UNLEASHING CAPACITY:

OPPORTUNITIES TO IMPROVE OIB STRATEGY

ORGANIC INDUSTRIAL BASE REPORT AY 2020-2021

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ES 6572 — INDUSTRY STUDY COURSE

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EXECUTIVE SUMMARY

Requirement:

The United States' (U.S.) Organic Industrial Base (OIB) is a bloodline for the Nation's defense. Nested in a vast ecosystem of organizations and industries providing support to the Nation, the OIB maintains, repairs, overhauls, and modifies weapon systems for the Nation's Armed Forces. The OIB provides an assured sustainment capability free from vulnerabilities that plague the commercial sector and larger Defense Industrial Base (DIB). Just as blood carries oxygen throughout the body to permit it to function optimally, a government-owned and operated weapon system sustainment capability supports global reach and readiness. The OIB bloodline must effectively deliver this capability in peacetime and have the capacity to increase flow when the United States must surge or mobilize its resources in response to an event.

Congress recognizes the importance of the OIB. The Fiscal Year (FY) 2020 National Defense Authorization Act (NDAA) Section 359 directed the Secretary of Defense to develop strategy to improve covered depots and ensure the OIB maintains the capacity and capability to support the readiness and material availability goals of current and future Department of Defense (DoD) weapon systems. In response, each service offered maintenance plans and proposed several investment initiatives, but none published an open-source strategy update. An environment marked by Great Power Competition (GPC) requires the OIB to develop a more integrated strategy framed on value creation, that improves readiness and maintains technological superiority.

Methodology:

Previous Eisenhower School reports established a Readiness Enabler Framework to assess the OIB through elements of governance, finance, materiel, infrastructure, and human capital. These reports offered process improvements to the framework and recommendations for surge capabilities. Building upon these foundations, Academic Year 2021's OIB Industry Study (IS), comprised of professionals from multiple government departments, agencies, and countries, spent four months examining OIB structure and processes. These professionals analyzed challenges presented by the Office of the Secretary of Defense (OSD) and depot leaders, and researched commonalities and differences with private industry.

This report emphasizes capacity as a common theme across the Readiness Enabler Framework. Industry defines capacity as maximum output that can be generated from unlimited resources, but based on fixed property, plant, and equipment footprint. The OIB defines capacity as depot capacity or the amount of workload facilities are designed to accommodate, and measures depot capacity in Direct Labor Hours (DLH). Sufficient capacity is necessary to act as a shock absorber when the nation requires an immediate surge or mobilization. However, the OIB must also retain capacity to support its steady-state depot-level maintenance operations. This report explores the challenges associated with retaining capacity for national emergencies while maximizing capacity during peacetime and provides recommendations to address each.

Findings:

The report offers OIB strategy recommendations and fresh approaches to address challenges confronting the OIB now and expect to grow in complexity with intensifying competition and advances in technology. This report will explain the current challenges the OIB faces, challenges on the rise, and why this report's recommendations are worth consideration. The report also identifies private industry practices that may help the OIB further develop its strategy and integrate elements of value creation, readiness enabler investment, business expertise, process management, and policy modernization for intellectual property, technical data, and software.

Recommendations:

The Eisenhower School's OIB IS recommends the following initiatives to improve U.S. readiness for military engagement against near peer competitors by expanding the OIB's production capacity. Recommendations will be explained further throughout the report:

- Change how the DoD communicates industrial capacity by augmenting DLH with supporting information, deliverables, and needs through a common methodology.

- Establish a DoD waiver of 48 CFR § 31.205-17, Idle Facilities and Idle Capacity Costs, to allow the cost of idle facilities that support surge capacity under DoD contracts.

- The DoD should partner with the U.S. Coast Guard (USCG) to support the expansion of the Coast Guard Yard to accommodate the servicing of Littoral Combat Ships, Frigates, and Destroyers as a wartime surge capability strategy.

- Develop an aggregate facility-based capacity metric for depots; updated metrics permit improved communication, infrastructure investment decisions, and partnership opportunities.

- Establish an additional concentration within the Eisenhower School for National Security and Resource Strategy specifically for sustainment professionals. Curriculum to be aimed at preparing military and civilian leaders to run the business operations of OIB with focus on increasing the understanding of operations management, facilities management, production, and manufacturing.

- Use the Air Force's Technology Repair Center (TRC) Core Competencies framework to develop and implement a cross-capabilities and capacity model. A DoD-wide listing of each depot's equipment and repair capabilities would allow the OIB to market and leverage the enterprise's full scope of organic capability to prevent unnecessary workload pushes to commercial sources and maximize reinvestment into the WCF.

- Update carryover policy to allow four to six months of annual carryover by activity group and transition from allowable carryover rate calculations.

- Revise DoDI 5000.02 to include sustainment milestones beyond Milestone C to force recurring, comprehensive reviews of the sustainment strategy and provide an authoritative mechanism to pursue alternate strategies.

- Use a business case analysis, supported by an NPV calculation, to analyze and justify proposed changes to the sustainment strategy.

- Exempt software support for complex U.S. weapon systems from the traditional “50/50” rule through increased public-private partnerships.

FACULTY ACKNOWLEDGEMENTS

This report and the research that supports its findings would not have been possible without the steadfast effort and exceptional support of Colonel Grant Izzi and Dr. Steven Bloom. Their professional insight, attention to detail, and unwavering commitment to this project were a source of unending inspiration that contributed immensely to each professional's learning experience.

Operating under the highly restrictive conditions caused by the COVID-19 global pandemic, Col Izzi and Dr. Bloom successfully coordinated 15 trips to multiple components of the Organic Industrial Base. The seminar engaged in face-to-face meetings with industry leaders and government officials. Travel afforded the seminar an opportunity to witness industrial activities and operations first-hand, contributing significantly to the team's overall understanding of the Organic Industrial Base and its many supporting industries.

Section 1 – INTRODUCTION

"A healthy defense industrial base is a critical element of U.S. power" [1]
- ***National Security Strategy of the United States, December 2017***

1.1 Background

The U.S. National Security Strategy (NSS) clearly conveys the importance of the OIB to national security. As an interconnected system of organizations and industries acting as a bloodline for the Nation's defense, the OIB delivers vital Maintenance, Repair, Overhaul (MRO) and modification services for weapon systems. However, the OIB's current strategy, and the incremental improvements it has driven in the ecosystem since WWII have not sufficiently transformed the OIB to be fully ready to deliver victory in an era of Great Power Competition. The time is now for the OIB to develop an integrated strategy that is informed by a culture of value-creation, implements a common understanding of OIB readiness enablers, and articulates policies that properly manage technology and intellectual property.

Title 10 of the United States Code (U.S.C.), Chapter 146 mandates the OIB's existence, and both Presidential Executive Order (EO) 13806 and the FY 20 NDAA, Section 359 reinforce the OIB's national security importance.[2] The U.S.C. defines core workloads and essential capabilities needed to maintain and repair weapon systems for national defense. EO 13806 declares the DIB as "essential to the economic strength and national security of the U.S," and directed the Secretary of Defense to conduct a whole-of-government effort assessing the current national security risks caused by manufacturing and production capability gaps organic to the government. Lastly, the FY 20 NDAA calls for a comprehensive strategy for improving depot infrastructure. This report supports U.S.C., FY 20 NDAA, 13806 requirements, and offers actionable recommendations based on firsthand observations, research, and analysis that better postures the OIB's current strategy for the future.

1.2 Organic Industrial Base Industry Study Analysis

Several geographically dispersed locations support the Nation's OIB. Each uniformed service is part of a larger network of allies, agencies, and industry partners charged with supporting national defense and security through weapon system fielding and sustainment. Depots use two analogies to describe their role in support of the DIB. First, the OIB provides an "insurance policy" for the nation in emergencies. In this analogy, investments in the OIB protect the nation from a loss of industrial manufacturing capability and the associated enabler functions. Secondly, the OIB is referred to as a "shock absorber" when unanticipated requirements arise. In this analogy, the OIB has scalable industrial capacity to produce critical goods and services while the private sector works to expand its capacity in support of national security objectives.

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[1] Donald J. Trump, *National Security Strategy of the United States of America* (Washington, DC: The White House, December 2017), https://trumpwhitehouse.archives.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

[2] National Defense Authorization Act for Fiscal Year 2020, § 359, S. 1790, 116th Congress (2019), 129.

While imperfect metaphors, this report recognizes the terms “insurance policy” and “shock absorber” as part of the OIB lexicon. Moreover, the OIB continuously supports “material or software (including inspection, repair, overhaul, or the modification or rebuild of end items, assemblies, subassemblies, and parts) requiring extensive industrial facilities, specialized tools, and support equipment or skilled personnel not available at lower levels of maintenance.”[3] *Figure 1.1*, though not all-inclusive, is a map of locations performing these industrial functions, highlighting the lead service. More information on the entities that assure the OIB’s success can be found in Appendix C.

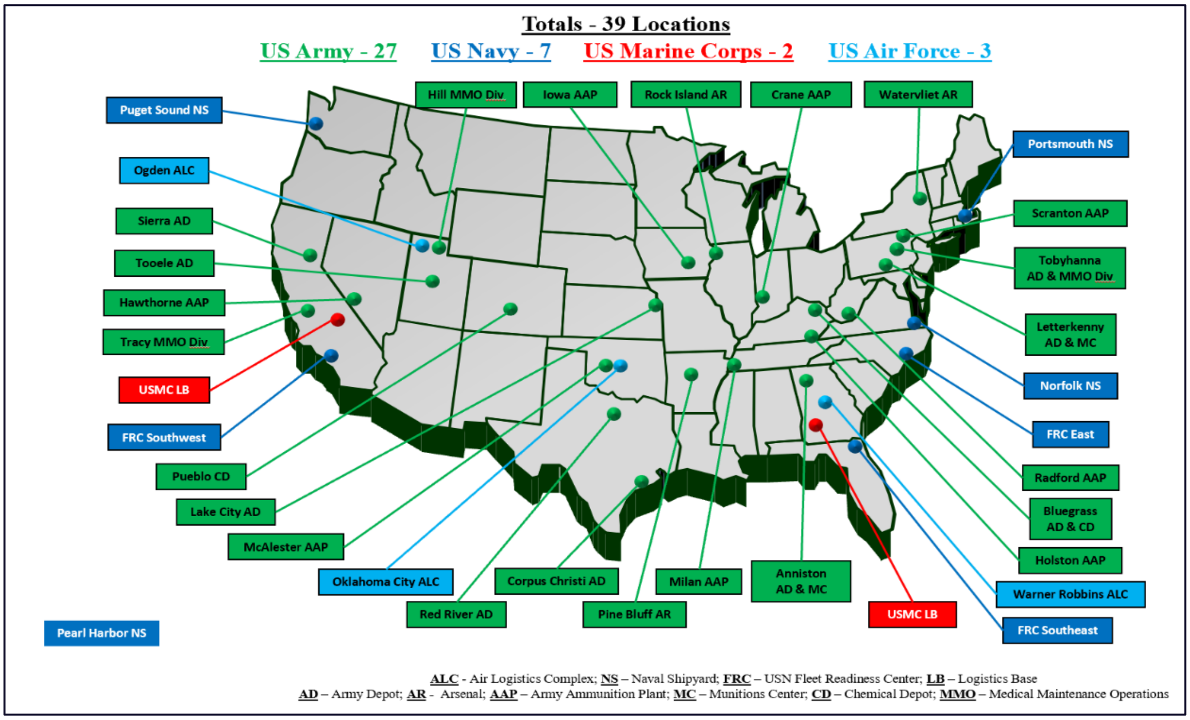

Figure 1.1 Department of Defense Major Organic Industrial Base Facilities

This report encapsulates four months of study and analysis by professionals from multiple government departments, agencies, and countries focused on national security and defense. The objective was to identify challenges to OIB capacity and recommend ways the nation and its industrial base could better prepare for victory in an era of GPC.

The Eisenhower School’s OIB IS visited 15 locations actively involved in weapon system MRO to complement this analysis. Anniston Army Depot in Alabama and Letterkenny Army Depot in Pennsylvania offered an overview of land combat system production and MRO. The USCG Yard in Maryland, the Navy’s Mid-Atlantic Regional Maintenance Center (MARC), and the BAE Systems Shipyard in Virginia provided an overview of maritime system MRO. Lastly, the study emphasized the highest cost per unit operation, aviation. This emphasis included site visits to the inter-agency, Air Force, and American industry cluster in Wichita, Kansas, which informed the report’s air component MRO recommendations.

[3] 10 U.S. Code 146 (2013) § 2460, Definition of depot-level maintenance and repair.

This cluster concept also introduced the IS to the triple helix model for innovation. The triple helix introduces a model fostering relationships across academia, industry, and government to spur innovation.[4] The IS engaged entities outside the OIB and sought opportunities to innovate existing processes and offer new ideas. Subsequent discussion panels included industry partners, public universities, research centers, the Government Accountability Office (GAO), and staff members from the House Armed Services Committee (HASC) to widen the report's perspective. Engagement dialogue provided a more nuanced view of the DIB's broader challenges and the complexities of building and utilizing capacity in the OIB. The diverse perspectives reinforced the triple helix model and emphasized the importance of relationships to furthering OIB success.

1.3 Strategy as an Organizing Function for Report Recommendations

Global competition is increasing pressure on the OIB to innovate for future requirements. The 2017 NSS stated, "Great Power Competition [has] returned,"[5] and the 2020 Defense Space Strategy also affirmed "Great Power Competition defines the strategic environment."[6] GPC is the primary lens through which U.S. leaders view the world in the near term and sets the tone for future international relationships. In this report, GPC is an engagement between sovereign nations, either near or in parity with one another, with the ultimate objective of superiority. One aspect of GPC is the perspective of national advantage. For the United States, GPC is driving the need for an assessment of current and future OIB requirements. These requirements set the immediate need for an improved OIB strategy.

Strategy is a coherent statement of an enterprise's purpose and the highest objectives it will pursue over the long term; a comprehensive strategy sets the broad plan for action.[7] The OIB strategy must prioritize the choices it makes "to coordinate, balance, and integrate all the types of means [at its disposal] … to achieve the articulated ends." [8] William Martel provided a framework for analyzing strategy along 2-axes, articulation and implementation, to measure success.[9] This report offers recommendations using these two axes to improve subordinate strategy alignments within the broader OIB strategy. For this purpose, a subordinate strategy is a plan of action or policy supporting the OIB strategy to provide ready forces and equipment to the Nation in a time of need. A prudent strategy must be communicated and resourced for action.

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[4] Henry Etzkowitz and Chunyan Zhou, *The Triple Helix: University-Industry-Government Innovation and Entrepreneurship*, 2nd ed. (New York: Routledge, 2017), https://nduezproxy.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,url,uid&db=nlebk&AN=1598217&site=eds-live&scope=site&ebv=EB&ppid=pp_20, 20.

[5] Trump, *National Security Strategy*, 28.

[6] U.S. Department of Defense, *Defense Space Strategy Summary*, (Washington D.C., 2020), 3, https://media.defense.gov/2020/Jun/17/2002317391/-1/-1/1/2020_DEFENSE_SPACE_STRATEGY_SUMMARY.PDF.

[7] William C. Martel, *Grand Strategy in Theory and Practice: The Need for an Effective American Foreign Policy* (New York: Cambridge Univ. Press, 2015), 30.

[8] Ibid., 32-33.

[9] Ibid.

Better articulation and implementation of strategy allows OIB leaders to improve in ways that will help the United States compete against adversaries in the future.[10] Improvements focus on value creation strategies, alignment of resources with readiness enabler investment, development of business acumen, and policy modernizations that deal with intellectual property, technical data, and software. Most recommendations propose improvements to OIB capacity.

1.4 The Role of Capacity

Defense industrial organizations perform cradle-to-grave research, development, depot maintenance, production, repair, and disposal of equipment, material, munitions, hardware, and software. Weapon systems receive support from air logistics centers and complexes, depots, and shipyards, ensuring readiness to win the nation's wars. The ability to perform these operations requires key inputs or "readiness enablers," which deliver combat-capable forces when needed.

As shown in the Eisenhower School's readiness enabler diagram (*Figure 1.2*), the OIB's governance, physical infrastructure, financing, materiel considerations, and human capital are ways by which the United States will successfully facilitate victory in GPC. The resources to support these readiness enablers should directly reflect the capacity needed for the current strategic environment and its associated risks.

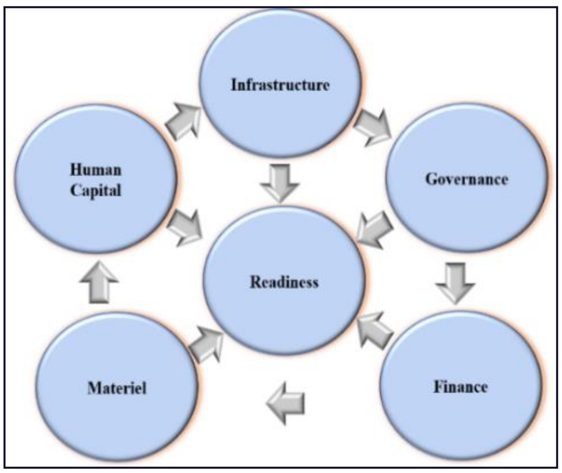

Figure 1.2 The Eisenhower School Readiness Enabler Framework

In each enabler, capacity is the "maximum output that can be generated from unlimited resources, but based on fixed property, plant, and equipment footprint."[11] The OIB is in the business of producing readiness, or "the capability of a unit/formation, ship, weapon system, or equipment to perform the missions or functions for which it is organized or designed."[12] Producing readiness requires "parts and systems, healthy and secure supply chains, and a skilled U.S. workforce."[13] In support of producing readiness, the report focused on identifying strategic bottlenecks by applying the Theory of Constraints, or identifying things that may hinder OIB capacity utilization by obstructing the total capacity available to produce the readiness level demanded.[14]

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[10] Ibid.

[11] Industry Analysis Lecture, Eisenhower School, National Defense University, March 19, 2021.

[12] Joint Chiefs of Staff, *Joint Personnel Support*, JP1-0 (Washington, DC: December 1, 2020), GL-8, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp1_0.pdf?ver=wzWGXaj9anm9XlmWKqKq8Q%3d%3d pp.

[13] Trump, *National Security Strategy*, 29.

[14] Board of Governors of the Federal Reserve System (US), Capacity Utilization: Total Index [TCU], accessed May 15, 2021, from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TCU.

For example, infrastructure and its role in expanding capacity for war mobilization is a key enabler for the OIB. Changing policies to invest in physical plant more strategically could provide national leaders with added flexibility and options in a crisis, or when there is a demand shock. Some facilities in the current OIB portfolio are being used well beyond their design life, many house missions for which they were never designed, and the warfighter's mentality of "getting it done by any means" has impacted OIB efficiency and effectiveness. To that end, this report proposes changes to the current investment strategy and analyzes the possibilities of synchronizing government and private sector capital investment.

Additionally, the human capital readiness enabler received significant attention in this report due to the specificity of training and technical proficiency for professionals in the OIB. There are challenges across the services with federal hiring mechanisms and protocol. However, this report focuses heavily on the need for more deliberate senior leader development and a particular emphasis on establishing business acumen amongst senior officers and civilians. The impending loss of experience and corporate knowledge throughout the OIB due to natural generational churn makes these recommendations particularly pressing.

Strategic implications of value creation received an entire section in this report. Therefore, the current state of the OIB's financial readiness informed recommendations more broadly. This report provides a general overview of assessing value using Net Present Value (NPV), judges the validity of existing capacity metrics, explains why DLH are inadequate for this purpose, and outlines measurements that might better serve the enterprise.

Other enablers, such as governance and materiel, receive less attention in this report, but their inclusion in the readiness enabler model is appropriate. During the academic year, the OIB IS regularly observed challenges with a diminishing national supply and manufacturing base. Materiel's role in the everyday activities of sustained supply for aging and obsolete equipment underlines the occasions where industry cannot, or will not, offer support because of profit considerations or lack of growth opportunities. These issues, as well as those associated with governance, may warrant additional study outside the scope of this report.

Finally, some areas of analysis do not fall neatly into any category, such as modernization of technical data rights policy or the treatment of software as part of the OIB portfolio. Technical data rights and software are essential to the overall discussion of readiness given their connection to the strategic environment of GPC, capabilities they provide the OIB and the Nation, and role they will play for the weapon systems on the battlefields of tomorrow.

Section 2 – STRATEGIC ENVIRONMENT

2.1 Introduction

The U.S. DIB and OIB operate in an evolving strategic environment and dynamic world-order. The deindustrialization of the United States over the last 50 years, end of the Cold War, focus on defeating the Soviet Union, increasing importance of digital technology, and rise of China create multi-faceted challenges to U.S. national defense.[15] As the United States navigates GPC with China and Russia, the OIB Industry Study asserts the U.S. DIB and OIB are at a crucial crossroads between maintaining the status quo and outpacing strategic competitors. An accomplished OIB legacy does not guarantee future of success in a changing world order. As the OIB assesses its strategy, a proactive value-creation perspective, common understanding of what drives OIB readiness, and astute management of technology and intellectual property should drive change and define requirements for the future. Framed on the Biden Administration's *2021 Interim National Security Strategic Guidance*, the Trump Administration's *2017 National Security Strategy*, and the *2018 National Defense Strategy*, the U.S. DIB and OIB need to prepare for, and adapt now, to future readiness needs shaped by GPC with China as the lead competitor. As the *National Security Strategy* states, a "healthy defense industrial base is a critical element of U.S. power."[16]

2.2 The State of the DIB Today

To prepare for the future, the OIB needs to assess the current state of the DIB. Today, the U.S. DIB faces five impactful forces that place the industrial base in a fragile state: iterations of sequestration; inefficient procurement practices; decreases in critical manufacturing and production capabilities; strategic competitors' foreign policies; and deficits in the number of trained STEM professionals and industrial trades.[17] Sequestration contributed to lower defense spending, while lengthy and bureaucratic procurement processes "induced contracting delays, deterred market entry, discouraged innovation, and increased costs to suppliers."[18] Ultimately, the DIB manufacturing sector demonstrates an eroding national competitive advantage.

The degradation of core manufacturing and production capabilities eroded "as a result of automation in the manufacturing industry, a lack of national focus on the industrial skills base,

[15] C. Todd Lopez, "DOD Aims to Bring Industrial Base Back to U.S., Allies," *DoD News*, January 15, 2021, https://www.defense.gov/Explore/News/Article/Article/2474015/dod-aims-to-bring-industrial-base-back-to-us-allies/

[16] Trump, *National Security Strategy*, 29.

[17] White House Office of Trade & Manufacturing Policy, "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," (Washington, DC: September 2018), 8, https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20DEFENSE-INDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF

[18] Ibid.

offshoring, and the inability to hire and retain skilled workers."[19] Simultaneously, the foreign policies of global competitors, such as China, strengthened their respective domestic growth and further threatened U.S. global competitive advantage. Decreases in the U.S. workforce, "specifically, skilled labor shortages in additive manufacturing; composites; non-destructive inspection, machining, and shipbuilding, diminish surge and sustainment efforts."[20] Additionally, COVID-19 caused a decrease in DLH, stalled supply chains, and delayed production across the DIB.[21] The DIB, a U.S. advantage, is ill-positioned for today's national security concerns. The strength of the DIB, a traditional U.S. advantage, is slowly eroding and increasing risk for the OIB.

2.3 The State of the OIB Today

The OIB is under intense pressure to provide goods and services to the Nation in an efficient and effective manner. The OIB mandate to prepare for future DoD requirements and missions exacerbates this pressure. GPC requires the OIB to sustain legacy weapon systems surpassing 70-year lifespans while modernizing maintenance support for the technologically advanced demands of the 21st century. However; issues such as: budgetary uncertainty; human capital development; infrastructure investments; manufacturing capability; supply chain and material management risks; product and network security; and intellectual property, make maintaining this delicate balance more difficult. The Eisenhower readiness framework introduced in the preceding section focuses on the nexus of these issues by providing areas ready for strategy improvement now.

Budgetary Uncertainty: Successful OIB operations and interaction with supporting organizations or businesses depend on a stable and adequate budget. Sequestration, fluctuations in defense spending, and continuing resolutions introduce variability and inefficiencies into the funding process, harm maintenance, and slow modernization. For instance, a study by the Center for Strategic and International Studies estimates that 17,000 companies ceased to be prime DoD suppliers during the period of 2001 and 2015 due to budget unpredictability within the DoD, [22] potentially impacting private sector support at Government facilities. Section 3 of this report addresses opportunities to mitigate these losses and create value in this fiscally constrained environment.

Human Capital Development: Human capital is necessary to lead, manage, and operate the OIB so it can deliver the necessary supplies to the Warfighter. When the OIB is unable to

[19] Lt Col J. Phillips, "Defense Industrial Base Workforce," (ES6132 Mobilization Paper, Eisenhower School, National Defense University, 2020), 1.

[20] Ibid.

[21] C. Todd Lopez, "Full Impact of COVID-19 on Industrial Base Not Yet Known," *DoD News*, September 9, 2020, https://www.defense.gov/Explore/News/Article/Article/2341714/full-impact-of-covid-19-on-industrial-base-not-yet-known/.

[22] Rhys McCormick, Andrew P. Hunter, and Gregory Sanders, "Measuring the Impact of Sequestration and the Drawdown on the Defense Industrial Base," (New York: Center for Strategic and International Studies, December 2017), xiv,xvii, https://www.csis.org/analysis/measuring-impact-sequestration-and-drawdown-defense-industrial-base.

hire or retain specific skilled trades or personnel to operate its facilities, the OIB may experience loss of readiness and capability in fulfilling its maintenance requirements. The industrial base regularly competes with the private sector for the same capabilities, e.g., welders, engineers, and software designers, and sometimes paces behind industry in compensation and other financial incentives. Concurrently, the OIB faces challenges in developing this talent in a largely unstructured training environment that emphasize on-the-job training. The subsection on human capital under Section 4 of this report addresses opportunities for the DoD to improve training and development programs and better identify available human capital and competencies.

Infrastructure Investments and Manufacturing Capability: Infrastructure and equipment for manufacturing are needed to maintain, repair, overhaul, and produce assets for the Warfighter. Despite statutes requiring the DoD to reinvest and recapitalize equipment and facilities at its working capital funded facilities, the lack of sustainable workload, degrading condition of equipment at depots and shipyards, and outdated and inefficient infrastructure threaten the OIB's ability to maintain existing assets and sustain readiness for surge and contingency environments. The subsections on infrastructure, materiel, and finance under Section 4 address opportunities for the OIB to improve naval infrastructure and Army metrics, and WCF financial policies which impact infrastructure investments.

Software and IP: As weapon systems become more automated and network-based, software and associated intellectual property become increasingly critical in sustaining readiness. Although current DoD weapon systems are largely designed with software integration early on, the OIB is continuously challenged to sustain legacy, hardware-centric systems with outdated software or without rights to the intellectual property. Consequently, readiness and modernization slow as the OIB resolves current software and IP gaps to field legacy systems. Section 5 of this report addresses opportunities for the DoD to improve software acquisition and IP rights to best align with software-centric systems and future maintenance demand.

In light of these issues and broader challenges, the OIB is facing a competitive business environment and a similar dynamic world order. This assessment highlights the issues facing the OIB to set requirements informing strategy. In light of these issues, the OIB needs to adjust its subordinate strategies to adapt to the changing conditions. This report melds the current state of the OIB, anticipated environmental conditions, and the strategy improvement framework of articulation and implementation to develop its recommendations.

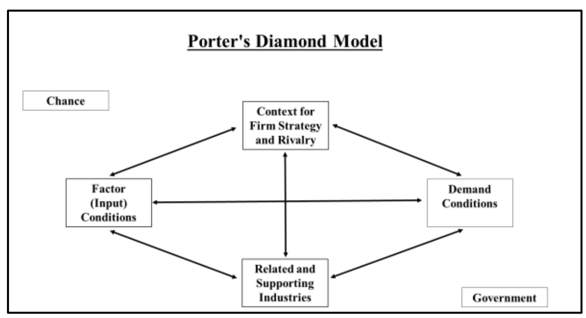

Figure 2.1 Porter's Diamond Model

2.4 National Competitiveness— Porter's Diamond Model

One aspect of the strategic environment is recognizing national competitive advantage. As part of the overall defense industrial base, political aims also influence the OIB strategic environment. Using the four determinants and two components of Porter's Diamond Theory of

National Advantage (see *Figure 2.1*), the OIB IS evaluated the national competitiveness of the U.S. DIB against the DIB's of China and Russia to further define the strategic environment surrounding the U.S. DIB and OIB. Through open-source information, albeit limited for China and Russia, the OIB IS concluded that right now, the U.S. DIB provides the United States with a competitive advantage over both China and Russia. However, without action, the advantage will wither away due to the multiple risk archetypes highlighted in EO 13806. A summary of the key Porter's Diamond assessments is displayed in Appendix E.

2.5 Conclusion

The strategic environment surrounding the OIB is evolving and complex. GPC will require leaders to assess organizations against current requirements and anticipate future demands. As a result, the OIB is at a crossroads between maintaining the status quo and outpacing strategic competitors. The OIB is under intense pressure to meet the Nation's requirements while working through a conundrum of challenges. From budgetary uncertainty to pacing technological advances, the challenges within the OIB remain complicated due to the relationships across enabling functions. With prudent planning and resourcing, the OIB can mitigate expected challenges and continue pursuing a more integrated strategy for the future.

Section 3 – VALUE CREATION

3.1 Introduction

The United States achieves a competitive advantage by creating more value than its strategic competitors. Value represents an increased return on investment for shareholders that is high enough to compensate for the cost of capital.[23] The OIB needs to create value for the Nation, not through profit like the private industry, but through investments which improve outcomes at an acceptable cost. Furthermore, it needs a way to accurately assess this value creation through a replicable, data-supported methodology.

This section explores foundational concepts of value creation in the private sector and how these concepts can inform the OIB in its investment decisions and capacity metrics. Specifically, this section assesses:

- Quantifying Outcomes for the OIB
- Using Return on Invested Capital (ROIC) for Investment Decisions
- Creating Value
- Value and Capacity Measurement Beyond Direct Labor Hours

Though different from private industry in several aspects, the OIB can benefit from metrics and tools used in business to evaluate its capacity and value creation. As no single metric will satisfactorily express depot capacity, a methodology to inquire, define, measure, record, and relay depot capacity could help the DoD. Transitioning from DLH to a history-informed, data-augmented, results-oriented, plain-language relation of measurable deliverables, costs, and risks/tradeoffs can convey capacity in a more relatable way.

The assessments in this section propose quantitative frameworks to transform historic OIB measurements towards an improved value creation strategy. The recommendations provide ways for the OIB to adapt to future readiness needs.

3.2 Quantifying Outcomes for the OIB

<u>Current State and Gaps</u>

Unlike private industry, the OIB does not have the opportunity to generate a profit. DoD Financial Management Regulation 7000.14-R mandates the OIB operate on a "break-even" basis through its Defense Working Capital Funds.[24] Structured like a business, except for profit generation, the OIB requires a foundation for assessing value creation.

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[23] Tim Koller, Richard Dobbs, Bill Huyett, and McKinsey and Company, *Value: The Four Cornerstones of Corporate Finance* (Hoboken, N.J.: John Wiley & Sons, 2011), 3.

[24] Department of Defense, *Financial Management Regulation*, DoD 7000.14-R, Volume 2A, Section 010219 (Washington, DC: DoD, January 2011), 1-52.

Background

Non-profits and not-for-profit organizations operate like the OIB, assessing outcomes as their value measurement in lieu of profit as a basis for value. Outputs are a direct result and typically quantifiable, such as number of engagements or people directly served. Outcomes are the organization's goals, which for a non-profit may include reduced poverty rates, increased education access, or improved health outcomes.

Recommendation

Instead of using profit for an evaluation basis, OSD can define and quantify outcomes to relate an economic value. The OIB provides outputs of repaired, overhauled, or modernized materiel to the nation, resulting in a military readiness outcome. Defining readiness varies widely in the DoD, making a conversion to an economic valuation seem like an impossible task. However, quantitative values are available and could evaluate readiness. First, one could apply a savings value of depot maintenance versus expected field maintenance costs without depot services. Additionally, DoD could use the costs of an average crew assigned to a weapon system and calculate the potential downtime costs avoided by restoring equipment to a useable status. These conversions will establish an improved comparison basis to incurred costs and foster both strategy implementation and articulation improvements.

3.3 Using Return on Invested Capital for Investment Decisions

Current State and Gaps

Return on Invested Capital (ROIC) measures how efficiently a company can allocate capital towards investments to generate more profit. ROIC ultimately drives value creation and sustainment over time.[25] The OIB, like private industry, requires a favorable ROIC. Substituting outcomes for profit, ROIC improvements for the OIB require investments targeted at increasing readiness through faster turnaround of MRO activities or improved upgrades and modifications that reduce field downtime. Improving ROIC also includes reducing operating costs to make the OIB more efficient in delivering readiness. Similarly, if new innovative investments cost less than legacy investments but improve the output or reduce operating expenses or inventory costs, the ROIC increases. *Figure 3.1* shows an example of all three ROIC gains through 10 percent improvements in readiness, costs, or better investments.

[25] Koller et al, 15.

	Readiness Outcomes	Operating Cost	Investment	ROIC	ROIC Improvement
Baseline	100	90	75	13.3%	
Improve Outcomes (+10%)	110	90	75	26.7%	100.0%
Reduce Costs (-10%)	100	81	75	25.3%	90.0%
Innovative Investment (-10%)	100	90	67.5	14.8%	11.1%

Figure 3.1 ROIC Improvement Through Improving Outcomes, Reducing Costs, and Innovative Investment

As demonstrated in *Figure 3.1*, modest increases in outcomes while keeping operating costs and investment constant produce the best ROIC. An example within the OIB would be altering processes in a more efficient manner to reduce wait time between stations, thus delivering the weapons system to Nation sooner and saving crew idle time. ROIC increases result from input cost reductions, even if they don't produce more outcomes or use innovation investment. A simple example includes finding lower cost supply vendors which does not lead to more output but these reduced costs provide a higher return on invested capital. In the chart, reducing investment costs by 10% leads to the lowest ROIC improvement when outcomes and costs don't change. However, if a lower priced investment can lead to outcome improvements and reduce operating costs, this would ultimately maximize the ROIC.

Background

A business can establish a higher ROIC when it has a competitive advantage and can charge a price premium or deliver its products more efficiently.[26] Companies can set a price premium, which is a price higher than a benchmark market value, if they create difficult to copy innovative products, possess exceptional quality above competitors, have a brand image customers prefer, have customer lock-in, or execute rational price discipline.[27] Yet, the design of the OIB restricts it from charging a price premium because prices are fixed annually and are adjusted to match the costs to break even. Without the means to charge a price premium for services, the OIB lacks incentives for setting realistic goals for exceeding product innovation, quality, or price leader policies. DoD customers are required to conduct business with the OIB but only based on the "50/50" rule, a statutory limit requiring no more than 50 percent of depot-level maintenance and repair work to be contracted outside of the OIB (Appendix B).[28]

Rather than improve ROIC through establishing a price premium advantage, the OIB strategy must instead rely on production cost efficiencies. The OIB can realize these efficiencies using innovative business methods, having access to unique resources, developing advantages in economies of scale, and having scalable or flexible characteristics.[29] Innovative business methods, unique resources, and right-sized scale emerge from a combination of production and logistics, requiring evaluations of how to improve throughput in the system while keeping costs

[26] Ibid., 121.
[27] Ibid., 124.
[28] 10 U.S. Code 146 (2009) §2466 (a).
[29] Koller et al, 124.

the same or reduced. Scalability and flexibility may provide an even more attractive strategy for the OIB to bolster its ROIC.

Businesses are scalable when they are performing well with an increased workload. If a business can maintain or increase its performance level with increased demand, then it is considered scalable. Scalability is often seen in businesses that provide products online. For example, smart phone applications can be disbursed to 100 or 100,000 customers with little to no cost changes. In manufacturing, this relies heavily on having sufficient capacity to expand in operations. Flexibility refers to the ability to adapt to changing or different conditions. Flexibility in manufacturing includes having employees who can be quickly retrained to meet new demands or retooling machines with speed and limited cost to produce altered products. Scalable and flexible business models provide opportunities for improved cost efficiencies.

Recommendation

To improve ROIC, the OIB should focus on improvements in scalability and flexibility due to its requirement for a surge. Private industry will establish operations for current and forecasted demand, while the OIB's design allows it to quickly respond to and absorb unexpected demand spikes from mobilization requirements. Scalability and flexibility improvements allow the OIB to take on more requirements during a surge, operate efficiently during steady-state, and continue operations when DoD maintenance and repair budgets are lean. Each investment decision at each echelon should evaluate scalability and flexibility criteria when considering capital efficiencies in improving ROIC.

3.4 Creating Value

Current State and Gaps

ROIC evaluation is compared to the cost of capital for a business to determine if the investment is creating value at an acceptable cost. The cost of capital includes a required return rate that investors expect. This can also be viewed as an opportunity cost, as companies and investors have alternatives to achieve this expected return. Additionally, the cost of capital includes the cost of debt, which is the market interest rate of the debt. Both equity and debt portions consider the time value of money. This concept asserts a given amount of money will have less value in the future than it does in the present. One dollar today holds more value than one dollar at any point in the future. The NPV concept examines future cash outflows and inflows and converts them into the present value by adjusting with a set interest rate, which is the cost of capital. Managers use this rate as the hurdle rate to evaluate investments and ensure value is created in the future using NPV assessments.

The OIB differs from private industry because it does not have a cost of debt or a cost of equity to calculate its true cost of capital. The federal government may operate in debt, but for simplifying evaluation of the OIB, this analysis assumes the DoD operates without debt assets. Statutory requirements stated in the Federal Acquisition Regulation require funds must be available before committing the government to purchase. For equity, the OIB does not have shareholders expecting a specified monetary return. *Figure 3.2* represents the differing cash flow structures of the commercial sector and the OIB.

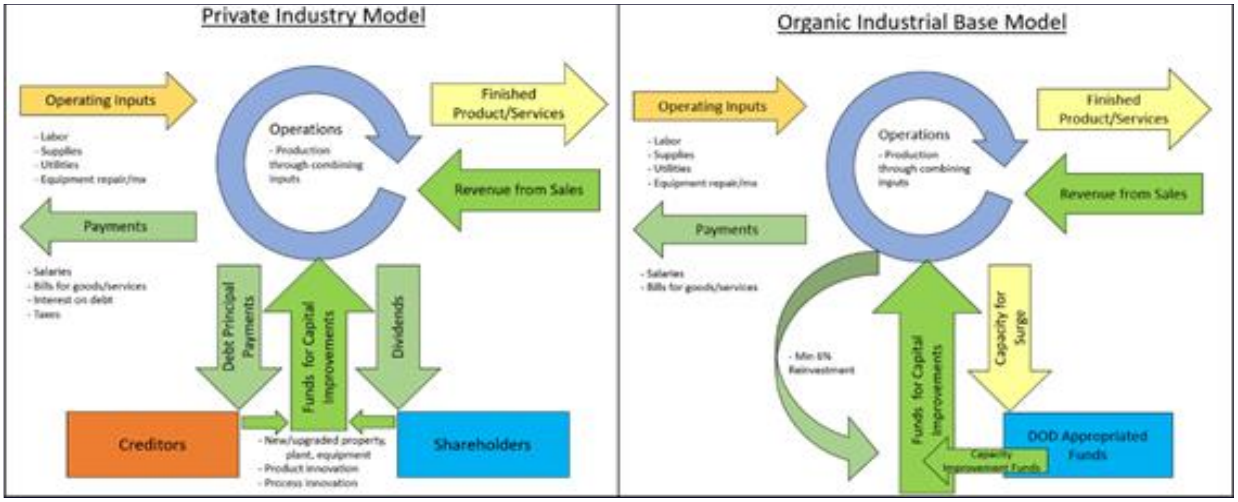

Figure 3.2 Private Industry vs OIB Cash/Product Flow

Background

The federal government established a standard measure for a discount rate, which serves as the cost of capital. The real discount rate used for evaluation is currently seven percent. The Office of Management and Budget (OMB) established this rate for cost-benefit analyses because public investments tend to displace private investment and consumption.[30] Setting a lower cost of capital for the government would produce favorable outlooks for more projects, reducing opportunities for other investments. For the OIB, the seven percent cost of capital is comparable to the private sector in the commercial MRO industry (i.e., BAE: 7.1 percent, General Dynamics: 7.5 percent, Huntington Ingalls: 6.8 percent).[31] This benchmark helps evaluate the OIB's value as it holds the cost of capital constant with its partners and competitors.

Recommendation

As the OIB evaluates each investment, depots and centers should consider NPV and the hurdle rate of seven percent. This governance tool will provide a clear picture of the OIB's ability to create value by consistently generating a ROIC higher than seven percent. While the Economic Analysis process accomplishes this for larger investments, each depot and center should be able to scrutinize its smaller investments to ensure they are improving ROIC higher than the seven percent hurdle rate.

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[30] Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Circular No. A-94 (Washington, DC: October 29, 1992).

[31] Current cost of capital for BAE, GD, and Huntington Ingalls, Bloomberg, March 2021, accessed Mar 21, 2021.

3.5 Value and Capacity Measurement Beyond Direct Labor Hours

Current State and Gaps

Accurately measuring the OIB's value creation and capacity require better metrics than Direct Labor Hours as its sole standard. DLHs inadequately express capabilities, leading to an absence of a holistic appreciation of the OIB's complexity outside of the depot ecosystem. What goes unreported are other measurable inputs: costs of labor, training, plant/property/equipment, materials, and reporting of outputs; deliverables and timeliness; and the operational requirement. Most of OIB does not have a capacity problem so much as it has a transparency problem and thus an understanding problem.

The DoD guidance directing OIB metrics collection originates with DoD Directive 4151.18 *Maintenance of Military Materiel*. This Directive levies the requirement for DoD components to compute and report depot maintenance capacity and utilization annually and minimize unutilized plant capacity.[32] To do so, the Directive mandates the techniques prescribed in DoD 4151.18-H, *Depot Maintenance Capacity and Utilization Handbook*, which explains the calculation of DLH as the single common metric used across the OIB to calculate capacity. It acknowledges detailed analysis of workloads, facilities, and resources merit consideration in capital investment decisions. However, there are no visible metrics adopted for these impacts.

Previous OIB IS classes at the Eisenhower School recommended expanding metrics to account for the lack of descriptive substance in DLH as the metric of choice. For instance, the 2019 OIB IS report focused its metrics recommendations on Data-Driven Decisions and a "Super-ordinate Metric" of Material Availability. Utilizing Results, Status, and Performance Metrics that were relatable, actionable, nested, and complimentary, the 2019 recommendations are a step in the right direction to quantifying capability, performance, and deliverables to put a finer point on capacity.[33] However, these metrics, combined with the current measure of DLH, still fall short of the cyclic and descriptive analysis needed to relate OIB capacity.

Background

The FY 20 NDAA Section 359 directed the Services to author a strategy to improve depot infrastructure and ensure the OIB maintains the capability to support the readiness and material availability goals of current and future DoD weapon systems. This NDAA directed the assessment and reporting of:

a. Cost and schedule performance of the depots
b. Material availability of weapon systems supported
c. Work in progress and non-operational items awaiting depot maintenance

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[32] Department of Defense, Maintenance of Military Materiel, DODD 4151.18 (Washington, DC: DoD, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/415118p.pdf, 4 and 8.

[33] Organic Industrial Base Industry Study AY2018-2019, *Organic Industrial Base Improvement Plan*, (Seminar report, Eisenhower School, National Defense University, 2019), 52-55 and 58.

d. The condition of the depot
e. The backlog of restoration and modernization projects
f. The condition of depot equipment
g. The vulnerability of the depot to adverse environmental conditions

Furthermore, this NDAA charged the Services to identify analytics and goals related to the above elements, investment plans, and tradeoffs to improve depot conditions and performance.[34] In short, the Services needed to relay their capabilities, capacity, challenges, and needs descriptively, beyond those expressed by DLH.

Much of the analysis included in the pending first edition of the annual report built upon work the Services started for the 2019 Master Plan for the OIB, a requirement levied by the Senate Armed Services Committee (SASC) as an addendum report to the FY 19 NDAA. The SASC directed this "OIB 20-Year Plan" to address many of the same issues: workload requirements, baseline conditions, costs to repair and modernize (or consolidate) facilities, master plans, and an updated investment strategy for each depot.[35] Initially, the Services did not agree on cross-service metrics (other than DLH) to measure and describe the conditions and depot capacity as mandated, a trend which continued into the FY 20 NDAA Depot Maintenance Strategies report. After months of work, each of the DoD Services agreed to report:

Unsynchronized Infrastructure Investment

The Army is investing in its infrastructure, but the current effort is unsynchronized. To the House Appropriations Committee, Army testified, "…we have World War II-era facilities, and many of them are outdated for today's requirement, let alone for the needs of the future force." The Army has spent more than $3B in facility, infrastructure, and operating environment improvements from 2009 through 2021, with FY21 alone including $800M in essential improvements to depots, arsenals, ammunition plants. The spending plan aligned with this testimony highlighted strategic investments include the OIB. This testimony matches external GAO assessments characterizing demonstrable facility age, backlog, and a lack of attributable metrics linked to detrimental readiness impacts. Ultimately, the Army is putting resources at an infrastructure problem without a visible capacity metric to benchmark success.

Source of Data:

- LTC T. Rayfield, "Unduly Constrained: An Opportunity to Improve OIB Facility Capacity" (ES6572 Industry Study Paper, Eisenhower School, National Defense University, 2021)

[34] NDAA for Fiscal Year 2020, 129.
[35] Department of the Air Force, Office of the Secretary of the Air Force, *Master Plan for Organic Industrial Base Infrastructure*, (Washington, DC: Department of the Air Force, 2019), 7.

a. Operational Availability / Equipment Readiness – Weapon System readiness in %
b. Schedule Performance – on time (scheduled) delivery of depot products
c. Building Conditions Index (BCI) – building inspection rating
d. Average Equipment Age – equipment valued over $250K

Despite agreed upon expanded metrics, the OSD recently rejected the Services' 55-page response as inadequate to answer the Congressional requirement.[36]

In summary, Congress deemed the metrics OSD uses to relay the OIB capacity and capability inadequate and passed two consecutive NDAAs requiring the Department to further articulate its capacity, issues, needs, and shortfalls. While the Services adequately built their 20-year plans for OIB modernization, they still fell short in relaying the capacity of the enterprise. This shortfall is partially due to the inadequacy of the metrics used and the disconnect between performance metrics and deliverables. If Congress cannot understand what the taxpayers receive in return for financing the OIB, the future looks bleak for funding, modernization, and expansion. Without relevant capacity measurements and metrics, the OIB can expect continued pressure from Congress to tell its story in a more relatable way. What the OIB needs is a methodology to do so, not an all-encompassing metric.

Recommendations

R1: **Adopt a replicable, data-supported methodology, to support OIB analysis.** Given the inadequacy of capacity metrics and consecutive NDAAs directing the description of the OIB's challenges, it is time to change how the DoD conveys its industrial capacity. The DoD must augment DLH with supporting information, deliverables, and needs through a common methodology designed to convey capacity in plain language. The difficulty of this charge is the incongruity of the OIB across the Services. The work, material, plant, equipment, and labor required for maintaining, repairing, overhauling, and modifying ships is vastly different from that required for tanks, airplanes, or sub-components. Since no "panacea metric" adequately conveys capacity, OSD should instead adopt a replicable, data-augmented, results-oriented methodology to guide OIB analysis.

[36] Department of Defense, Office of the Under Secretary of Defense for Acquisition and Sustainment, *DRAFT Military Department Appendixes to FY20 NDAA Section 359* (Washington, DC: DoD, 2021).

USCG Measuring Capacity Baseline

In a site visit to the USCG Aviation Logistics Center (ALC), the USCG had a MH 60 facility final assembly capable of supporting four MH-60s. The facility usage and design was 3.5 aircraft per month in four bays. Therefore, the ALC managed the workload with an 87.5% facility utilization rate. In this case, ALC centrally integrated aircraft maintenance with precision into their aircraft fleet operations. Due to their scale (~200 aircraft), the USCG closely aligns the managed workload lines with the planned resourcing to have an efficient business line. The MH-60 facility baseline could be the observed process of a design capacity as four bays producing 3.5 helicopters per month on one shift. The facility surge capacity would then be how increased labor, or additional shifts, could increase the facility utilization. Theoretically, adding a second shift may almost double the throughput to 6 helicopters per month and create a surge capacity of 71%. Likewise, a third shift may produce an additional capacity of 70% and define a maximum facility surge of 10 helicopters per month, assuming all other supply inputs can keep up. A facility-based capacity metric could be a Critical Key Performance Indicator (CKPI) added to each depot for its core logistics programs.

Source of Data:

- LTC T. Rayfield, "Unduly Constrained: An Opportunity to Improve OIB Facility Capacity" (ES6572 Industry Study Paper, Eisenhower School, National Defense University, 2021)
- Travis Rayfield, USCG ALC, author calculated based on site visit, April 15, 2021

While such a methodology would focus on present and future requirements, historic depot performance should also inform the process. Each depot has the tools and data available to reasonably estimate the capacity at which their depot presently operates. Furthermore, the depots have 20+ years of relevant increased operational tempo (if not "wartime operational tempo") performance data since September 11, 2001, to help evaluate current and future operating potential. Examining historical performance to benchmark capacity requires first identifying periods of output to explore. Periods of high operational tempo/output are relevant starting points as they help define the maximum output of the OIB. Once identified, the details of inputs, outputs, and deliverables in that timeframe are overlayed to set comparative benchmarks for depot performance. Relevant input, output, and deliverable inquiries must answer:

a. What was produced? (Throughput: What deliverables left the depot? On-time?)
b. At what Cost? (What was the Plant/Personnel/Equipment, Materials, Funding, Operating Cost, Overhead, etc.?)
c. What limited historical output? (Constraints?)
d. What was the maximum production possible at that time? (Max Capacity)

The process then repeats for lower periods of production, creating gates with known performance characteristics ("this level of output is possible with this level of input"). In this manner, individual depots create a database of relevant records of comparable performance to inform current and future production potential. *Figure 3.3* represents an example from one depot's historic data and relevant gates.[37] In theory, this process defines what is possible at each depot, at gated levels of funding, personnel, production, and costs, building a picture of past performance compared to current or future production. Knowledge of the past thus guides future performance estimates, investment, human capital decisions, and capacity.

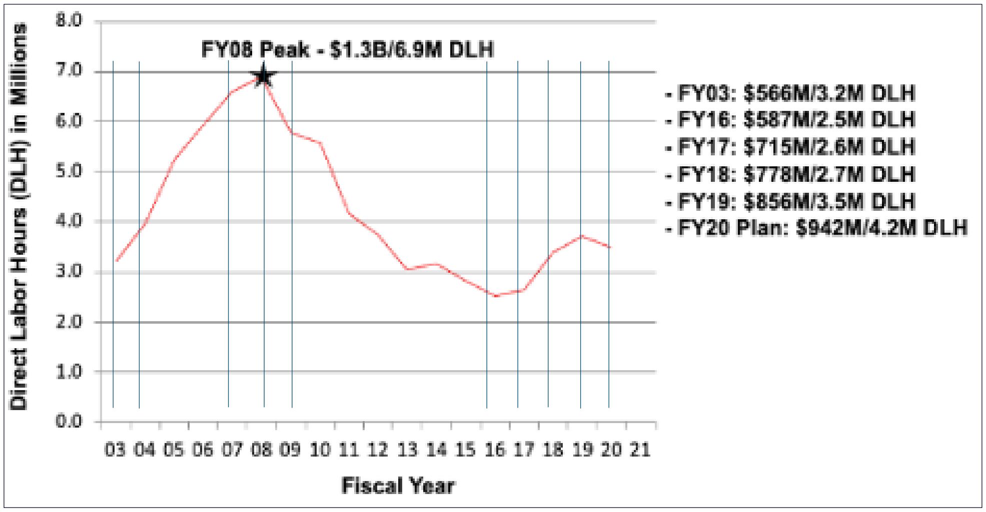

Figure 3.3 Example of Preliminary Historical Analysis and Relevant Gates

With past performance as a reference, the methodology then shifts to potential present and future production capacity. The Air Force's "The Art of the Possible" paradigm adopted such a process using the DoD analytic framework adopted from Goldratt's Theory of Constraints. The Theory of Constraints proposes each system has one important limiting factor, or constraint, that prevents it from producing more of its goals.[38] Constraints, often referred to as bottlenecks, define the current state of capacity. Increasing capacity for anticipated future demand or for a surge event requires a way to increase flow through the constraint to achieve an overall increase in throughput. Goldratt offers five focusing steps for an organization to target its efforts against its constraints. These are:

a. Identify the system's constraint.
b. Decide how to exploit the system's constraint.
c. Subordinate everything else to the above decisions.
d. Elevate the system's constraint.
e. If any of these steps break a constraint, go back to the first step but do not allow inertia to cause a system constraint.[39]

[37] Anniston Army Depot, *Anniston Army Depot Eisenhower School Visit Briefing 13 April 2021* (Anniston Army Depot, GA: Department of the Army, April 2021), DLH history chart, Slide 7.
[38] Eliyahu M. Goldratt and Jeff Cox, *The Goal: A Process of Ongoing Improvement*, 4th rev ed.,(Great Barrington, MA: North River Press, 2004).
[39] Ibid, 363.

R2: **Leverage a data-supported methodology to further define depot capacity.** Using a similar process, the Services should examine and detail OIB/depot processes for production at current and future levels to determine current and estimate future capacity.[40] To do so, the depots can:

a. Identify the Requirement/Deliverable (What does the depot produce now? OPLAN/GCP-based? Combatant Commander/Service needs? Surge?)
b. Define Labor/Materiel/Funding required (At what cost?)
c. Define Constraints, Shortfalls, Roadblocks, Limiting Factors (What limits output at current levels? What will keep Required Output from being produced?)
d. Define Additional Inputs Required to enable desired/required output (What is required to match/exceed historic levels of output? If growth is required, how much? Where?)
e. Define the maximum production possible today. What will that cost?
f. Define Tradeoffs and Risks (With more of this, we could do 'x.' Without 'x' we cannot achieve 'y.')
g. Repeat the Process

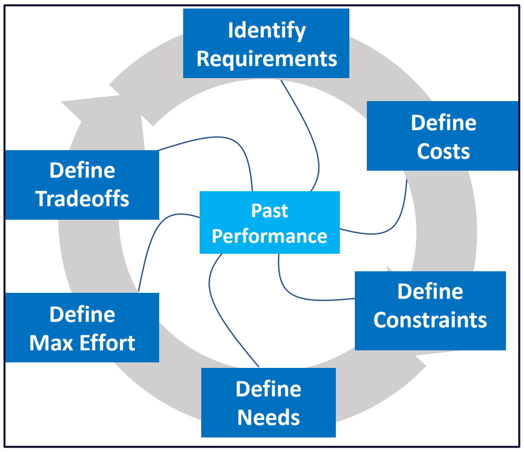

Figure 3.4 Diagram of Analysis Methodology

This methodology is tailorable across the Services, allowing for descriptive transmission of OIB capacity and comparison to previous performance; additional measurements or metrics are not (as evidenced via the most recent rejection of OIB metrics proposed by the Services for the FY 20 NDAA requirement). Nonetheless, the goal is to transition the OIB from a data-language explanation of capacity to a history-informed, data-augmented, results-oriented, plain-language discussion of measurable deliverables, measurable costs, and measurable risks/tradeoffs.

To implement these recommendations, OSD should:

a. Formalize the historical analysis of depot performance to better inform future capacity.
b. Make Direct Labor Hours relatable to depot output/throughput by defining the requirements (or outputs) produced for DLH in reporting OIB capacity.
c. Continue to relay data-based descriptive assessments and report the health, needs, and capacity of the OIB started by the FY 20 NDAA requirements.
d. Redefine Department-wide standards for measuring Capacity. Eliminate language from the DoD-I 4151.18-H that mandates DLH as the metric for capacity computation.

[40] Air Force Sustainment Center, *Art of the Possible Handbook*, AFSCH60-101 (Tinker AFB, OK: AFSC, 2021), 5, 40.

e. Change the DoD-I from a DLH-based computation of Capacity to a methodology-based analysis using an “Art of the Possible”-style process.

3.6 Conclusion

The OIB could significantly benefit from evaluating its ability to create value using private industry standards of Return on Invested Capital compared to its established cost of capital. Instead of using profit as a measurement, it can quantify outcomes in economic terms like non-profit entities as its basis for value creation. Additionally, each investment decision at the depots and centers should be evaluated based on NPV, clearing a hurdle rate of seven percent to verify the investment is creating real value. Furthermore, OSD should adopt a common methodology to relay the complex interaction of inputs, outputs, needs, and requirements in plain language to a general audience. Adopting a history-informed, data-augmented, results-oriented, plain-language methodology to convey deliverables, costs, and risks/tradeoffs as an alternative to DLH can allow the Services and the DoD to better articulate the OIB strategy.

These quantitative frameworks within the OIB strategy emphasize creating more value than our strategic competitors to retain and expand the nation’s competitive advantage in Great Power Competition.

Section 4 – READINESS ENABLERS

4.1 Introduction

Readiness enablers such as, infrastructure, materiel, human capital, and finance, are the fundamental elements of OIB readiness, and a common understanding of these key enablers are essential to delivering victory in the face of Great Power Competition. Infrastructure and materiel include the supplies, equipment, and facilities which are key inputs in the production process. Human capital includes the military, civilian, and private sector workforce needed to accomplish DoD objectives. Lastly, finance includes budgetary and fiscal conditions which are required to resource the product or service life cycle.

Understanding readiness enabler conditions and gaps is necessary to support strategic planning for new capacity or expanded capacity utilization. For instance, lack of dry dock capacity and the poor condition of equipment at naval shipyards impact the OIB's ability to maintain, repair, and overhaul ships to support DoD missions and capabilities. As another example, DoD funding limitations could affect senior leaders' ability to adequately invest in physical capacity, human capacity, and process improvements for military readiness.

This section explains the current state and gap of key readiness enablers and assesses:

- Navy plans for nuclear attack submarine MRO capacity and capacity utilization
- General naval infrastructure to support naval surge capacity
- Army infrastructure investment processes and its impact on future capacity and capacity utilization
- OIB military and civilian senior leader training and development
- OIB workload allocation policies and impacts to capacity utilization
- Defense Working Capital Funds policy impacts on OIB readiness and long-term sustainability

Each assessment concludes with a set of recommendations for DoD senior leaders regarding OIB capacity and capacity utilization improvements. Achieving capacity optimization within the OIB may lead to more effective management and use of limited DoD resources, improved delivery of products and services, and improved readiness during peacetime and wartime.

4.2 Readiness Enabler: Infrastructure and Materiel

Under infrastructure and materiel readiness enablers, this report examined the current state and gaps in the Navy's plans for nuclear attack submarine infrastructure, general naval infrastructure supporting DoD surge capacity, and Army processes used in infrastructure investment. A summary of the findings and recommendations are addressed in the following subsections.

4.2.1 Navy Attack Submarine MRO capacity and capacity utilization

Current State and Gaps

The Navy operates four naval shipyards, i.e., Puget Sound Naval Shipyard (NSY), Pearl Harbor NSY, Portsmouth NSY, and Norfolk NSY, that perform nuclear submarine MRO activities. While these shipyards are highly industrialized and scaled to execute complex depot-level maintenance, the shipyards have experienced significant delays in attack submarine maintenance. This is attributed partly to inadequate dry dock capacity and poor equipment conditions.

To address the equipment and facility needs at the public shipyards and at the behest of Congress, the Navy issued its *Shipyard Optimization Plan* (SIOP) in February 2018. While the purpose of this plan was to mitigate most of the capacity constraints at the public shipyards, this report has identified three primary weaknesses. Firstly, the SIOP's use of a 2017 submarine force structure to develop shipyard master plans understates the actual facilities and equipment needed for sustainment and readiness. The Navy's plans for facility and equipment investment do not adequately support the projected submarine force structure in the FY 2021 30-year shipbuilding plan. Second, the SIOP focuses on internal Navy capacity and capabilities but does not consider resource availability and utilization of industry or academia. By disregarding the capacity or capabilities of these additional resources, the Navy may not achieve the most affordable or effective solution to address maintenance requirements. And lastly, the SIOP optimizes public shipyards' facilities and equipment to recover 67 of the 68 planned maintenance periods,[41] but still lacks the capacity for one planned maintenance period and surge and contingency requirements. Consequently, the Navy may not achieve attack submarine readiness in all environments.

Background

For background purposes, the GAO reported in FY 2020 that the public shipyards were experiencing significant idle time, which directly contributed to the maintenance delays and lost operational capability of submarines. Idle time is when a submarine remains non-operational while waiting for available shipyard facilities to initiate its planned maintenance. Idle time grew in both frequency and duration each year from 2015 to 2019, resulting in 5 of 31 completed maintenance periods and 10 of 13 ongoing maintenance periods experiencing 471 and 2,325 days of idle time, respectively.[42] During this same timeframe, idle time increased "100 days in FY 2015 to 1,019 days in FY 2019 – a 919 percent increase."[43] This equates to an approximate

[41] U.S. Government Accountability Office, *Naval Shipyards: Key Actions Remain to Improve Infrastructure to Better Support Navy Operations,* by Diana Maurer, GAO-20-64 (Washington, DC: GAO, 2019), https://www.gao.gov/assets/710/705856.pdf, 1. (hereafter cited by Maurer, GAO-20-64)

[42] U.S. Government Accountability Office, *Navy Shipyards: Actions Needed to Address the Main Factors Causing Maintenance Delays for Aircraft Carriers and Submarines,* by Diana Maurer, GAO-20-588 (Washington, DC: GAO, 2020), https://www.gao.gov/assets/gao-20-588.pdf, 6. (hereafter cited by Maurer, GAO-20-588)

[43] Ibid., 11.

cumulative loss of 7.6 years of submarine operations supporting the United States' strategic and defense objectives.

In some instances, lack of dry dock availability contributed to delays in submarine overhaul and maintenance periods. Dry docks are the critical facilities that provide the Navy with the capacity to perform submarine availabilities. The Navy's two primary types of submarine dry docks are graving dry docks and floating dry docks. Currently, the Navy's four naval shipyards operate 17 nuclear-capable dry docks, including 10 along the west coast and Hawaii and 7 along the east coast. Although all 17 dry docks can perform MRO activities for *Los Angeles* class attack submarines, not all dry docks can service current *Virginia* class submarines. Only 13 of the dry docks can support current *Virginia* class attack submarines, and only 11 can accommodate future *Virginia* class attack submarines with the Virginia Payload Module.[44] Thus, the total dry dock infrastructure and configurations at the four public shipyards do not fully support the sustainment requirements of current and future attack submarine classes.

Additionally, for highly specialized capital equipment that supports submarine maintenance and dry dock availabilities, the Navy identified that the shipyard capital equipment was "beyond its effective service life, obsolete, unsupported by the original manufacturers or at risk of failure."[45] Compared to the private sector's average age of equipment of 7 to 10 years, the average age of equipment at the four pubic shipyards was significantly greater at 24 years.[46] In addition to the lack of dry docks, these equipment deficiencies impact the Navy's ability to maintain readiness, affordability, and on-time delivery of its submarines.

The SIOP is the Navy's plan to improve and modernize its four public shipyards over 20 years and at a cost of $21 billion. Since the issuance of the SIOP in February 2018, the Navy has 1) accelerated the planned attack submarine deliveries and subsequent maintenance; 2) projected 23 more attack submarines by FY 2046 than the FY 2017 force structure projection used in the SIOP; and 3) not addressed additional surge capacity for emergent submarine maintenance demand.[47] Whereas the SIOP initially planned to recover most of the Navy's then-projected maintenance delays, increases in submarine quantity and cadence without corresponding increases in capital investment further risks maintenance delays and loss of readiness.

[44] Maurer, GAO-20-64, 14.
[45] Ibid, 21.
[46] Ibid.
[47] Office of the Chief of Naval Operations, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels* (Washington, DC: DoD, 2020), https://media.defense.gov/2020/Dec/10/2002549918/-1/-1/0/SHIPBUILDING%20PLAN%20DEC%2020_NAVY_OSD_OMB_FINAL.PDF/SHIPBUILDING%20PLAN%20DEC%2020_NAVY_OSD_OMB_FINAL.PDF.

The USS Boise Faces Maintenance Delays and Lapsed Safety Certification

The USS Boise (SSN-764), a Los Angeles class nuclear attack submarine, illustrates the Navy's challenges and costs of inadequate capacity at its public shipyards. The Navy initially scheduled the USS Boise to undergo a planned maintenance availability at Norfolk NSY in FY 2013. However, Norfolk NSY did not have available dry docks to perform the effort and the Navy deferred the maintenance. The Boise returned to service, and in FY 2015, the ship completed its last deployment before expiry of its safety certification for diving. The expiry of this certification in June 2016 left the Boise non-operational and idle at a Norfolk NSY pier.

Following years of congressional and Navy concern with a growing attack submarine maintenance backlog, the Navy sought help from industry. The Naval Sea Systems Command (NAVSEA) already offloaded the USS Montpelier (SSN-765) overhaul to General Dynamics Electric Boat Corporation (EBC) and two submarine maintenance availabilities, the USS Helena (SSN-725) and USS Columbus (SSN-762), to Huntington Ingalls Corporation Newport News Shipbuilding (HIINC-NNS). On October 16, 2017, the Navy awarded a $385 million contract, assuming all options are exercised, to HIINC-NNS for the overhaul of the Boise. The Navy expects the work to complete by May 2023, almost seven years after the Boise became non-operational.

For the Navy, the Boise underscored gaps in the Navy's critical shipyard infrastructure for sustainment and readiness and the value of industry partnerships in addressing public shipyard deficiencies. During the performance of the Boise overhaul contract, Vice Adm. Tom Moore, then-commander of NAVSEA, recognized the benefits of industry integration in maintenance planning. He stated, "we would like to keep [HIINC-NNS] in the submarine maintenance business for the long-haul for a number of reasons: it's a surge volume for the public shipyards, and it's also, if we go to war, we'd like to have that capacity."

Source of Data:

- Sydney Lake, "Huntington Ingalls Lands $355M Navy Contract Modification," *Virginia Business*, September 22, 2020, https://www.virginiabusiness.com/article/huntington-ingalls-lands-355m-navy-contract-modification/.
- Megan Eckstein, "After Early Stumbles, Navy, Newport News Might be Turning the Corner on Private Yard Sub Repairs," *USNI News*, December 9, 2019, https://news.usni.org/2019/12/09/after-early-stumbles-navy-newport-news-might-be-turning-the-corner-on-private-yard-sub-repairs.

Recommendations

To improve attack submarine readiness in peacetime and surge environments, this report recommends:

R1: **Private shipyard integration in maintenance plans.** The Navy must integrate private and public shipyard capacity, facilities, and capital equipment into a master plan. Earlier integration of private shipyard capabilities and capacity into Navy maintenance and investment plans, like the SIOP, will afford Navy senior leaders 1) a more comprehensive understanding of defense industrial base health for submarine sustainment; 2) the ability to benchmark against private shipyards to match capital and technology; and 3) greater opportunities and options for strategic planning and resourcing of MRO services.

R2: **Create an Industrial base exception under the "50/50" rule.** The Navy should pursue an expansion of 10 U.S.C. § 2466 waivers to include industrial base health. 10 U.S.C. § 2466, commonly referred to as "50/50" rule, allows the Secretary of Defense to waive this law for national security reasons, which may include surge. The law, however, does not allow the Navy to promote and preserve defense industrial base health, especially in environments of diminishing manufacturing sources. By pursuing the waiver expansion, the Secretary of Defense will have the authority to redistribute excess workload from public shipyards to private shipyards to improve industry capacity and competencies that support MRO activities. In turn, industry is more capable of supporting a surge or need for reserve capacity, if requested by the Navy.

R3: **Idle facility waiver for surge capacity**. The Navy should pursue a waiver of 48 CFR § 31.205-17, Idle Facilities and Idle Capacity Costs, for idle facilities that support surge capacity. This law makes the costs of facilities that support surge capacity unallowable under Government contracts if the facilities are in excess of the contractor's current needs. Thus, the contractor is not incentivized to maintain surge capacity. By allowing the contractor to charge the cost of surge facilities to government contracts, the Navy would reduce industry's financial barriers to maintain surge facilities and increase total surge capacity in the DIB.

R4: **Direct investment in private and public sector surge capacity**. The Navy should invest in additional dry docks and associated capital equipment to increase surge capacity (SC) and improve its contingency response and readiness. *Figure 4.1* illustrates the current and planned dry dock capacity by shipyard, dry dock, and submarine class, and a recommendation for three additional floating dry docks to support SC. The advantages of placing government-owned, contractor-operated (GOCO) floating dry docks at EBC and HIINC-NNS are their 1) proximity to public, nuclear-capable shipyards, capital, and labor, 2) ability to strengthen private yard capabilities that support Navy MRO activities, and 3) ability to address surge requirements in the eastern hemisphere. While Pearl Harbor NSY does not have an adjacent, private nuclear submarine maintenance yard, an additional floating drydock at this shipyard would better accommodate battle repairs and surge requirements in the western hemisphere. Collectively, the Navy benefits from increased surge capacity in multiple geographic regions and enhancement of the DIB capabilities and competencies.

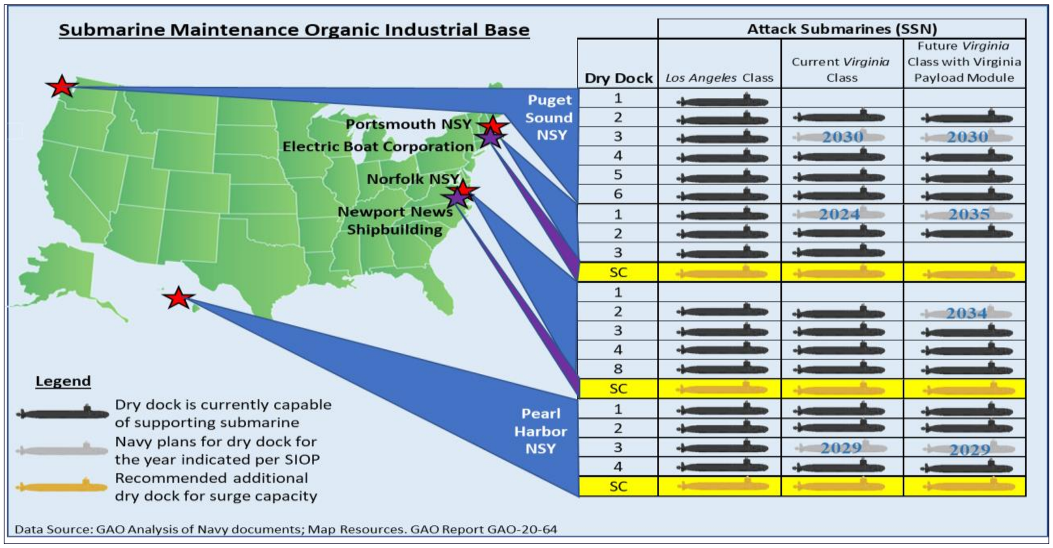

Figure 4.1 Current, Planned, and Recommended Dry Dock Capacity by Shipyard for Attack Submarines

4.2.2 General Naval Infrastructure to Support DoD Surge Capacity

<u>Current State and Gaps</u>

The U.S. Navy currently lacks reserve capacity for ship repair and overhaul because the four public shipyards are already operating beyond their capacity. Between 2015 and 2019, a GAO report noted that 56% of aircraft carriers and submarines completed depot-level maintenance late.[48] Additionally, the Chief of Naval Operations (CNO) ADM Gilday noted that "we are getting 35 to 40 percent of our ships out of maintenance on time: that's unacceptable…I can't sustain the fleet I have with that kind of track record."[49] In response, the Navy's SIOP focuses on upgrading and modernizing shipyards to meet Navy demand. However, this investment in improvement may not be enough to build reserve capacity for a future surge.

For the OIB to ramp up capacity to provide repairs or overhauls during times of conflict, it must have reserve capacity in its facilities to surge. However, this reserve capacity comes at the price of inefficiency due to idle equipment, plant, and workforce not performing work. Maintaining these inefficiencies is difficult, especially during periods of budget austerity, and consequently, the OIB may not have adequate resources to surge. To address these gaps, the OIB should consider capacity and demand opportunities external to the DoD.

<u>Background</u>

[48] Maurer, GAO-20-588.

[49] David B. Larter, "Is the U.S. Navy Winning the War on Maintenance Delays?," *Defense News* (19 September 2020), https://www.defensenews.com/naval/2020/09/19/is-the-us-navy-winning-the-war-on-maintenance/.

External to the DoD, several federal, state, and local organizations rely on non-DoD shipyards to maintain, repair, and overhaul their fleet of ships. Specifically,

USCG: The USCG currently operates 259 cutters, which are vessels 65 feet or greater in length. Of the current fleet, 57 vessels are in the 200 to 420ft in length range.[50] The USCG operates its own OIB shipyard in Baltimore, Maryland called the Coast Guard Yard. The Yard manages a WCF, giving it the flexibility to work on various ships, not just USCG assets. In the past, the Coast Guard Yard has completed work for the U.S. Navy, U.S. Army Corp of Engineers, and the National Oceanic and Atmosphere Administration (NOAA).[51]

Currently, the Coast Guard Yard can carry out only15% of the maintenance for the fleets, resulting in 85% of USCG ship maintenance being performed by commercial shipyards. The Coast Guard Yard is also restricted on the size of vessels that they can support. For example, the new Offshore Patrol Cutters (OPCs), which are 360 feet in length, cannot fit onto the facility's boast lift. However, in their 10-Year Plan, the USCG is seeking funding to upgrade their existing boat lift to accommodate OPCs.[52]

The USCG is also developing a new Polar Security Cutter (PSC) to replace its aging ice-breaking fleet. The current program of record is to construct three PSCs and potentially three smaller variants of the ice breakers. It does not appear that the USCG has a plan to expand the Coast Guard Yard to accommodate the 460 feet long vessels and will have to rely on commercial shipyards for overhaul and repair.

Military Sealift Command (MSC): MSC operates approximately 120 ships that provide support and carry cargo for the Army, Navy, Air Force, Marine Corps, and Defense Logistics Agency (DLA). The ships that comprise the fleets are a combination of Government-owned, Government-operated (GOGO); GOCO; and contractor-owned, contractor-operated (COCO) ships. The ships within the fleet utilize commercial shipyards to perform their maintenance and overhaul.[53]

NOAA: NOAA operates 17 research ships that collect data for nautical charts, fishery quotas, and climate modeling. Their fleet is maintained solely by commercial shipyards. NOAA’s parent agency, the Department of Commerce, has noted that the NOAA surface fleet experiences an average loss of 18 days per ship waiting to enter commercial shipyards for maintenance. Additionally, they have approximately $32

[50] “Coast Guard Operational Assets,” USCG Website, https://www.uscg.mil/About/Assets/ (accessed May 2, 2021).

[51] U.S. Coast Guard Yard, *The Ten-Year Strategy of the United States Coast Guard Yard* (Baltimore, MD: USCG, January 2019), https://www.dcms.uscg.mil/Portals/10/CG-4/documents/SFLC/Yard/USCG-Yard_Ten-Year-Strategy_signed_16-Jan-2019.pdf

[52] Ibid.

[53] Department of Defense, Inspector General, *Military Sealift Command's Maintenance of Prepositioning Ships*¸ DODIG-2018-151 (Washington, D.C.: DoD, September 2018).

million in deferred maintenance during FY2018. They note that the largest contributing factor is decentralized contracting and trouble with standardizing maintenance.[54]

State and Local Governments: Numerous state and local governments operate fleets of publicly owned ships but lack any organic capability to maintain their assets. Some of the larger fleets include the Alaska Marine Highway System, Washington State Ferries, and New York City Ferries.

The Alaska Marine Highway System operates 12 ferries, many of which are over 300 feet in length, to service 35 ports throughout the coast of Alaska. This system enables the transportation of goods and persons to communities isolated from a roadway system. Over the last several years, the system has struggled to maintain this critical service due to lack of funding and excessive delays during maintenance in commercial shipyards.[55]

The Washington State and Staten Island ferries operate 21 ships and 8 ships, respectively. Their ships operate throughout their state's coastal region and rely on commercial shipyards to maintain their fleets.

Recommendations

To improve DoD surge capacity, the OIB should consider expansion of DIB and OIB facilities and associated equipment that support surge. Additionally, to build OIB competencies, maintain skilled trades, and offset investment cost, the OIB should consider performing commercial ship MRO backlog in its public yards. Specifically, this report recommends:

R1: **Increase Capability at Existing USCG Yard.** Per the USCG's 10-Year Plan, it plans to invest in infrastructure to accommodate the OPC, a 360-foot ship. However, if this plan were to include an increased capability in partnership with the DoD to support 500-foot ships, the Coast Guard Yard could service the Littoral Combat Ship, Frigates, and Destroyers. This increased capability would not result in excess capacity, but rather increased reserve capacity because larger ship lifts would also simultaneously accommodate smaller USCG cutters. The increased capability would allow the USCG Yard to service more USCG ships, thus improving efficiency for the facility even if the U.S. Navy never utilizes this capacity.

R2: **Create West Coast USCG Yard.** Without a USCG-owned shipyard on the West Coast, nearly all Pacific-based cutters must utilize commercial shipyards. This also includes the new PSC, which should be operational in the next two to three years. The creation of a West Coast USCG Yard capable of servicing PSCs and other small cutters would allow the USCG to service closer to 50% of its fleet organically, much like the DoD. For additional cost savings, the USCG

[54] Department of Commerce, National Oceanic and Atmospheric Administration, Office of Marine and Aviation Operations, *Maintenance Briefing*, (Washington, D.C., October 2019), https://www.irso.info/wp-content/uploads/2019_IRSO_Day1_10-Hann-NOAA-Fleet-maintenance.pdf

[55] Elwood Brehmer, "Year in Review: Ferry System Still Long on Problems, Short on Solutions," *Alaska Journal of Commerce*, 16 December 2020.

may consider utilizing closed former public shipyards presently held by local governments, like facilities in Long Beach, California and Washington state.

R3: **Create Government-Owned Contractor Operated Shipyards.** The creation of one or more public-owned shipyards would 1) create additional surge capacity, and 2) allow other organizations to mitigate commercial and non-DoD backlog with minimal investment. A government-run facility could work under the WCF framework where the shipyard sets its price to breakeven and does not operate to make a profit. Working under the WCF umbrella would also ease the contracting burden that many other smaller organizations such as NOAA and the State of Alaska face when utilizing commercial shipyards. The servicing organizations would remain responsible for funding their repairs and overhauls but would pay the OIB for the use of the facilities and equipment.

4.2.3 Army Infrastructure Investment Processes and its Impact on Future Capacity and Capacity Utilization

Current State and Gaps

The Army faces challenges in upgrading its infrastructure to align with future DoD requirements. In testimony to the House Appropriations Committee and consistent with GAO reports, the Army testified, "…we have World War II-era facilities, and many of them are outdated for today's requirement, let alone for the needs of the future force."[56] This gap is attributed partly to the Army's inability to fully account for facility capacity and DoD policies that preclude facility investment optimization. By increasing visibility and planning for future infrastructure requirements, DoD senior leaders can better determine, prioritize, and allocate resources among its OIB depots.

A key example of a DoD policy that limits Army investment decisions is DoD 4151.18-H, *Depot Maintenance Capacity and Utilization Measurement Handbook,* which mandates use of DLH metrics for capacity measurement. Two limiting functions of this handbook include the inability to accurately capture investment costs and the inability to time infrastructure investment. First, the handbook does not accurately capture investment costs because it inadequately represents the costs of capital expenditures under DLH metrics. Identifying metrics that more accurately capture workload and facility investment costs could better optimize resources and investment decisions. Second, the handbook does not align with investments timelines because DLH metrics are only forecasted 1 - 2 years while investment forecasts require an excess of 5 years. The misalignment of timing between DLH metrics and infrastructure investments decreases opportunities to invest in depot facilities for future DoD missions adequately.

[56] C. Todd Lopez, "Improvements to Organic Industrial Base Prepare Services for Future Fight," *DoD News,* March 19, 2021.

Background

Core capabilities are the GOGO equipment and facilities described in 10 U.S.C. § 2464.[57] In declaring core capabilities, the Army must assign a cost-efficient workload to ensure technical competence in peacetime with the scalable capability to meet strategic and contingency plan requirements.[58] Additionally, the Army designates organic depot activities "…as a Center of Industrial and Technical Excellence (CITE) in one or more specific technical competencies required for core capabilities."[59] For the Army, the declaration of a CITE provides substantial flexibility. First, a CITE offers the authorization for a depot to enter into a private-public partnership (PPP or P3) under 10 U.S.C. § 2474.[60] Second, this designation requires depots to re-engineer industrial processes and adopt best business practices to serve as leaders in these core competencies.[61] The existing policy and authorities endorse business process innovation at CITE locations. The Depot Source of Repair (DSOR), core capabilities, and CITE designation set the OIB infrastructure requirements for goods, services, and modernity.

DoD 4151.18-H acknowledges the detailed analysis of workloads, facilities, and resources merit consideration in capital investment decisions.[62] However, there are no visible metrics adopted for these impacts. Additionally, the handbook specifies capacity measurements in terms of labor hours as the only proper technique, and directs the conversion of workstations and processes into DLHs.[63] This workforce perspective introduces a challenge to accurately equate modernization efforts, e.g., automation, robotics, and additive manufacturing, into appropriate DLH equivalents.

[57] 10 U.S. Code 146 (2018) § 2464.

[58] Ibid.

[59] DoD, *Maintenance of Military Materiel*, DODD 4151.18, 4.

[60] 10 U.S. Code 146 (2018) § 2474, "Centers of Industrial and Technical Excellence: designation; public-private partnerships."

[61] Ibid.

[62] Department of Defense, *Depot Maintenance Capacity and Utilization Measurement Handbook*, DOD Change 1 to 4151.18-H (Washington, DC: DoD, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415118h.pdf, 3.

[63] Ibid., 4.

Recommendations

R1: **Adopt a facility capacity baseline for each depot or arsenal.** DLH metrics for capacity measurement are based on current and near-term requirements and do not adequately support long-term readiness investment. The aggregate depot capacity should account for all programs operating simultaneously and have a design capacity for all system maintenance in parallel. A design capacity for all system maintenance will prevent under-resourcing of personnel and resources for product lines not in production. The OIB can accomplish this change through the adoption of an infrastructure utilization baseline model like *Figure 4.2*. Under this model, OIB leaders could visually describe capacity and associated infrastructure requirements to supported commands and customers. This methodology supplements the existing DoD sizing policy under DoDI 4151.18 and implemented via AR 700-90 to determine the size for a single shift working a 40-hour workweek manned at 75%.[64,65] With an aggregated facility capacity model by depot or CITE, the Army can better communicate baseline OIB requirements, improve infrastructure investments, and enter long-term P3 agreements.

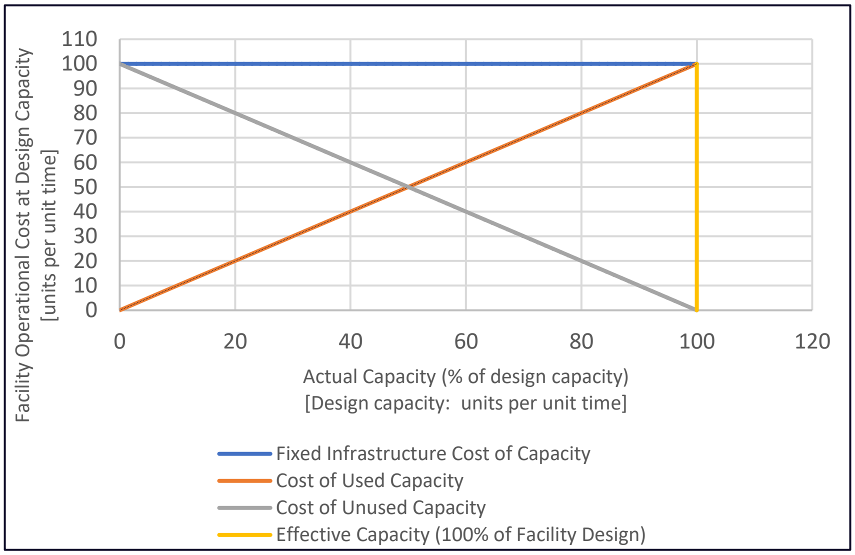

Figure 4.2 Infrastructure Utilization Conceptual Baseline Model

R2: **Expand P3 tools following adoption of improved infrastructure utilization metrics.** Following the implementation of improved metrics (see Recommendation R1 above), the OIB should leverage CITE authority to encourage and expand P3 activities. Because of improved metrics, OIB depots are better positioned to identify unused, but not excess, facilities or lack of existing infrastructure to define a facility capacity Business Case Analysis (BCA). Under this facility capacity BCA, the OIB CITE can pursue longer-term partnership agreements through lease arrangements or outgranting. The existing metrics prevent the use of lease and outgranting authorities permissible under AR 405-80 and 10 U.S.C. § 2667. Additionally, if the Army pursues lease operations under 10 U.S.C. § 2667, the proceeds of any lease activities go into a special account.[66] The unique account can support the construction and acquisition of new

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[64] Department of Defense, Office of the Under Secretary of Defense for Acquisition and Sustainment, DoD Instruction 4151.20, "Depot Maintenance Core Capabilities Determination Process," (Washington, DC, May 4, 2018), 3.

[65] Department of the Army, *Army Industrial Base Process*, AR 700-90, (Washington, DC, January 2020), 16.

[66] 10 U.S. Code 159 (2018) § 2667.

facilities in addition to other maintenance services. If this method realizes positive results for the Army, the DoD could expand real estate tool utilization to other services. The shift toward longer-term partnership agreements is essential to drive private capital investment in the OIB and improve long-term capacity, readiness, and modernization activities.

4.3 Readiness Enabler: Human Capital

Under human capital readiness enablers, this report examined the current state and gaps in the OIB's training and development of military officers and senior civilian leaders, and workload projections that support OIB readiness. A summary of the findings and recommendations are addressed in the following subsections.

4.3.1 OIB Military and Civilian Senior Leader Training and Development

Current State and Gaps

The OIB lacks a comprehensive structured plan to educate, train, and develop military and senior civilian leaders (O-6/GS-15 and up) to ensure they are prepared to run the business operations of OIB organizations and equipped to address associated unique challenges. The developmental gaps found in this assessment include limited exposure to depot operations before the leadership assignment and the absence of a business acumen foundation.

Depot Operations Exposure: Developmental structures for military officers lack opportunities for early exposure to plant production activity. With short rotations of one or two years, commanders report spending much of their time learning the depot processes and language. While overall leadership skills are strong and effective from existing training and previous assignments, shortfalls are consistently self-identified as a host of related topics. Shortfalls include knowing the various roles and responsibilities of internal organizations and customers, navigating political tensions, and thoroughly understanding financial management. Similarly, senior civilians face similar challenges due to compartmentalization and functional stovepipes. The DoD needs a more structured and executable career path for military and civilian personnel to expose individuals earlier to the various aspects of OIB operations.

Business Acumen Foundation: Career path offerings for military officers and senior civilians lack foundational business management education and experience. While most leaders have advanced degrees and many have taken business courses, there are no programs specifically designed or offered to teach the unique challenges associated with government production environments, and particularly the fiscal dynamics of WCF and appropriations. Expanding the availability of standardized, specialized training and education would ensure those in critical decision-making roles understand drivers of profit and loss and have a more comprehensive view of financial management and strategic execution of the enterprise business plan. Furthermore, real-world exposure to commercial business operations and practices at the upper management and executive-level could provide valuable insight to drive efficiencies. Even short initiations could break barriers and the groupthink tendencies internal cultures create.

Background

OIB leaders must understand capability, capacity, and surge parameters for their facilities. They are accountable for integration across immense infrastructures to sustain legacy systems while preparing for incoming workloads to support next-generation platforms. Military and civilian managers are expected to evaluate return on investment and advocate for capital investments. Leaders are driven to meet tight production schedules with maximum efficiencies across their resources, and they must balance community and congressional engagements.

To be an effective commander or director within the OIB, military and civilian personnel must combine operational expertise with an ability to focus and lead large groups through strategic execution of significant resources. The scope of the work accomplished is incredible. The Office of the Undersecretary of Defense for Acquisition and Sustainment reports that the OIB provides maintenance, repair, and overhaul of more than 339,287 vehicles, 241 ships and submarines, and 15,348 aircraft.[67] At the officer (O-6) or senior leader (GS-15) level, OIB personnel may be responsible for thousands of technicians generating billions of dollars in revenue for the DoD. One example is the Oklahoma City Air Logistics Complex (OC-ALC) located at Tinker Air Force Base, Oklahoma, where the Wing encompasses more than 10,000 personnel executing nearly $3.3B in revenue.[68]

Recommendations

To improve military officer and senior civilian leader development and training, this report recommends:

R1: **Improve depot operations exposure by developing focused rotations with earlier assignments**. Developing focused rotations includes using existing positions to expand offerings at the junior officer level. Unlike commercial production facilities which expose senior leaders to multiple business sectors before management roles, services tend to focus on operational experience over support activities. The OIB should consider rewarding leadership assignments through the depots, reducing the stovepipe of civilian and military exposure to business operations, and increasing earlier awareness and understanding of all aspects of business operations. Several senior DoD leaders interviewed in this study believe that, based on their career experience and growth, such training changes are needed to remove stigmatisms surrounding maintenance activities, create more opportunities for interaction with non-DoD stakeholders, and improve management effectiveness.

R2: **Improve depot operations exposure by improving tools for managing the political environment.** Military officers and senior civilian leaders need structured initiation and thorough coaching to manage the political environment effectively. A former depot commander interviewed in this study acknowledged that "the Commander must understand and

[67] Organic Industrial Base Industry Study Lecture #2, Eisenhower School, National Defense University, January 14, 2021.

[68] Depot Senior Civilian, Student Interview, Tinker AFB, OK: Air Logistics Complex, April 20, 2021.

deftly maneuver those relationships [with political stakeholders] while understanding that none of those decisions reside at the Depot."[69] Training would enable military officers and senior DoD leaders to 1) improve awareness of the political landscape and 2) identify community engagement opportunities that promotes an understanding of politics and bolsters advocacy for OIB facilities.

R3: **Expand business acumen by developing standardized and specialized higher education programs.** The DoD should develop and promote specific higher-educational initiatives for OIB leadership. Current and former senior military officers interviewed in this study acknowledged the military higher education does not adequately teach profit and loss business education, business operations, and how to run a business. These programs should closely mirror standard Master of Business Administration (MBA) programs for business or operations management with supplemental sessions to cover material specific to the DIB. The most beneficial programs would encompass a market-focused approach to business and drive understanding of profitability and cash flow.

R4: **Expand business acumen by developing focused executive-level rotations with industry.** The OIB should implement industry rotations, for services not already executing, to expose military officers and senior civilians to executive-level business activities. Industry rotations would build knowledge and awareness of corporate leadership and activities. Rotations, even condensed cycles of three to six months, would offer insight into different business models, varied approaches, and alternative perspectives. Another former depot commander stated, "we must gain the perspective of our industry partners. We must look at ourselves as a company generating value. Understanding their behavior, their interests, and their concerns for earnings helped me more effectively shape my 'asks' as a partner…I changed what I read, how I talk, and how I interact. That realization is imperative to being a depot commander."[70] Exposure to alternative perspectives and non-DoD operations would better enable senior DoD leaders to maintain awareness of current industry practices and develop innovative management approaches to defense problems.

R5: **Expand OIB business acumen through senior capstone education.** The OIB should adopt a senior capstone education program to enhance senior level sustainment education within the OIB. Similar to the Senior Acquisition Course (SAC) within National Defense University and the Eisenhower School, this report proposes a Senior Sustainment Course (SSC) that aims at preparing military and civilians to lead DoD business operations and understand the required sources required to ensure weapon system readiness. Like SAC, the Services could target potential candidates for enrollment, ensuring a more robust pipeline of business-educated, prepared senior leaders who have been widely exposed to the vital role of the OIB. Additionally, deliberately linking SSC with the SAC program would result in increased synergy and allow more professionals to gain life cycle exposure to key processes and critical issues.

[69] Former Depot Commander, Army, Student Interview, Ms. Janet Johnson, April 2021.
[70] Former Depot Commander, Air Force, Student Interview, Ms. Janet Johnson, April 2021.

4.3.2 OIB Workload Allocation Policies and Impacts to Capacity Utilization

Current State and Gaps

Gaps in OIB data management practices drive inefficiencies in industrial capacity utilization. First, the absence of a cross-service equipment and repair capabilities listing limits full awareness of available property, plant, and equipment, and associated capabilities across the OIB enterprise. Unaware of available capabilities and capacity across the enterprise, services may unnecessarily assign work to commercial sources, thus reducing investment in the WCF. Second, the lack of a cross-service automated IT system to manage and validate workload forecast to actuals, result in the lack of visibility of workload forecasting and execution data and an extensive manual validation process.

Background

Under the current Depot Source of Repair (DSOR) process, services give workload priority to CITE with matching core competencies. However, there is often more than one CITE who has the core competencies to complete the work. In the event of multiple CITEs, candidate depots and sources of repair would compete during a Depot Maintenance Interservice (DMI) review for MRO efforts. While selecting the candidate depot and source of repair is closer to the actual MRO need, multi-service visibility of depot capabilities and capacity reduces the cost and time associated with market research and minimizes the risk of incomplete or inaccurate information. The inability of the OIB to effectively and accurately communicate capabilities and capacity presents a missed opportunity for the OIB to maximize cost-efficiency, build technical competence and workforce proficiency, and reinvest revenue in the sustainment and modernization of the depots.

Regarding workload forecasting and execution data, services independently enter the data into automated systems which are not interoperable with other service systems. Then, each service will manually validate any deltas between workload forecasts and workload execution through the service's materiel command's tasking system.[71] The lack of a collaborative IT system is one of the key reasons for workload forecasting errors. Other reasons vary among services and predominately include inaccurate workload mix, carcass constraints, COVID impacts, and process inefficiencies.[72] To illustrate the impacts, in first quarter FY21, the USAF forecasted workload to the Army at $39.9M with a quantity of 489 assets. Actual obligations for first quarter FY21 were $22.8M with 813 assets.[73] The resulting delta of $17.1M and 324 assets forced the Army to realign resources for work not planned and funding not received. Though a truly automated and collaborative IT system in which Service financial systems can communicate is not attainable at this time due to manpower and funding constraints, a partially

[71] Department of the Air Force, Maintenance Interservice Support Management Office, personal communication (phone call) with the author, Lt Col J. Phillips, April 16, 2021. (hereafter cited by USAF MISMO)

[72] Erika Evoniuk, "FY21 Quarter 1 Results and Ongoing Efforts to Improve DMISA Relationship between Army and Air Force," (Wright-Patterson AFB, OH: Air Force Material Command, March 18, 2021) 7.

[73] Ibid.

automated IT system that allows for communication across services would 1) reduce errors that result from a manually-driven input and validation process and 2) provide quicker visibility on deltas. Consequently, services could more rapidly make decisions regarding weapons system sustainment and resource management within the OIB.

Recommendations

R1: **Create Cross-Service Capability Listing Implementation.** Using the Air Force's Technology Repair Center (TRC) Core Competencies framework, the joint OIB enterprise should develop and implement a cross capabilities and capacity model as proposed in *Figure 4.3* with an accompanying annex that lists each capability's specifications.[74] The purpose of this model is to better communicate available capacity, capability, and location of technologies for OIB MRO activities. Recommend the OIB enterprise explore using the Air Force's Depot Maintenance Inter-Service Agreement (DMISA) Management Application (DMA) system as the initial IT architecture to build, maintain, and distribute updates. The Air Force plans to use the DMA tool to manage DMISAs, where one service agrees to perform work for another service. DMA meets Financial Improvement and Audit Readiness compliance, has already been tested and approved by all services, and offers "metrics, tracking, and process guidance."[75]

*ANNEX	TECHNOLOGY GROUP	*AVAILABLE CAPACITY	LOCATION CODE
1	ROBOTICS		
A	Two Double Robotic Spot Weld Cells	40%	ANAD
B	Fanuc R-2000 iB Robotic Arm	30%	OC-ALC
C	Three Six-Axis Painting Robots	10%	TYAD
D	Robotic High-Pressure Water Blaster	50%	CCAD
2	CHEMICAL HANDLING		
A	Workforce certified on Chlorofluorocarbon 113 (CFC- 113) and methylene chloride	30%	OC-ALC
3	COMPUTER NUMERICAL CONTROLLED (CNC) MACHINES		
A	Eight Doosan Puma 3100LY CNC Machines	60%	WR-ALC
4	ADDITIVE MANUFACTURING		
A	2 ProX DMP 300 3D Printers	40%	PPA
B	Cold Spray System	20%	OO-ALC
C	Ultrasonic Vapor Degreaser	70%	FRC East, NC
5	DIAGNOSTICS		
A	Twelve Hammer Activated Measurement System for Testing and Evaluating Rubber (HAMSTER)	20%	NNSY

Figure 4.3 Cross-Service Capability Listing Example

R2: **Establish workload planning and execution system that is interoperable between services.** Recommend that all services utilize the Air Force's DMA tool (see Recommendation R1 above) to collaborate and share data on workload planning and execution as a gap-filler until the OIB can field a truly automated and collaborative financial system. Additionally, recommend OSD mandate each service updates data within DMA on a quarterly basis, by writing the mandate into the draft DoD Instruction (DoDI) 4151.XX, Military Department Inter-Service

[74] Department of the Air Force, *Designation of CITEs (DoD 4151.24, Public-Private Partnership for Product Support)*, Attachment: Technology Repair Center (TRC) Core Competencies (Washington, D.C.: Department of the Air Force, June 9, 2019, certified current as of April 19, 2021), 2-4.

[75] Guy Ragan, "Depot Maintenance Interservice Agreement (DMISA) Management Application (DMA) Update," (Wright-Patterson AFB, OH: Air Force Material Command, April 9, 2020), 4.

Depot Maintenance. With the proper configuration management, DMA can serve as a repository for cross-service workload forecasting and execution data, and facilitate the validation process.[76] Further, leveraging the existing tool's infrastructure, design tools, configuration managers, and licenses will reduce implementation costs when compared to developing new software. For manpower management of the application, the MISMO offices are postured to transition and support, as the automation would be a process efficiency for their teams.[77] Implementation of this software would allow for immediate visibility of any deltas between forecasted and executed workloads and give greater time to the depots to adjust resources to meet DoD objectives.

4.4 Readiness Enabler: Finance

Under finance readiness enablers, this report examined the effectiveness of DWCF policies on OIB readiness and long-term sustainability. A summary of the findings and recommendations are addressed in the following subsection.

4.4.1 DWCF Policy Impacts on OIB Readiness and Long-Term Sustainability

Current State and Gaps

OIB depots are challenged to operate efficiently due to DoD policies regarding locking of customer rates and carryover periods. Customer rates are locked in 18 to 24 months before execution and activity groups cannot react to short-term market changes, potentially eroding DWCF competitiveness. Additionally, capital investment programs (CIP) are heavily dependent on cash flow and workload which are subject to changing customer demand and external conditions, often within the 18 to 24 months. Changes in actual demand or inaccurate cost estimates or workload forecasts can result in fiscal losses for the depot. Concerning carryover periods, Services have observed carryover periods up to 10 months to complete prior fiscal work. Excessive carryover restricts the use of associated resources and could trigger funding decrements in subsequent fiscal years. Although constructive in moderation, too much carryover could limit OIB productivity in current and future years.

Background

The DoD's five DWCFs encompass over eighteen activity groups. Examples include the Army's Supply Management and Industrial Operations activity groups and Defense Logistics Agency's Supply Chain Management, Energy Management, and Document Services activity groups. Each activity group is required to "operate on a break-even basis,"[78] where revenue is tracked based on net operating results (NOR) and accumulated operating results (AOR). The NOR represents the difference between revenue and expenses within a fiscal year. The AOR

[76] USAF MISMO.
[77] USAF MISMO.
[78] Department of Defense, *Financial Management Regulation*, DoD 7000.14-R, Volume 11B: Reimbursable Operations Policy-Working Capital Funds, (Washington, D.C.: DoD, August 2019), 1.

represents all operating gains or losses since an activity group's creation.[79] If the NOR revenue exceeds costs in a fiscal year, creating a positive AOR, the OIB depot will reduce future customer rates. A positive AOR means the activity group has taken on too much profit, likely degrading price competitiveness and negatively impacting customers. Conversely, if NOR revenue is less than costs in a fiscal year, creating a negative AOR, future rates will increase to cover the losses. If severe enough, a negative AOR can compromise the continuity of operations, potentially making an activity group insolvent.

Activity groups manage AORs by setting customer rates and forecasting workloads. Rates and workloads are the two primary factors driving OIB viability and competitiveness. Critical inputs to customer rates include the predictability of resources, the costs of variable inputs like labor, raw materials, and fuel, forecasting the type and volume of work required, and current events. Unfortunately, customer rates are generally backward-looking pricing models that rely on past revenues to anticipate future costs. Generally, rates are locked 18-24 months out and do not change during the year of execution. This approach creates predictability for customers but erodes OIB competitiveness as costs change in real-time.

Within supply activity groups, revenues are generated based on cost recovery rates (CRR). A CRR is a markup to materiel costs to cover an activity's operating costs.[80] For instance, in FY 2020, the Air Force's Consolidated Sustainment Activity Group – Supply CRR was 0.971. This rate is below one because the CRR was 1.289 in FY 2019, and the Air Force had a surplus of gains would benefit the customers in future years.[81]

Within industrial operations and maintenance activity groups, revenues are generated based on direct labor hour (DLH) estimates. The OIB depot generates the DLH rate by dividing the sum of all production-related labor, material, and administrative expenses, adjusted for direct reimbursements, capital investments, and NOR, by the total number of DLH anticipated within the fiscal year.[82] In FY 2020, the Air Force's Consolidated Sustainment Activity Group – Maintenance DLH rate was $302.28 per hour. This rate is a 3.7 percent increase from FY 2019, based on increased estimated costs for FY2020.[83]

Because DWCF funds do not expire, activity groups can "carryover" work from one fiscal year to the next. "Carryover represents the dollar value of the production orders that have been ordered and funded by customers but not completed by the industrial activities at the end of

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[79] Department of the Army, "Army Working Capital Fund Fiscal Year 2021 Budget Estimates," (Washington, D.C., February 2020), accessed April 26, 2021, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2021/Base%20Budget/awcf/AWCF_FY_2021_PB_Army_Working_Capital_Fund.pdf, 7.

[80] Department of Defense, *Financial Management Regulation*, DoD 7000.14-R, Volume 11B: Reimbursable Operations Policy-Working Capital Funds, (Washington, D.C.: DoD, August 2019), 121.

[81] Seminar 15, "*Industry Study-Organic Industrial Base (OIB) Overview,"* (informational briefing, ES6752, Eisenhower School, National Defense University, March 12, 2021), 17.

[82] Department of Defense, *Financial Management Regulation*, DoD 7000.14-R, Volume 2B: Budget Formulation and Presentation (Washington, D.C.: DoD, November 2017), 291.

[83] Seminar 15, "OIB Overview," 17."

each fiscal year."[84] Carryover helps stabilize workloads and facilitates better planning and decision-making across the OIB. In this respect, there is an incentive to maintain carryover to enable continuity of operations. Allowable annual carryover is based on the dollar amount of new orders received and the outlay rate, or expected budget execution rate, of the customer financing the work.[85] Because allowable amounts can be somewhat convoluted, the generally accepted practice is to maintain approximately six months of carryover per fiscal year. Between 2007 and 2018, Navy, Marine Corps, and Air Force depots averaged less than six months of annual carryover worth a combined $3.1 billion. During this same period, Army depots averaged ten months of annual carryover worth $4.3 billion.[86]

Recommendations

R1: **Create Workflow Contract Policy.** The DoD should create a new policy where OIB depots and customers establish production schedules as formal contracts. Production schedules should be locked six to 12 months in advance and only change based on departmental-level approval. In the current environment, activity groups shoulder the preponderance of risk when workflows drop during the year of execution. When workflow drops, it leads to suboptimal resource use and may even cause activity groups to become insolvent. This recommendation promotes predictability across the OIB and would prevent the military departments from using depot maintenance and supply funds like liquid assets in the year of execution.

R2: **Update DoD Carryover Policy.** The DoD should update the carryover policy, allowing for four to six months of annual carryover by activity group and transition from allowable carryover rate calculations. Carryover is one of the significant benefits of DWCF use, enabling the uninterrupted provision of maintenance and supply services between fiscal years. Under the recommended policy change, activities should not be allowed to accumulate carryover beyond six months, where the inefficient use of resources ties up funds that could be used for competing priorities. The DoD may consider exceptions for exceptional conditions beyond a depot's control, such as Acts of God, operational changes, supply chain disruptions, or changes to a scope of work. By reducing the carryover period, OIB facilities are motivated more to right-size workload and capacity, while maintaining continuity of operations during times of fiscal uncertainty.

4.5 Conclusion

The renewal of great power competition has led to an increased focus on OIB readiness during peacetime and surge environments. While the DoD has invested significant financial resources and capital in the OIB since the Cold War, shortfalls in its infrastructure and materiel, human capital, and financial policies threaten future readiness. Consistent with the Eisenhower

[84] Department of the Army, "Army Working Capital Fund Fiscal Year 2021 Budget Estimates," 63.
[85] DoD, Financial Management Regulation, DoD 7000.14-4-R, Volume 2B, 345.
[86] U.S. Government Accountability Office, *"Depot Maintenance: DOD Should Adopt a Metric That Provides Quality Information on Funded Unfinished Work,"* GAO 19-452 (Washington, D.C.: GAO, 2019), https://www.gao.gov/assets/gao-19-452.pdf**.**

School Readiness Enabler Framework, the recommendations in this report have emphasized improvements of key inputs that maximize capacity and capacity utilization. Through the implementation of these recommendations, the OIB can better eliminate strategic bottlenecks and support the Nation.

In addition to the recommendations included in this section, this report recommends that the OIB dedicate additional resources to further understanding readiness enabler conditions, gaps, and opportunities for improvement. The scope of this report was limited to specific aspects of the infrastructure, materiel, human capital, and financial readiness enablers. The OIB may also benefit from studies of other aspects of these enablers or other key inputs to readiness.

Section 5 - TECHNICAL DATA AND SOFTWARE

5.1 Introduction

In a strategic environment defined by rapidly evolving technical sophistication and digital technology, improved access to technical data and effective software sustainment practices are essential to creating the conditions for the efficient delivery of weapon system readiness by the OIB. To sustain America's warfighting capabilities and ensure readiness, program offices rely heavily on the OIB to provide the necessary MRO services for their products. The OIB is the nation's insurance policy against a sometimes-fickle commercial DIB, cost-effectively providing the necessary services regardless of the business case or lack thereof. Recognizing the strategic importance of organic MRO support, Congress mandated using the OIB in 10 U.S.C. § 2464, providing specific instructions to the military Services on the stand-up of Core logistics capabilities and the acceptable timeline for their establishment.[87] 10 U.S.C. § 2366 goes further to mandate specific MRO planning requirements by acquisition milestone.[88] As a result, and as mandated by DoDI 5000.2, DoD leaders apply significant effort and funding to the development of a program's Life Cycle Sustainment Plan (LCSP) to ensure compliance with these statutes and, more importantly, to ensure the OIB can provide adequate MRO services as the assets become operational.[89]

In light of the current GPC environment, additional steps must be taken to facilitate the OIB's support of weapon system programs, particularly in the areas of technical data and software. In these areas the OIB is sometimes challenged to meet national needs due to antiquated legal, procedural, and/or organizational hurdles, resulting in reduced readiness rates. Neither China nor Russia is as encumbered in these areas as the United States due to their State-run economic models. President of the People's Republic of China, Xi Jinping has established a strong partnership between State and private sectors to "develop national security software (particularly in AI)." President of Russia**,** Vladimir Putin has reinforced the idea that "artificial intelligence is the future, not only for Russia, but for all humankind."[90] While the DoD appears to understand the gravity of the situation, as evidenced by the FY 18 NDAA, the following sections will lay out additional concerns and recommendations.

This section covers the challenges the OIB faces with technical data and software sustainment in the current environment and provides recommendations for consideration by DoD senior leaders to address the challenges. Overall, the recommendations aim to increase the efficiency and effectiveness of the OIB, making it better suited to support the Nation's needs in an increasingly dynamic and competitive strategic environment.

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[87] 10 U.S. Code 146 (2018) § 2464, Core logistics capabilities.

[88] 10 U.S. Code 139 (2019) § 2366a, Major defense acquisition programs: certification required before Milestone A approval.

[89] Department of Defense, *Operation of the Adaptive Acquisition Framework*, *DODI 5000.02* (Washington, DC: DoD, 2020), https://acqnotes.com/wp-content/uploads/2014/09/DoD-Instruction-5000.2-Operation-of-the-Adaptive-Acquisition-Framework-23-Jan-2020.pdf.

[90] Ibid.

5.2 Technical Data

In an environment characterized by rapidly evolving technology, advanced manufacturing techniques, and software enabled capabilities, a key challenge program offices face in establishing and maintaining Core logistics capabilities throughout the OIB is the availability of technical data. Technical data comes in various forms to include technical drawings, system specifications, quality assurance provisions, models, software documents, and other associated product standards.[91] Government access to this data is often critical to the proper execution of MRO activities within the OIB. Program offices seek to obtain technical data rights during the acquisition process to meet the goals of the LCSP. Although there is much debate over how effective various program offices have been in providing technical data to support initial depot capability at IOC+4, there is little doubt that the current regulatory structure focuses almost exclusively on the initial setup of an organic capability for product support rather than long-term technical data needs. Rather, the technical data acquired is based on an early plan for OIB support, with little to no strategy on how to acquire additional technical data in the future. As a result, the OIB frequently suffers from a lack of required technical data when the scope of work on a product changes, parts are no longer available, or parts become obsolete. These issues compound when the services extend the useful life of weapon systems beyond their original planned end dates. Given these challenges, additional steps must be taken to ensure technical data availability in support of evolving sustainment plans in the long-term.

There are four major types of technical data rights that the Government can possess as the result of an acquisition program. The first is Unlimited Rights. This is the most open form of data rights for the Government given that it allows the Government to do as it pleases with the technical data, to include making the technical data public and distributing the data to third parties.[92] Unlimited Rights are provided to the Government when development is executed using Government funding exclusively. Limited rights are acquired when a company has funded development at its own expense and allow it to withhold all data that does not pertain to form, fit, and function.[93] These rights can be adequate for certain MRO purposes, but frequently fall short of the information necessary for many activities the Government seeks to undertake within the OIB. Next is Government Purpose Rights (GPR). GPR are conveyed to the Government when both public and private funds are used to develop a product. Under GPR the Government is free to use the data for "Government purposes" but is specifically prohibited from commercial purposes for a five-year period.[94] This middle-ground approach protects the vendor from competition for a set period while still allowing the Government to meet most of its needs. Finally, Negotiated License Rights refer to unique licensing arrangements made between the Government and OEM for mutual benefit.[95]

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[91] Department of Defense, *Department of Defense Standard Practice Technical Data Packages*, MIL-STD-31000B (Washington, DC: DoD, 2018), http://everyspec.com/MIL-STD/MIL-STD-10000-and-Up/MIL-STD-31000B_55788/.

[92] "Data Rights," AcqNotes, accessed May 1, 2021, https://acqnotes.com/acqnote/careerfields/data-rights.

[93] Ibid.

[94] Ibid.

[95] Ibid.

OEMs aggressively protect their proprietary technical data for two reasons. First, the need to gain or maintain a competitive advantage in the market in which the OEM is competing. This has become increasingly important over the last two decades as the DIB has consolidated due to the availability of fewer defense contracts and increased competition for those contracts. Second, by protecting their proprietary technical data OEMs can guarantee additional sole-source Government contracts for modifications and MRO services on their products. OEMs who successfully limit access to their technical data often create market information asymmetries that result in a monopolistic MRO market structure. In these cases, the Government often finds itself in a sole-source situation for MRO services once a production contract is awarded unless it acquires the technical data rights necessary to support organic MRO services during the competitive phases of the program. Any additional technical data rights the Government seeks post-production becomes an expensive endeavor given the sole-source situation and value of the technical data to the company in light of the potential revenue lost.

Maintaining a Legacy Weapon System: B-52 Stratofortress

The B-52 Stratofortress began its development in the late 1940s with the award of a development contract to the Boeing company and entered operational service on June 29, 1955. The aircraft was initially planned for a service life of around 20 years or 5,000 operational hours; however, its longevity has been extended through numerous service life extension and modernization programs. Although many of the aircraft produced in the early years of the program have retired, the average age of the existing fleet of 76 bombers is still around 50+ years. Today's challenge is how to keep the aircraft relevant in the face of emerging threats and how to continue sustaining this aging platform given the Air Force's current plans to continue operating the B-52 through mid-century. If this comes to pass, it would make the B-52 the longest-serving complex weapon system in US history.

Source of Data:

- Loren Thompson, "Five Reasons the Air Force's B-52 Bomber Will Be the First Jet Ever to Stay in Service For 100 Years," *Forbes*, June 2, 2020, https://www.forbes.com/sites/lorenthompson/2020/06/02/five-reasons-the-air-forces-b-52-bomber-will-be-the-first-jet-ever-to-stay-in-service-for-100-years/?sh=24bf87c85ee6.
- U.S. Library of Congress, Congressional Research Service, *US Air Force Bomber Sustainment and Modernization: Background and Issues for Congress*, by Jeremiah Gertler, R43049 (2014), https://fas.org/sgp//crs/weapons/R43049.pdf.
- Thompson, "Five Reasons the Air Force's B-52 Bomber Will Be the First Jet Ever to Stay in Service For 100 Years."

The type of rights conveyed to the Government can significantly impact the OIB's ability to perform its MRO mission. At the same time, contractors are highly incentivized to restrict Government access to their technical data to protect future revenue and reduce commercial competition. Due to the complex nature of major acquisition programs, it can be difficult for the Government to prove what technical data was produced as a result of public funding. Consequentially, intense negotiations often occur over data rights, sometimes resulting in legal action. However, in many cases, the Government acquiesces to contractor demands and seeks alternative methods for meeting its technical data needs.

It is often difficult for a program office to accurately predict all the technical data the OIB will need during competitive phases of a product's acquisition. Often, the technical data pursued by the Government early in the acquisition process reflects an estimate of what the OIB will need under an early plan for sustainment. However, many weapon systems are kept in the inventory much longer than initially planned, often requiring changes to both the sustainment plan and type of work being performed by the OIB. Indeed, there are numerous examples of weapon systems that are currently operating within various services that were initially fielded mid-20th century. There is little doubt that the Life Cycle Sustainment Plans associated with those products bear resemblance to what was initially planned. With changes to the sustainment plan and type of work being performed comes potential changes to the technical data needed to sustain the product.

The program office's increasing reliance on the OIB to sustain weapon systems is due to weapon system age and changing MRO requirements. First, as weapon systems age, they are forced to compete with modern systems for sustainment funding. As a result, Operations and Maintenance (O&M) funding tends to be reduced over time for older weapon systems causing program offices to seek out the most cost-effective solutions to sustain their products. In many cases, the program offices will transfer work from the OEM, which is unaffordable, to the OIB due to the declining availability of funds. Second, MRO requirements often become more extensive as the product ages. This issue is compounded when a product's service life is extended, pushing the sustainment strategy into unknown territory. These circumstances, require additional work to bring the product back to serviceable condition. Regardless of the reason why the level of effort is changing for the OIB, new requirements for technical data are created and must be fulfilled for the product to be adequately sustained.

In other cases, program offices and the OIB have found themselves unable to acquire needed technical data due to the OEM going out of business or transitioning away from the defense market. In these situations, there is very little that can be done other than to redesign or reverse engineer the system at a high cost to develop the required technical information necessary to support the product. Again, this problem has been compounded through the contraction of the DIB and the services' tendency to extend the service life of many weapon systems, greatly increasing the likelihood that some companies will not remain through the product's life cycle. Preventing the loss of fielded system technical data is essential to effective and efficient product support.

Recommendations

R1: **Add Sustainment Milestones Post MS C:** Given changing requirements and inadequate funding during technical data procurement in the sustainment phase, the DoD should consider revising DoDI 5000.02 to include milestones beyond Milestone C. These additional milestones would force a comprehensive review of the sustainment strategy and plan for future sustainment based on changing variables that might not have been accounted for earlier in the program (as depicted in *Figure 5.1* below). Most importantly, additional milestones would provide a deliberate mechanism for the Milestone Decision Authority (MDA) to review and approve new sustainment strategy. High-level approval to request funding to support the plan would follow MDA approval. In cases where the Government would need to purchase additional technical data from the OEM, this process would provide the top-cover needed for program offices to submit their request through the Program Objective Memorandum (POM) process.

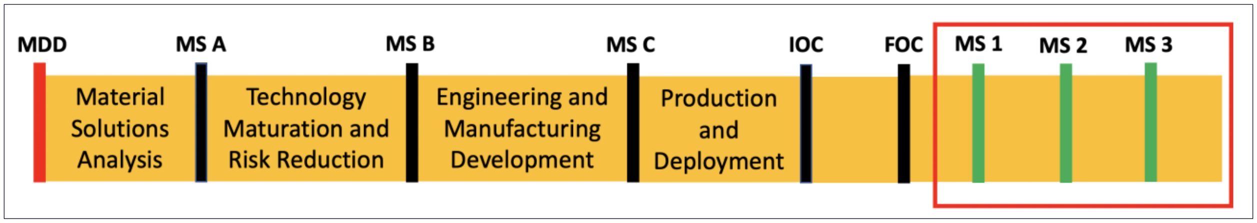

Figure 5.1 Current Acquisition Milestones and Proposed Sustainment Milestones

R2: **Net Present Value/Business Case:** In support of these new milestone events, the program office would build a business case supporting the sustainment strategy being proposed. Using an NPV calculation, the program office would analyze different sustainment options to determine the most cost-effective method to achieve the readiness goals for the product under current conditions. These options could include the purchase of technical data from the OEM, the cost to create technical data through reverse engineering, OEM-provided MRO services, and/or OIB provided MRO services. Through this analysis, the program office would present several scenarios backed by NPV data to facilitate and justify the recommendation provided to the MDA. This analysis could also provide analytical weight to justify additional funding as the request competes with other programs at the service and DoD levels.

R3: **TDP Procurement During Competition:** To account for the often-unpredictable service lives of many products, Congress should consider revising 10 U.S.C. 2366 to include language mandating a complete Technical Data Package (TDP) procurement during the competitive phase of the program when the service life is anticipated to extend beyond 20 years, unless formally waived by the MDA. Not only would this requirement allow the Government to drive future product and service prices down through competitive “build-to-print” contracts, but it would also provide the Government with the technical data necessary to support the product throughout its lifecycle and reduce costs associated with reverse engineering or sole-source procurement. In recent years, the Joint Light Tactical Vehicle (JLTV) program followed this approach and successfully purchased a complete TDP at an extremely low cost. Purchasing the TDP while in competition also reduces workforce requirements necessary to determine specific technical data requirements for OIB support and will reduce turnaround time when the OIB requires additional technical data, improving readiness.

R4: **Grant GPR After A Fixed Period:** Another potential solution to facilitate the acquisition of technical data in the long term is for Congress to pass a law granting the Government GPR to all technical data associated with a fielded system at IOC+20. In many ways, this law would mirror current patent law, which provides the inventor with protections from competition for a fixed amount of time. Again, this would eliminate the challenges associated with acquiring technical data deep in the sustainment phase, facilitate the transition of additional work to the OIB, and account for changing sustainment strategies. At the same time, this law would allow the OEM to make money on the fielded system for a significant amount of time, protecting their business strategy.

R5: **Grant GPR When OEM Departs Market:** To offset the technical data risks and challenges associated with diminishing manufacturing sources, Congress should consider passing a law that enables the DoD to acquire GPR to provide the Government with GPR on all technical data for fielded systems. This action would prevent the Government from finding itself in a position where the technical data is potentially missing and cannot be acquired by any means. With the high cost of new development programs and a flat or shrinking defense budget, there is an increased possibility that the Services will continue to extend the service lives of many weapon systems. As product service life extends, the chances of OEMs departing the defense market increases. This law would help enable program offices and the OIB to ensure the readiness of these weapon systems in a cost-effective manner.

5.3 Software

> *As our military systems become increasingly networked and automated, as autonomy becomes more prevalent, and as we become more dependent on machine learning (ML) and artificial intelligence, our ability to maintain superiority will be directly linked to our ability to field and maintain software that is better, smarter, and more capable than our adversaries' software.*[96]

Despite progress being made, the current DoD acquisition system is still anchored in a Cold War paradigm based on a classic and sequential engineering approach (design, development, production, and support) that requires years to complete and is primarily hardware focused. In the near future, OIB leaders can reasonably assume weapon system capabilities will be driven by a rapid pace in software development and upgrades measured in days instead of months. As illustrated by *Figure 5.2 Percentage of Functions Delivered by Software*, the quantity of software functions and lines of code will continue to grow as weapon systems evolve to meet the strategic environment's "rapid dispersion of technologies, and new concepts of warfare and competition that span the entire spectrum of conflict."[97] Software-driven capabilities development will be so fast that 6th Generation aircraft, as an example, will upgrade their performance in the field after sensing and acquiring operational environment and threat data. As a result, professionals will need to sustain continuous upgrades of software-driven capabilities at a pace never seen before.

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[96] Defense Innovation Board, *Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage* (Washington, DC: DoD, 2019), https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL.SWAP.REPORT.PDF.

[97] James Mattis, "Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge," (Washington, D.C.: DoD, 2018), 1, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

Future operational scenarios will require the DoD to quickly acquire leading-edge military capabilities and rapidly sustain advanced software-based capabilities. However, the current OIB ecosystem appears unprepared to sustain future complex software-driven weapon systems at the pace needed to gain and maintain a competitive advantage in the future. The OIB is built upon an anachronistic "50/50" rule, inhibited by a rigid and shortsighted Defense Acquisition System that does not prioritize sustainment upfront.

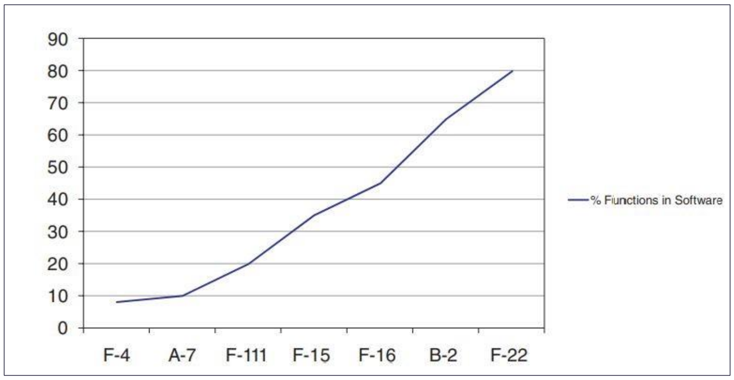

Figure 5.2 Percentage of functions delivered by software [98]

Aircraft Type	F-16	F-22	F-35
SLOC Total	Unknown	5,447,388	19,000,000
SLOC Aircraft	1,710,114	2,730,000	9,000,000
SLOC Safety-critical	259	152,000	500,000

Figure 5.3 Number of Software Lines of Code (SLOC) for specific aircraft [99]

At least two software-related challenges confront the current OIB ecosystem. First, the strict application of the "50/50" rule may be a future strategic constraint for the DoD when dealing with the sustainment of complex weapon systems. Today, the "50/50" rule is applied as an overall average across the DoD and does not provide equitable organic readiness across the Services. For example, if the Navy's MARC in Norfolk invests most of its funds in private sector depot-level activities, then other programs will be required to counterbalance with increased investments in organic depot-level activities in order to abide by "50/50" rule parameters, even if private investment is best suited for that platform's software architecture. If the "50/50" rule is not applied uniformly across weapon systems, then the DoD may struggle to ensure that advanced weapon systems in the future have the appropriate industry support to sustain sophisticated software suites.

[98] National Research Council, *Examination of the U.S. Air Force's Aircraft Sustainment Needs in the Future and Its Strategy to Meet Those Needs* (Washington, DC: The National Academies Press, 2011), https://doi.org/10.17226/13177, 119.

[99] Ibid, 120.

Second, the current Defense Acquisition System (DAS) addresses OIB sustainment requirements when weapon system development is nearly complete. In the case of advanced weapon systems, this approach will be highly inefficient due to engineering disconnects between the designed product and required software support.[100] The increasing speed of software development and the growing complexity of software-driven weapon systems will strain OIB resources if sustainment is not addressed early on. In an evolving strategic environment, the speed of technological advancement will accelerate and weapon systems will most likely demand frequent incremental software upgrades. To support this acceleration, the OIB and DAS will need to be closely linked and reconfigured to integrate development and sustainment planning early in the acquisition cycle.

Recommendations

R1: **GOGO to GOCO:** Considering the fast pace of software development, the government should exempt software support of complex U.S. weapon systems from the traditional "50/50 rule." Instead, the OIB should employ a GOCO model to capitalize on industry knowledge for software-driven weapon system sustainment. The OIB should increase public-private partnerships and shared execution with OEMs, with the DoD serving primarily in an oversight role. The investment ratio between the commercial and organic sectors will be proportional to the speed of the software development and the growth of software functions. The potential drawbacks of an invasive industry role in software sustainment will be counterbalanced by a more flexible DoD utilization of industry know-how for national security needs.

R2: **Prioritize Sustainment:** Within the DAS, the DoD should prioritize sustainment at the beginning of the Engineering and Manufacturing Development (EMD) phase. The earlier sustainment activities are planned the more prepared the OIB ecosystem will be to support product sustainment. Program offices, industry, and OIB personnel should work together to plan maintenance cycles and sustainment activities while the system is still in development. This new approach seeks a continuous collaboration between sustainment stakeholders from the beginning and throughout the product's lifecycle to ensure optimum sustainment solutions are achieved early.

5.4 Conclusion

In a new era of GPC and rapidly evolving technology, sustainment of both legacy and new warfighting capabilities will be essential to maintaining a strategic advantage over potential adversaries. The availability of technical data and improved software sustainment practices are key to the OIB's efforts to deliver effective and efficient warfighting readiness. These recommendations, along with a renewed focus on sustainment, will facilitate the OIB's mission to sustain warfighting capabilities, while reducing the costs and time necessary to meet readiness objectives. With rising GPC competitors, flat DoD budget projections, overused and aging

[100] Seminar 15 Contemporary Topics in National Security, (seminar discussion, ES6141, Eisenhower School, National Defense University, March 17, 2021).

weapon systems, and the increasing sophistication of new products, the time is right to address this challenge now.

Section 6 – CONCLUSION

The OIB is a bloodline for national security, delivering the necessary MRO, modification, and manufacturing services needed to support the advanced weapon systems that ensure a robust national defense. It sustains an ecosystem of allies, agencies, and industry partners that must stand ready to meet the security challenges and concerns of today as well as the future. To stay competitive against, and keep pace with near-peer adversaries, this bloodline must remain conditioned for day-to-day operations, but also to build and retain adequate capacity that can support the entire system during a major national mobilization for war, or for an immediate surge in demand.

However, the competitive advantages the United States currently enjoys against its competitors are not guaranteed into perpetuity. To accomplish these objectives, we need an improved strategy that considers new approaches to long standing problems. Strategies for Great Power Competition cannot remain as they were during the Cold War. The OIB's strategy must evolve to better articulate objectives and priorities, and to more effectively implement policies or actions that help achieve the same. OIB leaders must shift away from old methods of measuring inputs, and focus instead on creating value. While the OIB is certainly not the same as the private sector, and cannot be treated identically, industry has much to offer in the way of solutions to the problems the OIB faces.

More explicitly, the OIB can maximize value by improving its capacity, capacity utilization, and access to resources that produce readiness across all of the services. Great Power Competition requires leaders from every corner of the OIB to think competitively, beyond the battlefield, with business acumen, and a drive for process improvement. Advancements in technology and demands for greatly extended weapon system service lives increase the complexity of the sustainment ecosystem, requiring increased speed and agility in delivering solutions. The increased pace of change in areas like software will continue to drive a need for faster evaluation and responses that retain a decisive advantage.

Gaining and sustaining a national competitive advantage requires a strategy that addresses these challenges and achieves the stated national security objectives of the United States, especially those necessary to succeed in an era of GPC. More to the point, the OIB must clearly articulate and effectively implement its strategy in a way that accounts for the resources available across the enterprise, not just at a singular depot or shipyard. A culture of value-creation, a shared understanding of the things that actually enable readiness, and proper management of emerging technology and intellectual property will amplify the effects of an agile OIB strategy and deliver the capacity to respond to evolving global challenges.

APPENDICES

Appendix A: Abbreviated Recommendation List

This appendix succinctly captures the recommendations in this report by section using "Essential," "Supporting," and "Worthy of Further Consideration, Study, and Analysis" as the primary headers. "Essential" recommendations have clear projections to improve the OIB capacity and readiness for the Nation framed against the axes of articulation and implementation (see introduction). "Supporting" recommendations set the conditions, or further enable, "Essential" recommendations. Additional recommendations require further analysis to advance the concepts and fully integrate within the OIB.

Section 3: Value Creation Recommendation Summary:

Essential:

Strategy Implementation – Value and capacity measurement (pp. 21): Change the DoD's communication of industrial capacity by augmenting DLH with supporting information, deliverables, and needs through a common methodology.

Supporting:

Strategy Articulation – OIB quantifying outcomes (pp. 15): Define and quantify the OIB's outcomes to determine its economic value.

Strategy Articulation – Investment decisions (pp. 17): Improve ROIC by focusing on scalability and flexibility improvements that fulfill the requirement for a surge and operate efficiently during steady state operations.

Strategy Articulation – Creating value (pp. 18): Depots and centers consider NPV and the hurdle rate of seven percent for each investment.

Section 4: Readiness Enabler Recommendation Summary:

Infrastructure

Essential:

Strategy Implementation - Idle facility waiver (pp. 30): Establish a DoD waiver of 48 CFR § 31.205-17, Idle Facilities and Idle Capacity Costs, to allow the cost of idle facilities that support surge capacity under DoD contracts.

Strategy Implementation - Increase existing USCG Yard capability (pp. 33): The DoD should partner with the USCG to support the expansion of the Coast Guard Yard to accommodate the servicing of Littoral Combat Ships, Frigates, and Destroyers as a wartime surge capability strategy.

Strategy Implementation - Facility capacity baselines for depots or arsenals (pp. 36): Develop an aggregate facility-based capacity metric for depots; updated metrics permit improved communication, infrastructure investment decisions, and partnership opportunities.

Supporting:

Strategy Implementation - Industrial base exception to the "50/50" rule (pp. 30): Under 10 U.S.C. § 2466, paragraph (b), expand the waivers of limitation to include reasons of industrial base health.

Strategy Implementation - Expand P3 tools (pp. 36): Improve long-term capacity by leveraging existing CITE authority and improved facility metrics to expand P3 activities in the OIB.

Worthy of Further Consideration, Study, and Analysis:

Strategy Implementation - Private shipyard maintenance plan integration (pp. 29-30): The Navy should integrate private and public shipyard capacity, facilities, and capital equipment into a master maintenance and facility investment plan.

Strategy Implementation - Direct investment in private and public surge capacity (pp. 30): The Navy should invest in additional floating dry docks and associated capital equipment at private and public shipyards to increase surge capacity and contingency response.

Strategy Implementation - Create West Coast USCG Yard (pp. 33-34): Investment in a Pacific-based USCG Shipyard should be considered to support increased the organic industrial base for the USCG, including supporting the new Polar Security Cutter (PSC). This investment provides flexibility to the Nation by increasing the USCG's organic capability, while also providing the opportunity for the U.S. Navy's wartime surge capability strategy.

Strategy Implementation - Government-owned Contractor-operated Shipyards (pp. 30): Investment in one or more public-owned shipyard to service DoD and non-DoD vessels such as Military Sealift Command (MSC), National Oceanic and Atmospheric Admiration (NOAA), and public-owned ferries would address infrastructure sustainment challenges, while also providing the opportunity for the U.S. Navy's wartime surge capability strategy.

Human Capital

Essential:

Strategy Implementation - Expand OIB business acumen (pp. 39): Establish an additional concentration within the Eisenhower School for National Security and Resource Strategy specifically for sustainment professionals. Curriculum to be aimed at preparing military and civilian leaders to run the business operations of OIB with focus on increasing the understanding of operations management, facilities management, production, and manufacturing.

Strategy Implementation - Cross-Service capability listing (pp. 41): Use the Air Force's Technology Repair Center (TRC) Core Competencies framework to develop and implement a cross-capabilities and capacity model. A DoD-wide listing of each depot's equipment and repair capabilities would allow the OIB to market and leverage the enterprise's full scope of organic capability to prevent unnecessary workload pushes to commercial sources and maximize reinvestment into the WCF.

Supporting:

Strategy Implementation - Focused rotations with earlier assignments (pp. 38): Remove functional stovepipes and the negative perceptions associated with the depot workloads. Use existing positions to expand offerings at the junior officer and journeyman level to increase exposure to the various aspects of business operations for increase leadership effectiveness.

Strategy Articulation - Offer tools to manage the political environment (pp. 38-39): Develop a structured initiation and thorough coaching to military officers and senior civilians to manage the political landscape effectively. Offer the education and insight for Commanders and Directors to understand and deftly maneuver these relationships and harness the potential opportunities that exist by nourishing community engagement to promote growth and bolster advocacy for the OIB facilities.

Strategy Implementation - Increase Industry Exposure (pp. 39): Offer industry rotations to expose military officers and senior civilians to executive-level business activities would build knowledge and awareness of corporate leadership and activities.

Worthy of Further Consideration, Study, and Analysis:

Strategy Implementation - Interoperable workload planning and execution (pp. 41-42): All services utilize the Air Force's DMA tool, to collaborate and share data in real-time on workload planning and execution.

Finance

Essential:

Strategy Articulation - Carryover Policy (pp. 44): Update carryover policy to allow four to six months of annual carryover by activity group and transition from allowable carryover rate calculations.

Worthy of Further Consideration, Study, and Analysis:

Strategy Articulation - Workflow contract policy (pp. 44): Create policy where OIB depots and customers establish production schedules as formal contracts.

Section 5: Technical Data and Software Recommendation Summary:

Technical Data

Essential:

Strategy Implementation - Add sustainment milestones post MS C (pp. 49-50): Revise DoDI 5000.02 to include sustainment milestones beyond Milestone C to force recurring, comprehensive reviews of the sustainment strategy and provide an authoritative mechanism to pursue alternate strategies.

Strategy Articulation - Net Present Value/Business Case (pp. 50): Use a business case analysis, supported by an NPV calculation, to analyze and justify proposed changes to the sustainment strategy.

Worthy of Further Consideration, Study, and Analysis:

Strategy Implementation - TDP procurement during competition (pp. 50): Consider revising 10 USC 2366 to include language mandating a complete TDP procurement during the competitive phase of the program when the service life is anticipated to extend beyond 20 years, unless formally waived by the MDA.

Strategy Implementation - Grant GPR after a fixed period (pp. 50-51): Pass a law granting the Government GPR to all technical data associated with a fielded system at IOC+20.

Strategy Implementation - Grant GPR when OEM departs market (pp. 50): Pass a law granting the Government GPR to all technical data associated with a fielded system if the OEM goes bankrupt or otherwise departs the market.

Software

Essential:

Strategy Implementation - GOGO to GOCO (pp. 53): Exempt software support for complex U.S. weapon systems from the traditional "50/50" rule through increased public-private partnerships

Supporting:

Strategy Articulation - Prioritize Sustainment (pp. 53): Revise the current Defense Acquisition System to mandate and prioritize additional sustainment considerations at the beginning of the EMD phase.

Appendix B: Glossary of Terms

***6% Investment*:** statutory law requiring depots to gather no less than six percent of the average total dollar value of the combined MRO workload performed over the preceding three fiscal years. This money is intended to fund capital investments for the organic industrial base to include facilities, equipment, and infrastructure.

Accumulated Operating Result (AOR)**:** the net difference between expenses and funds received since the inception of the fund.

Activity Group / Sub-activity Group (AG/SAG): basic purpose for which an activity proposes to spend money (i.e., Station Operations). The activity group is beneath the Budget Activity fan of a funding account.

Agile**:** the ability to anticipate demand and when necessary, quickly respond to sustain operational tempo. This includes the flexibility to support rapid deployment, maneuver, aggregation, disaggregation, and redeployment of forces; the ability to attain and process accurate critical information in the near-real-time to inform decision-making; and the ability to build integrated plans that simplify command relationships, responsibilities, and common-user support.

Business Case Analysis (BCA)**:** a structured methodology and document that aids decision making by identifying and comparing alternatives to examine mission and business impacts (both financial and non-financial), risks, and sensitivities. The BCA concludes with a recommendation and associated specific actions and implementation plan to achieve stated organizational objectives and desired outcomes.

Capacity, Depot**:** the amount of workload, expressed in actual direct labor hours, that a facility can accommodate with all work positions manned on a single-shift, 5-day, 40-hour week basis while producing the product mix that the facility is designed to accommodate.

Capacity, Industry**:** maximum output that can be generated from unlimited resources, but based on fixed property, plant, and equipment footprint.

Capacity Utilization**:** expressed as a percentage and is calculated by taking the actual level of output, divided by potential output.

Capability**:** the ability to complete a task or execute a course of action under specified conditions and level of performance. Capability is how well customer expectations are met.

Carryover**:** funded depot level work not completed by the end of a given fiscal year.

Commercial Industrial Base (CIB)**:** the part of the larger DIB, consisting of the commercially-owned organizations, facilities or installations with capabilities to perform research, development, production, and depot-level maintenance/repair and upgrades/modifications on necessary military weapon systems, equipment, materials, munitions, hardware, and software to meet the requirements of national security.

Complex Software-Driven Weapon Systems**:** refers to those weapon systems that integrate capabilities that are software developed, upgraded, and sustained.

Continuous Process Improvement (CPI)**:** a comprehensive philosophy of operations that is built around the concept that there are always ways in which a process can be improved to better meet the needs of the customer and that an organization should constantly strive to make those improvements.

Continuous Process Improvement, DoD**:** is the evolution of just in time (JIT), Lean, and other best practices to support cost effective readiness support to the warfighter. CPI contains a toolbox with an open architecture that welcomes any effective combination of tools and techniques. These combinations may or may not be organized to be pulled out to achieve specific objectives. All tools remain at the immediate access to the CPI practitioner. An example of the components of a typical toolbox might include elements of Lean, Theory of Constraints (TOC), and Six Sigma (6σ). No single set of components in a toolbox is ideal to fully drive CPI under all circumstances.

Core**:** the depot maintenance capability (including personnel, equipment, and facilities) maintained by the Department of Defense at Government-owned, Government-operated facilities as the ready and controlled source of technical competence and resources necessary to ensure effective and timely response to a mobilization, national defense contingency situations, and other emergency requirements. Depot maintenance for the designated weapon systems and other military equipment is the primary workload assigned to DoD depots to support core depot maintenance capabilities.

Cost per Day of Availability (C/DA) Metric**:** used to measure efficiency sustainment efforts that affect the availability of a defined population of weapon systems.

Defense Industrial Base (DIB)**:** the worldwide industrial complex comprised of the OIB and CIB that enables research and development as well as design, production, delivery, and maintenance of military weapon systems/software systems, subsystems, and components or parts, as well as purchased services to meet U.S. military requirements.

Defense Industrial Capability**:** the skills and knowledge, processes, facilities and equipment needed to design, develop, manufacture, repair and support DoD products. Defense industrial capabilities include private and public industrial activities.

Defense Sustainment Industrial Base**:** the package of support functions required to maintain the readiness and operational capability of weapon systems, subsystems, software and support systems.

Defense Working Capital Fund (DWCF)**:** used by OIB to charge for goods and services provided to a variety of customers, including the Army, the Navy, the Air Force, other DoD and non-DoD agencies, and foreign countries. Under the working capital fund concept, the DWCF charges these customers for the anticipated full cost of these goods and services.

Demilitarization**:** the act of destroying the military offensive or defensive capability inherent in certain types of equipment or materiel. The term includes mutilation, scrapping, melting, burning, or alteration designed to prevent the further use of this equipment and materiel for its originally intended military or lethal purpose. It applies equally to materiel in unserviceable or serviceable condition that has been screened through an Inventory Control Point (ICP) and declared excess or foreign excess.

Depot Maintenance**:** that maintenance performed on materiel requiring major overhaul or a complete rebuild of parts, assemblies, subassemblies, and end-items, including the manufacture of parts, modifications, testing and reclamation as required. Depot maintenance serves to support lower categories of maintenance by providing technical assistance and performing that maintenance beyond their responsibility. Depot maintenance provides stocks of serviceable equipment by using more extensive facilities for repair than are available in lower-level maintenance activities.

Disposal**:** the act of getting rid of excess, surplus, scrap, or salvage property under proper authority. Disposal may be accomplished by, but not limited to, transfer, donation, sale, declaration, abandonment, or destruction.

Distribution**:** the movement of goods from supplier or manufacturer to point of sale. Distribution management is an overarching term that refers to numerous activities and processes such as packaging, inventory, warehousing, supply chain and logistics.

Effectiveness**:** the degree to which someone or something is successful in achieving a desired result. “Do the right THINGS at the right time, for the right length of time.”

Efficiency**:** the degree to which a desired result is achieved without wasting time and resources. “THINGS done right without wasting resources.”

Fixed Capital**:** property, plant, and equipment.

Flow Days**:** the number of days an item is in the depot maintenance process.

Full Operational Capability**:** attained when all units and/or organizations in the force structure scheduled to receive a system have received it and have the ability to employ and maintain it.

GOCO**:** government-owned, contractor operated.

GOGO**:** government-owned, government operated.

Governance**:** a standardized format to review strategic measures and progress toward goal accomplishment. This should include individual projects as well as the Continuous Process Improvement Program and take the form of regularly scheduled Strategy Alignment, Project Selection meetings in support of the DoD-wide Continuous Process Improvement Program.

Government Purpose Rights (GPR): rights to use, disclose technical data (TD) for government purposes only, and to have or permit others to do so for government purposes only. Government purposes include competitive procurement but do not include the right to permit others to use for commercial purposes.

Highly Qualified Expert (HQE)**:** individuals possessing expertise or recognized knowledge, skills, and experience in an occupational field. They are intended to bring enlightened thinking and innovation to advance the DoD national security mission. They are a temporary infusion of talent and provide non-permanent support for short-term endeavors.

Idle Time: a time interval during which a worker, equipment, or both do not perform useful work.

Initial Operational Capability (IOC)**:** attained when some units and/or organizations in the force structure scheduled to receive a system have received it and have the ability to employ and maintain it.

Intellectual Property: is a term referring to a number of distinct types of creations of the mind for which a set of exclusive rights are recognized and the corresponding fields of law.

Lexicon**:** a standard set of terms and definitions.

Life-Cycle Sustainment Plan (LCSP): is the primary program management reference governing operations and support planning and execution from Milestone A to final disposal.

Limited Rights: rights to use, duplicate, or disclose Technical Data (TD) in whole or in part, by or for the government, with the express written permission of the party furnishing the data to be released or disclosed outside the government.

Maintenance**:** all action taken to retain materiel in a serviceable condition or to restore it to serviceability. It includes inspection, testing, servicing, classification as to serviceability, repair, rebuilding and reclamation.

Maintenance and Availability Data Warehouse (MADW)**:** a database that provides availability, cost, inventory, and transactional data on every weapon system and readiness reportable piece of equipment within the DoD.

Maintenance, Repair, and Overhaul (MRO)**:** any action that helps keep or restore and item to its working condition.

Materiel**:** equipment, apparatus, and supplies used by an organization or institution.

Materiel Availability (A_m) Metric**:** used to measure both effectiveness and efficiency of sustainment efforts to affect the availability of a given weapon system being utilized within the system's planned lifecycle.

Military Readiness**:** a condition of the Armed Forces and their personnel, weapon systems, technology and equipment to perform during military operations.

Mobilization**:** to marshal something, such as resources, for action. During a federal emergency, mobilization is more explicitly "a process of assembling and organizing national resources to support national objectives."

Modification: are any change to the engineering baseline of a product that materially increases the efficiency or productive capacity of the equipment.

Net Operating Result (NOR)**:** the net difference between expenses and funds received in a given fiscal year.

Operation and Maintenance (O&M): appropriations which fund expenses such as maintenance services, civilian salaries, travel, minor construction projects, operating military forces, training and education, depot maintenance, working capital funds, and base operations support. O&M follows the Department's Annual Funding budget policy. O&M appropriations are available for obligation purposes for one year.

Operational Availability (A_o) Metric**:** used to measure the effectiveness of sustainment efforts to affect the availability of a weapon system's active inventory.

Organic Industrial Base (OIB)**:** the government-owned industrial capability comprised of the organizations and facilities that perform research, development, production, or depot-level maintenance, repair, demilitarization, and disposal of weapon systems, equipment, materials, munitions, hardware, and software. These include laboratories, research centers, arsenals, depots, shipyards, aircraft plants, and ammunition plants, whether operated by government personnel or contractors.

Outcome-Focused Metrics**:** used to assess the degree to which expected outcomes have been achieved. Performance to Promise (P2P): a commitment to meet a customer-required delivery date.

Outlay Rate**:** the outlay rate for appropriations is contained in the DOD Financial Summary Tables, which are published each year. The outlay rates provide a profile of how money appropriated for a program is expected to be spent over time according to the type of program.

Program Management Office (Program Office): is the organization or group of people who are in charge of project management within an organization.

Readiness**:** the capability of a unit/formation, ship, weapon system, or equipment to perform the missions of functions for which it is organized or designed. This is synonymous with operational readiness, and it includes the OIB's ability to meet the needs of the Combatant Commanders as they execute their assigned missions.

Reliability Contribution**:** measures the work performed by a depot for reliability and quality.

Resilient**:** the ability to withstand and quickly recover from kinetic or non-kinetic attacks against forces and asset; includes force protection measures, hardening critical infrastructure from attack, and deception efforts to complicate adversary decisions and targeting; and provide necessary support to maintain sufficient combat power to achieve campaign objectives, even in the face of continued and adaptive near-peer adversary actions.

Service**:** one of the military Services: Army, Navy, Marine Corps, Coast Guard, and Air Force.

Software Intensive System**:** any system where software represents the largest segment in one or more of the following criteria: system development cost, system development risk, system functionality, or development time.

Sole Source Acquisition**:** a contract for the purchase of supplies or services that is entered into or proposed to be entered into by an agency after soliciting and negotiating with only one source.

STEM**:** science, technology, engineering, and math.

Stock Availability**:** a measure of the ability of WCF inventory to fill a customer's requisition.

Strategic Planning**:** high-level priorities and goals the organization desires to accomplish, strategic measures to assess progress toward goals, and specific tasks the organization will perform in order to accomplish its goals.

Strategy**:** a prudent idea or set of ideas for employing the instruments of national power in a synchronized and integrated fashion to achieve theater, national, and/or multinational objectives.

Strategy, Comprehensive**:** coherent statement of an enterprise's purpose and the highest objectives it will pursue over the long-term; the approved outcome of strategic planning governance.

Strategy, Subordinate**:** a policy (or policies) or plan of action (or actions) designed to pursue a major objective or larger aim.

Supply**:** the procurement, distribution, maintenance while in storage, and salvage of supplies, including the determination of kind and quantity of supplies. The Producer Phase extends from determination of procurement schedules to acceptance of finished supplies by the military services. The Consumer Phase extends from receipt of finished supplies by the military services through issue for use or consumption.

Supply Chain**:** the linked activities associated with providing materiel to an end user starting from a raw material stage to a finished product.

Surge**:** the ability to increase organic industrial base programmed capacity utilization, using fixed capital, in response to operational requirements or unforeseen circumstances.

***Sustainment*:** the supportability of fielded systems and their subsequent lifecycle product support – from initial procurement to supply chain management (including maintenance) to reutilization and disposal.

Technical Data: recorded information of scientific or technical nature, regardless of form or character (such as equipment technical manuals and engineering drawings), engineering data, specifications, standards, and Data Item Descriptions (DID).

***Technical Data Package*:** a technical description of an item adequate for supporting an acquisition strategy, production, engineering, and logistics support.

***Technical Data Rights*:** the right for the government to acquire technical data.

***Theory of Constraints*:** A systematic approach to optimize resource utilization by identifying, exploiting, subordinating, elevating, and reassessing constraints in the process. Scientific principles are applied as a set of logical thinking processes to develop transformational breakthrough business solutions. A constraint is any resource whose capacity is less than the demand placed upon it. Theory of constraints attacks constraints and barriers (a restriction or other block to increases in output).

Unlimited Rights: rights to use, modify, reproduce, display, release, or disclose technical data (TD) in whole or in part, in any manner, and for any purpose whatsoever, and to have or authorize others to do so.

Value: represents an increased return on investment for shareholders that is high enough to compensate for the cost of capital.

***Weapon System*:** a combination of one or more weapons including all services, materials, equipment, and means of delivery and deployment required for self-sufficiency.

Appendix C: OIB Statutes and Policies

DEPOT MAINTENANCE STATUTES

1. *10 U.S.C. § 2208, Working capital funds*: This statute provides for the establishment of working-capital funds in the DoD to "(1) finance inventories of such supplies as [the Secretary of Defense] may designate; and (2) provide working capital for such industrial-type activities." [101]

2. *10 U.S.C. § 2460, Definition of Depot Maintenance*: Definition of depot-level maintenance and repair: This statute defines depot-level maintenance and repair as "material maintenance or repair requiring the overhaul, upgrading, or rebuilding of parts, assemblies, or subassemblies, and the testing and reclamation of equipment as necessary, regardless of the source of funds for the maintenance or repair or the location at which the maintenance or repair is performed."[102] Exceptions to this definition are "the procurement of major modifications or upgrades of weapon systems that are designed to improve program performance or the nuclear refueling or defueling of an aircraft carrier and any concurrent complex overhaul." [103]

3. *10 U.S.C. § 2464, Core Logistics Capabilities*: This statute requires that the Secretary of Defense identify the core logistics capabilities and workload to maintain proficiency and ensure effective and timely response to mobilization efforts in support of the U.S.'s National Security Requirements.[104]

4. *10 U.S.C. § 2466, Limitations on the performance of depot-level maintenance of materiel*: This statute, commonly referred to as the "50/50" rule, requires that not more than 50% of a service's annual funds for depot-level maintenance and repair workload may be used by non-Government personnel.

5. *10 U.S.C. § 2474, Centers of Industrial and Technical Excellence: designation; public-private partnerships*: This statute enables the services to identify their depot location as Centers of Industrial and Technical Excellence (CITEs). It authorizes each service to enter into public-private partnerships (PPP or P3) with the Original Equipment Manufacturers (OEMs) and other lower tiered suppliers. The PPPs allow contractors to execute core capabilities in government-owned facilities, allow contractors to perform maintenance under contract at the different depots, and allow non-DOD entities to use Government facilities and equipment not being used by the depot.[105]

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[101] 10 U.S. Code 131 (2019) § 2208, Working-capital funds.
[102] 10 U.S. Code 146 (2013) § 2460, Definition of depot-level maintenance and repair.
[103] Ibid.
[104] 10 U.S. Code 146 (2018) § 2464, Core logistics capabilities.
[105] U.S. Army Materiel Command Headquarters, *Centers of Industrial and Technical Excellence (CITE)* (Washington, DC: Department of the Army, 2014), https://www.acq.osd.mil/log/mpp/.depot.html/Army_CITE_Designations_11Aug2014.pdf.

6. *10 U.S.C. § 2476, Minimum capital investment for certain depots*: This statute requires each service invest a minimum of 6% of the "average total combined MRO workload funded at all the depots of that military department for the preceding three fiscal years." [106]

7. *10 U.S.C. § 2366a, Major defense acquisition programs: certification required before Milestone B approval*: This statute provides, in part, that a major defense acquisition program may not receive Milestone A approval or initiate prior to Milestone B approval until the milestone decision authority determines in writing "that planning for sustainment has been addressed and that a determination of applicability of core logistics capabilities requirements has been made." [107]

8. *10 U.S.C. § 2366b, Major defense acquisition programs: determination required before Milestone A approval*: This statute provides, in part, that a major defense acquisition program may not receive Milestone B approval until the milestone decision authority determines in writing that 1) "life-cycle sustainment planning and mitigation planning has identified and evaluated relevant sustainment costs…and that such costs are reasonable and have been accurately estimated," and 2) "an estimate has been made of the requirements for core logistics capabilities and the associated sustaining workloads required to support such requirements."[108]

OSD POLICY & ISSUANCES

1. *DoD Directive 4151.18, Maintenance of Military Materiel, dated March 31, 2004 incorporating Change 1, August 31, 2018*: This directive establishes policies and assigns responsibilities for the performance of DoD materiel maintenance.[109]

2. *DoD 4151.18-H, Depot Maintenance Capacity and Utilization Measurement Handbook, dated March 10,2007 incorporating Change 1, August 31, 2018*: This handbook provides guidance for a "common methodology to measure and provide visibility of the capacity and utilization of DoD organic activities."[110]

3. *DoDI 1348.30, Secretary of Defense Maintenance Awards, dated April 8, 2019*: This issuance establishes policy, assigns responsibilities, and prescribes procedures for the

[106] 10 U.S. Code 146 (2011) § 2476, Minimum capital investment for certain depots.

[107] 10 U.S. Code 139 (2019) § 2366a, Major defense acquisition programs: certification required before Milestone A approval.

[108] 10 U.S. Code 139 (2019) § 2366b, Major defense acquisition programs: certification required before Milestone B approval.

[109] Department of Defense, *Maintenance of Military Materiel,* DODD 4151.18 (Washington, DC: DoD, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/415118p.pdf.

[110] Department of Defense, *Depot Maintenance Capacity and Utilization Measurement Handbook*, DOD 4151.18-H (Washington, DC: DoD, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415118h.pdf.

Secretary of Defense Maintenance Awards Program to "enhance maintenance awareness, encourage maintenance excellence, and foster price and professionalism."[111]

4. *DoDI 4151.19, Serialized Item Management (SIM) for Life-Cycle Management of Materiel, dated January 9, 2014 incorporating Change 2, August 31, 2018*: This issuance establishes policy and assigned responsibilities for SIM implementation for life-cycle management of materiel[112]

5. *DoDI 4151.24, Depot Source of Repair (DSOR) Determination Process, dated October 13, 2017*: This policy establishes policy for "determining DSOR assignments for weapon systems and items of military equipment that require depot-level maintenance" and "directs inter-DoD component reviews of depot-level maintenance requirements against all DoD capabilities." [113]

6. *DoDI 4151.20, Depot Maintenance Core Capabilities Determination Process, dated May 4, 2018*: This issuance established policy to identify required core capabilities for depot maintenance and associated workloads.[114]

7. *DoDI 4151.21, Public-Private Partnerships for Product Support, dated November 21, 2016 incorporating Change 4, July 31, 2019*: This issuance establishes policy for the execution of public-private partnerships.[115]

8. *DoDI 4151.22, Condition-Based Maintenance Plus for Materiel Maintenance, dated August 14, 2020*: This issuance establishes policy for condition-based maintenance (CBM) as a "proactive maintenance strategy for achieving cost-effective weapon system life cycle sustainment."[116]

9. *DoD 7000.14-R, Volume 6A, Chapter 14, Depot Maintenance Reporting, dated April 2020*: This chapter prescribes "Depot Maintenance Cost System (DCMS) requirements

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[111] Department of Defense, *Secretary of Defense Maintenance Awards,* DODI 1348.30 (Washington, DC: DoD, 2019), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/134830p.pdf.

[112] Department of Defense, *Serialized Item Management (SIM) for Life-Cycle Management of Materiel,* DODI 4151.19 (Washington, DC: DoD, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/415119p.pdf.

[113] Department of Defense, *Depot Source of Repair (DSOR) Determination Process,* DODI 4151.24 (Washington, DC: DoD, 2017), https://www.acq.osd.mil/log/MPP/.policy.html/DoDI_4151.24_%20October_2017.pdf.

[114] Department of Defense, *Depot Maintenance Core Capabilities Determination Process,* DODI 4151.20 (Washington, DC: Department of Defense, 2018), https://www.acq.osd.mil/log/MPP/.policy.html/DoDI_4151.20_5.4.18.pdf.

[115] Department of Defense, *Public-Private Partnerships for Product Support,* DODI 4151.21 (Washington, DC: DoD, 2019), https://www.acq.osd.mil/log/MPP/.policy.html/DoDI4151_21%20PPP_Product_Support_Ch4_7.31.2019.pdf.

[116] Department of Defense, *Condition-Based Maintenance Plus for Materiel Maintenance,* DODI 4151.22 (Washington, DC: Department of Defense, 2012), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/415122p.pdf.

that are necessary to provide a comprehensive accounting of DoD depot maintenance workloads."[117]

10. *DoD 7000.14-R, Volume 6B, Chapter 10, Notes to the Financial Statements, dated March 2020*: This chapter "prescribes the format, content, and instructions for the preparation and presentation of notes to the principal financial statements."[118]

11. *DoD Manual 4151.22-M, dated June 30, 2011 incorporating Change 1, August 31, 2018*: This manual implements policy for the reliability centered maintenance (RCM) process.[119]

12. *DoD Manual 4151.23, dated June 24, 2016 incorporating Change 1, August 31, 2018*: This manual implements policy for conducting a cost comparability analysis of organic depot maintenance workloads.[120]

13. *Public-Private Partnering (PPP) for Product Support Guidebook, dated October 7, 2016*: This guidebook identifies the knowledge base on partnering processes and procedures and provides case studies on PPP.[121]

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[117] Department of Defense, *Financial Management Regulation: Reporting Policy,* DoD 7000.14 – R, Volume 6A (Washington, DC: DoD, 2020), https://comptroller.defense.gov/Portals/45/documents/fmr/Volume_06a.pdf.

[118] Department of Defense, *Financial Management Regulation: Notes to the Financial Statements,* DoD 7000.14 – R, Volume 6B, Chapter 10 (Washington, DC: Department of Defense, 2020), https://comptroller.defense.gov/Portals/45/documents/fmr/current/06b/06b_10.pdf.

[119] Department of Defense, *Reliability Centered Maintenance (RCM),* DoD Manual 4151.22-M (Washington, DC: Department of Defense, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415122m.pdf.

[120] Department of Defense, *DoD Organic Depot Maintenance Cost Comparability,* DODM 4151.23 (Washington, DC: DoD, 2018), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415123m.pdf?ver=2018-10-31-123816-847.

[121] Kristin K. French, "Public-Private Partnering (PPP) for Product Support Guidebook" (official memorandum, Washington, DC: DoD, 2016), https://www.acq.osd.mil/log/MPP/.policy.html/PPP_for_Product_Support_Guidebook_Oct2016.pdf.

Appendix D: OIB Locations and Capabilities

Organic Industrial Base Inventory Site	State	Service	Primary Mission	Primary Capability
309th Aerospace Maintenance and Regeneration Group	AZ	Air Force	Maintenance and Storage	Aviation Storage and Preservation, Maintenance, Regeneration
412th Test Wing	CA	Air Force	Test & Evaluation	Aviation
Air Force Test Center	CA	Air Force	Test & Evaluation	Aviation
Aircraft Plant 42 Palmdale	CA	Air Force	Manufacturing & Production	Aviation
96th Test Wing	FL	Air Force	Test & Evaluation	Aviation
Aircraft Plant 6 Marietta	GA	Air Force	Manufacturing & Production	Aviation
Warner-Robins Air Logistics Complex	GA	Air Force	Maintenance	Aviation Maintenance, Avionics Specialty, Commodities Maintenance, Software and Electronic Maintenance
Air Force Materiel Command	OH	Air Force	Research, Test & Evaluation, Logistics Support	Nuclear Systems Management, Discovery & Development, Life Cycle Management, Weapons System Sustainment
Air Force Research Laboratory	OH	Air Force	Research	Aviation

Organic Industrial Base Inventory Site	State	Service	Primary Mission	Primary Capability
Air Force Sustainment Center	OK	Air Force	Sustainment and Logistics	Aviation Maintenance, Aviation components and Engines
Oklahoma City Air Logistics Complex	OK	Air Force	Maintenance, Test & Evaluation	Aviation Maintenance, Aviation Software, Propulsion Maintenance, Innovation Center
Arnold Engineering and Development Center	TN	Air Force	Test & Evaluation	Aviation
Aircraft Plant 4 Dallas	TX	Air Force	Manufacturing & Production	Aviation
Ogden Air Logistics Complex	UT	Air Force	Maintenance	Aviation - 5th Generation Fighters, Landing Gear, Missiles, Software Development
Anniston Army Depot	AL	Army	Maintenance	Ground Vehicles & Equipment, Small Arms, Artillery
Anniston Munitions Center	AL	Army	Storage & Distribution	Missiles and Munitions, AMCOM Missiles, DA Missile Recycling Center
Aviation and Missile Research and Development Center	AL	Army	Design, Development & Engineering	Aviation & Missiles
Pine Bluff Arsenal	AR	Army	Manufacturing & Production	Missiles and Munitions, White/Red Phosphorous, Smoke/Obscurants
Sierra Army Depot	CA	Army	Storage & Distribution Operations	Ground Vehicles & Equipment, Supply Depot, DEMIL Storage
Pueblo Chemical Depot Army Base	CO	Army	Storage	Chemical Weapons Storage

Organic Industrial Base Inventory Site	State	Service	Primary Mission	Primary Capability
Iowa Army Ammunition Plant	IA	Army	Manufacturing & Production	Missiles and Munitions, Small Caliber
Rock Island Arsenal Joint Manufacturing & Technology Center	IL	Army	Manufacturing & Production	Ground Vehicles & Equipment, Towed Artillery, Hydro-Pneumatic, Recoil Mechanisms
Crane Army Ammunition Activity	IN	Army	Storage & Distribution	Missiles and Munitions, Supply Depot
Blue Grass Army Depot	KY	Army	Storage & Distribution	Missiles and Munitions, Ammo Supply Depot, DEMIL, Chemical Defense Equipment
Natick Soldier Research, Development and Engineering Center	MA	Army	Design, Development & Engineering	Individual Equipment
Army Research Laboratory	MD	Army	Research	*Unknown
Edgewood Chemical and Biological Center	MD	Army	Design, Development & Engineering	Chemical and Biological Defense
Tank Automotive Research, Development and Engineering Center	MI	Army	Design, Development & Engineering	Ground Vehicles & Equipment
Lake City Army Ammunition Plant	MO	Army	Manufacturing & Production	Missiles, Small Caliber Munitions
Armaments Research, Development and Engineering Center	NJ	Army	Design, Development & Engineering	Armaments
Hawthorne Army Depot	NV	Army	Storage & Distribution	Missiles and Munitions

Organic Industrial Base Inventory Site	State	Service	Primary Mission	Primary Capability
Watervliet Arsenal	NY	Army	Manufacturing & Production	Armaments, Cannon Tubes, Mortars, Towed Artillery
Joint Systems Manufacturing Center	OH	Army	Manufacturing & Production	Ground Vehicles & Equipment
McAlester Army Ammunition Plant	OK	Army	Manufacturing & Production, Storage & Distribution	Missiles and Munitions, Bomb Production
Letterkenny Army Depot	PA	Army	Maintenance	Air Defense, Missile Systems, Ground Support Equipment
Letterkenny Munitions Center	PA	Army	Storage & Distribution	Missiles and Munitions, Tactical Missiles, Missile Certification, USN/USAF Missiles, Ammo Storage
Scranton Army Ammunition Plant	PA	Army	Manufacturing & Production	Missiles and Munitions, Projectile Metal Parts
Tobyhanna Army Depot	PA	Army	Maintenance	C4ISR, Avionics, Missile Guidance & Control
Holston Army Ammunition Plant	TN	Army	Manufacturing & Production	Missiles and Munitions, Explosives (RDX/HMX)
Milan Army Ammunition Plant	TN	Army	Manufacturing & Production	Missiles and Munitions
Corpus Christi Army Depot	TX	Army	Maintenance	Aviation - Rotary Wing

Organic Industrial Base Inventory Site	**State**	**Service**	**Primary Mission**	**Primary Capability**
Red River Army Depot	TX	Army	Maintenance	Bradley, MLRS, Tactical Wheeled Vehicles, RESET Track and Road Wheels
Red River Army Depot	TX	Army	Maintenance	Ground Vehicles & Equipment
Tooele Army Depot	UT	Army	Storage & Distribution	Missiles and Munitions, Chem Storage, Chem DEMIL Facility
Radford Army Ammunition Plant	VA	Army	Manufacturing & Production	Missiles and Munitions, Propellants, Explosives
Aviation Logistics Center	NC	Coast Guard	Maintenance	Aviation
Coast Guard Yard	MD	Coast Guard	Maintenance	Ships
Marine Depot Maint Command Production Plant Barstow	CA	Marine Corps	Maintenance	Combat Vehicles, Ordnance, Constructions Equipment, Communications and Electronics
Marine Depot Maint Command Production Plant Albany	GA	Marine Corps	Maintenance	Combat Vehicles, Ordnance, Constructions Equipment, Communications and Electronics
Fleet Readiness Center - Southwest	CA	Navy	Maintenance	Aviation, Aviation Components
Naval Air Warfare Center China Lake	CA	Navy	Design, Development & Engineering	Aviation, Aviation Weapons
Naval Air Warfare Center Point Mugu	CA	Navy	Design, Development & Engineering	Aviation, Aviation Weapons

Organic Industrial Base Inventory Site	State	Service	Primary Mission	Primary Capability
Naval Facilities Engineering and Expeditionary Warfare Center	CA	Navy	Research & Development	Expeditionary Equipment, S&T Reinvention Lab
Naval Information Warfare Center Pacific	CA	Navy	Engineering	Communications and Network Systems, Information Warfare, ISR, Unmanned Systems
Naval Surface Warfare Center Corona	CA	Navy	Test & Evaluation	Joint Warfare Assessment Lab, Measurement S&T Lab, Missile Defense Assessment, Range and Test Instruments, Measurement Standards
Naval Surface Warfare Center Port Hueneme	CA	Navy	Test & Evaluation	Combat and Weapon Systems, Radars and Air Systems, Surface Surveillance
Southwest Regional Maintenance Center	CA	Navy	Maintenance	Ships - Non-Nuclear
Fleet Readiness Center - Southeast	FL	Navy	Maintenance	Aviation, Aviation Components
Naval Air Warfare Center Orlando	FL	Navy	Design, Development & Engineering	Aviation, Aviation Weapons
Naval Surface Warfare Center Panama City	FL	Navy	Design, Development & Engineering	Littoral Systems, Mine Warfare Systems, Naval Special Warfare Systems, Amphibious Warfare Systems
Navy Experimental Diving Unit	FL	Navy	Engineering	Diving Systems, Hyperbolic Systems, Life Support Systems
Southeast Regional Maintenance Center	FL	Navy	Maintenance	Ships - Non-Nuclear

Organic Industrial Base Inventory Site	State	Service	Primary Mission	Primary Capability
Pearl Harbor Naval Shipyard	HI	Navy	Maintenance	Ships - Non-Nuclear and Nuclear, Intermediate Maintenance
Naval Surface Warfare Center Crane	IN	Navy	Design, Development & Engineering	Sensors, Electronics, Electronic Warfare Systems, Special Warfare Systems
Naval Air Warfare Center Patuxent River	MD	Navy	Design, Development & Engineering	Aircraft Launch and Recovery, Propulsion and Power, UAVs, Avionics
Naval Surface Warfare Center Carderock	MD	Navy	Design, Development & Engineering	Surface & Undersea Platforms, Military Logistics Systems
Portsmouth Naval Shipyard	ME	Navy	Maintenance	Ships - Non-Nuclear and Nuclear
Fleet Readiness Center - East	NC	Navy	Maintenance	Aviation, Aviation Components
Naval Air Warfare Center Lakehurst	NJ	Navy	Design, Development & Engineering	Aviation, Aviation Weapons
Naval Surface Warfare Center Philadelphia	PA	Navy	Design, Development & Engineering	Propulsion, Power and Auxiliary Machinery, Machinery Controls & Networks
Naval Undersea Warfare Center Newport	RI	Navy	Design, Development & Engineering	Submarines
Naval Information Warfare Center Atlantic	SC	Navy	Engineering	Communications and Network Systems, Cyber Infrastructure, Knowledge Management Services
Midatlantic Regional Maintenance Center	VA	Navy	Maintenance	Ships - Non-Nuclear

Organic Industrial Base Inventory Site	**State**	**Service**	**Primary Mission**	**Primary Capability**
Naval Surface Warfare Center Dahlgren	VA	Navy	Design, Development & Engineering	Intelligent Automation, Software Engineering, Digital Engineering, Hypersonic Weapons, Directed Energy
Naval Surface Warfare Center Indian Head EOD Technology	VA	Navy	Design, Development & Engineering	Ordnance, Energetics, Explosive Ordnance Disposal
Norfolk Naval Shipyard	VA	Navy	Maintenance	Ships - Non-Nuclear and Nuclear
Northwest Regional Maintenance Center	VA	Navy	Maintenance	Ships - Non-Nuclear
Office of Naval Research	VA	Navy	Research	Navy & Marine Corps Research & Development
Surface Combat Systems Center	VA	Navy	Test & Evaluation	In-Service Surface Combat Systems, Warfare System Integration
Naval Undersea Warfare Center Keyport	WA	Navy	Test & Evaluation	Undersea Warfare Systems
Puget Sound Naval Shipyard	WA	Navy	Maintenance	Ships - Non-Nuclear and Nuclear, Intermediate Maintenance

Organic Industrial Base Inventory Site	OCONUS	Service	Primary Mission	Primary Capability
Naval Base Guam	Guam	Navy	Maintenance	Ships - Non-Nuclear
Forward Deployed Regional Maintenance Center (Bahrain)	Bahrain	Navy	Maintenance	Ships - Non-Nuclear
Forward Deployed Regional Maintenance Center (Yokosuka)	Japan	Navy	Maintenance	Ships - Non-Nuclear
Forward Deployed Regional Maintenance Center (Naples)	Italy	Navy	Maintenance	Ships - Non-Nuclear, AEGIS Ashore
Forward Deployed Regional Maintenance Center (Rota)	Spain	Navy	Maintenance	Ships - Non-Nuclear, AEGIS Ashore

Appendix E: Porter's Diamond

Porter's Diamond – U.S. Defense Industrial Base

Chance Events	Firm Strategy, Structure, and Rivalry	Factor Conditions	Demand Conditions	Related and Supporting Industries	Government Policy and Influence
• Engaged in GPC • Responds to world events and maintains world order • Wars in Iraq and Afghanistan • Numerous contingency operations	• Competition between US defense companies • Structure enables competition in all domains • Free market system, global access • Incentives to invest, protect IP • Sound corporate governance • Property rights respected • U.S. economic momentum • U.S. military might (GPC)	• Access to high quality business inputs • Access to low-cost capital/financing • Access to domestic natural resources • Human resources • Ample opportunities for capital investment • Robust and modern infrastructure • Numerous universities and other industries providing advances in scientific knowledge • US is a leading global source of technological innovation	• Sophisticated needs • Private & government opportunity • Strategic value & consequences • Global mobility, rising wealth = demand • Largest and most competitive defense market • Demanding requirements and state-of-the-art expectations • US viewed as the most technologically advanced military in the world	• Technological efficiencies • GPC momentum to rebuild • Covid lessons learned • Immigrants still come to the U.S. to study • A robust network of supporting industries, many of which are competitive globally • Many national 1st and 2nd tier suppliers and other related industries • Intense competition at all levels of supply chains	• Highest defense budget in the world • Desire to keep the American military in the lead • Robust enforcement of anti-trust laws • Effort to bring back production capability • International competition • Effort to enhance and strengthen domestic supply chain resilience • International partnerships (NATO)

Porter's Diamond – China Defense Industrial Base

Chance Events	Firm Strategy, Structure, and Rivalry	Factor Conditions	Demand Conditions	Related and Supporting Industries	Government Policy and Influence
• Great Power Competition • Territorial Disputes • Taiwan • Corruption	• State Owned Enterprises • Investment in R&D • Enterprises • Limited competition amongst defense companies	• Large population for labor options • Large number of STEM graduates • Decline due to factors such as One Child Policy • Science & Technology Infrastructure • Venture capital availability and domestic credit to private sector • Strong manufacturing base	• World's market for all goods, particularly high-tech items • Continued focus on consumer driven economy	• Extensive transportation infrastructure, including high speed rail, airport access, and major seaports • Improved access to fiber internet • Chinese Academy of Sciences • Emphasis on dual-use tech – Defense/Civilian	• Direct role in promoting industries • Shift from planned economy to more free market governance • Cumbersome bureaucracy • Lack of transparency

Porter's Diamond – Russia Defense Industrial Base

Chance Events	Firm Strategy, Structure, and Rivalry	Factor Conditions	Demand Conditions	Related and Supporting Industries	Government Policy and Influence
• Engaged in GPC • Responds to world events and desire to establish world order • Military operations in Syria • Conflict and Arms Sales to Turkey • Military build up in Arctic Region • Climate Change	• Competition between Russian and Western defense companies • Intense domestic competition within the Russian Defense Industrial Base • State-run industries supporting national defense	• Access to domestic natural resources • Large Human Resources • Skilled and unskilled laborers • Limited international resources— US sanctions	• International market for non-US manufactured arms and services • Heavy reliance on government contracts to maintain defense industry	• Extensive transportation infrastructure, including high speed rail, airport access, and major seaports • Main supplier of Energy and energy related products to Western Europe • Emphasis on dual-use tech – Defense/Civilian	• Defense budget heavily connected to national economy • Desire to expand Russian influence and prestige around the world • Effort to bring back production capability • Seeking international partnerships • Working to promote Russian companies to international markets • Seeking continued foreign investments to strengthen infrastructure and distribution networks