannot move across the river for either movement or combat. This does not affect distance attacks by field artillery units.
- **Lakes** are blue hexes not connected to an SPOD. Lakes may also be connected to rivers. Lakes are impassable. No units may cross a lake to an adjacent hex. Field artillery units firing from a distance (two or more nodes away) may fire over a lake but must include the lake in their distance estimation.
- **Oceans** are blue hexes connected to an SPOD. Oceans are impassable. Oceans cannot be fired over.

Game Board

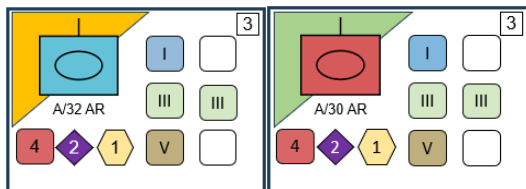


MISSION ORDERS - RESERVE	MISSION ORDERS - EXECUTION	MISSION ORDERS - OUT OF PLAY	MISSION ORDERS - DISCARD	SPECIAL CARDS - DRAW DECK	ASSETS IN RESOUPACKAGING IN CONUS	ASSETS IN TRANSIT ACROSS THE OCEAN
--------------------------	----------------------------	------------------------------	--------------------------	---------------------------	-----------------------------------	------------------------------------

On the player's edge of the map, at both ends, is a reference key, spaces for various card decks used in the game, and the offshore delivery queue. The reference key

provides reminders about how to read tracker cards and unit block stickers. The spaces for the card decks provide the player with organization to keep track of which cards are in play and which are out of play.

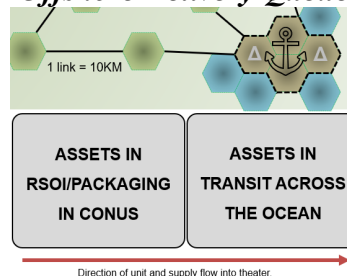
Tracker Cards



Each unit and SPOD/APOD has an associated tracker card. These cards provide the player with a method of tracking each unit's on-hand quantities. Limiting both combat units and sustainment units to a specific amount of supply that can be carried requires the player to consider what supplies a unit must move and attack with and where

resupply can come from. Damage to the combat and sustainment units is tracked by turning the unit block (described in the next section). However, players can also target SPODs and APODs, causing infrastructure damage. This damage is tracked on the SPOD/APOD tracker card.

Offshore Delivery Queue



The Offshore Delivery Queue provides players with a method to plan and track incoming units and supplies for the next two turns.

Terrain Reference Table

Terrain	Movement	Supply	Combat	Artillery
	Unrestricted movement	Unrestricted movement. Can hold up to three supply tokens not stored with a unit as indicated by unit tracker card).	No advantage.	No advantage.
	Unrestricted movement	Unrestricted movement. Can hold up to twelve supply tokens as indicated by the port tracker card. SPOD can hold up to four units. APOD can hold up to three units.	Provides occupant with a defensive advantage. Defender's damage hit increased by two (2). Ex. damage is scored on a 9 instead of a 7.	Field Artillery units occupying a port and attacked from two or more links away receive a defensive advantage. Defender's damage hit increased by two (2). Ex. damage is scored on a 8 instead of a 7. Ports can also be attacked in lieu of attacking the occupying unit. In this case, no defensive advantage applies.
	Unrestricted movement	Unrestricted movement. Can hold up to three supply tokens not stored with a unit as indicated by unit tracker card).	Provides occupant with a defensive advantage. Defender's damage hit increased by one (1). Ex. damage is scored on a 8 instead of a 7.	Field Artillery units occupying a town and attacked from two or more links away receive a defensive advantage. Defender's damage hit increased by one (1). Ex. damage is scored on a 8 instead of a 7.
	Unrestricted movement	Unrestricted movement. Can hold up to three supply tokens not stored with a unit as indicated by unit tracker card).	Provides occupant with a defensive advantage. Damage hit increased by two (2). Ex. damage is scored on a 9 instead of a 7.	Field Artillery units occupying a city and attacked from two or more links away receive a defensive advantage. Defender's damage hit increased by two (2). Ex. damage is scored on a 8 instead of a 7.
	Cannot be crossed unless a link already bisects the river.	Cannot be crossed unless a link already bisects the river. Cannot store supply.	No advantage.	No advantage.
	Impassable.	Impassable. Cannot store supply.	No advantage.	No advantage. When firing over a lake, field artillery must include the lake in their distance calculation.
	Impassable.	Impassable. Cannot store supply.	No advantage.	No advantage.

The Playing Pieces



The figure above illustrates how to read information on unit blocks in *Lines and Webs*.

Identifying the Unit: The symbol at the center indicates the unit's type. Its color indicates the faction belongs to (Blue = Delta; Red = Gamma). The background color indicates the battalion affiliation of the unit.

Steps: The overall condition of the unit, which reflects various factors including its personnel strength and combat readiness, is represented by its step count. This corresponds to the colored square and number on the border of the unit's block. Each unit has four steps. The green square indicates the unit still has all four steps; the yellow square shows it has lost a single step; red that it has lost two steps; and black that it has lost three steps. If a unit takes another step loss when degraded to the black square, the unit is "destroyed" and removed from the board.

Combat Strength: The numbers in each step square indicate the current combat strength of that unit and translate to the number of dice that unit can use in combat. The icon positioned away from the player's side of the board (toward the front line of troops or FLOT) indicates the unit's current combat strength.

Weapons/Supply Range: The number in the hex indicates the range the unit can reach with weapons or supplies. If the hex is yellow, it indicates weapons range. If the

hex is grey, it indicates supply range.

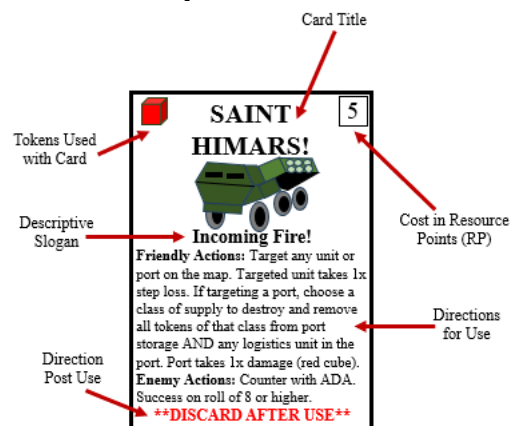
Movement Range: The number in the purple diamond indicates how many links the unit may move in a single turn by expending a green fuel token.

Unit Types

Mechanized Infantry <ul style="list-style-type: none"> • Combat company for both sides. • Low combat power 	Armor Company <ul style="list-style-type: none"> • Combat company for both sides. • High combat power 	Field Artillery Company <ul style="list-style-type: none"> • High combat power from a distance. • Low combat power up close.
Engineer Company <ul style="list-style-type: none"> • Low combat power • Use reduces damage to infrastructure. 	Air Defense Artillery Company <ul style="list-style-type: none"> • Low combat power • Defends against indirect in a 4-node radius. 	Aerial Port Squadron <ul style="list-style-type: none"> • Low combat power • Use enables delivery of units and supplies to APOD
Sustainment Units <ul style="list-style-type: none"> • Low combat power. • Allows transfer of supplies across the battlefield. • Larger units can move more supplies further distances. 		

There are seven types of units used in this wargame. The wargame demonstrates opposing sustainment systems, so although each players' combat units are matched, their sustainment units are designed differently. Players begin with a starting package on the map but have additional units available for delivery into the theater.

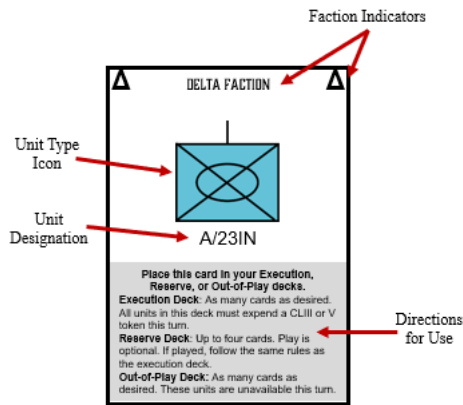
Special Cards



Special cards are used in the game to provide effects players are expected to

encounter in large-scale combat operations. Players use resource points (RP) to buy special cards which are immediately available for use. The following ten cards are available to players. See the Special Cards Section for more information.

Mission Order Cards



Mission order cards provide players with a method to plan the flow of combat. Only combat units have mission order cards. Players place these cards in the order in which want to move their combat units. See the Description of Turn Sequence Section for more information.

Tokens



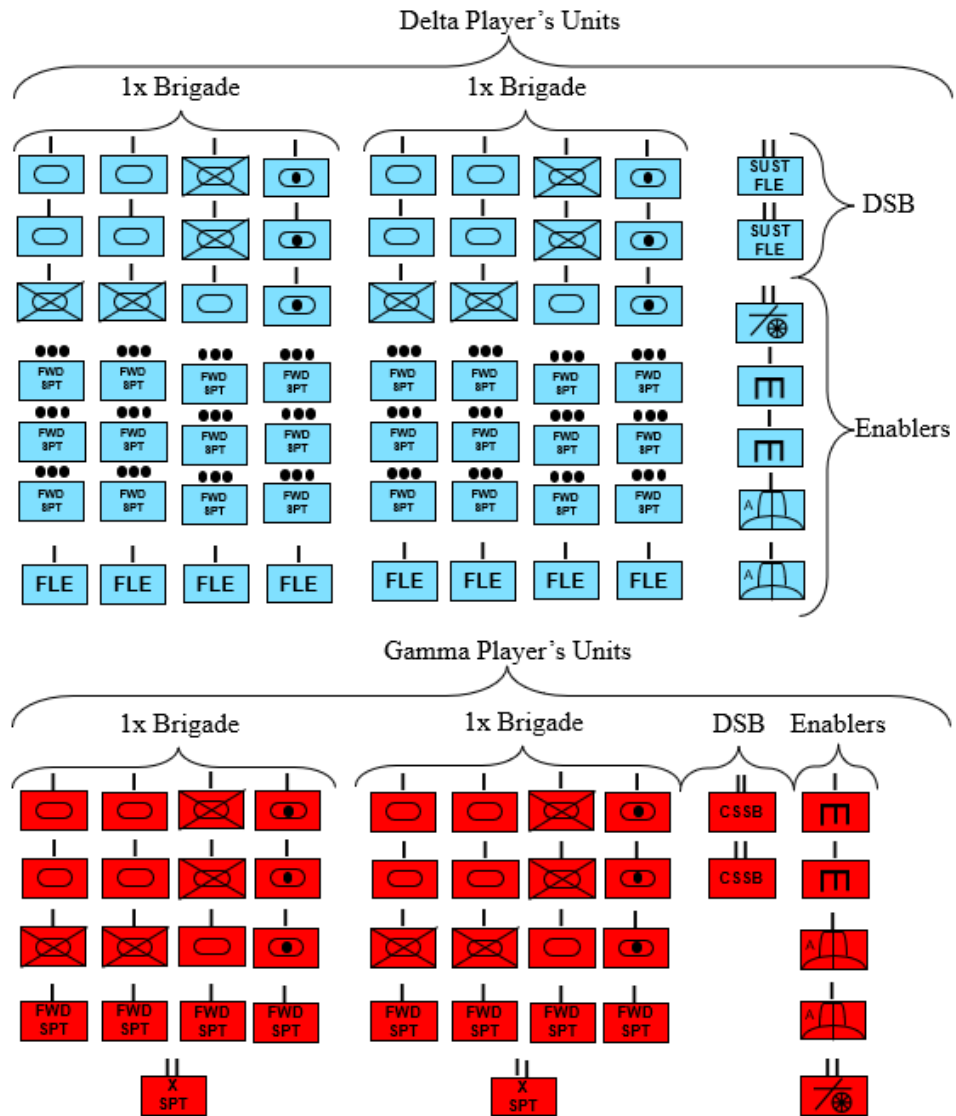
This wargame utilizes several different plastic cubes, referred to as tokens, to represent different types of physical elements in the game. These tokens represent supply (food/water, fuel, and ammunition), suppression, degradation, and damage to infrastructure. Tokens are the main method players use to track logistics requirements and simulate moving supplies across the battlefield.

Node Blocked Marker

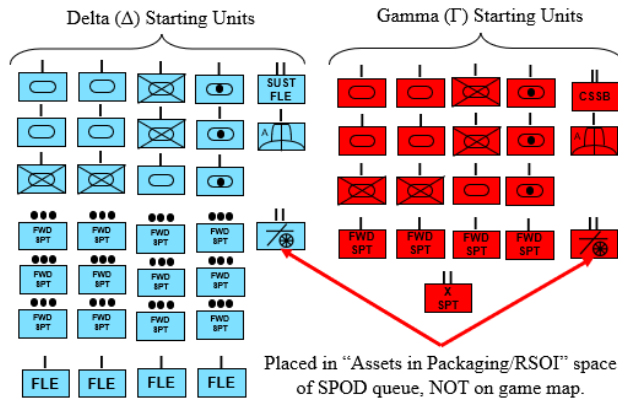


These markers are placed on a node when that node is blocked. Its presence prevents movement through the node by both units and supplies.

Available Units



Setup



Game Map: Place the game map between the two opposing players. Each player controls the SPOD marked with their faction's Greek Letter (Δ or Γ) and the APOD on that same side of the game map.

Special Card Deck: Each player has a special card deck containing three of each type of special card. Place the special card deck beside the game map to the player's left.

Starting Units: Each player begins with the units depicted in the figure above. Additional units are available for purchase after the start of the game. All units start at full strength (green box pointed toward enemy side of the game map).

Place starting unit blocks onto the game map anywhere between the player's side of the board and the closest grey dotted line. A recommended starting deployment of units can be found in each player's reference card, but players may deploy their units in any manner.

Mission Order Cards: Mission order cards for each unit on the map are collected into a deck and placed in the "Mission Orders – Out of Play" box on the game board.

Unit Tracker Cards: Unit tracker cards for each unit on the map are arranged below or to the side of the game board. The tracker cards allow the player to array their cards in the same manner as their units are arrayed on the game map for easy identification.

Starting Supplies: Each unit in play begins with a basic load of supplies, recorded on the unit tracker cards. For combat units a basic load equals the shaded boxes depicted on the associated unit tracker cards. Place a supply cube matching the color of the shaded box in each box. Blue cubes are class one (CL I, food, and water) and are placed in the blue shaded box. Green cubes are class three (CL III, fuel) and are placed in the green shaded box. Brown cubes are class five (CL V, ammunition) and are placed in the brown shaded box. For sustenance units a basic load equals all storage boxes on the tracker card filled. The shaded boxes indicate that unit's basic load and are the only boxes which must match the color of box to the color of the cube. All other boxes may be filled with supply cubes in any manner the player desires.

Starting Delivery Queue: Finally, players place their Aerial Port Squadron unit, four (4) green tokens, four (4) blue tokens, and four (4) brown tokens onto the "Assets in Packaging/RSOI" space of the SPOD queue on the game board.

Turn Sequence

Summary of Turn Sequence

PHASE 1: DEPLOY

- Concurrent Play
- Move units and supplies in the offshore delivery queue forward one space.

PHASE 2: SPEND RESOURCES

- Concurrent Play
- Spend up to 25 Resource Points (RP) to acquire supply tokens, special cards, or new units.
- Units and supplies are placed into “Assets in Packaging/RSOI” in offshore delivery queue.
- RP does not roll over.

PHASE 3: TRANSPORT SUPPLIES

- Concurrent Play
- Limited to five minutes.
- Stand up sustainment units at the start of the phase. Return unit blocks phase up once that unit’s sustainment points are exhausted.
- Supply movement is limited by Sustainment Points (SP).
- SP = the number of links a unit can move half its supply carrying capacity. Ex. An FSC can move five tokens, each token for five links.
- Three Resupply Methods: Move Supplies OR Move and Resupply OR Displace.

PHASE 4: ISSUE ORDERS

- Concurrent Play
- Collect mission cards for all units on the map.
- Organize cards into three decks: execution, reserve, and out-of-play.
- Execution deck: as many or as few cards as desired (each unit MUST move or fire)

- Reserve deck: up to four cards; play of these cards is optional.
- Out-of-Play: as many or as few cards as desired; these cards may not be played at all this turn.
- Include Command Post special card in either Execution or Reserve deck as desired.

PHASE 5: ROLL FOR INITIATIVE

- Concurrent Play.
- Each player rolls a die.
- The die with the higher roll gets initiative (plays first) in the next phase.

PHASE 6: EXECUTE ORDERS

- Played sequentially, starting with the player who has initiative.
- Players turn over a card from their execution or reserve decks and play the indicated unit.
- Expend CLIII (green) or CLV (brown) (or both) tokens to play the desired unit.
- Resolve Combat when units are in adjacent nodes not divided by a river.

PHASE 7: CLI CONSUMPTION/RESET

- Concurrent Play.
- Consume CLI (blue) token for each unit on the map during turns 3, 6, 9, 12, and 15.
- Mark units that cannot consume CLI with a red token.
- Return displaced units back to face up.
- Remove all suppression markers (yellow token).
- Turn 10d die to the next number to indicate the start of the next turn.

Description of Turn Sequence

Phase 1: Deploy

Sequencing: Concurrent.

Summary: In this phase, units and supplies move from the offshore delivery queue forward one space, moving from packaging/RSOI in CONUS (continental United States) to transit across the ocean onto the game map via an SPOD or APOD.

Actions: All units arriving at a port start with a full basic load of supplies. Units and supplies may always be delivered to the SPOD and maybe delivered to the APOD when it is controlled by the Aerial Port Squadron (control requires occupation). Once units are deployed to an SPOD or APOD, their tracker card is placed with the player's other in use tracker cards and the unit's mission card is place in the "Out of Play" deck on the game board.

SPODs/APODs cannot receive supplies or units exceeding their storage capacity.

Phase 2: Spend Resources

Sequencing: Concurrent.

Summary: During this phase, players may acquire supply tokens, special cards, or new units by spending Resource Points (RP).

Resource Points (RP): Points representing a player's strategic assets and the limitations of employing those assets in a theater of combat. Each player receives 25RP each turn. Resource points do not roll over.

Supply tokens each cost one RP. Each new unit costs RP according to the number in the hexagon in the top right corner of the unit's tracker card. Each Special Card costs RP according to the number in the hexagon in the top right corner of the card.

Actions: Use RP to purchase units, supplies, and special cards. Purchased supply tokens and units are placed in the player's delivery queue in the space marked "Assets in Packaging/RSOI". When an APOD is not controlled by an Aerial Port Squadron

(APS), supplies, not units, may be delivered directly to the APOD at a cost of 2xRP per supply token. This represents the cost of strategic air lift. When an APOD is controlled by an APS, players can deliver units and supplies to the APOD at no additional cost, not to exceed the APOD's storage capacity. This allows the player to bypass the delivery queue wait time.

Phase 3: Transport Supplies

Sequencing: Concurrent.

Summary: During this phase, players conduct resupply operations simultaneously.

Actions: This phase is limited to five minutes. For the first turn, players should conduct resupply from the player's front line of troops (FLOT), or forward most units, back toward the SPOD. At the beginning of the phase, all sustainment units are placed on their edge so that the sticker is facing the owning player. When the player completes all resupply actions a unit is allowed, the tipped back down with the sticker facing up. This provides the players with a method of tracking which units are still able to conduct resupply, and which are exhausted.

Cross-Leveling: Units located in the same node (only allowed in the SPOD and APOD) may cross-level supplies except when both units are combat units. Combat units may only cross-level CL I (food and water) and CL III (fuel). If both combat units are the same type, they may cross-level CL V (ammunition).

Sustainment Points: Each sustainment unit has a Sustainment Point (SP) limit, defining the distance that unit can move each supply token.

Resupply Methods: Each sustainment unit may utilize one of three resupply methods each turn.

MOVE SUPPLIES: In this method, any supplies in theater (on the game map) may

be moved. Each sustainment unit may move half its total storage capacity (number of boxes on the tracker card; round up), moving each token the number of links of that unit's SP. Supplies may only be moved into an open storage space on the receiving unit's tracker card. If no space is open, up to three tokens can be delivered directly to the node. However, these tokens are not carried with the unit when it moves and are lost if not picked up by the end of the turn, Phase 7.

MOVE AND RESUPPLY: In this method, sustainment units may first move by expending a CLIII (fuel) token, then conduct resupply according to the rules in the MOVE SUPPLIES method. Movement of the sustainment unit is limited by that unit's movement points. This method requires the expenditure of a CLIII token to utilize.

DISPLACE: Sustainment units can displace by placing their unit block face down. A displaced unit cannot be targeted by fires, but also cannot deliver or receive supplies. This does not expend a CLIII token. Displacement only lasts until the end of the turn.

Phase 4: Issue Orders

Sequencing: Concurrent.

Summary: In this phase, players plan out their sequence of orders for execution in Phase 6 using mission orders cards. This represents the need to sequence of events and movements to achieve objectives while operating in the expected communications degraded environment of multi-domain operations. Mission orders cards represent an order issued to a unit to either move or engage in combat. Only combat units have mission orders cards since sustainment units receive their orders during Phase 3.

Actions: To issue orders, players collect mission orders cards for all combat units on the map. These cards can be organized into three decks: execution, reserve, and out-of-

play. For both the execution and reserve deck, the cards are placed so that when the deck is face down, the top card is the first card the player wishes to play. Any cards not placed in the execution or reserve decks are placed in the out-of-play deck and cannot be used at all during this phase. During this phase, players may include special cards placed in their executions deck. The position of the card in the deck dictates when they can be played.

Execution Deck: Players can place as many or as few cards into the execution deck as desired. However, each unit with a card in the execution deck must at least expend a CLIII (fuel) token whether the player moves that unit on the game map or not. The only exception to using a CLIII (fuel) token is for field artillery units, which may choose to expend either CLIII and move or CLV (ammunition) and fire on an enemy unit from afar.

Reserve Deck: Players may place up to four units' mission cards into the reserve deck. These cards allow a player to optionally use those units based on the flow of play. The reserve deck simulates a commander's ability to react to battle. Units in the reserve deck may be played at any point during Phase 4 as long as one player still has cards to play from their execution deck. Units given orders from the reserve deck, that unit follows the same rules of supply expenditure as the execution deck. If both players have exhausted their execution deck, then only one additional reserve card may be played by each.

Out-of-Play Deck: Players may place as many or as few cards in the out-of-play deck as desired. Any cards in this deck may not be played at all this turn.

Phase 5: Roll for Initiative

Sequencing: Concurrent.

Summary: In this phase players roll for initiative for the next phase.

Actions: Initiative goes to the player with the higher roll.

Phase 6: Execute Orders

Sequencing: Sequential.

Summary: In this phase, players can move units and engage in combat. This phase is conducted sequentially, starting with the player who has initiative. Players turn over a card from their execution or reserve decks to move or attack with the revealed unit.

Players continue in turn until all cards from the execution deck are exhausted and each player has an opportunity to play one more card from their reserve deck.

Actions: To conduct movement, players expend a CLIII (fuel) token and move units along the map as limited by that unit's movement points. Units may move into combat, in which case, the unit expends both a CLIII (fuel) and a CLV (ammunition) token.

Armor Units: Armor units are the only units which must expend both a CLIII and CLV token for combat even when on the defense. Units must engage units in adjacent nodes in combat. This means it is possible for a unit to use the maximum limit of its movement points, then move down a link to a now adjacent node to conduct combat. This seems to break the movement rules, but in playtesting proved to make the game work, finding the balance between too easy and too hard to engage in combat.

Field Artillery Units: Field artillery units have the option to expend CLIII and move, expend CLIII and CLV to move and attack, or expend CLV and attack from distance. During this phase, engineer units may expend CLIII to move to a port and expend additional CLIII to make repairs to that port. Repairs remove one token of damage from the port. Only one token per port may be removed per turn.

Phase 7: CLI Consumption/Reset

Sequencing: Concurrent.

Summary: During this phase, units consume food and water and reset for the next turn.

Actions: During this phase, *in all turns*, reset actions are taken before the next turn. Any displaced units are turned face up and any suppressed units (indicated with a yellow block) are unsuppressed. Remove all node blocked markers. The d10 die is turned to the next number to track the current turn.

Every third turn, one CLI (food and water) is consumed. Units that cannot consume CLI are degraded and marked with a red token on the unit block. Degraded units cannot move or attack and remain degraded until they can receive and consume a CLI token. If a unit is still degraded by the next time CLI consumption is required, it takes a step loss.

Combat Rules

Combat Sequence

Initiation: Combat is initiated when one unit moves onto a node adjacent to a node occupied by an enemy unit. Attacking players indicate combat by moving down the link to the adjacent node. When combat is initiated, it must be resolved. Units do not have the choice to move out of contact. The number on the edge of the block indicates the current combat strength of that unit, and how many dice that unit can use in combat. The field artillery (FA) unit is the only type which does not follow this system. See the FA specific rules in the sub-section below.

Engagement: When engaging in combat, both units must expend a CLV (ammunition) token. Armor units must expend both CLIII and CLV. This rule replicates the high cost of fuel associated with tanks in real life. If a unit cannot expend the requisite supply tokens it may not initiate combat. If a unit challenged to combat cannot expend the requisite supply tokens, it endures an attack without fighting back.

Order of Combat: The defending unit rolls their dice first. Defender's score on a roll of seven or better on a d12 die. The first scored hit sends the unit into suppression (marked with a yellow token). Each hit after results in a step loss on the receiving unit. The attacker then rolls dice based on the resultant combat power. The attacker also scores a hit on a seven or better unless the defender occupies a town, city, or port. These locations provide the defender with an advantage. A town increases the attackers required roll for a hit from seven to eight (+1) while a city or port increases it from a seven to a nine (+2).

Winning Conditions: The unit with the higher number of hits wins the engagement. The winner of the engagement retains control of the node on which combat occurs. Whoever loses the engagement retreats from the node according to the retreat rules discussed in the next section. If the number of hits scored is equal, the attacker returns to its original node and the defender retains control of its current node. At this point, the winner of the engagement can choose to engage in another attack by expending additional CLV and/or CLIII. If a unit receives enough hits to run out of step loss options (for a full-strength unit, suppression plus four hits) it is destroyed, and the unit is removed from the board.

Field Artillery Specific Combat Rules:

Field artillery (FA) units can enter either a direct fight (attacking a unit in an adjacent node) or an indirect fight (attacking a unit from two or three nodes away). If an FA unit engages in a direct fight, it follows the rules of combat like any other unit but is limited to a single die. FA unit engaging in an indirect fight can target an enemy unit that is two or three nodes away from its position. In this scenario, the FA unit identifies its intended target and expends CLV to attack. The FA unit is the only unit that can increase its dice by expending additional CLV tokens. FA units can expend up to three CLV tokens and roll a die for each token. Hits are scored on a seven or better unless modified by defensive positions. Opposing unit can only counterattack with FA units. ADA units do not defend against FA attacks.

Retreat Rules

When combat is conducted and it does not end in a draw, the losing unit must retreat. In this instance, the winning unit retreats the loser two nodes in whatever direction they prefer. This moves them out of combat range and allows the winner to organize the battlefield to their advantage. If nodes are occupied in such a way that the losing unit cannot retreat two nodes without stacking with another unit, the loser takes an additional step-loss instead.

Suppression

When units engage in combat, the first hit taken results in suppression of that unit rather than a step loss. Suppression is indicated by a yellow token and lasts for the entire turn. Suppressed units can fight, but not move. For field artillery units, rolling twelve models that the first shot was also a luck accurate shot. In this instance, a twelve dice roll counts for both a suppression and a step loss on the enemy unit. This only applies to field artillery units.

Special Cards

Summary

Special cards are used in the game to provide effects players may encounter in large-scale combat operations. Players use resource points (RP) to buy special cards which are immediately available for use.

9-LINE RECOVERY! *Requires 1x RP to purchase.* This card can be applied to any single enemy unit. Mark target unit with a black cube. Targeted unit cannot move or fight. This lasts until a unit can receive replacements/repair parts (orange cube) through either regular supply transport or the Air Drop Inbound Special Card. *This card is discarded after use.*

AIR DROP INBOUND! *Requires 3x RP to purchase.* Use this card to deliver a single orange cube (representing replacement personnel or CL IX maintenance parts) or a single supply token to one unit. The delivery of an orange cube removes a black cube from the target unit. In the absence of a black cube, the delivery of an orange cube removes a step loss from that unit. *This card is discarded after use.*

CLOSE AIR SUPPORT! *Requires 1x RP to purchase.* This card allows a player to target any single enemy unit (not infrastructure) within 2x nodes of a friendly unit. Any air defense within four nodes of the targeted unit can roll a d12 dice in defense. Rolling an 8 or higher defends against incoming missiles from close air support. *This card is discarded after use.*

COMMAND POST! *Requires 3x RP to purchase.* This card allows a player to conduct a simultaneous attack with up to three units. Place this card in the Mission Orders – Execution Deck prior to the three

units the player wishes to move in concert. When this card is turned over, the player then displays the next three cards to conduct simultaneous movement. Each unit must still individually expend CL III and/or V for movement and/or combat. *This card is discarded after use.*

CYBER ATTACK! *Requires 1x RP to purchase.* Using this card allows players to disrupt their opponents tactical plan. Use this card during Phase 6: Execute Orders to shuffle the opposing player's Mission Order - Execution Deck into any desired order. The opposing player cannot look at the new order. *This card is discarded after use.*

DRONE RECON! *Requires 5x RP to purchase.* This card negates the Command Post Special Card. Play this card after the use of a Command Post Special Card in Phase 6: Execute Orders. *This card is discarded after use.*

MASS CAL! *Requires 1x RP to purchase.* Players may only use this card after a successful combat engagement. Target enemy unit involved in combat engagement. The targeted unit takes an additional step loss. *This card is discarded after use.*

SAINT HIMARS! *Requires 5x RP to purchase.* This card allows a player to target any unit or port on the map. A targeted unit takes 1x step loss. A targeted port takes 1x damage (indicated by placing a red token on the port tracker card). Any air defense within four nodes of the targeted unit can roll a d12 dice in defense. Rolling an 8 or higher successfully blocks incoming missiles from SAINT HIMARS. *This card is discarded after use.*

SCOUTS OUT! *Requires 1x RP to purchase.* This card allows the attacker to roll first and score hits first during combat. Player using this card chooses the unit to gain this advantage. Chosen unit must be in a combat engagement. *This card is discarded after use.*

SF In The Area! *Requires 3x RP to purchase.* Use this card to block a single node for both movement and transport of supplies. Place a node blocked marker on the node affected. The color of the node blocked marker indicates the player who is prohibited from transporting supplies or movement through that node. This effect lasts until the end of the turn (Phase 7: CL I Consumption/Reset). *This card is discarded after use.*

2024. VERSION 1.3

 LINES

AND

 WEBS

OFFICIAL RULE BOOK

CREATED BY: MAJ CATHERINE R. DEETER

APPENDIX C

WARGAME COMPONENTS FOR *LINES AND WEBS*

Instructions and Summary

All the components of this wargame are printable using a regular color printer and a plotter printer. This appendix details those components. The table below describes the recommended dimensions and materials for each component. Items in grey are game pieces that do not require custom prints.

Summary of Components for a DIY <i>Lines and Webs</i>				
No.	Category	Item	Quantity	Recommended Dimensions & Materials
1	Maps	Game Map	1	Using a Plotter: 36" x 40"
2	Game Aids	12-sided Die	10	These can be found in board game stores.
3		10-sided Die	1	
4		Dice Tower (recommended)	2	
5		Timer or Stopwatch	1	
6	References	Rule Book	2	Regular Paper: 8.5" x 11" Refer to Appendix B.
7		Delta Player Card	1	Regular Paper: 8.5" x 11"
8		Gamma Player Card	1	
9	Tokens	Food Cube (Blue)	300	Plastic or Wooden Cubes: 10mm x 10mm x 10mm Print at 95% size.
10		Fuel Cube (Green)	300	
11		Ammunition Cube (Brown)	300	
12		Damage Cube (Red)	50	
13		Suppression Cube (Yellow)	50	
14		Repair/Replacements Cube (Orange)	50	
15		Degraded Cube (Black)	50	
16		Delta Node Blocked Marker (Blue)	6	Cardstock: 8.5" x 11" Print 1 copy of document labeled "Node Blocked Markers" on cardstock, single-sided.
17		Gamma Node Blocked Marker (Red)	6	

18	Special Cards	Special Card Front Side	3	Cardstock: 8.5" x 11" Print 3 copies of document labeled "Special Cards" on card stock, single-sided. Cut cards out of cardstock.
19		Special Card Back Side	3	Sticker Paper: 8.5" x 11" Print 3 copies of document labeled "Special Cards Back" on sticker paper, single-sided at xx %. Cut out stickers and place on the back of the cardstock special cards.
20	Mission Order Cards	Mission Order Cards Front Side	1	Cardstock: 8.5" x 11" Print 1 copy of document labeled "Mission Order Cards" on card stock, single-sided. Cut cards out of cardstock.
21		Mission Order Cards Back Side	1	Sticker Paper: 8.5" x 11" Print 1 copy of document labeled "Mission Order Cards Back" on sticker paper, single-sided at xx %. Cut out stickers and place them on the back of the cardstock mission order cards.
22	Unit Tracker Cards	Unit Tracker Cards	1	Card stock: 8.5" x 11" Print 1 copy of document labeled "Unit Tracker Cards" on cardstock, single sided. Cut out all cards around thick black borders, but do not split apart the CSSB, BSB, or SUST FLE card sections.
23	Unit Blocks	Wooden Blocks	104	Wooden Blocks: 20mm x 20mm x 10xmm 63x blue wooden blocks 41x red wooden blocks
24		Unit Stickers	1	Sticker Paper: 8.5" x 11" Print 1 copy of document labeled "Unit Stickers" on sticker paper, single-sided. Cut out individual unit stickers and place on wooden blocks.

Table 2. Summary of Components for Printing.

Source: Created by Author.

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