THE ARSENAL OF DEMOCRACY

TECHNOLOGY, INDUSTRY, AND DETERRENCE IN AN AGE OF HARD CHOICES

EYCK FREYMANN
HARRY HALEM

FOREWORD BY ADMIRAL JAMES O. ELLIS JR., USN (RET.), AND NIALL FERGUSON

NOTES

Foreword

1. Robert Kagan, "Challenging the US Is a Historic Mistake," *Wall Street Journal*, February 3, 2023.
2. Max Boot wrote on X on September 18, 2023, "The artillery duels and trench warfare are straight out of WWI, and yet much of the Ukrainian artillery fire is now being spotted by drones and adjusted on tablet computers. It feels like a mash-up of 'All Quiet on the Western Front' and 'Blade Runner.'"
3. James A. Michener, *The Bridges at Toki-Ri* (Dial Press trade paperback edition, 2015), 35.
4. *Department of Defense Authorization for Appropriations for Fiscal Year 1981, Hearings before the Committee on Armed Services, US Senate*, 96th Congress, Second Session, S. 2294 (1980) (statement of Senator Sam Nunn).
5. Calculated from World Bank, "World Development Indicators."

Introduction

1. Paul Mour and Adam Satariano, "A.I. Begins Ushering In an Age of Killer Robots," *New York Times*, July 2, 2024.

2. See, for example, Aamer Madhani, "US Intelligence Finding Shows China Surging Equipment Sales to Russia to Help War Effort in Ukraine," Associated Press, April 19, 2024; Joyce Lee, "North Korea's Kim Jong Un Oversees Tests of 'Suicide Drones,'" Reuters, August 26, 2024; Oded Yaron, "Gold for Drones: Massive Leak Reveals the Iranian Shahed Project in Russia," *Ha'aretz*, February 21, 2024; Aadil Brar, "How China's Fighter Jet Parts Ended Up in North Korea's Copy of US Drone," *Newsweek*, January 19, 2024; Greg Hadley, "SPACECOM Alarmed as China, Russia, Iran, and N. Korea Forge Closer Ties in Space," *Air & Space Forces Magazine*, June 24, 2024.
3. Alexandra Prokopenko, "What Are the Limits to Russia's 'Yuanization'?," *Carnegie Politika*, May 27, 2024.
4. Philip Zelikow, "Confronting Another Axis? History, Humility, and Wishful Thinking," *Texas National Security Review* 7, no. 3 (2024).
5. Gabriel Collins and Andrew Erickson, *Annexation of Taiwan: A Defeat from Which the US and Its Allies Could Not Retreat* (Baker Institute for Public Policy, Rice University, July 2024), 5–6.
6. Xinhua News Agency, "习近平主持召开二十届中央国家安全委员会第一次会议强调 加快推进国家安全体系和能力现代化 以新安全格局保障新发展格局" [Xi Jinping presided over the first meeting of the 20th Central National Security Committee and emphasized that we should accelerate the modernization of the national security system and capabilities and ensure the new development pattern with a new security pattern], May 30, 2023.
7. Andrew Erickson, "PRC Pursuit of 2027 'Centennial Military Building Goal': Sources and Analysis," *Andrew S. Erickson* (blog), April 2023.
8. Jimmy Goodrich, "China's Evolving Fortress Economy," Working Paper No. 5 (UC Institute on Global Conflict and Cooperation, July 2024) 1–25.
9. John P. Glennon, ed., "Memorandum of Conversation, by the Ambassador at Large (Jessup)," *Foreign Relations of the United States, 1950, Korea*, vol. VI (US Department of State, Office of the Historian, 1976).
10. Eyck Freymann and Hugo Bromley, *On Day One: An Economic Contingency Plan for a Taiwan Crisis* (Hoover Institution Press, 2024), 15–19.
11. Freymann and Bromley, *On Day One*.

12. Ivan Kanapathy, "Countering China's Use of Force," in *The Boiling Moat: Urgent Steps to Defend Taiwan*, ed. Matt Pottinger (Hoover Institution Press, 2024), 92–94.
13. Mackenzie Eaglen, "The Bias for Capability over Capacity Has Created a Brittle Force," *War on the Rocks*, November 17, 2022.
14. US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2023* (October 19, 2023).
15. Franklin D. Roosevelt, "The Arsenal of Democracy," fireside chat, December 29, 1940. Recording and transcript available at the Miller Center, UVA.
16. Bloomberg Government, "Federal Appropriations for FY24: Overview," June 3, 2024.
17. For key texts in each category, see Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Cornell University Press, 1991); Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars* (Cornell University Press, 1984); Thomas G. Mahnken, *Technology and the American Way of War Since 1945* (Columbia University Press, 2010).
18. Williamson Murray and Allan R. Millett, eds., *Military Innovation in the Interwar Period* (Cambridge University Press, 1996).
19. This approach also shares some similarities with works like Eliot Cohen's *Supreme Command* and Aaron Friedberg's *In the Shadow of the Garrison State*, both of which use historical cases to illuminate current policy dilemmas. However, whereas Cohen examines civil–military relations and Friedberg focuses on domestic mobilization, we focus on the intersection of technological adaptation, industrial capacity, and deterrence. See Eliot A. Cohen, *Supreme Command: Soldiers, Statesmen, and Leadership in Wartime* (Free Press, 2002); Aaron L. Friedberg, *In the Shadow of the Garrison State: America's Anti-Statism and Its Cold War Grand Strategy* (Princeton University Press, 2000).
20. US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2024* (December 18, 2024).
21. Among various examples, see Thomas J. Christensen, *The China Challenge: Shaping the Choices of a Rising Power* (W. W. Norton, 2015).
22. Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the US, and*

Israel (Stanford University Press, 2010); Michael C. Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton University Press, 2010).

23. James Rainey and Laura Potter, "Delivering the Army of 2030," *War on the Rocks*, August 6, 2023; Chris Gordon, "Cover Story: Retooling for China," *Air & Space Forces Magazine*, January 26, 2024; Andrew Feickert, *The Army's AimPoint and Army 2030 Force Structure Initiatives*, CRS Report No. IF11542 (Congressional Research Service, 2022); US Marine Corps, *Force Design 2030: Annual Update* (Department of the Navy, June 2022); US Navy, *Chief of Naval Operations: Navigation Plan 2022* (July 2022); Shawn Cochran, Kirsten M. Keller, Mark Touken, et al., *The Forces We Need: Building Multi-Capable Airmen to Enable Agile Combat Employment* (RAND, 2023); Andrew Feickert, *US Marine Corps Force Design 2030 Initiative: Background and Issues for Congress*, CRS Report No. R47614 (Congressional Research Service, 2023).
24. David Lauterborn, "Secretary of Defense James Mattis," HistoryNet, December 1, 2016.
25. Jay Mens, "Two Types of Applied History: Analogy and Genealogy," *Journal of Applied History* 5, no. 2 (2023): 89–110.
26. Matt Pottinger, ed., *The Boiling Moat: Urgent Steps to Defend Taiwan* (Hoover Institution Press, 2024).
27. The most detailed and lucid analysis of Taiwan's job now is Ivan Kanapathy, "Countering China's Use of Force" and "Countering China's Gray Zone Activities," in *The Boiling Moat*, ed. Matt Pottinger, 83–103, 105–29.
28. For a thorough discussion of why these capabilities are urgently needed and could buy time to shore up medium-term deterrence, see Collins and Erickson, *Annexation of Taiwan*.
29. Michael J. Mazarr, "Beating the Ossification Trap: Why Reform, Not Spending, Will Salvage American Power," *War on the Rocks*, February 15, 2024; US Department of Defense, *Military and Security Developments: 2023*.
30. Demetri Sevastopulo, "China Military Exercises near Taiwan Could Be Used to Conceal Attack, US Says," *Financial Times*, February 13, 2025.
31. For the most comprehensive and compelling argument that superintelligent AI may soon be achieved, see Leopold Aschenbrenner,

"Situational Awareness: The Decade Ahead" (Working Paper, Situational-Awareness.ai, June 6, 2024). For foundational analysis of superintelligent AI's strategic implications, see Nick Bostrom, *Superintelligence: Paths, Dangers, Strategies* (Oxford University Press, 2014) and Stuart Russell, *Human Compatible: Artificial Intelligence and the Problem of Control* (Viking, 2019). For high-level strategic analysis integrating AI with historical lessons of deterrence and stability, see Henry Kissinger, Eric Schmidt, and Daniel Huttenlocher, *The Age of AI: And Our Human Future* (Little, Brown, 2021). On contemporary military implications, see Paul Scharre, *Four Battlegrounds: Power in the Age of Artificial Intelligence* (W. W. Norton, 2023). See also Vincent Boulanin, Lora Saalman, Petr Topychkanov, Fei Su, and Moa Peldán Carlsson, *Artificial Intelligence, Strategic Stability and Nuclear Risk* (Stockholm International Peace Research Institute [SIPRI], June 2020).

32. Congressional Budget Office, "Long-Term Implications of the 2024 Future Years Defense Program," October 25, 2023.
33. Michael J. Boskin, John Rader, and Kiran Sridhar, eds., *Defense Budgeting for a Safer World: The Experts Speak* (Hoover Institution Press, 2023).
34. On the argument that even large spending increases would not resolve DOD's challenges, see Mazarr, "Beating the Ossification Trap"; Michael Brown, "A Plan to Revitalize the Arsenal of Democracy," *War on the Rocks*, May 10, 2024.
35. Megan Eckstein, "Navy's Sub Readiness Boss Unveils Steps to Reach On-Time Maintenance," *Defense News*, November 7, 2023.
36. Amrita Jash, "By the Numbers: China's Nuclear Inventory Continues to Grow," *The Interpreter*, Lowy Institute, February 27, 2024.
37. Zelikow, "Confronting Another Axis?"

Chapter 1

1. James J. Schneider, "War Plan RAINBOW 5," *Defense Analysis* 10, no. 3 (2007).
2. Michael E. O'Hanlon, *The Future of Land Warfare* (Brookings Institution Press, 2015), 4–7.

3. Samuel P. Huntington, "National Policy and the Transoceanic Navy," US Naval Institute, May 1954.
4. Carl von Clausewitz, *On War*, trans. Michael Howard and Peter Paret (Princeton University Press, 1989), 1:28.
5. J. C. Wylie, *Military Strategy: A General Theory of Power Control* (Naval Institute Press, 1967).
6. T. N. Dupuy, *Understanding War: History and Theory of Combat* (Paragon House, 1989).
7. Gregory Daly, "Command at Cannae," ch. 5 in *Cannae: The Experience of Battle in the Second Punic War* (Routledge, 2002), 156–202; Douglas C. Sanders, "Julius Caesar and the Gallic Campaign: A Road Map to the Use of the Instruments of Power" (master's thesis, United States Marine Corps Command and Staff College, March 3, 2010); Frederick W. Kagan, "Setting the Terms of Battle," in *The End of the Old Order: Napoleon and Europe, 1801–1805* Da Capo Press, 2006), 549–80.
8. Of course, sometimes terrain is intrinsically favorable for an attacker, but knowledge of one's own ground is often crucial. This follows Clausewitz's dictum that the defense is the strongest form of war. See Stephen D. Chiabotti, "Clausewitz as Counterpuncher: The Logic of Conventional Deterrence," *Strategic Studies Quarterly* 12, no. 4 (2018): 9–14.
9. David M. Glantz and Jonathan M. House, "Kursk to the Dnepr," in *When Titans Clashed: How the Red Army Stopped Hitler* (University Press of Kansas, 2015).
10. Paul Sonne, Isabelle Khurshudyan, Serhiy Morgunov, and Kostiantyn Khudow, "Battle for Kyiv: Ukrainian Valor, Russian Blunders Combined to Save the Capital," *Washington Post*, August 24, 2022.
11. Sergio Miller, "Russia's Withdrawal from Kherson," *Wavell Room* (blog), January 6, 2023.
12. Nearly every major naval engagement in World War II was near a littoral, island, or choke point. National Museum of the US Navy, "Pacific Naval Surface Battles," accessed November 13, 2024.
13. Jason R. Musteen, *Nelson's Refuge: Gibraltar in the Age of Napoleon* (Naval Institute Press, 2011).
14. Thurgood Marshall Jr. and Peter Goelz, "A Bold Strategy: The British Raid on St. Nazaire," National WWII Museum, April 2, 2021.

15. Evan Mawdsley, *The War for the Seas: A Maritime History of World War II* (Yale University Press, 2019); R. Dunley, *Britain and the Mine, 1900–1915: Culture, Strategy and International Law* (Springer International Publishing, 2018); Dietrich Schindler and Jiří Toman, eds., *The Laws of Armed Conflicts: A Collection of Conventions, Resolutions, and Other Documents*, 4th rev. and complete ed. (Martinus Nijhoff, 2004); David Letts, "Naval Mines: Legal Considerations in Armed Conflict and Peacetime," *International Review of the Red Cross* 98, no. 902 (2016): 543–65; Matthew Cancian, "An Offensive Minelaying Campaign Against China," *Naval War College Review* 75, no. 1 (2022): 1–18. See also Hugo Bromley and Eyck Freymann, "The Malacca Myth: Why a Naval Blockade Would Fail to Coerce China," *International Security*, forthcoming.
16. Wayne P. Hughes and Robert P. Girrier, "The Great Variables," in *Fleet Tactics and Naval Operations*, 3rd ed. (Naval Institute Press, 2018).
17. Shawn Woodford, "Dupuy's Verities: The Requirements for Successful Defense," *Dupuy Institute* (blog), March 15, 2019; Shawn Woodford, "A Comment on the Importance of Reserves in Combat," *Dupuy Institute* (blog), April 1, 2019.
18. David J. Lonsdale, "Ancient Greek Warfare," in *Alexander the Great: Lessons in Strategy* (Routledge, 2007), 41.
19. David T. Zabecki, *The German 1918 Offensives: A Case Study in the Operational Level of War* (Routledge, 2006); Ryan J. Karasow, "Observing the Past to Prepare for the Future: Operational Art in the Ardennes Campaign" (master's thesis, School of Advanced Military Studies at the US Army Command and General Staff College, 2018).
20. Dupuy, *Understanding War*.
21. Wayne P. Hughes and Robert P. Girrier, "The Great Trends," in *Fleet Tactics and Naval Operations*, 3rd ed. (Naval Institute Press, 2018).
22. Yuki Yagi, "The Imperial Japanese Navy and the Battle of the Philippine Sea: An Analysis of the Main Causes of Defeat" (Sciendo, April 2021). The Battle of Leyte Gulf is at times considered the largest naval battle in history. Although the formal Order of Battle for Leyte Gulf included more tonnage, there were fewer ships engaged than on paper. Nevertheless, the same trends apply at the Philippine Sea as applied at Leyte Gulf.

23. Brent D. Sadler, "Rearming US Navy Ships at Sea Is No Longer an Option, but a Necessity," *Defense News*, March 5, 2024.
24. Christopher J. Keller, John Roy, John Cullen, Ronald Walck, and James Young, *Corps and Division Planner's Guide to Reconstitution Operations* (Center for Army Lessons Learned, October 25, 2019).
25. Henry J. Hendrix, *At What Cost a Carrier?* (Center for a New American Security, March 2013).
26. Hughes and Girrier, *Fleet Tactics and Naval Operations*.
27. Geoff Ziezulewicz, "Is the Navy Ready to Repair Battle-Damaged Ships in Wartime?," *Navy Times*, June 8, 2021; Earl P. Jessop, "Repair Ships, Advance Bases, and Fleet Mobility in War Time," *Proceedings* (US Naval Institute) 58, no. 8 (1932).
28. Jeff Schogol, "How Ukraine Might Maintain Its Abrams, Challenger, and Leopard Tanks to Fight Russia," *Task & Purpose*, January 27, 2023.
29. Repairing the USS *Cole* took three years and involved several difficulties. "Details of the Efforts to Rebuild the Cole," ABC News, January 17, 2001. Similarly, the USS *John S. McCain* took three years to return to the fleet after its 2017 collision, as did the USS *Fitzgerald*. See Sam LaGrone, "USS *Fitzgerald* Returns to Sea After Repairs Caused by Fatal 2017 Collision," USNI News, February 3, 2020; Sam LaGrone, "USS *John McCain* Back to Operations Almost 3 Years After Fatal Collision," USNI News, June 16, 2020.
30. Hughes and Girrier, *Fleet Tactics and Naval Operations*. This text remains the most important modern work on naval power.
31. Hughes and Girrier, *Fleet Tactics and Naval Operations*.
32. Midway is a clear example of this. See Harold C. Train and E. J. King, *Battle of Midway* (Office of Naval Intelligence, March 13, 1943).
33. David C. Evans and Mark R. Peattie, *Kaigun: Strategy, Tactics, and Technology in the Imperial Japanese Navy, 1887–1941* (US Naval Institute, 2012), 94–132.
34. Jutland lasted for a day and night, whereas land campaigns—even short ones—in the modern day last for weeks to months.
35. Samuel Eliot Morison, *The Struggle for Guadalcanal: August 1942–February 1943*, vol. 5 (Naval Institute Press, November 2010).
36. For an extensive discussion of the character of air combat, see John A. Warden, *The Air Campaign: Planning for Combat* (iUniverse, 1998).

37. Loren M. Olsen, *The Battle of Britain, a Study in Command and Control* (US Army War College, 1991).
38. John B. Hattendorf, "XVIII. The Aircraft Carrier, Naval Aviation, and the Changing Character of Naval Battle during the War in the Pacific, 1941–1945," in *La Bataille, L'Homme et la Guerre* (Hermann, 2018), 249–64.
39. Japan did get off a response, sinking the American carrier *Yorktown*, demonstrating the lethality of naval combat even for the victor. Jonathan B. Parshall and Anthony P. Tully, *Shattered Sword: The Untold Story of the Battle of Midway* (Potomac Books, 2007); Craig L. Symonds, *The Battle of Midway* (Oxford University Press, 2011).
40. H. F. D. Davis, "Building Major Combatant Ships in World War II," *Proceedings* (US Naval Institute) 73, no. 5 (1947).
41. Allan R. Milett, in *Military Effectiveness, Volume 3: The Second World War*, 2nd ed., ed. Allan R. Millett and Williamson Murray (Cambridge University Press, 2010), 64.
42. Brent Crane, "America's SOS," Wire China, October 27, 2024.
43. Peter C. Luebke, Timothy L. Francis, and Heather M. Haley, *Contested Logistics: Sustaining the Pacific War* (Naval History and Heritage Command, Department of the Navy, 2023).
44. Harold W. Nelson, *Logistics in World War II: Final Report of the Army Service Forces* (Center of Military History, US Army, 1947).
45. Ernest J. King, "United States Navy at War: Final Official Report to the Secretary of the Navy" *Proceedings* (US Naval Institute) 71, no. 515 (1946): 25.
46. Norman Friedman, *British Cruisers of the Victorian Era* (Seaforth Publishing, 2012), 34–35.
47. Steven Gray, *Black Diamonds: Coal, the Royal Navy, and British Imperial Coaling Stations, Circa 1870–1914* (University of Warwick, 2014), 68–75.
48. Archer Jones and Andrew J. Keogh, "The Dreadnought Revolution: Another Look," *Military Affairs* 49, no. 3 (1985).
49. Jones and Keogh, "The Dreadnought Revolution."
50. Elmer Belmont Potter, *Sea Power: A Naval History* (Naval Institute Press, 1981), 195–99.
51. Leonard Wainstein, "The Dreadnought Gap," *Proceedings* (US Naval Institute) 92, no. 9 (1966).

52. Arthur J. Marder, "Fisher and the Genesis of the Dreadnought," *Proceedings* (US Naval Institute) 82, no. 12 (1956).
53. Marder, "Fisher."
54. Marder, "Fisher."
55. Robert Massie, *Dreadnought: Britain, Germany, and the Coming of the Great War*, "Part III: The Navy" (Random House, 1991).
56. Geoffrey Till, "Adopting the Aircraft Carrier: The British, American, and Japanese Case Studies," in *Military Innovation in the Interwar Period*, ed. Williamson R. Murray and Allan R. Millett (Cambridge University Press, 1996), 191–226.
57. Till, "Adopting the Aircraft Carrier," 191–226.
58. For more on AirLand Battle Doctrine and Maritime Strategy and their contributions to the US victory in the Cold War, see Christopher Ford and David Rosenberg, "The Naval Intelligence Underpinnings of Reagan's Maritime Strategy," *Journal of Strategic Studies* 28, no. 3 (2005): 379–409; Thomas Mahnken, Evan Montgomery, and Tyler Hacker, *Innovating for Great Power Competition: An Examination of Service and Joint Innovation Efforts* (Center for Strategic and Budgetary Assessments, January 11, 2023), 19–23.
59. Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (Scribner, 2022), 74–75.
60. William J. Perry, "Desert Storm and Deterrence," *Foreign Affairs* (Fall 1991), 69; Ben Wray, "The Battle to Control Microchip Supplies Will Define the Twenty-First Century," *Jacobin*, May 25, 2024; Tiberiu-Dan Onuta, "Considerations on Strategy and Technology Interrelationships," *Small Wars Journal* (October 2015): 5. The program would later become known broadly as the Second Offset; the First Offset referred to the Eisenhower-era emphasis on American strategic nuclear forces as a counter to the Soviet conventional advantage.
61. These efforts were the Navy's Timation program, the Army's SECOR system, and the Air Force's Project 621B. See Patrick J. O'Brien and John M. Griffin, "Global Positioning Systems Engineering Case Study," *AFIT Documents* 34 (Air Force Center for Systems Engineering, 2007), 21–23.
62. Matthew E. Skeen, "The Global Positioning System: A Case Study in the Challenges of Transformation," *Joint Force Quarterly* 51 (2008): 89;

Brad Parkinson, interview by Michael Geselowitz, Center for the History of Electrical Engineering, November 2, 1999.

63. Skeen, "Global Positioning System," 89–90.
64. Skeen, "Global Positioning System," 89; US Department of the Air Force, Space and Missile Systems Organization, *NAVSTAR Global Positioning System: Program Management Plan*, July 15, 1964.
65. Dominic A. Paolucci, *Summary Report of the Long Range Research and Development Planning Program* (Lulejian and Associates, February 7, 1975); Annie Jacobsen, *The Pentagon's Brain: An Uncensored History of DARPA, America's Top-Secret Military Research Agency* (Little, Brown, 2016), 192; Jeremy Kuzmarov, "The Improbable Militarist: Jimmy Carter, the Revolution in Military Affairs, and the Limits of the American Two-Party System," *Class, Race and Corporate Power* 6, no. 2 (2018): 15; Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Air University Press, 1985), 139; Perry, "Desert Storm and Deterrence"; Barry D. Watts, *The Evolution of Precision Strike* (Center for Strategic and Budgetary Assessments, 2013), 5.
66. Jacobsen, *Pentagon's Brain*, 193.
67. William Perry, "Fallows' Fallacies: A Review Essay," *International Security* 6, no. 4 (1982): 175.
68. One example was the Army's MQM 105 Aquila targeting UAV. The DARPA program that generated the prototype was ambitious, but once the Army took developmental control, it tried to cut the cost of each unit while retaining advanced sensors on the vehicle. As a result, the Aquila was plagued by basic performance issues. See Richard Van Atta, "DARPA's Process for Creating New Programs: Perspectives on the US Defense Advanced Research Projects Agency," in *The DARPA Model for Transformative Technologies: Perspectives on the US Defense Advanced Research Projects Agency*, ed. William B. Bonvillian, Richard Van Atta, and Patrick Windham (Open Book Publishers, 2020), 250.
69. Edward C. Keefer, *Harold Brown: Offsetting the Soviet Military Challenge, 1977–1981*, vol. 9 (Historical Office, Office of the Secretary of Defense, 2017), 589–90.
70. Keefer, *Harold Brown*, 590–91.
71. William Perry, interview by Edward Keefer and Philip Shiman, Office of the Secretary of Defense Historical Office, June 21, 2012, 7–8.

72. Lockheed Martin, "Sea Shadow," October 1, 2020.
73. Keefer, *Harold Brown*, 585.
74. Keefer, *Harold Brown*, 585.
75. Keefer, *Harold Brown*, 585–86.
76. Thomas Heinrich, "Cold War Armory: Military Contracting in Silicon Valley," *Enterprise and Society* 3, no. 2 (June 2002): 250.
77. Heinrich, "Cold War Armory," 251.
78. Heinrich, "Cold War Armory," 271–72.
79. Glenn R. Fong, "Breaking New Ground or Breaking the Rules: Strategic Reorientation in US Industrial Policy," *International Security* 25, no. 2 (2000): 165–68.
80. Ellen M. Lord and Jeffrey Nadaner, *A 21st Century Defense Industrial Strategy for America* (Hudson Institute, June 2021), 26; Heinrich, "Cold War Armory," 272.
81. Harry Halem, "Ukraine's Lessons for Future Combat: Unmanned Aerial Systems and Deep Strike," *US Army War College Quarterly: Parameters* 53, no. 4 (October 20, 2023).
82. US Department of Defense, *Quadrennial Defense Review Report* (US Department of Defense, September 30, 2001), 6.
83. US Department of Defense, Office of Force Transformation, *Military Transformation: A Strategic Approach* (Office of the Secretary of Defense, 2003), 29.
84. US Government Accountability Office, *F-35 Joint Strike Fighter: More Actions Needed to Explain Cost Growth and Support Engine Modernization Decision* (Government Accountability Office, May 2023), 4–44.
85. Christopher Leonard, "Lockheed Martin's $1.7 Trillion F-35 Fighter Jet Is 10 Years Late and 80% over Budget—and It Could Be One of the Pentagon's Biggest Success Stories," *Fortune*, August 2, 2023, https://fortune.com/longform/lockheed-martin-f-35-fighter-jet/.
86. Laura Grego, George N. Lewis, and David Wright, *Shielded from Oversight: The Disastrous US Approach to Strategic Missile Defense* (Union of Concerned Scientists, July 2016).
87. CBS News, "Transcript: CIA Director William Burns on 'Face the Nation,' Feb. 26, 2023," February 26, 2023.
88. Michael Brown, "A Plan to Revitalize the Arsenal of Democracy," *War on the Rocks*, May 10, 2024.

89. Ryan Ashley, "Japan's Revolution on Taiwan Affairs," *War on the Rocks*, November 23, 2021.
90. Andrew Tilgham, *Guam: Defense Infrastructure and Readiness* (Congressional Research Service, August 3, 2024); Oriana Skylar Mastro, "Defense, Deterrence, and the Role of Guam," in *Defending Guam*, ed. Rebeccah Heinrichs (Hudson Institute, July 2022), 44–48.
91. Jeff Schogol, "Top Marine General Says Moving Marines from Okinawa to Guam 'Puts Us Going the Wrong Way,'" *Task & Purpose*, January 15, 2025.
92. Leilani Chavez, "What's Next for the US-Philippines Basing Agreement?," *Defense News*, February 5, 2024; Geoff Ziezulewicz, "A Return to the Philippines," *Navy Times*, February 8, 2023.
93. See discussion in Oriana Skylar Mastro, "The Military Challenge of the People's Republic of China," in *Defense Budgeting for a Safer World: The Experts Speak*, ed. Michael J. Boskin, John Rader, and Kiran Sridhar (Hoover Institution Press, 2023), 46.
94. Andrew S. Erickson and Joel Wuthnow, "Why Islands Still Matter in Asia: The Enduring Significance of the Pacific 'Island Chains,'" *National Interest*, February 5, 2016.
95. James I. Matray, "Dean Acheson's Press Club Speech Reexamined," *Journal of Conflict Studies* 22, no. 1 (2002).
96. Alexander Chieh-cheng Huang, "The United States and Taiwan's Defense Transformation," Brookings Institution, February 16, 2010.
97. For a counterargument, see Elbridge Colby, *The Strategy of Denial: American Defense in an Age of Great Power Conflict* (Yale University Press, 2022).
98. Andrew F. Krepinevich, *Maritime Warfare in a Mature-Strike Regime* (Center for Strategic and Budgetary Assessments, 2014).
99. This situation is changing, but many of the details are not specified in open sources. Office of Naval Intelligence, *The People's Liberation Army Navy: A Modern Navy with Chinese Characteristics* (Office of Naval Intelligence, August 2009).
100. Directed-energy weapons are military systems that use concentrated energy, such as lasers or microwaves, to damage or destroy targets. Integrated battle management software is a computerized system that coordinates and manages various military operations, enhancing

situational awareness and decision-making on the battlefield. For more on DMO, see Ronald O'Rourke, *Defense Primer: Navy Distributed Maritime Operations (DMO) Concept*, CRS Report No. IF12599 (Congressional Research Service, 2024).

101. Curtis E. Lemay Center, *Air Force Doctrine Note 1-12: Agile Combat Employment* (US Air Force, August 23, 2022).
102. Stacie L. Pettyjohn, Andrew Metrick, and Becca Wasser, "The Kadena Conundrum: Developing a Resilient Indo-Pacific Posture," *War on the Rocks*, December 1, 2022; Carl Rehberg and Josh Chang, *Moving Pieces: Near-Term Changes to Pacific Air Posture* (Center for Strategic and Budgetary Assessments, November 18, 2022). Kadena's vulnerability to surprise strikes is an old problem. See, for example, Christopher J. Bowie, *The Anti-Access Threat and Theater Air Bases* (Center for Strategic and Budgetary Assessments, 2002).
103. Sandeep Mulgund, "Command and Control for Agile Combat Employment," Wild Blue Yonder, Air University, August 30, 2021; Curtis E. Lemay Center, *Air Force Doctrine Note 1-12*; Isaiah Oppelaar, "Agile Combat Employment: The Next Big Thing for NATO Air Power," *Journal of the JAPCC* 36 (October 2023).
104. US Marine Corps, *Force Design 2030: Annual Update* (June 2023).
105. US Army, *The US Army in Multi-Domain Operations 2028* (US Army, December 6, 2018).

Chapter 2

1. UPTIDE stands for Unified Pacific Fleet Project for Tactical Improvement and Data Extraction.
2. Throughout this chapter, naval combat is taken to include land-based air forces directed toward naval means. See Michael P. Hettinger Jr., *21st Century Anti-Scouting for Carrier Strike Groups: Countering in the Anti-Access/Area Denial Environment* (Writing & Teaching Excellence Center, US Naval War College, May 7, 2019); George Galdorisi, "UAVs Can Fill the Navy's Scouting Gap," *Proceedings* (US Naval Institute) 149, no. 1 (2023).

3. Gabriel Collins and Andrew Erickson, *Annexation of Taiwan: A Defeat from Which the US and Its Allies Could Not Retreat* (Baker Institute for Public Policy, Rice University, July 2024), 89.
4. Christopher A. Lawrence, "Density of Deployment in Ukraine," Dupuy Institute, July 2, 2024.
5. John Keegan, *The Price of Admiralty: The Evolution of Naval Warfare from Trafalgar to Midway* (Viking, 1989), 260–62.
6. Andrew K. Blackley, "The Barr and Stroud Rangefinder," *US Naval Institute Naval History*, February 2024.
7. Wayne P. Hughes, "Naval Operations: A Close Look at the Operational Level of War at Sea," *Naval War College Review* 65, no. 3 (2012): 22–46; Joint Advanced Warfighting School, *Horatio Nelson and the 1798 Mediterranean Campaign* (National Defense University, Joint Forces Staff College, January 2006).
8. Joseph F. Callo, "Lasting Lessons of Trafalgar," *US Naval Institute Naval History*, October 1, 2005.
9. Modern military capabilities, particularly the combination of satellite surveillance, advanced radar systems, and long-range precision strike, have fundamentally altered this calculus. Major powers like China are now capable of making naval forces far more vulnerable to detection and tracking.
10. Eric Grove, "Tsushima—A Decisive Victory: The Great Naval Battle 100 Years On," *RUSI Journal* 150, no. 2 (2005): 54–59.
11. Robert K. Massie, *Castles of Steel: Britain, Germany, and the Winning of the Great War at Sea* (Vintage Books, 2007). Germany and Britain fielded five and nine battlecruisers in scouting formations, respectively, or around 20 percent of their heavy warship fleets. These were combined with a number of light cruisers for additional scouting potential. If one considers German and British cruisers scouting or counter-scouting assets, alongside screening assets, then the percentage rises to around a third.
12. Edmund B. Hernandez, "The Fundamental Naval Tactical Problem," *Proceedings* (US Naval Institute) 148, no. 11 (2022).
13. See Thomas Hone, Norman Friedman, and Mark David Mandeles, *Innovation in Carrier Aviation*, Newport Paper 37 (Naval War College Press, 2011).

14. National Defense University, *Military Innovation Carrier Aviation: The Relevant History* (National Defense University Institute for National Strategic Studies, 1997).
15. Roberta Wohlstetter, *Pearl Harbor: Warning and Decision* (Stanford University Press, 1962).
16. Richard W. Bates and Walter D. Innis, *The Battle of Savo Island, August 9, 1942* (Department of Analysis, Naval War College, 1950).
17. Julian Stafford Corbett, "Fighting Instructions, 1530–1816," *Publications of the Navy Records Society* 29 (Navy Records Society, 1905).
18. Leyte Gulf is a premier example. See Douglas MacArthur, "The Leyte Operation," in *Reports MacArthur: The Campaigns of MacArthur in the Pacific*, vol. 1 (US Government Printing Office, 1966); the contemporaneous tactical report by Richard W. Bates, *The Battle for Leyte Gulf, October 1944: Strategical and Tactical Analysis*, *Volume I: Preliminary Operations until 0719 October 17th, 1944 including Battle off Formosa* (US Naval War College, 1953).
19. Andrew F. Krepinevich, "Echoes of History," in *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers* (Yale University Press, 2023).
20. Robert G. Angevine, "Hiding in Plain Sight—The US Navy and Dispersed Operations under EMCON, 1956–1972," *Naval War College Review* 64, no. 2 (2011).
21. John F. Lehman, *Oceans Ventured: Winning the Cold War at Sea* (W. W. Norton, 2018); John B. Hattendorf and Ernest J. King, *The Evolution of the US Navy's Maritime Strategy: 1977–1986*, Newport Papers 19 (Naval War College, 2004).
22. Robin Higham and Frederick W. Kagan, eds., "The Soviet Cold War Navy," in *The Military History of the Soviet Union* (Palgrave Macmillan US, 2002), 237–58.
23. Angevine, "Hiding in Plain Sight."
24. Andrew Krepinevich, *Maritime Competition in a Mature Precision-Strike Regime* (Center for Strategic and Budgetary Assessments, 2014), 43.
25. Peter M. Swartz, *Understanding an Adversary's Strategic and Operational Calculus: A Late Cold Case Study with 21st Century* (Center for Naval Analyses, August 2013).

26. Lehman, *Oceans Ventured*.
27. Norman Friedman, *The Fifty-Year War: Conflict and Strategy in the Cold War* (Naval Institute Press, 2000), 343–67. For technical details, see also Owen Cote, *The Third Battle: Innovation in the US Navy's Silent Cold War Struggle with Soviet Submarines* (Naval War College Press, 2003).
28. Lehman, *Oceans Ventured*.
29. William E. Odom, *The Collapse of the Soviet Military* (Yale University Press, 1998).
30. Odom, *The Collapse of the Soviet Military*. For more detail on Soviet General staff perceptions in this period, see John G. Hines, Ellis M. Mishulovich, and John F. Shull, *Soviet Intentions 1965–1985, Volume II, Soviet Post-Cold War Testimonial Evidence* (BDM Federal, 1995).
31. Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Cornell University Press, 1999), 284–90; Chris Miller, *The Struggle to Save the Soviet Economy: Mikhail Gorbachev and the Collapse of the USSR* (University of North Carolina Press, 2016).
32. Stephen Kotkin, *Armageddon Averted: The Soviet Collapse, 1970–2000* (Oxford University Press, 2008).
33. Kenneth P. Ekman, "Applying Cost Imposition against China," *Strategic Studies Quarterly* 9, no. 1 (2015); David C. Gompert, Astrid Stuth Cevallos, and Cristina L. Garafola, *War with China: Thinking Through the Unthinkable*, Research Report, RR-1140-A (RAND, 2016); Bryan Clark, *The Emerging Era in Undersea Warfare* (Center for Strategic and Budgetary Assessments, January 22, 2015).
34. Evan Montgomery and Toshi Yoshihara, "Leaderless, Cut Off, and Alone: The Risks to Taiwan in the Wake of Ukraine," *Texas National Security Review*, April 5, 2022; David M. Moore, *The Strategic Outset: China's Cyber Campaign to Initiate an Invasion of Taiwan* (Squadron Officer School, May 21, 2021); Joel Wuthnow, Derek Grossman, Philip C. Saunders, Andrew Scobell, and Andrew N. D. Yang, eds., *Crossing the Strait: China's Military Prepares for War with Taiwan* (National Defense University Press, 2022), 10.
35. US Space Force, "Space Threat Fact Sheet" (Headquarters Space Force Intelligence), July 16, 2024.

36. Michael J. Sterling, *Soviet Reactions to NATO's Emerging Technologies for Deep Attack* (RAND, 1985); Larry A. Brisky, "The Reconnaissance Destruction Complex: A Soviet Operational Response to Airland Battle," *Journal of Soviet Military Studies* 3, no. 2 (1990): 296–306.
37. US Marine Corps, "History of Modernization," accessed November 15, 2024.
38. See Missile Threat, "Missiles of the United States," Center for Strategic and International Studies (CSIS), March 3, 2021.
39. Dazzling a satellite involves disrupting or degrading a satellite by shining a powerful laser at its optical sensors. This can temporarily or permanently render a satellite useless.
40. US Space Force, "Space Threat Fact Sheet" (July 16, 2024).
41. Raymond H. Milkman, "Operations Research in World War II," *Proceedings* (US Naval Institute) 94, no. 5 (1968); Joseph F. McCloskey, "British Operational Research in World War II," *Operations Research* 35, no. 3 (1987): 453–70.
42. Travis Sharp, Thomas G. Mahnken, and Tim Sadov, *Extending Deterrence by Detection: The Case for Integrating Unmanned Aircraft Systems into the Indo-Pacific Partnership for Maritime Domain Awareness* (Center for Strategic and Budgetary Assessments, 2023).
43. Commander A. P. Amila Prasanga, "The Strategic Impact of Military Drone Proliferation on Indo-Pacific Maritime Security," *Center for International Maritime Security* (blog), November 7, 2023.
44. Oren Liebermann, Jennifer Hansler, Haley Britzky, and Natasha Bertrand, "Russian Fighter Jet Forces Down US Drone over Black Sea," CNN, March 15, 2023; David Brennan, "US Global Hawk 'Eye in the Sky' Is Watching Ukraine's Counteroffensive," *Newsweek*, June 25, 2023; UAWire, "The US Sends Another Strategic Reconnaissance Drone to the Black Sea," March 28, 2023.
45. Igor Delanoë, "Russia's Black Sea Fleet in the 'Special Military Operation' in Ukraine," Foreign Policy Research Institute, February 2024.
46. There is already evidence of stress on the P-8 fleet. Gidget Fuentes, "3rd Fleet: Aircraft Intact as Navy Prepares to Investigate P-8 Poseidon Mishap in Hawaii," USNI News, November 22, 2023; Garry J. Schmitt and Giselle Donnelly, "The Navy's Decision to Stop Buying P-8 Poseidons Is a Mistake," *National Interest*, February 25, 2020.

47. Eric Heginbotham, *The US-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017* (RAND, 2015), 187–88.
48. The Littoral Combat Ship, *Arleigh Burke*–class destroyer, and future *Constellation*-class destroyer are not principally designed to operate as scouts. *Arleigh Burke* in particular performs crucial fleet air defense and antisubmarine functions. Similarly, the *Constellation*-class frigate and Littoral Combat Ship are both relatively lightly armed and would be vulnerable to Chinese missile attack if they pushed into China's RSC on scouting missions. See Louis Bearn and Nick Childs, "Navies Raise Their Air- and Missile-Defence Game," *IISS Military Balance* (blog), December 4, 2023.
49. Olli Pekka Suorsa and Adrian Ang U-Jin, "How China Integrates Drones into PLA Operations Surrounding Taiwan," *The Diplomat*, May 27, 2023; US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2023* (October 19, 2023), 64.
50. Elsa B. Kania, *The PLA's Unmanned Aerial Systems: New Capabilities for a "New Era" of Chinese Military Power* (China Aerospace Studies Institute, 2018); Ian Burns McCaslin, *Red Drones over Disputed Seas: A Field Guide to Chinese UAVs/UCAVs Operating in the Disputed East and South China Seas* (Project 2049 Institute, April 2018); Michael J. Dahm, *Special Mission Aircraft and Unmanned Systems* (Johns Hopkins Applied Physics Laboratory, October 2020); Stacie Pettyjohn, Hannah Dennis, and Molly Campbell, *Swarms over the Strait: Drone Warfare in a Future Fight to Defend Taiwan* (Center for a New American Security, June 20, 2024), 53.
51. These platform units include the medium-altitude MQ-9 Reaper and the high-altitude MQ-4/RQ-4 Triton/Global Hawk.
52. The Wing Loong II MALE UAV series serves as China's counterpart to the US MQ-9A Reaper, sharing similar dimensions (11 meters in length, 20-meter wingspan) and purposes. Although the Wing Loong II has certain performance limitations compared with the Reaper—lower top speed (370 kilometers per hour versus the Reaper's 444), shorter endurance (20 hours versus Reaper's 27 hours), and significantly reduced payload capacity (400 kilograms versus Reaper's

1,700)—it remains a capable platform for both reconnaissance and offensive strikes. Its most significant advantage lies in its cost: At $1–$2 million per unit compared with the Reaper's $25-plus million, it is a much more affordable technology. The Wing Loong II can carry light air-to-surface weapons for land attack, and, uniquely, the larger variant can deploy YJ-9E anti-ship missiles against small vessels. For more on the Wing Loong, see Tom Risen, "China Plays Catch-Up to U.S. Drones," *Aerospace America*, October 2017; J. Michael Dahm, *Special Mission Aircraft and Unmanned Systems* (Johns Hopkins Applied Physics Laboratory, 2020), 19–25.

53. The exact cost of Reaper is difficult to determine. According to the DOD, in FY 2019, a Reaper cost around $27 million per unit. In FY 2020, it cost around $33 million per unit. See Office of the Under Secretary of Defense, *Program Acquisition Cost by Weapons Systems* (US Department of Defense, February 2020), 1–6.
54. The WZ-7's range is far shorter than the Global Hawk's (7,000 km versus 23,000 km), but this limitation is less significant given that potential US-China conflicts would occur close to China's shores. For more on the BZK-005, see Kania, *PLA's Unmanned Aerial Systems*. For more on the WZ-7, see J. Michael Dahm, *Special Mission Aircraft and Unmanned Systems* (Johns Hopkins Applied Physics Laboratory, 2020), 19–25.
55. AeroVironment, *Puma AE RQ-20B Datasheet*, 2017.
56. Joseph Clark, "Defense Innovation Official Says Replicator Initiative Remains on Track," DOD News, January 26, 2024.
57. China's antisatellite program runs back to the early 2000s. Phillip C. Saunders and Charles D. Lutes, *China's ASAT Test: Motivations and Implications* (National Defense University Institute for National Strategic Studies, 2007).
58. Ukrainian data confirms this broader trend. David Hambling, "Jam-Resistant American Radio Keeps Ukraine's Long-Range Drones Flying," *Forbes*, April 17, 2024.
59. Jeffrey L. Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces* (US Army War College Press, 2018); Todd C. Lopez, "Artillerymen Must Be Ready to Operate in Space Degraded, Denied Environments, Spacecom

Leader Says," *DOD News*, September 2, 2021; Center for Army Lessons Learned, *Operating in a Denied, Degraded, and Disrupted Space Operational Environment Handbook: Lessons and Best Practices* (2018).

Chapter 3

1. China's stockpiles and production capacity of cruise missiles are not clear from open sources.
2. R. J. Overy, *The Air War: 1939–1945* (Potomac Books, 1980), 5–18; Stephen Lee McFarland, *America's Pursuit of Precision Bombing, 1910–1945* (Smithsonian Institution Press, 1995).
3. L. Johnman and H. Murphy, "'The First Fleet Victor Since Trafalgar': The Battle of Cape Matapan and Signals Intelligence, March 1941," *Mariner's Mirror* 91, no. 3 (2005): 436–53.
4. John M. Miller, *Crete and the Three Levels of War* (Individual Study Project, US Naval War College, May 2, 1989).
5. Robert S. Ehlers Jr., *The Mediterranean Air War: Airpower and Allied Victory in World War II* (University Press of Kansas, 2015).
6. Christopher Shores, Brian Cull, and Nicola Malizia, *Air War for Yugoslavia, Greece, and Crete 1940–41* (Grub Street, 1987).
7. Modern missiles have a significantly smaller circular error probable (CEP)—in plain English, significantly greater accuracy—than older weapons, principally by virtue of their improved guidance systems. Unlike in World War II and the Cold War, most weapons can hit within several meters, reducing the need for a very high yield warhead in a number of cases and theoretically reducing the number of weapons that must be fired at an individual target. Hitting a fixed target nevertheless remains significantly easier than hitting a moving target, a theme we will return to throughout this book. For a somewhat dated but still accessible technical discussion of missile accuracy, see Rafael Yanushevsky, *Modern Missile Guidance* (CRC Press, 2008).
8. For more detail on this history, see William H. Bartsch, *Doomed at the Start: American Pursuit Pilots in the Philippines, 1941–1942* (Texas A&M University Press, 1992); William H. Bartsch, *December 8, 1941: MacArthur's Pearl Harbor* (Texas A&M University Press, 2003).

9. Stacie Pettyjohn, Andrew Metrick, and Becca Wasser, "The Kadena Conundrum: Developing a Resilient Indo-Pacific Posture," *War on the Rocks*, December 1, 2022.
10. Pettyjohn, Metrick, and Wasser, "The Kadena Conumdrum."
11. Office of the Under Secretary of Defense (Comptroller), *Pacific Deterrence Initiative* (US Department of Defense, April 2022).
12. The 8:1 fighter to bomber ratio includes reserve squadrons and Air National Guard squadrons.
13. Curtis E. Lemay Center, *Air Force Doctrine Note 1-12*, August 23, 2022.
14. Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, *The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan* (Center for Strategic and International Studies, January 2023), 83.
15. Eric Tegler, "The Boeing-Kratos PJDAM Is a 300-Mile Smart Bomb," *Forbes*, October 25, 2023.
16. Robert Haddick, Mark Montgomery, and Ike Harris, "Sink China's Navy," in *The Boiling Moat*, ed. Matt Pottinger (Hoover Institution Press, 2024): 138–41.
17. China has missiles that have a longer range, but the targeting problem becomes more difficult at extended distances. Attrition on China's strike network will reduce this range.
18. US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2024* (December 18, 2024), 66.
19. Christopher Mihal, "Understanding the People's Liberation Army Rocket Force: Strategy, Armament, and Disposition," *Military Review*, Army University Press, September 2021; US Department of Defense, *Military and Security Developments: 2024*, 66.
20. ChinaPower, *How Are China's Land-based Conventional Missile Forces Evolving?* (Center for Strategic and International Studies [CSIS], September 21, 2020, updated May 12, 2021).
21. Center for Strategic and International Studies (CSIS) Missile Defense Project, "YJ 18," Missile Threat, updated April 23, 2024. For more on China's anti-ship capabilities, see US Department of Defense, *Military and Security Developments: 2024*, 64–65, 88.
22. James R. Holmes, "Defend the First Island Chain," *Proceedings* (US Naval Institute) 140, no. 4 (2014).

23. US Department of Defense, *Military and Security Developments: 2024*.
24. Missile Threat, "Hsiung Feng IIE," Center for Strategic and International Studies (CSIS), April 23, 2024.
25. Gabriel Collins and Andrew Erickson, *Annexation of Taiwan: A Defeat from Which the US and Its Allies Could Not Retreat* (Baker Institute for Policy, Rice University, July 2024), 89.
26. Office of the Historian, "The August 17, 1982 US-China Communiqué on Arms Sales to Taiwan," US Department of State, accessed July 3, 2024; Xinhua News Agency, "China, US Need to Uphold Principles Enshrined in 3 Communiques: Envoy," January 11, 2017.
27. Dzirhan Mahadzir, "Japan Signs Deal for 400 Tomahawk Land Attack Missiles," USNI News, January 28, 2024,
28. Kosuke Takahashi, "Japan Proposes Co-Production of SM-6 Missiles to the US," *Naval News*, March 4, 2025.
29. David E. Sanger, "Philippines Orders US to Leave Strategic Navy Base at Subic Bay," *New York Times*, December 28, 1991.
30. Rene Acosta, "US, Philippines Add Four More Sites to EDCA Military Basing Agreement," USNI News, February 2, 2023.
31. *Defense Post*, "Philippine Military Says Will Acquire US Typhon Missile System," December 23, 2024.
32. Center for Arms Control and Non-Proliferation, "Fact Sheet: Ballistic vs. Cruise Missiles" (April 2017).
33. Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945–1960* (US Air Force, Office of Air Force History, 1990), 7–33.
34. Markus Schiller, "Missile Identification and Assessment," International Institute for Strategic Studies (IISS), April 2022.
35. Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Air University Press, 1985).
36. William Freer, *The Hypersonic Threat to the United Kingdom* (Council on Geostrategy, January 25, 2024).
37. William Freer, *Britain's Hypersonic Challenge: Strategic Opportunities and Risks* (Council on Geostrategy, September 10, 2024).
38. There are also weapons technically classified as hypersonic that are non-HGV ballistic missiles, such as Russia's air-launched Kinzhal. However, hypersonic speeds impose obvious design constraints that

limit the performance of weapons like the Kinzhal and reduce the benefits of hypersonic capability.

39. Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress* (Congressional Research Service, August 14, 2024).
40. US Department of Defense, *Military and Security Developments: 2024*, 150.
41. US Department of Defense, *Military and Security Developments: 2024*, 89.
42. US Department of Defense, *Military and Security Developments: 2024*, 109.
43. US Department of Defense, *Military and Security Developments: 2024*, 109.
44. US Department of Defense, *Military and Security Developments: 2024*, 150.
45. See Stephen Losey, "US Air Forces Conducts Final Test of Lockheed's Hypersonic Missile," *Defense News*, March 29, 2024; RTX, "RTX Completes Technical Review for Prototype of US Navy's HALO Missile," January 9, 2024.
46. Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress* (Congressional Research Service, August 14, 2024), 5.
47. Justin Katz, "HALO: Navy Taps Lockheed, Raytheon to Start Developing Hypersonic Ship-Killing Weapon," *Breaking Defense*, March 29, 2023.
48. Sayler, *Hypersonic Weapons*, 7.
49. Ben Felton, "Hypersonic Attack Cruise Missile to Be Integrated on RAAF Super Hornets," *Australian Defence*, July 11, 2024.
50. John Hill, "Raytheon Expand Capacity to Build the Hypersonic Attack Cruise Missile," *Airforce Technology*, October 3, 2024.
51. Mikayla Easley, "AUKUS Partners Aim to Catch China in Hypersonics Race," *National Defense Magazine*, February 17, 2023.
52. Seth Cropsey, "Hypersonic Capabilities and Allies," RealClearDefense, April 18, 2023.
53. Guy Norris, "UK Unveils HVX Hypersonic Demonstrator Plan," *Aviation Week*, July 18, 2022.
54. Timothy Wright, "Accelerating the UK's High-Speed Missile Ambitions," International Institute of Strategy Studies (IISS), August 11, 2023.
55. Kim Minseok, "South Korea Unveils Hypersonic Cruise Missile Prototype Concept," *Aviation Week*, December 6, 2021.

56. Seong Hyeon Choi, "South Korea Brings Hypersonic Tech to the Aukus Table in a Sign Seoul Is Moving Closer to the US and Its Other Allies," *South China Morning Post* (*SCMP*), May 5, 2024.
57. Sayler, *Hypersonic Weapons*, 21.
58. Gordon Arthur, "Japan Reveals Test Launch of Its Hypersonic Strike Missile Program," *Defense News*, July 10, 2024.
59. Missile Threat, "JASSM/JASSM ER," Center for Strategic and International Studies (CSIS), April 23, 2024.
60. Naval Air Systems Command (NAVAIR), "Long Range Anti-Ship Missile (LRASM)," US Navy.
61. Chris Gordon, "Lockheed Martin Looks to Boost LRASM Production as US Rushes to Buy Anti-Ship Weapons," *Air & Space Forces Magazine*, April 4, 2023.
62. HIMARS is a lightweight, highly mobile rocket launcher mounted on a standard army medium tactical vehicle truck. It can launch multiple precision-guided rockets and missiles with a range of up to 300 kilometers (186 miles). Each HIMARS unit costs approximately $5 million, and they have been highly effective on the battlefield in Ukraine. See Ben Felton, "Lockheed Pitches LRASM Touting HIMARS to Australia," *Naval News*, October 4, 2022.
63. See, for example, David Axe, "To Hide Their Rocket Launchers from the Chinese, US Marines Could Print Instant Bunkers," *Forbes*, August 21, 2020.
64. Micah McCartney, "China's Neighbor Receives HIMARS Boost from US Amid Invasion Threat," *Newsweek,* November 4, 2024; *Defense Post*, "Taiwan Receives First Batch of ATACMS Missiles from US," November 15, 2024.
65. Leo Chiu, "A Quick Guide to the Storm Shadow Missiles in Ukraine," *Kyiv Post*, December 21, 2023.
66. A low-observable non-hypersonic cruise missile costs between $1 million and $3 million, while a hypersonic weapon, depending on design characteristics and production lines, costs between $10 million and $40 million.
67. Cancian, Cancian, and Heginbotham, *First Battle*.
68. Aaron-Matthew Lariosa, "US Navy Looks to Drastically Increase Missile Production," *Naval News*, April 5, 2023.

69. Joseph Trevithick, "Army Fires Tomahawk Missiles from Its New Typhon Batter IN Major Milestone," *The War Zone* (*TWZ*), July 3, 2023.
70. US Navy, "SLAM-ER Missile," September 27, 2021.
71. Army Recognition, "Contract Awards for Boeing to Produce 650 SLAM-ER Missiles for Saudi Arabia," May 14, 2020.
72. Zuzanna Gwadera, "Poland to Acquire Several Hundred Naval Strike Missiles," Missile Dialogue Initiative, September 27, 2023.
73. Tim Martin, "Weapons Tracing Shows Russia Firing New Cruise Missiles at Ukraine Just Weeks After Production," *Breaking Defense*, May 10, 2023.
74. US Department of Defense, *Military and Security Developments: 2024*.
75. US Department of Defense, *Military and Security Developments: 2024*.
76. Jeffrey Lewis, David Joël Boon, and Decker Eveleth, "China's Growing Missile Arsenal and the Risk of a 'Taiwan Missile Crisis,'" Nuclear Threat Initiative, November 18, 2020.
77. Carter Johnston, "US Navy Confirms SM-6 Air Launched Configuration Is 'Operationally Deployed,'" *Naval News*, July 5, 2024.
78. In this respect, the AIM-174B effectively resurrects the long-range air-to-air combat capability once provided by the AIM-54 Phoenix missile, which was retired along with the F-14 Tomcat. See Ian Easton, "CMSI Note #12: Finally, a PLA Navy Missile Gap?," US Naval War College, China Maritime Studies Institute, February 20, 2025.
79. Carter Johnston, "New US Navy Hypersonic Missile Design Unveiled At SNA 2025," *Naval News*, January 24, 2025.
80. Edward Lundquist, "Neighborhood Problems in the Taiwan Strait," Institute for National Defense and Security Research, April 1, 2019.
81. Colin Clark, "Australia Announces $7B for SM-2, SM-6 Missiles in Huge Munitions Purchase," Breaking Defense, October 21, 2024.
82. Lawrence "Sid" Trevethan, "The PLA Rocket Force's Conventional Missiles," US Naval Institute, April 1, 2023.
83. Joshua Arostegui, *China Maritime Report #32: The PCH191 Modular Long-Range Rocket Launcher: Reshaping the PLA Army's Role in a Cross-Strait Campaign* (Naval War College China Maritime Studies Institute, November 2023).
84. Lyle Goldstein and Nathan Waechter, "Chinese Strategists Evaluate the Use of 'Kamikaze' Drones in the Russia-Ukraine War," RAND, November 7, 2023.

85. Sarah Wheaton, "Ukraine Downs Hypersonic Russian Missile Using Patriot Defense System," *Politico*, May 6, 2023.
86. Of course, there are operational differences between these situations and the air campaign that the PLA might wage in the Indo-Pacific. Differences include Ukraine's size, its need to defend fixed civilian infrastructure, and Russia's pervasive difficulties with battle damage assessment. Ukraine is much larger than Taiwan, creating both gaps in its defense network and areas it can leave unprotected to maximize resources. Ukraine also has an extremely centralized power generation system, creating natural air defense concentration around certain areas. Moreover, Russia struggles to assess the damage its attacks cause and then integrate that information into future targeting plans. Nevertheless, the basic concept of long-term aerial bombardment with missiles and drones matches China's pattern of procurement choices.
87. Associated Press, "Israel Says 99% of Drones and Missiles Launched by Iran Were Intercepted," AP News, April 14, 2024.
88. Associated Press, "Iran Fires at Least 180 Missiles into Israel as Region-wide Conflict Grows," AP News, October 1, 2024.
89. Harry Halem and Eyck Freymann, "Ukraine Shows Why Taiwan Needs More Air Defense," *War on the Rocks*, April 7, 2022.
90. Halem and Freymann, "Ukraine Shows."
91. Elisabeth Gosselin-Malo, "Norway to Develop New NASAMS Radar with Raytheon and Kongsberg," *Defense News*, October 23, 2024.
92. Northrop Grumman, "Northrop Grumman and Diehl Defence to Collaborate on Integrated Air and Missile Defense Capabilities," March 12, 2024.
93. New Voice of Ukraine, "Germany Pushes USA to Supply Ukraine with Additional Patriot Air Defense Systems," April 23, 2024.
94. Halem and Freymann, "Ukraine Shows."
95. Halem and Freymann, "Ukraine Shows."

Chapter 4

1. John J. Mearsheimer, "Assessing the Conventional Balance: The 3:1 Rule and Its Critics," *International Security* 13, no. 4 (1989): 54–89.

2. Eliot A. Cohen, "Toward Better Net Assessment: Rethinking the European Conventional Balance," *International Security* 13, no. 1 (1988): 50–89.
3. Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars* (Cornell University Press, 1984).
4. The US Naval Institute's *Proceedings* has published a series of pieces on a near-future US-China War, covering issues from space operations to logistics. All pieces point to the necessity of fighting in the Philippine Sea, even if US strategy demands combat elsewhere. See Scott Tait and Anthony LaVopa, "It All Comes Down to Sea Control," *Proceedings* 149, no. 12 (2023); Paul Giarra, Bill Hamblet, and Gerard Roncolato, "War in 2026: Phase III Scenario," *Proceedings* 49, no. 12 (2023).
5. John J. Mearsheimer, *The Tragedy of Great Power Politics* (W. W. Norton, 2001), 26–43.
6. Salvatore Mercogliano, "Logistics Wins (and Loses) Wars," *Proceedings* (US Naval Institute) 150, no. 2 (2024).
7. Paul Doell, "The Ready Reserve Force Is in Urgent Need of Funding," *Maritime Executive*, July 10, 2017.
8. Iskander Rehman, *Planning for Protraction: A Historically Informed Approach to Great-Power War and Sino-US Competition* (International Institute for Strategic Studies, 2023).
9. Eliot Cohen and Phillips O'Brien, "Russia-Ukraine War: A Study in Analytic Failure," Center for Strategic and International Studies (CSIS), September 24, 2024.
10. Timothy Nenninger, "American Military Effectiveness in the First World War," in *Military Effectiveness*, vol. 1, *The First World War*, ed. Allan R. Millett and Williamson Murray (Cambridge University Press, 2010), 116–56.
11. Allan R. Millett and Williamson Murray, eds., *Military Effectiveness*, vol. 3, *The Second World War* (Cambridge University Press), 45–89.
12. T. R. Fehrenbach, *This Kind of War: The Classic Korean Way History* (Brassey's, 1963), 108–50.
13. Jon Michael King, "The Vietnam War: A Case Study for Strategic Sealift in Large-Scale Conflict" (master's thesis, US Army Command and General Staff College, 2020).

14. During the Gulf War, the RRF struggled to meet demands. Although the "iron mountain" of supplies was eventually moved into theater, US and allied logistics lines enjoyed uncontested sea lanes, an abundance of time, and sheer volume. Operations were not efficient and significant quantities of material were lost in the process. Subsequent reforms such as the Maritime Security Program (MSP) and the establishment of pre-positioned stocks, notably at Diego Garcia, aimed to remedy these problems in future operations, but they were undermined by cost-cutting measures in the 1990s (Stephen Carmel, interview with the author, November 18, 2024). For a critical analysis of Gulf War logistics, see James K. Matthews and Cora J. Holt, *So Many, So Much, So Far, So Fast: The Logistics of Operation Desert Shield/Desert Storm* (US Army Center of Military History, 1996). See also William Pagonis and Michael Krause, *Operational Logistics and the Gulf War*, Land Warfare Papers (Institute of Land Warfare, Association of the United States Army, October 1992).
15. Caspian Policy Center, "Kazakhstan Grants the US Access to Ports for Afghanistan," March 9, 2018; CNN, "Pakistan Reopens NATO Supply Routes to Afghanistan," last modified July 3, 2012.
16. Logistics were also crucial during initial combat operations. See "Logistics Goes to War," *Army Logistician* 35, no. 4 (2003).
17. US Department of Defense, "Statement from Secretary of Defense Lloyd J. Austin III on Ensuring Freedom of Navigation in the Red Sea," December 18, 2023.
18. Louis Morton, "War Plan Orange: Evolution of a Strategy," *World Politics* 11, no. 2 (1959): 221–50.
19. Henry G. Gole, "War Planning at the US Army War College, 1934–40: The Road to Rainbow," *Army History*, no. 25 (1993): 13–28.
20. Kali Martin, "Solely a Bluff: Relocating the US Fleet to Pearl Harbor," National WWII Museum, October 20, 2021.
21. Vice Admiral Homer Wallin, *Pearl Harbor: Why, How, Fleet Salvage and Final Appraisal* (Naval History Division, 1968), 29.
22. Roberta Wohlstetter, "Signals and Honolulu" and "Noise in Honolulu" in *Pearl Harbor: Warning and Decision*, (Stanford University Press, 1962), 5–70, 71–169.

23. Richard Leighton and Robert Coakley, *United States Army in World War II: Global Logistics and Strategy 1940–1943 (*Center of Military History, US Army, 1955), 162.
24. Leighton and Coakley, *United States Army in World War II: 1940–1943*, 125, 174.
25. Alan Gropman, *The Big L: American Logistics in World War II* (National Defense University Press, 1997), 306.
26. Leighton and Coakley, *United States Army in World War II: 1940–1943*, 177.
27. Leighton and Coakley, *United States Army in World War II: 1940–1943*, 179–185.
28. Leighton and Coakley, *United States Army in World War II: Global Logistics and Strategy 1943–1945* (Center of Military History, US Army, 1955), 404.
29. Leighton and Coakley, *United States Army in World War II: 1940–1943*, 411.
30. War Department General Staff, *Logistics in World War II: Final Report of the Army Service Forces. A Report to Under Secretary of War and the Chief of Staff, by the Director of the Service, Supply, and Procurement Division* (Washington, DC: US Print Office, 1950), 49.
31. Leighton and Coakley, *United States Army in World War II: 1940–1943*, 397.
32. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 402.
33. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 479.
34. Ashley Veasey, "Liberty Shipyards: The Role of Savannah and Brunswick in the Allied Victory, 1941–1945," *Georgia Historical Quarterly*, 93, no. 2 (2009).
35. Roland W. Charles, *Troopships of World War II* (Army Transportation Association, April 1947); Peter C. Luebke, Timothy L. Francis, and Heather M. Haley, *Contested Logistics: Sustaining the Pacific War* (Naval History and Heritage Command, 2023).
36. NavSource Online, "USS AFDB-1," Service Ship Photo Archive, May 19, 1956.

37. Lara Godbille, "The Seabee Legacy," *Military Engineer* 109, no. 707 (2017): 72–74.
38. Meanwhile, the United States used mines and submarine warfare to attack Japan's logistical chains. However, using similar tactics against China today would be highly problematic and almost certainly ill-advised, since they would have a devastating effect on neutral countries' trade and could push many Asian countries into China's arms.
39. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 190.
40. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 658.
41. Millett and Murray, eds., *Military Effectiveness*, vol. 3, 63.
42. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 403.
43. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 405.
44. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 408.
45. Leighton and Coakley, *United States Army in World War II: 1943–1945*, 815.
46. Kiona N. Smith, "After D-Day, These Floating Harbors Helped Win WWII," *Forbes*, June 6, 2021; Ryan Hilger, "Service Squadron Ten and the Great Western Base," Center for International Maritime Security, April 15, 2021.
47. Michael Coles, "Ernest King and the British Pacific Fleet: The Conference at Quebec, 1944 ('Octagon')," *Journal of Military History* 65, no. 1 (January 2001).
48. Association of the United States Army, "Guam Defense Critical Amid 'Massive Threats,'" August 1, 2024; Clara Fong and Diana Roy, "Guam's Strategic Importance in the Indo-Pacific," Council on Foreign Relations, September 9, 2024; Unshin Lee Harpley, "How to Save Guam from Chinese Missiles with Layered Defense and Local Control," *Air & Space Forces Magazine*, August 1, 2024.
49. Dmitry Filipoff, *Distributed Maritime Operations: Solving What Problems and Seizing Which Opportunities?* (Atlantic Council, July 1, 2024).
50. Curtis E. Lemay Center, *Air Force Doctrine Note 1-12*, August 23, 2022.

51. US Marine Corps, *Tentative Manual for Expeditionary Advanced Base Operations*, 2nd ed. (US Department of the Navy, May 2023).
52. Air Mobility Command Public Affairs, "Civil Reserve Air Fleet," US Air Force, July 2014.
53. Kris Osborn, "Chinese YU-20 Tanker Refuels Carrier-Based J-15, Massively Increases Pacific Threat," *Warrior Maven*, August 7, 2023.
54. Major Paul Gucwa, "Increased Aerial Refueling Compatibility Facilitates True Joint Environment," US Navy, October 3, 2022.
55. Military Sealift Command, "History and Heritage," US Navy, accessed November 15, 2024.
56. Military Sealift Command, "Ship Inventory," US Navy, accessed November 15, 2024.
57. Sam LaGrone, "Navy Could Sideline 17 Support Ships Due to Manpower Issues," USNI News, August 22, 2024.
58. LaGrone, "Navy Could Sideline."
59. John McCown, "What to Watch 2023: America Must Begin Growing Its Merchant Marine," Center for Maritime Strategy, January 10, 2023.
60. US Maritime Administration, "National Defense Reserve Fleet," US Department of Transportation, last updated March 28, 2025.
61. Seth Cropsey and Harry Halem, *A Strategic Concept for the Merchant Marine* (Yorktown Institute, May 2024).
62. For aging ships—particularly steam-powered RRF ships—finding spare parts can be a challenge, as is finding people who know how to operate and maintain the equipment. See Megan Eckstein, "Lack of Funds Hampers Emergency Naval Fleet from Growing Faster," *Defense News*, April 6, 2023.
63. John Grady, "MARAD Head 'Not at All Confident' Ready Reserve Fleet Could Be Crewed in a Crisis," USNI News, March 29, 2023.
64. The US Merchant Marine is divided into distinct segments—Jones Act versus non–Jones Act and Section 2 owners versus non–Section 2 owners—that often compete, highlighting the absence of a cohesive maritime strategy or a central executive authority to align these differences for the national interest. Jones Act ships, which must be US built, are approximately four or five times more expensive to construct and take significantly longer to produce compared with foreign-built vessels, leading to an aging fleet in poor condition, as exemplified by the

tragic sinking of the *El Faro* off Jacksonville, Florida, in 2015. These failures underscore why the United States needs a comprehensive maritime policy. See National Transportation Safety Board, "Sinking of the US Cargo Vessel *El Faro*," accessed November 18, 2024.

65. Cropsey and Halem, *Strategic Concept*.
66. Bureau of Transportation Statistics, "Number and Size of US-Flag Merchant Fleet and Its Share of World Fleet," US Department of Transportation.
67. Isaac B. Kardon and Wendy Leutert, "Pier Competitor: China's Power Position in Global Ports," *International Security* 46, no. 4 (2022): 9–47.
68. See discussion in Eyck Freymann, *One Belt One Road: Chinese Power Meets the World* (Harvard Asia Center Press, 2021). For a more recent discussion of related technical issues, see Grady McGregor, "China's Crane Reign," The Wire China, March 26, 2023; Victoria Bela, "China Stakes Global Dominance in Race to Build Intelligent Ports," *South China Morning Post*, January 30, 2024; Daniel F. Runde, Austin Hardman, and Clara Bonin, *Responding to China's Growing Influence in Ports of the Global South*, Center for Strategic and International Studies (CSIS), October 30, 2024; Mark E. Green, John Moolenaar, and Carlos A. Gimenez, *Handling Our Cargo: How the People's Republic of China Invests Strategically in the US Maritime Industry* (Select Committee on the CCP, Majority Staff Report, September 2024).
69. US Maritime Administration, "Voluntary Intermodal Sealift Agreement (VISA)," last updated October 20, 2020.
70. Cropsey and Halem, *Strategic Concept*.
71. "Stockpiling of Defense Articles for Foreign Countries," US Code 22 (2024), § 2321h.
72. For more on the need to harden air bases in the Indo-Pacific, see Timothy Walton and Thomas Shugart, *Concrete Sky: Air Base Hardening in the Western Pacific* (Hudson Institute, 2025).
73. US Department of Defense, *Pacific Deterrence Initiative* (March 2023).
74. US Department of Defense, *European Deterrence Initiative* (March 2024).
75. Congressional Research Service, "The European Deterrence Initiative: A Budgetary Overview," (CRS Reports, July 1, 2021).

76. First employed to fund the Iraq and Afghanistan wars, the OCO mechanism allowed Congress to appropriate cash for specific operations while avoiding interservice bureaucratic fights in the DOD. The Biden administration eliminated OCO given accusations that it discouraged funding transparency. The result for EDI has been a funding drop from $6.5 billion in FY 2019 to $3.6 billion in FY 2024 to $2.9 billion in FY 2025. See Congressional Research Service, "The European Deterrence Initiative: A Budgetary Overview," updated June 16, 2020; Congressional Research Service, "FY2022 NDAA: Overseas Contingency Operations," January 14, 2022; US Department of Defense, *European Deterrence Initiative: Department of Defense Budget Fiscal Year (FY) 2024* (March 2023); US Department of Defense, *European Deterrence Initiative FY2025 Budget Request*, March 2024.
77. Noah Robertson, "Pacific Problems: Why the US Disagrees on the Cost of Deterring China," *Defense News*, April 3, 2024.
78. For FY 2025, the PDI budget request is $9.9 billion, targeting investments to enhance US force posture, infrastructure, presence, and readiness and the capabilities of allies in the Indo-Pacific. Key areas of investment include military construction, logistical support improvements, and resilience enhancements to communication networks. The PDI also funds ballistic missile defense activities, contributing to the development and integration of a Joint Missile Defense System (MDS) to protect Guam against ballistic, hypersonic, and cruise missile threats. This builds on prior years' allocations, which included $4.1 billion in FY 2022 and $6.5 billion in FY 2023 for presence and posture, alongside other critical categories such as logistics, training, ally defense capabilities, and infrastructure improvements.
79. Shawn Harding, "There and Back, and There Again: US Military Bases in the Philippines," *Proceedings* (US Naval Institute) 150, no. 5 (2024).
80. Michael Pietrucha, "Making Places, Not Bases a Reality," *Proceedings* (US Naval Institute) 141, no. 10 (October 2015).
81. US Navy, "Expeditionary Sea Base (ESB)," updated March 21, 2025.
82. Military Sealift Command, "Offshore Petroleum Distribution System (OPDS)," US Navy, accessed November 15, 2024.
83. Military Sealift Command, "Maritime Prepositioning Force," US Navy, accessed November 15, 2024.

84. LaGrone, "Navy Could Sideline."
85. Thomas Newdick, "New Dutch Navy Support Vessels Will Be Missile-Toting Wingmen to Frigates," *The War Zone* (*TWZ*), September 25, 2024.
86. Ministerie van Defensie, "Nieuwe Vaartuigen Met Wapens en Apparatuur Bieden Betere Bescherming" [New vessels with weapons and equipment offer better protection], September 24, 2024.
87. Robert D. Blackwill and Philip Zelikow, *The United States, China, and Taiwan: A Strategy to Prevent War* (Council on Foreign Relations, 2021), 35–37.
88. Richard L Kilpatrick Jr., "Revisiting the Five Powers War Risk Exclusion," National University of Singapore Centre for Maritime Law Working Paper 24/01, January 2024.
89. Xinhua News Agency, "李秉宣 [Li Bingxuan] and 韩学扬 [Han Xueyang], 东部战区接续开展联合演训组织联合封控和联合保障行动" [The eastern theater conducts successive joint exercises to organize joint blockade and control and joint support operations], 新华社, August 9, 2022, quoted in Lonnie D. Henley, *China Maritime Report No. 26: Beyond the First Battle: Overcoming a Protracted Blockade of Taiwan* (China Maritime Studies Institute, March 2023).
90. Bridget Diakun, "China's Military Drills Force over 200 Vessels to Reroute," *Lloyd's List*, August 4, 2022.
91. Diakun, "China's Military Drills."
92. Kathrin Hille and Demetri Sevastopulo, "China Is Ratcheting Up Pressure on Taiwan: What Will the US Do Next?," *Financial Times*, August 6, 2022.
93. Brian Spegele and Joyu Wang, "Chinese Military Launches Drills Encircling Taiwan in Test of New President," *Wall Street Journal*, May 23, 2024.
94. Cong. Rec. S10972–S10978 (daily ed. September 19, 1996), cited in Christopher J. McMahon, "The US Merchant Marine: Back to the Future?," *Naval War College Review* 69, no. 1 (2016): 86–108.
95. Ministry of the Interior National Immigration Agency, "Statistics," Republic of China (Taiwan), accessed October 23, 2023.
96. Zack Cooper and Connor Fiddler, "Important Asia Provisions in the House and Senate 2024 NDAA," American Enterprise Institute, August 11, 2023.

97. Jeffrey W. Hornung, "Taiwan and Six Potential New Year's Resolutions for the US-Japanese Alliance," *War on the Rocks*, January 5, 2022.
98. Daniel L. Haulman, "Vietnam Evacuation: Operation Frequent Wind," in *Short of War: Major Air Force Contingency Operations. Air Force History and Museum Publication*, ed. Edward A. Warnock (Air University Press, 1983), 83–93.
99. Nicole Gaouette, Jennifer Hansler, Barbara Starr, and Oren Liebermann, "The Last U.S. Military Planes Have Left Afghanistan, Marking the End of the United States' Longest War," CNN, August 31, 2021.
100. Michael Crowley, "US Warns Americans Abroad Not to Count on a Rescue," *New York Times*, February 16, 2022.
101. LaGrone, "Navy Could Sideline."

Chapter 5

1. Megan Eckstein, "Navy's 2024 Plan Backs Long-Range Weapons, Shrinks Amphibious Fleet," *Defense News*, March 13, 2023.
2. Clayton Swope, "No Place to Hide: A Look at China's Geosynchronous Surveillance Capabilities," Center for Strategic and International Studies (CSIS), January 19, 2024.
3. Chloe Hoorman and Elise Vincent, "Ukrainian Naval Drone Attacks Force Russian Fleet Out of Crimea," *Le Monde*, July 22, 2024.
4. Ronald O'Rourke, *Defense Primer: Navy Distributed Maritime Operations (DMO) Concept* (Congressional Research Service, October 2, 2024).
5. Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress* (Congressional Research Service, September 29, 2023), 5; Defense Advanced Research Projects Agency, "Long-Range Anti-Ship Missile (LRASM)," accessed October 18, 2024.
6. Matthew Allen, "The Deployment of Untried Technology: British Naval Tactics in the Ironclad Era," *War in History* 15, no. 3 (2008): 269–93.
7. Stanley Sandler, "The Emergence of the Modern Capital Ship," *Technology and Culture* 11, no. 4 (1970): 576–95.

8. Arthur Burke, *Torpedoes and Their Impact on Naval Warfare* (Naval Undersea Warfare Center Division, Defense Technical Information Center, 2017).
9. John Dotson, "The *Jeune École* Offers Lessons for a New Contested Maritime Environment," US Naval Institute, August 2024.
10. Hugues Canuel, "From a Prestige Fleet to the *Jeune École*: French Naval Policy and Strategy under the Second Empire and the Early Third Republic (1852–1914)," *Naval War College Review* 71, no. 1 (2018): 93–118.
11. Frank Hoffman, "What We Can Learn from Jackie Fisher," *Proceedings* (US Naval Institute) 130, no. 4 (2004); Rindert Zinderen Bakker, "The Development of the Destroyer" in *Warship 6: Destroyer HMCS Haida* (Amsterdam University Press, 2016), 12–13.
12. Robert K. Massie, in *Dreadnought: Britain, Germany, and the Coming of the Great War* (Random House, 1991), provides a comprehensive account of the political and strategic context of the dreadnought revolution. For critical analysis of the financial and technological foundations of British naval policy, see Jon Tetsuro Sumida, *In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy, 1889–1914* (London: Unwin Hyman, 1989). Nicholas Lambert, in *Sir John Fisher's Naval Revolution* (Columbia: University of South Carolina Press, 1999), revises our understanding of the strategic thinking behind the dreadnought program, while Norman Friedman, in *Fighting the Great War at Sea: Strategy, Tactics and Technology* (Annapolis: Naval Institute Press, 2014), 39–65, details how naval powers adapted their existing fleets to the new technology.
13. Thomas C. Hone, "Replacing Battleships with Aircraft Carriers in the Pacific in World War II," *Naval War College Review* 66, no. 1 (2013): Article 6.
14. Alan Stephens, ed., *The War in the Air 1914–1994* (Tuggeranong, Australian Capital Territory: Air Power Development Centre, 2009), 1–18.
15. Geoffrey Till, "Adopting the Aircraft Carrier: The British, American, and Japanese Cases," in *Military Innovation in the Interwar Period*, ed. C. Williamson Murray and Allan R. Millett (Cambridge University Press, August 13, 1998), 191–226.

16. Wayne P. Hughes, *Fleet Tactics*, 3rd ed. (Naval Institute Press, 2018), 90.
17. See Samuel Eliot Morison, *The Struggle for Guadalcanal: August 1942–February 1943*, vol. 5 (Little, Brown, 1949).
18. Missile Threat, "DF-21 (CSS-5)," Center for Strategic and International Studies (CSIS), April 23, 2024; Peter Suciu, "China's Carrier Killers: How DF-21D and DF-26B Missiles Threaten the US Navy," *National Interest*, September 21, 2024.
19. Ronald O'Rourke, *China Naval Modernization: Implications for US. Navy Capabilities—Background and Issues for Congress* (Congressional Research Service, August 16, 2024).
20. Missile Threat, "Missiles of China," Center for Strategic and International Studies (CSIS), April 12, 2021.
21. Henk Warnar, "Ukraine and Russia in the Black Sea: A Naval War of Mutual Denial," *Atlantisch Perspectief* 47, no. 4 (2023): 12–16.
22. Justin Bronk and Jack Watling, *Mass Precision Strike: Designing UAV Complexes for Land Forces* (Royal United Services Institute [RUSI]), April 11, 2024.
23. There is some debate as to whether these weapons—like the Shahed 136/Geran 2 Iranian-Russian munition—should be termed "loitering munitions" or "low-cost cruise missiles." Strictly speaking, a cruise missile is any weapon, distinct from a suicide aircraft like a Kamikaze, that uses traditional aerodynamic lift during most of its flight. The Shahed 136 certainly fits that definition. Nevertheless, we call them "loitering munitions" to help distinguish cheap and slow weapons that have limited payloads and cannot attack moving targets from traditional cruise missiles, which are significantly more capable.
24. H. I. Sutton, "Uncrewed Platforms Have Been Critical to Ukraine's Success in the Black Sea," Royal United Services Institute (RUSI), August 20, 2024.
25. Sutton, "Uncrewed Platforms"; Stacie Pettyjohn and Hannah Dennis, "The Pentagon Isn't Buying Enough Ammo," *Foreign Policy*, May 21, 2024; Tyler Rogoway, "Navy Just Reloaded a Vertical Launch System for the First Time While Underway at Sea," *The War Zone* (*TWZ*), October 12, 2024.
26. Gidget Fuentes, "Navy Conducts First Successful Tests Reloading Missiles and Rearming Warships at Sea," USNI News, October 15, 2024.

27. Thomas Hone, Douglas Smith, and Roger Easton, "The Politics of Developing the Aegis Combat System: Pt. 1," Center for International Maritime Security (CIMSEC), April 24, 2023.
28. Todd South, "New Navy Contracts Boost Battle Command, Electronic Warfare Potential," *Army Times*, September 17, 2024.
29. Patrick Tucker, "Navy Still Bullish on Lasers but Widely-Deployed Directed-Energy Ship Defense Remains Years Away," *Defense One*, August 8, 2024.
30. Stew Magnuson, "Directed Energy Weapons: Here Now? Or 5 Years Off?," *National Defense Magazine*, February 29, 2024.
31. Naval Technology, "Railgun Potentially Cancelled: What Went Wrong for the US Superweapon?," December 5, 2017.
32. Dale C Rielage, "An Open Letter to the US Navy from Red," *Proceedings* (US Naval Institute) 143, no. 6 (2017).
33. O'Rourke, *Defense Primer*.
34. O'Rourke, *Defense Primer*.
35. Richard O'Rourke, *Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress* (Congressional Research Service, August 6, 2017).
36. *Naval Technology*, "Ghost Fleet Overlord Unmanned Surface Vessels, USA," March 23, 2023.
37. O'Rourke, *Navy Large Unmanned Surface and Undersea Vehicles*, 10.
38. Dylan Malyasov, "US Navy Receives New GARC Drone Boats," *Defense Blog*, February 10, 2024.
39. O'Rourke, *Navy Large Unmanned Surface and Undersea Vehicles*, 6.
40. O'Rourke, *Navy Large Unmanned Surface and Undersea Vehicles*, 12.
41. O'Rourke, *Navy Large Unmanned Surface and Undersea Vehicles*, 2.
42. US Department of Defense, "Contracts for March 27, 2019, Navy"; US Government Accountability Office, "Extra Large Unmanned Undersea Vehicle: Navy Needs to Employ Better Management Practices to Ensure Swift Delivery to the Fleet," September 2022.
43. Sam LaGrone, "GAO: Navy's XLUUV Undersea Minelayer $242M Over Budget, 3 Years Behind Schedule," USNI News, September 28, 2022.
44. Kris Osborn, "MADL: How F-35s Talk to Each Other Is a Clear Game Changer," *National Interest*, September 8, 2021.

45. Rob Wittman, "The Nation Needs a Real Plan to Grow the Navy," *Proceedings* (US Naval Institute) 148, no. 3 (2022); Matthew Olay, "CNO: Investing in Industrial Base, Growing the Fleet Are Top Priorities," US Department of Defense, April 8, 2024; Jeremy Greenwood and Emily Miletello, "To Expand the Navy Isn't Enough: We Need a Bigger Commercial Fleet," Brookings Institution, November 4, 2021.
46. Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress* (Congressional Research Service, September 24, 2024), 2.
47. O'Rourke, *Navy Force Structure and Shipbuilding Plans*.
48. Alexander Palmer, Henry Carroll, and Nicholas Velazquez, "Unpacking China's Naval Buildup," Center for Strategic and International Studies (CSIS), June 5, 2024.
49. Sam LaGrone, "Pentagon: Chinese Navy to Expand to 400 Ships by 2025, Growth Focused on Surface Combatants," USNI News, November 29, 2022.
50. Seth Jones, "China Is Ready for War; America Is Not," *Foreign Affairs*, October 2, 2024.
51. Gidget Fuentes, "USS *John McCain* Back to Operations Almost 3 Years After Fatal Collision," USNI News, June 16, 2020.
52. Ronald O'Rourke, *Navy Constellation (FFG-62) Class Frigate Program: Background and Issues for Congress* (Congressional Research Service, August 5, 2024).
53. Mallory Shelbourne and Sam LaGrone, "Constellation Frigate Unplanned Weight Growth Could Limit Service Life, Says GAO," USNI News, May 29, 2024.
54. Colin Grabow, "US Maritime Policy Needs an Overhaul," *War on the Rocks*, September 6, 2024.
55. Alexander Wooley, "Float, Move, and Fight: How the US Navy Lost the Shipbuilding Race," *Foreign Policy*, October 10, 2021.
56. Andrea Magi, "The Role of Aircraft Carriers in a Contested Age," Joint Air Power Competence Centre, July 2022.
57. S. J. Paparo, "Aircraft Carriers: Still Indispensable," *Proceedings* (US Naval Institute) 150, no. 7 (2024).
58. US Navy, "Two U.S. Navy Carriers Join Japan Destroyer on Multi-Large Deck Event in Philippines," November 7, 2023; Askia Collins,

"Republic of Korea, US Navies Conclude Carrier Strike Group Exercise," Commander, US 7th Fleet, June 4, 2022; Jordan Brown, "USS *Ronald Reagan* Carrier Strike Group Joins Royal Australian Navy for Sea, Air and Intelligence Integration during Talisman Sabre 23," US Pacific Fleet, August 3, 2023.

59. Sean Monaghan, Eskil Jacobsen, Sissy Martinez, et al., "Is NATO Ready for War?," Center for Strategic and International Studies (CSIS), June 11, 2024.
60. NATO, "Exercise Northern Viking Strengthens NATO's Strategic Posture in the North Atlantic," September 3, 2024.
61. Richard Hooker, *A Security Strategy for the Black Sea* (Atlantic Council Task Force on Black Sea Security, December 15, 2023).
62. Craig Hooper, "In a Russia-Ukraine Peace, Montreux Convention Will Stress NATO Black Sea Peacekeepers," *Forbes*, July 3, 2023.
63. US Navy, "IKE Carrier Strike Group Arrives in Middle East Region," November 4, 2023.
64. Ben Ho and Wendy He, "HMS *Queen Elizabeth*'s Indo-Pacific Deployment," *Proceedings* (US Naval Institute) 147, no. 3 (2021). The *Charles De Gaulle* is essentially a miniature US-style carrier, but its significantly smaller size at 42,000 tons limits its air wing. The *Queen Elizabeth*–class carriers are both jump-jet ships, necessitating that they use only aircraft capable of landing vertically, thereby restricting the air wing's size, composition, and diversity.
65. Huntington Ingalls is the only prime capable of creating supercarriers, and it receives most carrier maintenance contracts because of its specialized yards and equipment.
66. Congressional Research Service, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress* (September 29, 2023).
67. Workups are the training and preparation phase for an aircraft carrier's crew and equipment, involving drills and exercises to ensure operational readiness. Refit/overhaul is a maintenance phase where the carrier undergoes extensive repairs, system upgrades, and structural modifications to enhance its capabilities and extend its service life.
68. This debate has been ongoing for decades. Bryan McGrath, "The Paradox of American Naval Power," *War on the Rocks*, August 13, 2014;

Mackenzie Eaglen, "A Sensible Course to 350 Ships in Support of a Three-Hub Navy," American Enterprise Institute, February 26, 2018; Mark Montgomery, "Engaging the 'Two-Hub' Model," *Proceedings* (US Naval Institute) 137, no. 2 (2011); Thomas Mahnken, "Forward Presence in the Modern Navy: From the Cold War to a Future Tailored Force," Naval History and Heritage Command, August 16, 2017.

69. O'Rourke, *Defense Primer*.
70. Dmitry Filipoff, "Fighting DMO Pt. 7: The Future of the Aircraft Carrier in Distributed Warfighting," Center for International Maritime Security, April 17, 2023.
71. Jan Tegler, "Despite Delays, Navy to Accelerate Delivery of Unmanned Tanker," *National Defense Magazine*, January 26, 2024; Sam LaGrone, "MQ-25A Stingray IOC Pushed to 2026 Following Manufacturing Delays," USNI News, April 4, 2023.
72. Joseph Trevithick, "Navy's HALO Hypersonic Anti-Ship Missile Planned for Ships, Submarines, As Well As Jets," *The War Zone* (*TWZ*), June 5, 2024.
73. Although VLS is technologically ingenious, it has intrinsic design constraints: A missile in a VLS cell must fit the cell's specifications and have a deployment mechanism that fits the cell's tolerances. US VLS cells are almost all "hot launch" systems, meaning the missile is ignited as it exits the cell, rather than "cold launch" systems, where a separate, smaller propellant pushes the missile into the air before igniting the main motor. The US Navy's Mk41 VLS cells can withstand high heat, enabling reuse after hot launches. But longer-range missiles, and faster missiles, naturally burn hotter, raising the odds of VLS cell damage after sustained usage. Moreover, although a surface combatant's armament can be adapted—at this point, only in port—to different missions, its armament is limited only to what is stored in VLS cells. For more, see Defense Systems Information Analysis Center (DSIAC), "A Promising Future for US Navy: Vertical Launching Systems," November 2, 2019.
74. The Navy has begun to design a new generation of destroyers under the DDG(X) program. The new destroyer will be equipped with more than one hundred VLS cells for launching offensive missiles and will also feature a strong point defense missile system for close-range protection

against incoming threats. Some models will carry directed-energy weapons as well. Procurement will start late in this decade. A warship with these specifications may be worth pushing into combat range, despite the risk that it will come under attack from enemy missiles and UAS. See Congressional Research Service, "Navy DDG(X) Next-Generation Destroyer Program: Background and Issues for Congress," last updated August 5, 2024.

75. Sam LaGrone, "All Freedom Littoral Combat Ships in Commission Tapped for Early Disposal," USNI News, March 29, 2022.
76. US Navy, "Landing Craft, Air Cushion (LCAC)," October 14, 2021.
77. Ronald O'Rourke, *Navy Medium Landing Ship (LSM) (Previously Light Amphibious Warship [LAW]) Program: Background and Issues for Congress* (Congressional Research Service, August 5, 2024).
78. Megan Eckstein, "With Blade Issues Resolved, Navy Seeking Four Ship to Shore Connectors a Year," *Defense News*, January 21, 2022; Naval Technology, "US Navy Takes Delivery of Ship to Shore Connector LCAC 105," March 10, 2023.
79. Military Sealift Command, "Expeditionary Sea Base," US Navy, accessed November 15, 2024.
80. Military Sealift Command, "Expeditionary Sea Base."

Chapter 6

1. US Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957* (Government Printing Office, 1960), 723.
2. US Congress, *United States Statutes at Large, 1939–1941*, vol. 54, part 1 (Government Printing Office, 1941), 779–80; Matt Wright, "Just-in-Time Production," *Proceedings* (US Naval Institute) 149, no. 1 (2023).
3. Naval History and Command, "US Navy Active Ship Force Levels, 1938–1944," US Navy, November 17, 2017.
4. Jim Garamone, "World War I: Building the American Military," US Army, April 17, 2017.
5. Benn Steil and Elisabeth Harding, "For the First Time, the US Is Spending More on Debt Interest Than on Defense," Council on Foreign Relations, March 23, 2024.

6. Roger Wicker, *21st Century Peace Through Strength: A Generational Investment in the US Military* (Office of Senator Roger Wicker, Ranking Member of the Armed Services Committee, May 29, 2024).
7. Roger Wicker, "America's Military Is Not Prepared for War—or Peace," *New York Times*, May 29, 2024.
8. Roger Wicker, "Senator Wicker and Colleagues Advocate for Sufficient Attack Submarine Funding to Meet the Moment," press release, May 14, 2024.
9. National Museum of the United States Air Force, "North American P-51D Mustang," accessed November 15, 2024.
10. Charles K. Hyde, *Arsenal of Democracy: The American Automobile Industry in World War II* (Wayne State University Press, 2013).
11. Notably, US success in aircraft production in World War II also resulted from remarkable organizational and logistical coordination between government agencies, military branches, and private industries, which ensured the efficient scaling up of production, not just the simplicity of the design and supply chains.
12. The five largest US defense firms are all either primarily or almost exclusively aerospace manufacturers, while Boeing in particular has some commercial contracts to sustain it. By contrast, Huntington Ingalls and the element of General Dynamics that does naval construction have only military contracts. See Luke Nicastro, *The US Defense Industrial Base: Background and Issues for Congress* (Congressional Research Service, September 23, 2024).
13. Walter S. Poole, *Adapting to Flexible Response 1960–1968* (Historical Office, Office of the Secretary of Defense, 2013).
14. These service chiefs were Chief of Naval Operations Admiral Arleigh Burke and Chief of Staff of the Air Force General Hoyt Vandenberg.
15. AcqNotes, "Quick Sheet: Defense Acquisition System," August 28, 2017.
16. Shannon Seay, "Defense Acquisition System Overview," Defense Acquisition University (DAU), March 20, 2017.
17. Defense Acquisition University (DAU), "Joint Capabilities Integration and Development System (JCIDS)," accessed November 15, 2024.
18. Defense Acquisition University (DAU), "Planning, Programming, Budgeting & Execution Process (PPBE)," accessed November 15, 2024.

19. Howell Raines, "Reagan Sticks to Agenda That Won Him the Election," *New York Times*, March 8, 1981.
20. Joseph Sims, "Lessons from the 600-Ship Navy," *Naval History*, August 2022.
21. Colin Grabow, "The Case for Expanded Shipbuilding Subsidies Remains Wanting," Cato Institute, March 16, 2023.
22. John F. Lehman, "The 600-Ship Navy," *Proceedings* (US Naval Institute) 112, no. 1 (1986); US General Accounting Office, *Update of the Issues Concerning the Proposed Reactivation of the Iowa Class Battleships and the Aircraft Carrier Oriskany* (April 20, 1981).
23. National Research Council, "Appendix A: A Historical Perspective on the US Defense Industrial Base," in *Defense Manufacturing in 2010 and Beyond: Meeting the Changing Needs of National Defense* (National Academies Press, 1999).
24. John J. Hamre, "Reflections: Looking Back at the Need for Goldwater-Nichols," Center for Strategic and International Studies (CSIS), January 27, 2016.
25. Hamre, "Reflections."
26. Charley Coleman, "UK Defence Policy and the Role of the Armed Forces," House of Lords Library, August 24, 2023.
27. Mark Cancian, "We Need a Map for Goldwater-Nichols Reform So We Don't Get Lost," *War on the Rocks*, March 17, 2016.
28. Goldwater-Nichols restructured the US military's command hierarchy, significantly increasing the authority of the chairman of the Joint Chiefs of Staff and promoting greater interservice cooperation. It aimed to resolve inefficiencies and communication issues by mandating joint operations and planning among the Army, Navy, Air Force, and Marines. It also streamlined the military chain of command by placing combatant commanders directly under the Secretary of Defense, bypassing the service chiefs.
29. US Department of Defense, *State of Competition within the Defense Industrial Base* (Government Printing Office, 2022).
30. David Thornton, "Consolidating the Defense-Industrial Base in the Post–Cold War Era: Budgetary Priorities and Procurement Policies in the US and Western Europe," *Public Finance and Management* 7, no. 3, (2007).

31. Congressional Research Service, *The US Defense Industrial Base: Background and Issues for Congress* (October 12, 2023).
32. Jason Shell, "How the IED Won: Dispelling the Myth of Tactical Success and Innovation," *War on the Rocks*, May 1, 2017.
33. Jen Judson, "30 Years: MRAP—Rapid Acquisition Success," *Defense News*, October 25, 2016.
34. Mark Cancian, "Long Wars and Industrial Mobilization: It Won't Be World War II Again," *War on the Rocks*, August 8, 2017.
35. Sam Skove, "US to Sextuple 155mm Production, Improve Arms Factories," *Defense One*, March 28, 2023.
36. Jen Judson, "US Army Awards $1.5B to Boost Global Production of Artillery Rounds," *Defense News*, October 6, 2023; Jason Sherman, "Army Raises Future Monthly 155mm Artillery Shell Production Target 70K to 85K," *Inside Defense*, March 28, 2022.
37. European producers struggled in aggregate to ramp up production in 2022 and 2023, but German ammunition heavyweight Rheinmetall by early 2024 had increased production to a maximum of fifty thousand shells per month, partly by buying up spare capacity throughout Europe and Asia. South Korea also retains production capacity and a deep stockpile.
38. Otto Kreisher, "Shipbuilding Industry Struggles to Recruit and Retain Workforce," USNI News, June 21, 2019,
39. Carten Cordell, "Inflation, Workforce Issues Challenge Defense Contractors amid Security Pivot," Nextgov.com, February 10, 2023.
40. Richard Burgess, "SECNAV: Frigate Delay Due to 'Atrocious' Shipyard Worker Retention," *Seapower Magazine*, May 16, 2024.
41. Carten Cordell, "Inflation, Workforce Issues."
42. Naval Sea Systems Command, "US Navy Celebrates Expanding Talent Pipeline for Submarine Industrial Base," US Navy, May 3, 2024.
43. Office of the Under Secretary of Defense for Acquisition and Sustainment, *State of Competition within the Defense Industrial Base* (US Department of Defense, February 2022).
44. This is a particular problem for blue-collar workers. See Kreisher, "Shipbuilding Industry."
45. Burgess, "SECNAV."

46. Team Submarine Public Affairs, "Navy's Needed Revitalization of the Submarine Workforce Accelerates," Naval Sea Systems Command, April 11, 2024.
47. Northeast Wisconsin Technical College, "Shipbuilder Welder Apprenticeship," accessed November 15, 2024.
48. Lisbeth Perez, "Hill Witnesses Spotlight DIB Workforce Retention Challenges," MeriTalk, February 28, 2024.
49. Josh Luckenbaugh, "Defense Companies Face Post-Pandemic Workforce Shortages," *National Defense Magazine*, September 2, 2023.
50. There are some ships that would be relevant, such as the *Ticonderoga*-class cruisers, which sport excellent air defenses. However, most retired ships are simply too outdated to safely return to service. Sam LaGrone, "After a Decade of Debate, Cruisers Set to Exit Fleet in 5 Years," USNI News, April 21, 2022.
51. Katherine Blakeley, "Defense Spending in Historical Context: A New Reagan-esque Buildup?," Center for Strategic and Budgetary Assessments, November 8, 2017.
52. US Department of Defense, "Department of Defense Releases the President's Fiscal Year 2025 Defense Budget," March 11, 2024.
53. US Government Accountability Office, *DOD Active-Duty Recruitment and Retention Challenges*, March 2023; Nora Bensahel and David Barno, "Addressing the US Military Recruiting Crisis," *War on the Rocks*, March 10, 2023; Robert Rose, "Ending the Churn: To Solve the Recruiting Crisis, the Army Should Be Asking Very Different Questions," Modern War Institute at West Point, February 9, 2024.
54. Mark A. Milley, "Strategic Inflection Point: The Most Historically Significant and Fundamental Change in the Character of War Is Happening Now—While the Future Is Clouded in Mist and Uncertainty," *Joint Forces Quarterly* 110 (2023): 6–15.
55. The B-2 stealth bomber costs $2 billion apiece and will be phased out for the lower-maintenance B-21, which costs just $750 million apiece. A *Virginia*-class submarine costs $4.3 million apiece and the latest aircraft carrier class, the *Gerald R. Ford*, costs $13 billion per unit. See Harrison Kass, "Why the Air Force's B-2 Bomber Costs $2,000,000,000," *National Interest*, August 30, 2024; Brandon Weichert, "The B-21 Raider

Bomber and NGAD Fighter: Giant Mistakes for the US Air Force?," *National Interest*, May 30, 2024; Jerry Petersen, "Virginia-Class Fast-Attack Submarine USS *Idaho* Launches into Thames River," ExecutiveGov, August 14, 2024; Harrison Kass, "Nuclear Aircraft Carriers in the US Navy: Most Expensive Warships Ever," *National Interest*, October 26, 2024.

56. The lead *Constellation*-class frigate cost almost $1.3 billion to build, and the twenty-three commissioned Littoral Combat Ships cost around $500 million each. See US Naval Institute, *Report to Congress on Constellation Class Frigate Program (FFG-62)* (February 1, 2022); Emma Salisbury, "Lessons from the Littoral Combat Ship," *War on the Rocks*, November 15, 2021.
57. Jerry Useem, "Boeing and the Dark Age of American Manufacturing," *The Atlantic*, April 20, 2024; US Government Accountability Office, *DOD Needs to Improve Its Planning for Using Contractors to Support Future Military Operations* (US Government Accountability Office, March 2010); Nicholas Jordan and Jennifer Mapp, "In the Dark: How the Pentagon's Limited Supplier Visibility Risks US National Security," *War on the Rocks*, June 14, 2023; US Department of Defense, *Securing Defense-Critical Supply Chains* (February 2022); US Department of Defense, *2023 National Defense Industrial Strategy* (2023).
58. Defense Acquisition University (DAU), "ACQuipedia." This resource remains the gold standard for the intricacies of the acquisition process.
59. Sam LaGrone, "Compromise $857B Defense Policy Bill Authorizes 11 Battle Force Ships, $25M for Nuclear Cruise Missile Research," USNI News, December 6, 2022; Megan Eckstein, "House Panel Takes Aim at Navy Size, New Capabilities in Defense Bill," *Defense News*, May 14, 2024.
60. Bryant Harris, "Congress Supersizes Munitions Production with Emergency Authorities," *Defense News*, December 13, 2022.
61. Anshu Siripurapu, "What Is the Defense Production Act?," Council on Foreign Relations, December 22, 2021.
62. Douglas Bell and Conrad Crane, "Korean War Economic Mobilization Is More Relevant to the Current Pandemic Than World War II," *War on the Rocks*, May 6, 2020.

63. Douglas I. Bell, *"A Little-Known Bill of Great National Significance": The Uses and Evolution of the Defense Production Act, 1950–2020* (US Army Heritage and Education Center).
64. Daniel Raimi, host, "The History of the Defense Production Act in the Energy Sector, with Ty Priest," *Resources Radio*, podcast, April 26, 2022.
65. White House Briefing Room, "Fact Sheet: President Biden Takes Bold Executive Action to Spur Domestic Clean Energy Manufacturing," June 6, 2022.
66. General Dynamics, "Scranton Operations: Forging and Machining Capabilities," February 2021.
67. Jeff Gifford, "Raytheon Gets New Stinger Missile Contract as War in Ukraine Boosts Demand," *Phoenix Business Journal*, June 1, 2022.
68. Valerie Insinna, "5% GDP: Top SASC Republican Pitches Dramatic Jump in Defense Spending $55B More in FY25," *Breaking Defense*, May 29, 2024; Rick Green, "GreenSource Fabrication Secures $46.2m Federal Defense-Production Grant," *New Hampshire Business Review*, January 12, 2024; Bill Greenwalt, Jerry McGinn, and Christopher Zember, "The Defense Production Act Is Helping Rebuild the US Industrial Base: Let's Keep It That Way," *Defense News*, June 15, 2022.
69. Defense Innovation Unit, "Solutions," accessed November 15, 2024.
70. Gordian Knot Center for National Security Innovation, "National Security Information," Stanford University, accessed November 15, 2024.
71. Jaspreet Gill, "From Prototypes to Operations: In Record-Breaking Year, DIU Transitioned 17 New Tech," Breaking Defense, January 25, 2023.
72. The DOD is currently implementing a "zero trust" environment, in which it is assumed that adversaries have already infiltrated a system, and expects to complete this transition by 2027. See US Department of Defense, "DOD Makes Headway on Cloud Computing," March 29, 2023.
73. Brandi Vicent, "Fiscal 2025 Budget Docs Reveal How Project Maven Is Still Evolving," *Defense Scoop*, March 14, 2024.

74. For example, the DOD could expand the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, which are currently available only for small high-tech contractors. It could also ramp up funding for Accelerate the Procurement and Fielding of Innovative Technologies (APFIT) and Rapid Defense Experimentation Reserve (RDER) programs. These ideas have already been proposed in Wicker, *21st Century Peace*.
75. Heather Somerville, "Investors Are Betting on Defense Startups. The Pentagon Isn't," *Wall Street Journal*, January 25, 2024.
76. Somerville, "Investors Are Betting."
77. Steve Escavarage and Adam Hammer, "To Stay Competitive, US Military Complex Must Hurdle 'Valley of Death,'" *Marine Corps Times*, September 27, 2023.
78. Defense Innovation Board, *Terraforming the Valley of Death* (US Department of Defense, July 2023); US Army Acquisition Support Center, "Understanding Acquisition: The Valley of Death," Army AL&T, October 6, 2021.
79. Brandi Vincent, "Exiting DIU Director Urges Pentagon to Refresh How It Adopts Commercial Tech for Future Wars," *FedScoop*, July 14, 2022.
80. Michael Brown and Lorin Selby, "Revisiting the Hedge Strategy with Renewed Urgency," *War on the Rocks*, September 7, 2023; Michael Brown, "The Big Disconnect: Defense R&D and Warfighter Capabilities," *Forbes*, March 26, 2024.
81. *Naval News*, "Fincantieri to Build 4th Constellation-Class Frigate for the US Navy," May 29, 2023.
82. Kathryn Toomey, "Understanding ITAR: The International Traffic in Arms Regulations," Shipping Solutions, October 26, 2022.
83. John Schaus and Elizabeth Hoffman, "Is ITAR Working in an Era of Great Power Competition?," Center for Strategic and International Studies (CSIS), February 24, 2023.
84. The United Kingdom's BAE Systems is one major exception, having integrated into the US market after acquiring United Defense in 2005. It has an unusual structure with separate arms in the United States and the United Kingdom. See Bloomberg News, "BAE Systems to Acquire United Defense Industries," *Los Angeles Times*, March 8, 2005; BAE

Systems, "Special Security Agreement," accessed November 15, 2024; NBC News, "BAE to Buy United Defense for Nearly $4 Billion," March 7, 2005.

85. Tom Corben, "Even with Intended Reforms, US Defence Trade Rules Threaten AUKUS Cooperation," *The Strategist*, June 18, 2024.
86. Bureau of International Security and Nonproliferation, "Missile Technology Control Regime (MTCR) Frequently Asked Questions," US Department of State, accessed November 15, 2024.
87. Kari Bingen, "How to Deepen US-Japan Space Cooperation to Meet the Urgent Security Challenges Ahead," Center for Strategic and International Studies (CSIS), March 29, 2024.
88. Sandra Erwin, "US Defense Companies Find Roadblocks in Selling Space Technologies to Allies," SpaceNews, June 12, 2023.
89. Jeff Foust, "US Government Plans Review of Space Technology Export Controls," SpaceNews, April 10, 2024.
90. Tom Corben and William Greenwalt, "Breaking the Barriers: Reforming US Export Controls to Realise the Potential of AUKUS," United States Study Centre, May 17, 2023.
91. Schaus and Hoffman, "Is ITAR Working"; Deborah Cheverton and John T. Watts, "AUKUS Is Hamstrung by Outdated US Export Control Rules: Here's What Congress Can Do," Atlantic Council, November 15, 2023.
92. Corben and Greenwalt, "Breaking the Barriers."
93. Bureau of Alcohol, Tobacco, Firearms and Explosives, "§ 447.21 The US Munitions Import List," US Department of Justice; Bureau of Alcohol, Tobacco, Firearms and Explosives, "Form 6 Part 1: Application and Permit for Importation of Firearms, Ammunition, and Implements of War," US Department of Justice.
94. Bureau of Industry and Security, "Export Administration Regulations (EAR)"; US Department of the Treasury, "The Committee on Foreign Investment in the United States (CFIUS)"; Federal Register, "Defense Federal Acquisition Regulation Supplement (DFARS)"; all accessed November 15, 2024.
95. David Carpenter and Brandon Murrill, *The Buy American Act and Other Federal Procurement Domestic Content Restrictions* (Congressional Research Service, November 8, 2022); Office of the Under

Secretary of Defense for Acquisition and Sustainment, "Reciprocal Procurement MOU," accessed November 15, 2024.

96. James Schoff, "A High-Tech Alliance: Challenges and Opportunities for US-Japan Science and Technology Collaboration," Carnegie Endowment for International Peace, July 2021.
97. Damien Cave, "Australia to Fast-Track Missile Production for US Exports," *New York Times*, July 28, 2023.
98. Recent bipartisan efforts in Congress have attempted to pursue ITAR reform. Concerned about US export controls constricting technology cooperation key to implementing AUKUS, the House, led by Democratic Representative Joe Courtney of Connecticut, passed a bill 393-4 instructing the State Department and the Pentagon to provide reports of the export licenses needed to advance AUKUS exchanges through AUKUS protocols. See Bryan Harris, "Congress Lays Groundwork for AUKUS Export Control Reform," *Defense News*, March 22, 2023; John Lee, "Primer: Australian Prime Minister Anthony Albanese's Visit to the United States," Hudson Institute, October 23, 2023; Cheverton and Watts, "AUKUS Is Hamstrung"; Ice Miller, "Senators Seek to Clamp Down on US Arms Exports," May 4, 2021.

Chapter 7

1. Miriam McNabb, "Has the US China Trade War Changed DJI's Drone Market Share? The Latest from Drone Industry Insights," DroneLife, March 5, 2021.
2. Edge computing is a method for locating computing power and data storage geographically closer to data sources, resulting in reduced latency. The Internet of Things (IoT) is the most commonly used edge computing system, since IoT distributes processing power and data across a number of colocated devices. See "What Is Edge Computing?," Accenture, accessed November 15, 2024.
3. Anton Shilov, "US Congressman Accuses SMIC of Making 7nm Chips for China, Violating US Sanctions," Tom's Hardware, November 8, 2024.
4. The FPV copter is a small drone, controlled by an operator using a first-person view video camera, with four or more motors enabling vertical takeoff and landing.

5. The Fritz-X had aerodynamic control surfaces, including movable tail fins that could be adjusted based on the radio signals received. The bombardier or radio operator in the aircraft used a joystick or other control device to send radio commands to the bomb. See National Air and Space Museum, "Bomb, Guided, Fritz X (X-1)," accessed November 15, 2024.
6. Samuel J. Cox, "H-070-1: The Vietnam War Easter Offensive, Part 1," Naval History and Heritage Command, April 2022.
7. Benjamin S. Lambeth, *Moscow's Lessons from the 1982 Lebanon Air War* (RAND, 1984).
8. John David Blom, *Unmanned Aerial Systems: A Historical Perspective*, Paper No. 37 (Combat Studies Institute, US Army Command and General Staff College, 2010), 81–92.
9. Joe Ritter, "Getting Drones Ready for Conventional War," *War on the Rocks*, June 20, 2022.
10. Naval Air Systems Command, "MQ-9A Reaper," accessed November 15, 2024.
11. David Hambling, "Why the Air Force Needs a Cheaper Reaper," *Forbes*, June 10, 2020.
12. John Shaw, "The Influence of Space Power upon History (1944–1998)," *Air Power History* 46, no. 4 (1999).
13. Richard P. Hallion, *Strike from the Sky: The History of Battlefield Air Attack, 1910–1945* (Smithsonian Institution Press, 1989).
14. Williamson Murray, *War in the Air, 1914–45* (Cassell Military, 2002).
15. Charles Crawley, "How Did the Evolution of Communications Affect Command and Control of Airpower: 1900–1945?" (research paper, Air War College, April 1, 1996).
16. Dmytro Shumlianskyi, "In 2025, The Ukrainian Defense Forces Started Receiving About 200 Thousand Drones Per Month," *Militarnyi*, February 9, 2025.
17. The DOD classifies drones into five "Groups" based on size, without drawing a distinction between copters and fixed-wing. The Federal Aviation Administration distinguishes between small and large UAS, but for more precise differentiation among large UAS, the FAA employs DOD classifications; see Federal Aviation Administration, "Section 3. Large UAS (MGOW 55 Pounds or More)," last accessed November 15, 2024. Although nonstandard, the seven-category typology we present

here makes for a cleaner differentiation between the kinds of drones used in Ukraine. See UAS Task Force, *Unmanned Aircraft System Airspace Integration Plan* (US Department of Defense, March 2011), D-3.

18. Strategic bombardment is a military strategy that involves large-scale bombing campaigns targeting an enemy's infrastructure, industry, and civilian areas to weaken their war capacity and morale. Counter-battery suppression is a tactical operation aimed at neutralizing or destroying an enemy's artillery batteries to reduce the enemy's capability to conduct indirect fire attacks, thereby protecting friendly forces and maintaining battlefield dominance.
19. Infiniti Electro-Optics, "What Is CUAS (Counter-Unmanned Aircraft System)?," accessed November 15, 2024.
20. Radar tracking, similar to traditional aerial surveillance, depends on terrain and line of sight conditions. Both skilled operators and advanced AI can exploit these limitations to avoid detection. RF analysis enables identification of control signals and UAS classification, helping to determine appropriate countermeasures. However, highly sophisticated UAS can evade RF analysis by switching frequencies regularly. Acoustic detection measures UAS sound signatures but is subject to environmental interference. These sensors are most effective when positioned on high ground or aboard a drone. Optical sensors use camera-based surveillance to classify UAS through detection of a range of wavelengths, from visible light to infrared. See Dedrone, "Counter-Drone: The Comprehensive Guide to Counter-UAS/C-UAS/CUAS," accessed November 15, 2024; and Bhargav Patel and Dmitri Rizer, *Counter-Unmanned Aircraft Systems: Technology Guide* (National Urban Security Technology Laboratory, September 2019).
21. RF jammers offer a low-cost solution to disable a UAS by breaking its remote controller connection, though the UAS may default to preprogrammed behaviors like returning to "home" base. Kinetic and directed energy solutions require line of sight and risk collateral infrastructure damage. Cyber takeover preserves the enemy UAS for intelligence gathering but is generally ineffective against encrypted systems and swarms. See D-Fend Solutions, "Comprehensive Guide to Counter-Drone Mitigation Technologies," and DroneShield, "What Is the Best Drone Defeat Technique?," both accessed November 15, 2024.

22. McNabb, "US-China Trade War."
23. Aaron Karp, "US House Committee Advances Legislation to Effectively Ban DJI Drones in US," *Commercial UAV News*, March 28, 2024.
24. Ana Swanson, "US Weighs Ban on Chinese Drones, Citing National Security Concerns," *New York Times*, January 2, 2025.
25. Demetri Sevastopulo, "Chinese Sanctions Hit US Drone Maker Supplying Ukraine," *Financial Times*, October 31, 2024.
26. Siladitya Ray, "Largest US Drone Manufacturer Says It Will Need to Ration Batteries for Customers After Sanctions by China," *Forbes*, October 31, 2024.
27. Miriam McNabb, "Commerce Department Issues NPRM to Limit Use of Chinese-Made Drones and Components," DroneLife, January 3, 2025.
28. Julian Borger, "The Drone Operators Who Halted the Russian Armoured Vehicles Heading for Kyiv," *The Guardian*, March 28, 2022; Аеророзвідка [Aerial Reconnaissance], "Аеророзвідка–це надійний партнер Сил Безпеки і Оборони у розробці та впровадженні передових стандартів ведення війни" [Aerial reconnaissance is a reliable partner of the Security and Defense Forces in the development and implementation of advanced standards of warfare], accessed November 15, 2024.
29. Joseph Trevithick, "Super-Quiet Special Operations Drones May Migrate to Pacific Theater," *The War Zone* (*TZW*), August 13, 2024.
30. Heather Somerville and Brett Forrest, "How American Drones Failed to Turn the Tide in Ukraine," *Wall Street Journal*, April 10, 2024.
31. David Kirichenko, "Ukraine's Drone Front," Center for European Policy Analysis (CEPA), June 6, 2024.
32. Harry Halem, "Ukraine's Lessons for Future Combat: Unmanned Aerial Systems and Deep Strike," *Parameters* 53, no. 4 (2023): 19–32.
33. David Hambling, "Ukraine Shows US How to Beat China in Drone Battery Wars," *Forbes*, November 14, 2024.
34. ZenaDrone, "Battery Powered vs Gas Powered Drone," accessed November 15, 2024.
35. Ellen Wald, "The US Wants to End Its Reliance on Chinese Lithium: Its Policies Are Doing the Opposite," Atlantic Council, January 23, 2024.
36. Siladitya Ray, "Largest US Drone Manufacturer."

37. Robert Rapier, "Why China Is Dominating Lithium-Ion Battery Production," *Forbes*, August 4, 2019; Benchmark Source, "Lithium Ion's Leading Producers in 2030: China to Dominate as West Ramps Up," September 2, 2024.
38. Tony Deligio, "Drones and Injection Molding Ready for Takeoff," *Plastics Technology*, May 16, 2023.
39. Jennifer DiMascio, "US Air Force Collaborative Combat Aircraft (CCA)," Congressional Research Service, August 15, 2024.
40. Gregory Allen and Isaac Goldston, "The Department of Defense's Collaborative Combat Aircraft Program: Good News, Bad News, and Unanswered Questions," Center for Strategic and International Studies (CSIS), August 6, 2024.
41. Allen and Goldston, "Collaborative Combat Aircraft Program."
42. Benjamin Jensen, Christopher Koeltzow, Allen Agnes, and Eric Williams, "Cockpit or Command Center? C2 Options for Collaborative Combat Aircraft," Center for Strategic and International Studies (CSIS), October 29, 2024.
43. For more discussion on the limitations of CCAs, see Heather Penney, *Five Imperatives for Developing Collaborative Combat Aircraft*, Mitchell Institute for Aerospace Studies, October 2022; Allen and Goldston, "Collaborative Combat Aircraft Program."
44. Penney, *Five Imperatives*, 16.
45. Stephen Losey, "US Air Force Warns of Aging Fighters, Poor Purchasing Efforts," *Defense News*, September 12, 2022.
46. Allen and Goldston, "Collaborative Combat Aircraft Program."
47. Jon Harper, "Air Force Plans to Spend More Than $6B on CCA Drone Programs Over the Next 5 Years," *DefenseScoop*, March 20, 2023; Stephen Losey, "US Air Force Readies to Award Collaborative Combat Aircraft Deals," *Defense News*, February 13, 2024.
48. Allen and Goldston, "Collaborative Combat Aircraft Program."
49. DiMascio, "CCA."
50. DiMascio, "CCA."
51. DiMascio, "CCA."
52. Allen and Goldston, "Collaborative Combat Aircraft Program."
53. Ryan Hefron, "ACE: Air Combat Evolution," Defense Advanced Research Projects Agency (DARPA), accessed November 15, 2024.

54. One might term this a "center of gravity," per Clausewitz's theory of warfare. A particularly helpful discussion of the concept and its utility in military thought is found in Antulio Echevarria II, *Clausewitz's Center of Gravity: Changing Our Warfighting Doctrine—Again!* (US Army War College Press, 2002).
55. Indu Chandran and Kizheppatt Vipin, "Multi-UAV Networks for Disaster Monitoring: Challenges and Opportunities from a Network Perspective," *Drone Systems and Applications* 12 (2024): 1–28.
56. Zachary Kallenborn, "Swarm Talk: Understanding Drone Typology," Modern War Institute at West Point, December 10, 2021.
57. Stacie Pettyjohn, "Drones Are Transforming the Battlefield in Ukraine but in an Evolutionary Fashion," *War on the Rocks*, March 5, 2024.
58. Gabija Cepurnaite, "Edge Computing for Drones: The Edge of UAV Industry Transformation," STL Partners, accessed November 15, 2024.
59. Miniaturized synthetic aperture radar (SAR) is a compact radar system that uses the motion of the radar antenna over a target region to create high-resolution images, providing detailed ground- or surface-mapping capabilities from a small, lightweight platform. This technology is particularly useful for drones and small satellites, allowing for efficient and precise surveillance and reconnaissance.
60. One major issue is the need for precise alignment between the power transmitter and the drone's receiver, which is difficult to maintain as drones move, leading to reduced power transfer efficiency. In addition, the energy drones use to stay in position while charging further decreases overall effectiveness. Managing power distribution across a swarm is also complex owing to the varying energy needs and flight patterns of individual drones, resulting in uneven power allocation. Moreover, integrating wireless power transfer (WPT) with the drones' existing communication and navigation systems presents additional difficulties. This integration requires ensuring that power transfer does not interfere with drone operations and that the system remains reliable and secure, particularly in large-scale deployments. See Tamoghna Ojha, Theofanis P. Raptis, Andrea Passarella, and Marco Conti, "Wireless Power Transfer with Unmanned Aerial Vehicles: State of the Art and Open Challenges," *Pervasive and Mobile Computing* 93 (2023): 101820.

61. David Hambling, "Ukraine Is Spoofing Russian Drones Out of the Sky," *Forbes*, April 21, 2023.
62. US Department of Homeland Security, *Risks and Mitigation Strategies for Adversarial Artificial Intelligence Threats: A DHS S&T Study*, June 2023, 12.
63. US Department of Homeland Security, *Risks and Mitigation Strategies*, 14.
64. US Department of Homeland Security, *Risks and Mitigation Strategies*, 26–29.
65. US Marine Corps, "Expeditionary Advanced Base Operations (EABO)," August 2, 2021.
66. Shephard News, "US Buys 21 Tactical Resupply Drones for Navy and Marines," April 12, 2023.
67. Eyal Boguslavsky, "First Batch of Hermes 90 Thor Drones Delivered to Philippine Army," *Israel Defense*, February 28, 2023.
68. Khalem Chapman, "Elbit Systems, KAI to Co-operate on Next-Gen Unmanned ISTAR Solution," Key.Aero, March 19, 2021.
69. Reuters, "BAE Systems Australia Unveils Homegrown Military Drone," February 27, 2023.
70. Dinakar Peri, "As Part of UAV Deal with US Firm, India Is Expected to Develop Some Components Locally," *The Hindu*, June 25, 2023.
71. Airforce Technology, "Cardinal II Unmanned Aircraft System," March 28, 2016; Emma Helfrich and Tyler Rogoway, "Taiwan Shows Off Its Radar-Killing Kamikaze Drones," *The War Zone* (*TWZ*), November 16, 2022.
72. In June 2024, the US government approved a sale of 720 Switchblade missiles and 291 Altius 600M loitering munitions to Taiwan, for a combined price of $360 million. See Brad Lendon, "Taiwan to Acquire More Than 1,000 Armed Drones in New US Arms Sale," CNN, June 19, 2024.
73. Elisabeth Gosselin-Malo, "Taiwan Taps Satellite Hookups to Help Down Invading Drones," *Defense News*, October 18, 2024.
74. Jason Hsu and Richard Y. K. Chen, "Keeping Taiwan Online," *Project Syndicate*, September 13, 2023.
75. Cindy Wang, Jamie Tarabay, and Bruce Einhorn, "Musk Ultimatum to Taiwan Imperils Its Push to War-Proof Internet," *Bloomberg*, July 6, 2023.

76. Meaghan Tobin and John Liu, "Why Taiwan Is Building a Satellite Network Without Elon Musk," *New York Times*, last updated March 15, 2024.
77. Jim Garamone, "Hicks Discusses Replicator Initiative," DOD News, US Department of Defense, September 7, 2023.
78. Josh Rogin, "The US Military Plans a 'Hellscape' to Deter China from Attacking Taiwan," *Washington Post*, June 10, 2024.
79. Eric Tegler, "A Defense Startup CEO Says There's Too Much Negativity on Replicator," *Forbes*, February 21, 2024; Noah Robertson, "Replicator: An Inside Look at the Pentagon's Ambitious Drone Program," *Defense News*, December 19, 2023; Matt Berg, "'Disorganized and Confusing': Lawmakers, Industry Rip Pentagon Plans for Drones," Politico, December 17, 2023; Chris Jenks, "Year Ahead: The US DOD Replicator Initiative and the Acquisition Process for Autonomous Weapons," Articles of War, Lieber Institute at West Point, January 9, 2024.
80. Seth J. Frantzman, "Twenty Years of Israel-US Air Defense Investment Pays Off," *National Interest*, April 15, 2024. Israeli expertise in UAS operations and development, particularly for fixed-wing platforms, is extensive and decades old. See Ralph Sanders, *An Israeli Military Innovation: UAVs* (National Defense University, 2002).

Chapter 8

1. Reuters, "Australia to Invest Billions of Dollars in Nuclear Submarine Shipyard," October 15, 2024; Army Technology, "An Uncertain Course Forward for UK Shipbuilding and Buying," February 8, 2023.
2. Andrew F. Krepinevich, *Maritime Competition in a Mature Precision-Strike Regime* (Center for Strategic and Budgetary Assessments, 2015).
3. Arnold Hague, *The Allied Convoy System, 1939–1945: Its Organization, Defence and Operation* (Naval Institute Press, January 1, 2000).
4. Gerhardt Thamm, "Unraveling a Cold War Mystery: The Alfa SSN: Challenging Paradigms, Finding New Truths, 1969–97," *Studies in Intelligence* 52, no. 3 (2007).
5. Today, two major kinds of sensors are used for this purpose: towed sonar arrays or sonobuoys.

6. Paul Dibb and Richard Brabin-Smith, "Why the US Will Stay Dominant in Undersea Warfare," *The Strategist*, April 26, 2024.
7. Owen Walker and Austin Krusz, "There's a Case for Diesels," *Proceedings* (US Naval Institute) 144, no. 6 (2018).
8. Colin Wall and Pierre Morcos, "Invisible and Vital: Undersea Cables and Transatlantic Security," Center for Strategic and International Studies (CSIS), June 11, 2021.
9. Matthew Carle, "The Mission Behind Operation Ivy Bells and How It Was Discovered," Military.com, February 7, 2017.
10. Nuclear Threat Initiative, "United States Submarine Capabilities," March 6, 2023.
11. See further discussion in this section about US submarines in Guam.
12. The *Seawolf* was built during the late Cold War as a next-generation attack submarine meant to succeed the *Los Angeles*–class boats still in service. Owing to high costs and declining demand after the end of the Cold War, the planned *Seawolf* fleet was reduced to only three boats. *Seawolf* boats remain in the fleet and are used as technological test beds and for high-value intelligence collection. In many respects, the *Seawolf* class is more sophisticated than the *Virginia* class. Even though *Seawolf* boats are expensive to produce in large quantities, they still deliver significant value. See Naval Technology, "SSN Seawolf Class," September 11, 2020.
13. Mike Sweeney, "Submarines Will Reign in a War with China," *Proceedings* (US Naval Institute) 149, no. 3 (2023).
14. Asia Maritime Transparency Initiative, "Exploring China's Unmanned Ocean Network," June 16, 2020.
15. Eli Tirk and Daniel Salisbury, *China Maritime Report No. 38: PLAN Anti-Submarine Warfare Aircraft—Sensors, Weapons, and Operational Concepts* (China Maritime Studies Institute, May 2024).
16. Laura Heckmann, "'Tsunami' of New Tech Complicates Anti-Sub Warfare Mission," *National Defense Magazine*, February 2, 2023; Jeff W. Benson, "A New Era in Anti-Submarine Warfare," USNI News, August 27, 2014.
17. For an in-depth, open-source discussion of ASW that remains relevant despite its age, see Tom Stefanick, *Strategic Antisubmarine Warfare and Naval Strategy* (Free Press, 1987).

18. Polina Lemenkova, "Visualization of the Geophysical Settings in the Philippine Sea Margins by Means of GMT and ISC Data," ResearchGate, 2020.
19. US Naval War College, "CMSI Conference: Chinese Undersea Warfare: Development, Capabilities, Trends," China Maritime Studies Institute, April 2023.
20. H. I. Sutton, "First Image of China's New Nuclear Submarine Under Construction," *Naval News*, February 1, 2021.
21. US Naval War College, "CMSI Conference."
22. For more analysis of China's submarine fleet, see Ronald O'Rourke, *China Naval Modernization: Implications for US Navy Capabilities—Background and Issues for Congress* (Congressional Research Service, March 18, 2020).
23. O'Rourke, *China Naval Modernization*.
24. This is another set of questions that the analytical community has grappled with since the early 2010s. See Ian Easton, *China's Evolving Reconnaissance Strike Capabilities: Implications for the US-Japan Alliance* (Project 2049 Institute and the Japan Institute for International Affairs, February 2014); Sidarth Kaushal, *China's Reconnaissance Strike Complex: Echoes of Imperial Japan's Strategy?* (Royal United Services Institute [RUSI], April 26, 2022); Nick Danby, "Carrier Strike Groups Should Be Ready to Go Dark in Conflict," *War on the Rocks*, August 29, 2023; US-China Economic and Security Review Commission, "China's Pursuit of Advanced Weapons," *Annual Report to Congress*, October 31, 2018.
25. J. Michael Dahm and Alison Zhao, *China Maritime Report No. 28: Bitterness Ends, Sweetness Begins: Organizational Changes to the PLAN Submarine Force Since 2015* (China Maritime Studies Institute, 2023); Alastair Gale, "The Era of Total US Submarine Dominance Over China Is Ending," *Wall Street Journal*, November 20, 2023; Rajeswari Pillai Rajagopalan, "China's Growing Submarine Capabilities," *The Diplomat*, October 31, 2023; Nuclear Threat Initiative, "China Submarine Capabilities," August 13, 2024.
26. Toshi Yoshihara, "Chinese Views of Taiwan's Geostrategic Value," *SPF China Observer* 45 (December 4, 2023).
27. Huizhong Wu and Johnson Lai, "Taiwan Suspects Chinese Ships Cut Islands' Internet Cables," AP News, April 18, 2023.

28. Seth Cropsey, "The Sorry State of America's Submarine Fleet," *Wall Street Journal*, September 29, 2023.
29. US Departments of Energy and the Navy, *The United States Naval Nuclear Propulsion Program 2020* (Department of Energy, Department of the Navy, 2020).
30. Edward Bartlett, "The Navy's Submarine Maintenance Crisis Needs Ready, Affordable Solutions," *Proceedings* (US Naval Institute) 150, no. 1 (2024); USNI News, "Report on Virginia-Class Attack Submarine Program," US Naval Institute, July 4, 2023; Seth Cropsey, "Delayed Repairs Shrink the US Submarine Fleet," *Wall Street Journal*, September 14, 2022.
31. Roger Wicker, "The US Navy Needs More Attack Submarines," *Wall Street Journal*, July 16, 2023.
32. Gale, "Era of Total US Submarine Dominance."
33. Submarines typically have a service life of thirty to forty years. The new *Virginia*-class boats, including the Virginia Payload Module, cost around $4.3 billion apiece. Ronald O'Rourke, *Navy Virginia-Class Submarine Program and AUKUS Submarine (Pillar 1) Project: Background and Issues for Congress* (Congressional Research Service, June 12, 2024).
34. Tory Shepherd, "US Virginia Class Submarines Hit Further Two-Year Delay as Australia Awaits 2030 Delivery," *The Guardian*, June 8, 2023.
35. Bartlett Maritime Corporation, "Our Company," accessed November 15, 2024.
36. Megan Eckstein, Joe Gould, and Bryant Harris, "How the US Plans to Expand Its Submarine Industrial Base for AUKUS," *Defense News*, March 15, 2023.
37. Scott Gourley, "Manufacturing the Very Lightweight Torpedo: A Key Factor in Next Gen Defense Technology," Northrop Grumman, accessed November 15, 2024.
38. The US Navy developed the Advanced Capability (ADCAP) Mk-48 in the 1980s to counter the USSR's *Alfa*-class submarines, the Soviet Navy's premier high-speed interceptor attack boats.
39. This calculation assumes that thirty subs hold an average of fifteen torpedoes apiece. See Seaforces Online, "Submarine Weapon System: Mk.48 ADCAP Torpedo," accessed November 15,2024.

40. Lockhead Martin Newsroom, "Lockheed Martin to Build Advanced Sonar Systems as Navy's Heavyweight Torpedo Returns to Production," May 25, 2016.
41. O'Rourke, *Navy Virginia-Class*, 55; Sam LaGrone, "Senators Question SecNav, OMB on Submarine Funding Ahead of 17 Attack Boat Buy," USNI News, October 28, 2024; David Axe, "US Navy Submarines Are Expensive. Check Out This Graph," *Forbes*, December 15, 2020.
42. Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress* (Congressional Research Service, September 29, 2023).
43. David Vergun, "Submarine Warfare Played Major Role in World War II Victory," DOD News, US Department of Defense, March 16, 2020.
44. Robert Cecil Stern, *The Hunter Hunted: Submarine Versus Submarine: Encounters from World War I to the Present* (Naval Institute Press, 2007), 153.
45. Jeff Vandenengel, "Fighting Along a Knife Edge in the Falklands," *Proceedings* (US Naval Institute) 45, no. 12 (2019).
46. Submarines can detect and engage each other using sonar systems, with passive sonar listening for sounds and active sonar emitting pulses to locate targets. Submarines typically engage one another when both are submerged, using homing torpedoes. Surface engagements are rare.
47. Submarine Force Pacific, "Origins of SOSUS," accessed November 15, 2024.
48. Brian Taddiken and Kirsten Krock, "66 Years of Undersea Surveillance," *Naval History Magazine* 35, no. 1 (2021).
49. Mizuho Kajiwara, "Maritime Security and Underwater Surveillance Technology: Lessons from the Cold War," *Indo-Pacific Outlook* 1, no. 3 (January 24, 2024).
50. Navy Lookout, "Royal Navy Submarines and Non-Acoustic Sensor Technology," February 12, 2021.
51. Submarine heat signatures are very low. Hans Ohff, "Nuclear Versus Diesel-Electric: The Case for Conventional Submarines for the RAN," *The Strategist*, July 2018.

52. Katarzyna Kubiak, *Quantum Technology and Submarine Near-Invulnerability*, Global Security Policy Brief (European Leadership Network, 2020).
53. Rudy Ruitenberg, "Armed with Quantum Sensors, France Eyes Leaps in Electronic Warfare," *Defense News*, June 25, 2024.
54. Michal Krelina, "Quantum Technology for Military Applications," *EPJ Quantum Technology* 8, no. 24 (2021).
55. Michael J. Biercuk and Richard Fontaine, "The Leap into Quantum Technology: A Primer for National Security Professionals," *War on the Rocks*, November 17, 2017.
56. Natasha Bajema, "Will AI Steal Submarines' Stealth?," *IEEE Spectrum*, July 16, 2022.
57. Northrop Grumman has designed a renewable underwater UUV-recharging dock; however, it remains a paper concept. See Northrop Grumman, "Mission Unlimited: Inventing Autonomous Recharging of Unmanned Underwater Vehicles," accessed November 15, 2024.
58. Naval Technology, "Orca XLUUV, USA," April 19, 2024; Prakash Panneerselvam, "Unmanned Systems in China's Maritime 'Gray Zone Operations,'" *The Diplomat*, January 23, 2023; Julian Kerr, "Australia's Future Extra-Large UUV Named 'Ghost Shark,'" Janes, December 12, 2022; *Naval News*, "Msubs Wins UK Royal Navy Contract for Cetus XLUUV," December 1, 2022.
59. Matthew Cancian, "An Offensive Minelaying Campaign Against China," *Naval War College Review* 75, no. 1 (2022).
60. Artem Galushko, "Ukraine Sea Drones Show the Way," Australian Naval Institute, March 2, 2023.
61. Richard D. Parker, "SUBPAC Conducts Clandestine Mine Exercise," US Pacific Fleet Newsroom, September 21, 2015.
62. Gareth Evans, "The Allure of Supercavitating Torpedoes," Naval Technology, June 19, 2017.
63. John Keller, "Is World Ready for an Undersea Missile? Supercavitating Torpedo Offers Speed of 230 Miles per Hour," *Military and Aerospace*, June 19, 2018.
64. Scott Truver, "Red Subs Rising?," *Proceedings* (US Naval Institute) 145, no. 10 (2019).

65. *Naval News*, "Australia Joins MU90 Light Weight Torpedo ISS Program," March 2, 2023.
66. Richard R. Burgess, "Small Torpedo Being Prototyped by Raytheon to Arm the Navy's Submarines," *Seapower*, January 13, 2023.

Chapter 9

1. US Department of Defense, *Space Policy Review and Strategy on Protection of Satellites* (September 2023), 5.
2. Richard Mason, James Bonomo, Tim Conley, et al., *Analyzing a More Resilient National Positioning, Navigation, and Timing Capability* (RAND, May 17, 2021), 35.
3. Matthew Mowthorpe and Markos Trichas, "A Review of Chinese Counterspace Activities," *Space Review*, August 1, 2022.
4. US Space Force, "Space Threat Fact Sheet" (Headquarters Space Force Intelligence), April 29, 2024.
5. US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2024* (December 18, 2024), 86; US Space Force, "Space Threat Fact Sheet" (April 29, 2024).
6. Jacob Mezey, *Russian and Chinese Strategic Missile Defense: Doctrine, Capabilities, and Development* (Atlantic Council, August 2024).
7. Martin van Creveld, "Less Than Meets the Eye," *Journal of Strategic Studies* 28, no. 3 (June 2005): 449–52.
8. Hugo Grotius, *The Free Sea* (*Mare Liberum*), ed. David Armitage (Liberty Fund, 2004); Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660–1783* (Brown Little, 1890); Julian Corbett, *Some Principles of Maritime Strategy* (Longmans, Green and Co., 1911); J. C. Wylie, *Military Strategy: A General Theory of Power Control* (Naval Institute Press, 1967); Wayne P. Hughes, *Fleet Tactics and Naval Operations* (Naval Institute Press, 1986).
9. Carl von Clausewitz, *On War*, trans. Michael Howard and Peter Paret (Princeton University Press, 1984; original work published in 1832); Antoine-Henri Jomini, *The Art of War*, trans. G. H. Mendell and W. P. Craighill (J. B. Lippincott,1862; original work published in 1838).

10. Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (Coward-McCann, 1942); Hugh Trenchard, various speeches and writings, particularly as articulated during his tenure with the Royal Air Force from 1919 to 1930; Billy Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power—Economic and Military* (G. P. Putnam's Sons, 1925); Alexander P. de Seversky, *Victory Through Air Power* (Simon and Schuster, 1942); John Warden, *The Air Campaign: Planning for Combat* (National Defense University Press, 1988).
11. Philip S. Meilinger, ed., *The Paths of Heaven: The Evolution of Airpower Theory* (School of Advanced Airpower Studies, Air University Press, 1997), 255, 580.
12. *National Security Space: 21st Century Challenges, 20th Century Organization: Hearing before the Subcommittee on Strategic Forces of the Committee on Armed Services*, House of Representatives, 114th Congress, Second Session (2016) (testimony of James O. Ellis Jr., USN (Ret.), Former Commander, US Strategic Command).
13. Francis Doiron, Jamie Green, and Rosie Suedieck, eds., *Spacepower: Doctrine for Space Forces* (US Space Force, 2020).
14. Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (Frank Cass, 2002).
15. Bleddyn E. Bowen, *War in Space: Strategy, Spacepower, and Geopolitics* (Edinburgh University Press, 2020); John J. Klein, *Space Warfare: Strategy, Principles, and Policy* (Routledge, 2006).
16. Colin S. Gray, "The Influence of Space Power upon History," *Comparative Strategy* 15, no. 4 (1996): 293–308. For more on Gray's theory, see Marc J. Berkowitz, "Gray's Influence on Space Power Theory and Strategy," *Comparative Strategy* 40, no. 2 (2021): 209–14.
17. Roger Launius, "Sputnik and the Dawn of the Space Age: A Conversation with Roger Launius," *Ad Astra* (National Space Society) (2007): 12–15.
18. Office of the Historian, "Sputnik, 1957," US Department of State, accessed November 15, 2024.
19. SDI was a space-based antiballistic missile program that included lasers and kinetic interceptors. US Department of State, "Strategic Defense Initiative (SDI), 1983."
20. James M. Acton, "Space Nukes Are Bad," Carnegie Endowment for International Peace, October 8, 2024.

21. National Museum of the United States Air Force, "Cold War in Space: Top Secret Reconnaissance Satellites Revealed," accessed November 15, 2024.
22. A third phase of the program was developed in the decades following, with its first launch in October 1982 and final launch in July 1995. Sharon Watkins Lang, "SMDC History: DSCS Transfers to ARSPACE," US Army, February 14, 2017; Mission and Spacecraft Library, "DSCS (Defense Satellite Communications System)," NASA, accessed November 15, 2024. For more on the background and warrants behind keeping information on US communications and reconnaissance satellites classified, see George Bush to Gerald Ford, memorandum, "Modification of the Classification and Dissemination Controls for the Products of Reconnaissance Satellites," June 8, 1976, George Washington University National Security Archive.
23. Space and Missile Systems Center and SMC History Office, "Evolution of GPS: From Desert Storm to Today's Users," US Air Force, March 24, 2016.
24. *Hearings Before the House Armed Services Committee Subcommittee on Strategic Forces on Fiscal Year 2025 National Security Space Programs*, 118th Cong., 4 (May 1, 2024) (statement of Dr. John F. Plumb, Assistant Secretary of Defense for Space Policy).
25. Unshin Lee Harpley, "DOD Official Confirms Russia Is Developing an 'Indiscriminate' Space Nuke," *Air & Space Forces Magazine*, May 2, 2024.
26. Thomas Dickey and Michael Gleason, "The Future of Warfare: How Technology Is Shaping the Battlefield," *Journal of Strategic Airpower & Spacepower* 3, no. 1 (2021): 27.
27. Adam Satariano, Scott Reinhard, Cade Metz, Sheera Frenkel, and Malika Khurana, "Elon Musk's Unmatched Power in the Stars," *New York Times*, July 28, 2023.
28. BBC News, "Ukraine War: Biden Calls for Putin to Face War Crimes Trial after Bucha Killings," April 4, 2022.
29. Theodora Ogden, Anna Snack, Melusine Lebret, James Black, and Vasilios Mavroudis, *The Role of the Space Domain in the Russia-Ukraine War* (Centre for Emerging Technology and Security, February 2023).

30. David Axe, "The Russians Installed a GPS Jammer in Ukraine: The Ukrainians Blew It Up with a GPS-Guided Bomb," *Forbes*, November 2, 2023; Thomas Withington, "Jamming JDAM: The Threat to US. Munitions from Russian Electronic Warfare," Royal United Services Institute, June 6, 2023.
31. Julian Borger, "Elon Musk Ordered Starlink to Be Turned Off During Ukraine Offensive, Biography Claims," *The Guardian*, September 7, 2023; Anthony Capaccio, "SpaceX Contract to Supply Starlink in Ukraine Is Worth $23 Million," *Bloomberg*, April 9, 2024.
32. Ron Gurantz, *Satellites in the Russia-Ukraine War* (US Army War College Press, August 2024).
33. Thomas X. Hammes, *The Sling and the Stone: On War in the 21st Century* (Zenith Press, 2004).
34. Si Jia, "Meiguo kongjun 9 yue 7 ri xuanbu, X-37B dangtian fashe sheng kong, zhixing di wu ci zai gui feixing renwu" [The US Air Force announced on September 7 that the X-37B was launched that day to perform its fifth on-orbit mission], *Jiefangjun Bao*, September 24, 2017.
35. Kevin Pollpeter, Eric Anderson, Jordan Wilson, and Fan Yang, *China Dream, Space Dream: China's Progress in Space Technology and Implications for the United States* (US Institute on Global Conflict and Cooperation [IGCC], March 2, 2015), iv. The authors refer to space as the "new commanding height of war."
36. Kevin Pollpeter, *Coercive Space Activities: The View from PRC Sources* (China Aerospace Studies Institute, February 2024), iii.
37. Xu Wei and Chang Xian-qi, "Shi Lun Kongjian Weishe" [Space deterrence and its strategic application], *Zhuangbei Zhihui Jishu Xueyuan Xuebao* 13, no. 1 (February 2022).
38. Pollpeter, *Coercive Space Activities*, v.
39. Kevin Pollpeter, "Innovation in China's Space Industry: Overcoming Decoupling," *Asian Security* 19, no. 2 (2023): 117.
40. Pollpeter et al., *China Dream, Space Dream*, vi.
41. US Department of Defense, *Military and Security Developments: 2024*, 99.
42. US Department of Defense, *Military and Security Developments: 2024*.
43. US Space Force, "Space Threat Fact Sheet" (April 29, 2024).

44. Khyle Eastin, "Interview: China's Vision for Space," National Bureau of Asian Research, November 21, 2023.
45. Namrata Goswami, "Space and Technology Were Big Winners at China's 20th Party Congress," *The Diplomat*, November 23, 2022.
46. Kevin Pollpeter, *China's Role in Making Outer Space More Congested, Contested, and Competitive* (China Aerospace Studies Institute, October 2021), 9.
47. Jeffrey Lewis, "China's Orbital Bombardment System Is Big, Bad News—but Not a Breakthrough," *Foreign Policy*, October 18, 2021.
48. Pollpeter, "Innovation in China's Space Industry," 116.
49. Pollpeter et al., *China Dream, Space Dream*, vii.
50. Kevin Pollpeter, "China's Space Program: Making China Strong, Rich, and Respected," *Asia Policy* 15, no. 2 (April 2020): 12.
51. Pollpeter, "Innovation in China's Space Industry," 119.
52. Pollpeter et al., *China Dream, Space Dream*.
53. Liu Zhen, "China's BeiDou and Russian GLONASS Sign New Deal to Rival America's GPS Satellite Navigation," *South China Morning Post*, February 5, 2022.
54. Chinese theoretical writings are clear on this, particularly Xiao Tianliang, Lou Yaoliang, Kang Wuchao, and Cai Renzhao, *In Their Own Words: The Science of Military Strategy 2020* (China Aerospace Studies Institute, 2022). See also Mark Stokes, Gabriel Alvarado, Emily Weinstein, and Ian Easton, *China's Space and Counterspace and Activities* (Project 2049 Institute and Pointe Bello, March 30, 2020).
55. "Types of Orbit: Orbiting Spacecraft," European Space Agency, accessed November 15, 2024.
56. Bart Hendrickx, "Kalina: A Russian Ground-Based Laser to Dazzle Imaging Satellites," *Space Review*, July 5, 2022; Ken Moriyasu, "China Can 'Grapple' US Satellites with Robotic Arm, Commander Says," *Nikkei Asia*, April 21, 2021; Brian Weeden, *2007 Chinese Anti-Satellite Test Fact Sheet* (Secure World Foundation, November 23, 2010).
57. US Space Force, "Space Threat Fact Sheet" (April 29, 2024).
58. Mark A. Gubrud, "Chinese and US Kinetic Energy Space Weapons and Arms Control," *Asian Perspective* 35, no. 4 (2011): 617–41.

59. For more on this issue, see Juliana Suess, "The Nuclear Option—Russia's Newest Counter Space Weapon?," Royal United Services Institute (RUSI), February 27, 2024.
60. Donald J. Kessler, Nicholas L. Johnson, J.-C. Liou, and Mark Matney, "The Kessler Syndrome: Implications to Future Space Operations," *Advances in the Astronautical Sciences* 137 (January 24, 2010).
61. Colin Demarest, "Electronic Warfare in Ukraine Has Lessons for US Weapons, Navigation," *Defense News*, May 6, 2024; Lara Seligman, "Russia Jamming US Smart Bombs in Ukraine, Leaked Docs Say," Politico, April 12, 2023.
62. US Space Force, "Space Threat Fact Sheet" (April 29, 2024).
63. US Space Force, "X-37B Begins Novel Space Maneuver," October 20, 2024.
64. Juliana Suess, "You Can't Hide in Space Anymore: China's Shenlong Spaceplane," Royal United Services Institute (RUSI), June 20, 2024.
65. Pavel Luzin, "Russian Space Spending for 2023," *Eurasia Daily Monitor*, February 10, 2023.
66. Jaganath Sankaran, "Limits of the Chinese Antisatellite Threat to the United States," *Strategic Studies Quarterly* 8, no. 4 (2014): 20–47.
67. Marcus Solarz Hendriks and Harry Halem, *From Space to Seabed: Protecting the UK's Undersea Cables from Hostile Actors* (London: Policy Exchange, February 19, 2024); Dustin Volz, Drew FitzGerald, and Peter Champelli, "US Fears Undersea Cables Are Vulnerable to Espionage from Chinese Repair Ships," *Wall Street Journal*, May 19, 2024; Aaron Bateman, "Undersea Cables and the Vulnerability of American Power," Engelsberg Ideas, May 7, 2024.
68. Thomas Newdick, "E-8 JSTARS Has Flown Its Last Operational Mission," *The War Zone* (*TWZ*), September 26, 2023.
69. Paul S. Szymanski, "How to Win the Next Space War: An Assessment," Wild Blue Yonder, Air University, April 4, 2022; US Defense Intelligence Agency, "Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion," June 27, 2022.
70. US Congress, Office of Technology Assessment, *Anti-Satellite Weapons, Countermeasures, and Arms Control* (US Government Printing Office, 1985).

71. Babak Shakouri Hassanabadi, "Space Force and International Space Law," *Space Review*, July 30, 2018.
72. Matthew Daniels, *The History and Future of US–China Competition and Cooperation in Space* (Johns Hopkins University Applied Physics Laboratory, 2020); Bruce W. MacDonald, Carla P. Freeman, and Alison McFarland, *China and Strategic Instability in Space: Pathways to Peace in an Era of US-China Strategic Competition* (US Institute of Peace, February 2023).
73. Cyber operations also require significant planning and persistence. Thus, initial disruptions at the outbreak of a war could be significant. Over time, both belligerents might adapt and build more resilient space-based arrays, but this would happen only in a long war.
74. Ria Urban, "Space Systems Command Facilitates Multiple Contract Awards for Proliferated Low Earth Orbit Satellite-Based Services," *Space Impulse*, July 24, 2023.
75. Tereza Pultarova and Elizabeth Howell, with contributions from Daisy Dobrijevic and Adam Man, "Starlink Satellites: Facts, Tracking and Impact on Astronomy," Space.Com, April 14, 2022.
76. Direct-ascent weapons are missiles launched from the ground or high-altitude aircraft designed to intercept and destroy satellites in orbit. They travel directly to their target, typically using kinetic impact to disable or destroy the satellite. Timothy Wright, "Do ASATs Mean Less Security in Space?," *IISS Military Balance* (blog), March 17, 2020. Most analyses lack the necessary technical assessment to identify the difficulties with using direct ascent ASAT against small targets.
77. Congressional Budget Office, "Large Constellations of Low-Altitude Satellites: A Primer," May 2023.
78. David Zikusoka, "Spying in Space: How a Surge in Satellites Will Revolutionize Intelligence," *Foreign Affairs*, February 2, 2024.
79. Satellites launched into high-altitude/geostationary orbit might be beyond the range of China's publicly known ASAT systems. See US Space Force, Space Operations Command, "LEO, MEO or GEO? Diversifying Orbits Is Not a One-Size-Fits-All Mission (Part 1 of 3)," July 18, 2023; Courtney Albon, "Spy Agency Eyes May Launch of First Proliferated Constellation," C4ISRNet, April 9, 2024.

80. NASA Office of Inspector General, *NASA's Efforts to Mitigate the Risks Posed by Orbital Debris* (January 27, 2021), 1–15.
81. Japan's JAXA operates several sophisticated imaging satellites and over a dozen spy satellites it has launched since the early 2000s, but it probably lacks an antisatellite program. The European Space Agency (ESA), an intergovernmental body with indirect links to the EU, has launched several earth-observation, communications, and other satellites and has a meaningful fleet of launch vehicles. However, because ESA includes so many national participants, it is unlikely to be militarized.
82. Todd Harrison, *Building an Enduring Advantage in the Third Space Age* (American Enterprise Institute, May 2024).
83. John Olson, Steven Butow, Eric Felt, and Thomas Cooley, *State of the Space Industrial Base 2022* (US Space Force, August 2022), 39.
84. Citigroup, *Space: The Dawn of a New Age* (Citigroup Global Perspectives and Solutions, May 9, 2022).
85. Amy Thompson, "SpaceX Sets a New Reusability Record," *The Hill*, July 11, 2023.
86. Kate Duffy, "Elon Musk Says He's 'Highly Confident' That SpaceX's Starship Rocket Launches Will Cost Less Than $10 Million Within 2–3 Years," *Business Insider India*, February 11, 2022.
87. Michael Sheetz, "SpaceX, Blue Origin, Virgin Galactic Executives Urge Senators to Improve the FAA," CNBC, October 18, 2023; Dave Adalian, "More Starbase Delay, but SpaceX Rockets Ahead," EarthSky, May 3, 2022.
88. Sandra Erwin, "Space Force Changed Launch Procurement Plan Due to Concerns About Capacity," *SpaceNews*, July 19, 2023.
89. Kalliroi Landry, "Constellations Podcast: Episode 181—Being a Disruptor, Spiral Development and Proliferated Tactical Data Networks," Kratos Defense, June 5, 2024.
90. Laura Speckman, Andrew Cortopassi, Andre Doumitt, et al., *Emerging In-Space Propulsion Technologies* (Aerospace Corporation, January 2023).
91. Defense Advanced Research Projects Agency (DARPA), "DARPA, NASA Collaborate on Nuclear Thermal Rocket Engine," January 24, 2023.

92. Andrew Jones, "Chinese Megawatt-Level Space Nuclear Reactor Passes Review," *SpaceNews*, August 31, 2022.
93. Roxana Bardan, "NASA, DARPA Will Test Nuclear Engine for Future Mars Missions," NASA News Release, January 24, 2023.
94. Katherine McAlpine, "Space Force Funds $35M Institute for Versatile Propulsion," *University Record*, University of Michigan, October 16, 2024.
95. US Department of Defense, *Space Policy Review and Strategy on Protection of Satellites* (September 2023), 9.
96. National Nuclear Security Administration, "10 CFR Part 810," US Department of Energy, accessed November 15, 2024.
97. The Five Eyes is the intelligence alliance comprising the agencies of the United States, the United Kingdom, Australia, New Zealand, and Canada. It is the deepest, most robust, and longest-standing intelligence partnership in the world. For the history and operations of the Five Eyes, see Corey Pfluke, "A History of the Five Eyes Alliance: Possibility for Reform and Additions," *Comparative Strategy* 38, no. 4 (2019): 302–15.
98. Chris Daehnick, John Gang, and Ilan Rozenkopf, "Space Launch: Are We Heading for Oversupply or a Shortfall?," McKinsey & Company, April 17, 2023.
99. Sandra Erwin, "Lockheed Martin Declares Success Demonstrating Tech for In-Orbit Satellite Servicing," *SpaceNews*, April 17, 2023.
100. SpaceLogistics, "Mission Extension Vehicle (MEV)," fact sheet (Northrop Grumman, 2021).
101. Andrew Jones, "China's Shijian-21 Towed Dead Satellite to a High Graveyard Orbit," *SpaceNews*, January 27, 2022.
102. Astroscale, "Astroscale's ELSA-d Successfully Demonstrates Repeated Magnetic Capture," August 25, 2021.
103. Alec Cavaciuti, J. Davis, and J. Heying, *In-Space Servicing Assembly and Manufacturing for the New Space Economy* (Center for Space Policy and Strategy, July 2022), 2.
104. Christian Zur, "Escaping the Tyranny of the Rocket Equation," *Scientific American*, February 18, 2020.
105. Olson et al., *State of the Space Industrial Base 2022*, 63.
106. US Space Command, "USSPACECOM Outlines Requirements for Sustained Maneuver, Dynamic Space Operations," April 21, 2023.

107. NASA Science Editorial Team, "New AI Algorithms Streamline Data Processing for Space-Based Instruments," NASA, December 20, 2022.
108. MarketsandMarkets, "Remote Sensing Services Market Size, Share & Growth Analysis," 2022.
109. Olson et al., *State of the Space Industrial Base 2022*, 82.
110. Olson et al., *State of the Space Industrial Base 2022*, 78.
111. Shaza Khan, "Seeing the Unseen: How Synthetic Aperture Radar Is Revolutionizing Space and Military Operations," Mercury Systems, September 9, 2024; Alicia Passah, Samarendra Nath Sur, Ajith Abraham, and Debdatta Kandar, "Synthetic Aperture Radar Image Analysis Based on Deep Learning: A Review of a Decade of Research," *Engineering Applications of Artificial Intelligence 123*, part A (August 2023).
112. Khan, "Seeing the Unseen."
113. Debra Werner, "Perfecting the SAR Process," *Aerospace America*, September 2023.
114. Theresa Hitchens, "NRO Moves Closer to Formal Program to Buy Commercial Radar-Sat Data," *Breaking Defense*, March 20, 2024.
115. Sandra Erwin, "Northrop Grumman's Ground Station for Missile Warning Satellites Passes Design Review," *SpaceNews*, June 1, 2023.
116. Andrew Davies and Patrick Kennedy, *From Little Things: Quantum Technologies and Their Application to Defence* (Australian Strategic Policy Institute, November 2017).
117. QKD uses quantum mechanics to encrypt messages with a largely unbreakable key.
118. Juan Yin, Yuan Cao, Yu-Huai Li, et al., "Satellite-to-Ground Entanglement-Based Quantum Key Distribution," *Physical Review Letters* 119, no. 20 (2017).
119. Andrew Jones, "China Plans to Take 'Hack-Proof' Quantum Satellite Technology to New Heights," Space.com, October 30, 2023.
120. Challenges of quantum communications in space include atmospheric interference, precise beam targeting, and photon loss over distance.
121. National Institute of Standards and Technology, "NIST Releases First 3 Finalized Post-Quantum Encryption Standards," August 13, 2024.
122. Edward Parker, "When a Quantum Computer Is Able to Break Our Encryption, It Won't Be a Secret" (RAND, September 13, 2023).

123. *Federal Register*, "Announcing Issuance of Federal Information Processing Standards (FIPS) FIPS 203, Module-Lattice-Based Key-Encapsulation Mechanism Standard, FIPS 204, Module-Lattice-Based Digital Signature Standard, and FIPS 205, Stateless Hash-Based Digital Signature Standard," August 14, 2024.
124. Ciel Qi, "China's Quantum Ambitions: A Multi-Decade Focus on Quantum Communications," *Yale Journal of International Affairs*, February 2, 2024.
125. Kelley Sayler, *Defense Primer: Quantum Technology* (Congressional Research Service, August 14, 2024).
126. White House, "National Security Memorandum on Promoting United States Leadership in Quantum Computing While Mitigating Risks to Vulnerable Cryptographic Systems," May 4, 2022.

Chapter 10

1. Congressional Commission on the Strategic Posture of the United States, *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States* (Institute for Defense Analyses, October 2023).
2. US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2024* (December 18, 2024), 101; US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2022* (November 29, 2022), 94.
3. Alison A. Kaufman and Brian Waidelich, *PRC Writings on Strategic Deterrence: Technological Disruption and the Search for Strategic Stability* (Center for Naval Analyses, February 2023).
4. Joel Wuthnow, "Shield, Sword, or Symbol: Analyzing Xi Jinping's 'Strategic Deterrence,'" Brookings Institution, March 7, 2024.
5. Lawrence Freedman and Jeffrey Michaels, *The Evolution of Nuclear Strategy: New, Updated and Completely Revised*, 4th ed. (Palgrave Macmillan, 2019); Robert Jervis, *The Meaning of the Nuclear Revolution: Statecraft and the Prospect of Armageddon* (Cornell University Press, 1989).
6. The Chinese literature on MAD draws extensively from Western Cold War concepts, generally defining MAD as the situation brought about

by two states' "mutual vulnerability" (*xianghu cuiruo* 相互脆弱) to second strikes by the other. See Kaufman and Waidelich, *PRC Writings on Strategic Deterrence*, 15.

7. Erin R. Mahan and Jeffrey A. Larsen, eds., *Evolution of the Secretary of Defense in the Era of Massive Retaliation: Charles Wilson, Neil McElroy, and Thomas Gates 1953–1961*, Cold War Policy Series (Historical Office, Office of the Secretary of Defense, 2012).
8. Bernard Brodie, "The Anatomy of Deterrence," *World Politics* 11, no. 2 (1959): 173–91.
9. Albert Wohlstetter, *The Delicate Balance of Terror* (RAND, 1958); Xuegong Zhao, "The Limits of Confrontation: Nuclear Weapons, the 1958 Taiwan Strait Crisis, and China-US Relations," *Journal of Cold War Studies* 25, no. 2 (2023): 112–49; Richard W. Maass, "Salami Tactics: Faits Accomplis and International Expansion in the Shadow of Major War," *Texas National Security Review*, 2022.
10. Historians still debate how much Kennedy, in his short time in office, actually affected changes in doctrine and target planning that were already under way. See Frank Gavin, "The Myth of Flexible Response: United States Strategy in Europe during the 1960s," *International History Review* 23, no. 4 (December 2001): 847–75.
11. Thomas Schelling, *Arms and Influence* (Yale University Press, 1966), 99.
12. James F. Schnabel and Robert J. Watson, *The Joint Chiefs of Staff and National Policy, Volume III, 1950–1951: The Korean War, Part One* (Office of Joint History, Office of the Chairman of the Joint Chiefs of Staff, 1998).
13. Schnabel and Watson, *Joint Chiefs of Staff*, 239.
14. M. H. Halperin, *The 1958 Taiwan Straits Crisis: A Document History (U)*, Memorandum RM-4900-ISA (abridged) (RAND, 1975).
15. *New York Times*, "China's Atomic Weapon Story Told," May 5, 1985.
16. Scott D. Sagan, "Lessons of the Yom Kippur Alert," *Foreign Policy*, no. 36 (1979): 169–71.
17. Heather Williams, Kelsey Hartigan, Lachlan MacKenzie, and Reja Younis, "Russian Nuclear Calibration in the War in Ukraine," CSIS Briefs, Center for Strategic and International Studies, February 2024.
18. In examining limited nuclear use in a Sino-American conflict, classical theories on nuclear coercion and rational deterrence help explain

how China might view limited nuclear strikes as a tool to achieve decisive advantages while managing escalation risks. See Thomas C. Schelling, *Arms and Influence* (Yale University Press, 1966); Charles L. Glaser, *Rational Theory of International Politics: The Logic of Competition and Cooperation* (Princeton University Press, 2010). Recent studies underscore that China's evolving nuclear doctrine deliberately maintains ambiguity, complicating US escalation calculations. See Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and US-China Strategic Stability," *International Security* 40, no. 2 (2015): 7–50; Avery Goldstein, *Deterrence and Security in the 21st Century: China, Britain, France, and the Enduring Legacy of the Nuclear Revolution* (Stanford University Press, 2000). Technical analyses further demonstrate how advances in precision make limited nuclear strikes increasingly feasible, enhancing the tactical appeal of such options in China's arsenal. See Keir A. Lieber and Daryl G. Press, "The New Era of Counterforce: Technological Change and the Future of Nuclear Deterrence," *International Security* 41, no. 4 (2017): 9–49. Research on regional nuclear strategies reveals how China might use limited nuclear options to deter further US action, leveraging concentrated US bases in the Indo-Pacific to maximize strategic impact. See Vipin Narang, *Nuclear Strategy in the Modern Era: Regional Powers and International Conflict* (Princeton University Press, 2014). This combination of doctrinal uncertainty, advancing technical capabilities, and the vulnerability of regional US installations generates unique escalatory pressures that merit close examination.

19. Caitlin Talmadge, "Would China Go Nuclear? Assessing the Risk of Chinese Nuclear Escalation in a Conventional War with the United States," *International Security* 41, no. 4 (2017): 50–92.

20. Tong Zhao, "What's Driving China's Nuclear Buildup?," Carnegie Endowment for International Peace, August 5, 2021; Gerald C. Brown, "Understanding the Risks and Realities of China's Nuclear Forces," Arms Control Association, June 2021; Henrik Stålhane Hiim, "The Last Atomic Waltz: China's Nuclear Expansion and the Persisting Relevance of the Theory of the Nuclear Revolution," *Contemporary Security Policy* 45, no. 2 (2024): 2–3; Henrik Stålhane Hiim, M. Taylor Fravel, and Magnus Langset Trøan, "The Dynamics of an Entangled

Security Dilemma: China's Changing Nuclear Posture," *International Security* 47, no. 4 (2023); Susan Turner Haynes, *Chinese Nuclear Proliferation: How Global Politics Is Transforming China's Weapons Buildup and Modernization* (University of Nebraska Press, 2016); Fiona Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and US-China Strategic Stability," *International Security* 40, no. 2 (2015); M. Taylor Fravel and Evan S. Medeiros, "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure," *International Security* 35, no. 2 (2010).

21. The concept of "People's War," to which the PLA adhered until the reforms of the late 1970s, heavily discounted the role of nuclear weapons. See Mao Tse-tung, "The Chinese People Cannot Be Cowed by the Atom Bomb," *Selected Works of Mao Tse-tung*, vol. 5, January 28, 1955 (Foreign Languages Press); Tung Ming, "The People's Revolutionary Strategy Will Surely Triumph over US Imperialism's Counter-Revolutionary Strategy," *Peking Review*, no. 37 (September 1966): 12–14.
22. Liping Xia, "China's Nuclear Doctrine: Debates and Evolution," Carnegie Endowment for International Peace, June 30, 2016.
23. Michael S. Chase and Andrew S. Erickson, "The Conventional Missile Capabilities of China's Second Artillery Force: Cornerstone of Deterrence and Warfighting," *Asian Security* 8, no. 2 (2012): 115–37.
24. Ron Christman, "Conventional Missions for China's Second Artillery Corps: Doctrine, Training, and Escalation Control Issues," in *Chinese Aerospace Power: Evolving Maritime Roles*, ed. Andrew S. Erickson and Lyle J. Goldstein (Naval Institute Press, 2011).
25. US Department of Defense, *Military and Security Developments: 2024*, 101–03.
26. Reports that Chinese *Jin*-class submarines are now being outfitted with JL-3 ICBMs could change Chinese SSBN targeting. Tony Capaccio, "China Has Put Longer-Range ICBMs on Its Nuclear Subs, US Says," Bloomberg, November 18, 2022; Office of Naval Intelligence, *The People's Liberation Army Navy, a Modern Navy with Chinese Characteristics* (Office of Naval Intelligence, March 1, 2009), 22; US Department of Defense, *Military and Security Developments Involving the People's Republic of China: 2023* (October 19, 2023), 55.

27. Fiona S. Cunningham, "Strategic Substitution: China's Search for Coercive Leverage in the Information Age," *International Security* 47, no. 1 (2022): 46–92.
28. Keir A. Lieber and Daryl G. Press, "The End of MAD? The Nuclear Dimension of US Primacy," *International Security* 30, no. 4 (2006): 7–34.
29. Shou Xiaosong, 战略学 [Science of military strategy] (Academy of Military Science Press, 2013), 148.
30. Michael D. Swaine, "China's Assertive Behavior. Part One: On 'Core Interests,'" *China Leadership Monitor* 34, no. 22 (2011): 1–25.
31. Hans M. Kristensen, Matt Korda, Eliana Johns, and Mackenzie Knight, "Chinese Nuclear Weapons, 2024," *Bulletin of the Atomic Scientists* 80, no. 1 (2024): 49–72; US Department of Defense, *Military and Security Developments: 2024*, 101.
32. US Department of Defense, *Military and Security Developments: 2024*, 56
33. US Department of Defense, *Military and Security Developments: 2024*, 61.
34. US Department of Defense, *Military and Security Developments: 2024*, 105
35. US Department of Defense, *Military and Security Developments: 2024*, 92, 105.
36. US Department of Defense, *Military and Security Developments: 2024*, 101.
37. Wuthnow, "Shield, Sword, or Symbol."
38. Cunningham, "Strategic Substitution."
39. Zou Zhibo and Liu Wei, 构建中美核战略稳定性框架: 非对称性战略平衡的视角 [Constructing the Sino-US nuclear strategic stability framework: An asymmetric strategic balance approach) 国际安全研究 (*Journal of International Security Studies*) 1 (2019), cited in Kaufman and Waidelich, *PRC Writings on Strategic Deterrence*, 24.
40. Anonymous US government official, quoted in Andrew S. Erickson, "China's Approach to Conventional Deterrence," in *Modernizing Deterrence: How China Coerces, Compels, and Deters*, ed. Roy D. Kamphausen (National Bureau of Asian Research, 2023), 26.
41. James Lacey, "Battle of the Bastions," *War on the Rocks*, January 9, 2020.

42. Choe Sang-Hun, "North Korea Says It Tested Multiple-Warhead Missile Technology," *New York Times*, June 26, 2024; Dan White, "Putin and Kim's Comprehensive Strategic Partnership: Alignment Against the West, a Hedge Against China," Wilson Center, Kennan Institute, September 5, 2024.
43. Hans M. Kristensen, Matt Korda, Eliana Johns, and Mackenzie Knight, "North Korean Nuclear Weapons, 2024," *Bulletin of the Atomic Scientists* 80, no. 4 (2024): 251–71.
44. US Department of State, "Secretary Antony J. Blinken at Aspen Security Forum Fireside Chat Moderated by Mary Louise Kelly of National Public Radio," July 19, 2024.
45. Jonathan Masters and Will Merrow, "What Are Iran's Nuclear and Missile Capabilities?," Council on Foreign Relations, October 11, 2024.
46. Hans M. Kristensen, Matt Korda, Eliana Johns, and Mackenzie Knight, "Status of World Nuclear Forces," Federation of American Scientists, March 29, 2024.
47. Kristensen et al., "Status of World Nuclear Forces."
48. Hans M. Kristensen and Matt Korda, "Indian Nuclear Forces, 2020," *Bulletin of the Atomic Scientists* 76, no. 4 (2020): 217–25.
49. Even if China, Russia, North Korea, and Iran could coordinate politically, they would likely be averse to combining their nuclear forces under a single control system.
50. National Nuclear Security Administration, *Fiscal Year 2023 Stockpile Stewardship and Management Plan* (US Department of Energy, 2023), 1–4.
51. Joseph Labrum, "Strategic Shifts Require Reshaping the U.S. Nuclear Arsenal," *Proceedings* (US Naval Institute) 150, no. 10 (2024).
52. US Department of Defense, *Military and Security Developments: 2024*, 87.
53. US Department of Defense, *Military and Security Developments: 2024*, 101.
54. Sari Arho Havrén, "China's No First Use of Nuclear Weapons Policy: Change or False Alarm?," Royal United Services Institute (RUSI), October 13, 2023; Tong Zhao, "The Real Motives for China's Nuclear Ex-

pansion," *Foreign Affairs*, May 3, 2024; Nicola Leveringhaus, "How China's Nuclear Past Shapes the Present: Ideological and Diplomatic Considerations in Nuclear Deterrence," in *Modernizing Deterrence: How China Coerces, Compels, and Deters*, ed. Roy D. Kamphausen (National Bureau of Asian Research, 2023).

55. Kaufmann and Waidelich, *PRC Writings on Strategic Deterrence*, 45–46.
56. Zuo Xiying, "Meiguo dui hua changgui weishe zhanlue de tiaozheng" [Adjustments in the United States' conventional deterrence strategy against China], CSIS Interpret: China, original work published in *Guoji anquan yanjiu* 5 (September 16, 2022): 19; Song Minghang, "Zhong mei chongtu shijiao xia zhongguo he zhanlue de zai sika" [Rethinking China's nuclear strategy from the perspective of Sino-US conflict] (master's dissertation, Shuoshi Xuewei Lunwen, 2022), 1.
57. A September 2017 poll by Fuji News Network found that 69 percent of Japanese opposed having the United States bring nuclear weapons into Japan. See Mike Mochizuki, "Three Reasons Why Japan Will Likely Continue to Reject Nuclear Weapons," *Washington Post*, November 6, 2017. For a historical perspective on the Philippines, see Robert McClintock, memorandum to acting secretary, "Presidential Decision on Categories of Information for Symington Subcommittee to Be Protected by Executive Privilege," September 19, 1969.
58. Missile Threat, "Defense Support Program (DSP)," Center for Strategic and International Studies (CSIC), July 28, 2021.
59. Cunningham, "Strategic Substitution."
60. Peter Suciu, "7 Days: How the Soviet Union Planned to Crush NATO in a Land War," *National Interest*, March 18, 2021.
61. Raymond Garthoff, "The NATO Decision on Theater Nuclear Forces," *Political Science Quarterly* 98, no. 2 (1983): 201.
62. Garthoff, "NATO Decision," 199.
63. Susan Colbourn, *Euromissiles: The Nuclear Weapons That Nearly Destroyed NATO* (Cornell University Press, 2022), chap. 2.
64. Tom Nichols, Douglas Stuart, and Jeffrey D. McCausland, eds., *Tactical Nuclear Weapons and NATO* (US Army War College, Strategic Studies Institute, April 2012), 5–6.
65. Nichols, Stuart, and McCausland, *Tactical Nuclear Weapons*, 25–30.

66. Cold War International History Project, *Document Reader Part II: The Euromissiles Crisis and the End of the Cold War, 1977–1987* (Wilson Center, December 10–12, 2009).
67. Garthoff, "NATO Decision," 205.
68. Garthoff, "NATO Decision," 208.
69. Nichols, Stuart, and McCausland, *Tactical Nuclear Weapons*, 57; Colbourn, *Euromissiles*, chap. 11.
70. Toby Dalton, Karl Friedhoff, and Lami Kim, *Thinking Nuclear: South Korean Attitudes on Nuclear Weapons* (Chicago Council on Global Affairs, February 21, 2022); Yuki Tatsumi, Pamela Kennedy, and Kenji Nagayoshi, "Japan's Strategic Future and Implications for the US-Japan Alliance," Stimson Center, February 28, 2024; Kim Soo-yeon, "Yoon Says He Will Request Redeployment of US Tactical Nukes in Case of Emergency," Yonhap News Agency, September 22, 2021.
71. Washington neither confirms nor denies having nuclear weapons in Japan and the Philippines.
72. Andrew Erickson, "Good Riddance to the INF Treaty: Washington Shouldn't Tie Its Own Hands in Asia," *Foreign Affairs*, August 29, 2019.
73. Anya L. Fink, *Nuclear-Armed Sea-Launched Cruise Missile (SLCM-N)* (Congressional Research Service, October 17, 2024).
74. Air-launched nuclear-armed Long-Range Stand-Off (LRSO) weapons are advanced cruise missiles designed to be launched from aircraft and deliver nuclear warheads over distances of more than 2,400 kilometers while remaining outside the range of enemy defenses. These weapons enhance a nation's strategic deterrence capability by allowing precise, long-range nuclear strikes without putting the launching aircraft at risk. Center for Arms Control and Non-Proliferation, "Fact Sheet: Nuclear Sea-Launched Cruise Missiles" (May 2024); Bryant Harris, "GOP Moves to Instate Sea-Launched Cruise Missile Nuclear Program," *Defense News*, June 21, 2023.
75. Dalton, Friedhoff, and Kim, *Thinking Nuclear*.
76. Dasl Yoon and Timothy W. Martin, "South Korea's Interest in Nuclear Weapons Hasn't Gone Away—It's Just on Hold," *Wall Street Journal*, September 16, 2023.
77. Martha Raddatz and Luis Martinez, "ABC News Exclusive: Inside the US Nuclear Ballistic Missile Submarine in South Korea," ABC News, July 20, 2023.

78. Fink, *Nuclear-Armed Sea-Launched Cruise Missile*.
79. Akiyama Nobumasa, *Japan's Realism Diplomacy*, Center for Strategic and International Studies (CSIS), June 8, 2023.
80. The 1987 Constitution of the Republic of the Philippines, Article II, Section 8, Ratified February 2, 1987.
81. Eric Heginbotham and Richard J. Samuels, "Vulnerable US Alliances in Northeast Asia: The Nuclear Implications," *Washington Quarterly* 44, no. 1 (2021): 170; Brad Roberts, *Living with a Nuclear-Arming North Korea: Deterrence Decisions in a Deteriorating Threat Environment* (Stimson Center, November 2020), 14, 17.
82. Hans M. Kristensen, Matt Korda, Eliana Johns, and Mackenzie Knight, "Nuclear Weapons Sharing, 2023," *Bulletin of the Atomic Scientists*, November 8, 2023.
83. Joshua Byun and Do Young Lee, "The Case Against Nuclear Sharing in East Asia," *Washington Quarterly* 44, no. 4 (October 2021): 71; Peter Douglas Feaver, *Guarding the Guardians: Civilian Control of Nuclear Weapons in the United States* (Cornell University Press, 1992), 183–98.
84. Jesse Johnson, "Japan Should Consider Hosting US Nuclear Weapons, Abe Says," *Japan Times*, February 27, 2022.
85. Tatsumi, Kennedy, and Nagayoshi, "Japan's Strategic Future."
86. Jennifer Ahn, "The Evolution of South Korea's Nuclear Weapons Policy Debate," Council on Foreign Relations, August 16, 2022; Kim Soo-yeon, "Yoon Says He Will Request Redeployment of US Tactical Nukes in Case of Emergency," Yonhap News Agency, September 22, 2021.
87. Joint Declaration on the Denuclearization of the Korean Peninsula, Republic of Korea and Democratic People's Republic of Korea, January 20, 1992.
88. Nobumasa Akiyama, "Mitigating Japan's Nuclear Dilemma," Stimson Center, May 7, 2024; Ministry of Foreign Affairs of Japan, "Three Non-Nuclear Principles," statement by Prime Minister Eisaku Sato at the Budget Committee in the House of Representatives, December 11, 1967.
89. William Hennigan, "Inside the $100 Billion Mission to Modernize America's Nuclear Missiles," *Time*, September 13, 2022.
90. Liam Stack, "Update Complete: US Nuclear Weapons No Longer Need Floppy Disks," *New York Times*, October 24, 2019.

91. Office of the Press Secretary, "Fact Sheet: An Enduring Commitment to the US Nuclear Deterrent," White House, November 17, 2010.
92. Air Force Nuclear Weapons Center, "Sentinel ICBM" accessed November 15, 2024.
93. Based on limited public information, the B-21 looks like a very long range stealth bomber, akin to the B-2, the only aircraft in US service that can remain stealthy while carrying air-launched standoff weapons—missiles with long-enough ranges that the attacker can evade defensive fire. However, the B-21 will have a number of conventional missions alongside nuclear delivery, particularly in a China conflict, where it would be used alongside US submarines to penetrate and break the Chinese reconnaissance network. *Aerotech News*, "B-21 Bomber to Be Unveiled First Week in December," September 21, 2022; Maya Carlin, "The US Air Force's B-21 Raider Problem Gives Me the Chills," *National Interest*, May 16, 2024.
94. US Government Accountability Office, *Columbia Class Submarine: Program Lacks Essential Schedule Insight amid Continuing Construction Challenges* (2023); John Barrientos, "The US Navy Has a Nuclear Workforce Problem," Council on Foreign Relations, March 26, 2024.
95. Congressional Commission on the Strategic Posture of the United States, *America's Strategic Posture*, October 2023, 7.
96. Congressional Commission, *America's Strategic Posture*, 7.
97. Congressional Commission, *America's Strategic Posture*, 33.
98. Congressional Commission, *America's Strategic Posture*, 60.
99. Hans Kristensen and Matt Korda, "The 2022 Nuclear Posture Review: Arms Control Subdued by Military Rivalry," Federation of American Scientists, December 27, 2022.
100. A "dial-a-yield" weapon is an explosive device whose power can be adjusted before use, allowing military planners to tailor the explosion to specific targets. This capability applies to both nuclear and conventional weapons. Andrea Howard, "Tactical Nuclear Weapons Are Back," *Proceedings* (US Naval Institute) 144, no. 4 (2018): 1382.
101. Although a submarine can quickly submerge and move away after launching a missile, the initial launch still reveals its location, making it temporarily vulnerable to detection and potential counterattack. In addition, the use of a strategic asset like an SSBN for a nonstrategic strike could compromise its primary role in ensuring a credible second-

strike capability. The risk of exposing the submarine's position is a significant concern, as it could undermine the overall strategic deterrence posture.

102. Office of the Secretary of Defense, *Nuclear Matters Handbook*, chap. 4 (US Department of Defense, 2020).
103. See Oleg Bukharin, "A Breakdown of Breakout: US and Russian Warhead Production Capabilities," Arms Control Association, 2002. Newer information is naturally hard to identify in open sources. However, there is no reason to believe that Russia has changed its practice of retiring older warheads and producing new ones for its nuclear arsenal. See Kristensen et al., "Status of World Nuclear Forces."
104. David E. Hoffman, "Mutually Assured Misperception on SDI," Arms Control Association, October 2010.
105. The Aegis Ballistic Missile Defense (BMD) is a naval-based system that uses ship-based interceptors to detect, track, and destroy short- to intermediate-range ballistic missiles during their midcourse phase in space. The Patriot missile system, a ground-based air and missile defense platform, intercepts and destroys tactical ballistic missiles, cruise missiles, and advanced aircraft at medium to long ranges. Terminal High Altitude Area Defense (THAAD) is another ground-based system designed to intercept and destroy short-, medium-, and intermediate-range ballistic missiles during their terminal phase using a hit-to-kill approach. Complementing these systems, the Ground-Based Interceptor (GBI) program forms a crucial part of the US homeland missile defense strategy, employing interceptors in Alaska and California to target and neutralize incoming long-range ballistic missiles in their midcourse phase in space.
106. Center for Arms Control and Non-Proliferation, "Fact Sheet: US Ballistic Missile Defense," June 12, 2023.
107. Wuthnow, "Shield, Sword, or Symbol."

Conclusion

1. Franklin D. Roosevelt, "The Arsenal of Democracy," fireside chat, December 29, 1940. Recording and transcript available at the Miller Center, University of Virginia.