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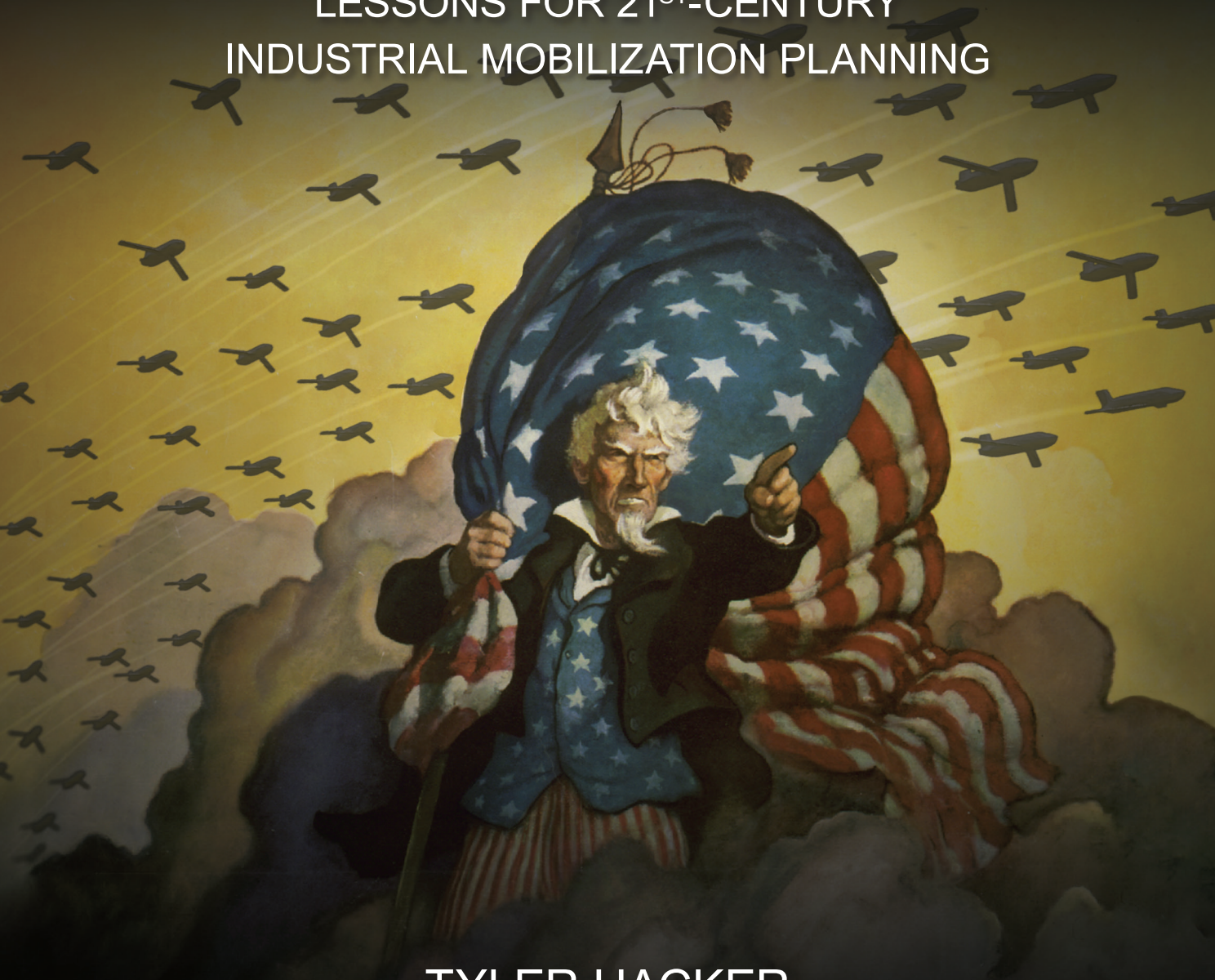
ARSENAL OF DEMOCRACY: MYTH OR MODEL?

LESSONS FOR 21ST-CENTURY INDUSTRIAL MOBILIZATION PLANNING



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ABOUT THE AUTHOR

Tyler Hacker is a research fellow at the Center for Strategic and Budgetary Assessments. His work focuses on long-range strike, future operational concepts, and great power conflict. Since joining CSBA, he has written on topics including precision-guided munitions, ground-based fires, joint command and control, military innovation, and European security. Prior to joining CSBA, Tyler was an analyst at the Congressional Research Service, where he conducted research on topics in defense logistics. Tyler previously served as a field artillery officer in the United States Army in Germany, where he participated in NATO operations and exercises in Poland, Romania, and the Baltic states. He has also worked at the U.S. Army War College and the American Enterprise Institute. Tyler holds a BA in international studies from Virginia Military Institute and an MA in security studies from Georgetown University.

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Executive Summary

Sustained expenditures of large quantities of precision-guided munitions in conflicts in Europe and the Middle East have highlighted the voracious demands of modern warfare and cast doubt on previous assumptions about munition requirements for great power war. A protracted conflict with the People's Republic of China (PRC) would create immense demands for munitions, requiring production to be expanded far beyond surge capacity. These concerns have led to calls for the United States to mobilize its defense industry and rapidly expand munitions production, with policymakers and commentators including former president Joseph Biden hearkening back to the nation's role as the "Arsenal of Democracy" in World War II.

These references are well founded, as America's industrial achievements in World War II remain impressive by any standard. But the same pride and nostalgia that make these references resonate have sometimes obscured the true cost, length of time, and scale of effort required to mobilize industry to support the allied victory. Moreover, industrial mobilization is a topic the U.S. military has not seriously considered since the end of the Cold War.

In this context, this monograph revisits the Arsenal of Democracy to identify enduring lessons and cautions for contemporary industrial mobilization planning. To accomplish this, it recounts the history of mobilization to separate mythology from fact, examines the evolution of the munitions industrial base since the 1940s, and draws lessons from the development of the Arsenal of Democracy for today's policymakers and defense planners. By doing so, the study aims to contribute to ongoing efforts to assess the U.S.–Chinese military–industrial balance and the trends affecting its future trajectory.

This recounting of mobilization planning and execution from the interwar period through peak production in 1943–1944 reveals that the staggering increases in war production during World War II and the allied grand strategy these materials supported were mainly possible because of the circumstances of the era. The United States had years to mobilize before engaging in the war's costliest campaigns, enjoyed a homeland mostly safe from attack, controlled vast raw material extraction and refining resources, and had the world's largest reserve of latent commercial industrial capacity available for conversion to war

production. The nation finds itself in a different environment today, with little in the way of mobilization planning; a homeland vulnerable to unconventional, conventional, and nuclear attack; and decades of globalization and deindustrialization that have, by many metrics, left China the superior manufacturer. Combined with a consolidated defense sector that specializes in advanced munitions and platforms with exquisite production requirements and complex global supply chains, expanding or mobilizing war production in the present era is likely to require much more time and effort. These trends make the Arsenal of Democracy more useful as an aspiration than as a model for modern industrial mobilization.

Nevertheless, the planning and execution of World War II's industrial mobilization contains aspects of the same challenges currently faced by the U.S. military and defense industry. History reveals a striking series of parallels between the 1930s and today: insufficient munition stockpiles, a winnowed defense industrial base, and the renewed specter of multitheater war amid technological and political changes that are evolving the nature of warfare and the geoeconomic landscape. Given the enduring nature of industrial warfare, many fundamental planning considerations, tradeoffs, and risks inherent to industrial mobilization in the United States remain unchanged. Relevant lessons for mobilization planning and execution include:

Industrial mobilization planning is difficult but essential. The supreme lesson of the Arsenal of Democracy is the value of detailed preconflict planning and preparation for industrial mobilization and protracted war. Interwar mobilization plans were far from perfect, but the efforts of the War Department in the 1920s and 1930s were instrumental in expanding military production from 1939 to 1943. The military's plans and supporting documents provided the foundation for mobilization by identifying priority goods, materials, and chokepoints; driving industrial engagement and investment in advance of conflict; and decreasing the time necessary to expand the production of key munitions. Moreover, the plans went beyond paper to guide the limited resources of the interwar period toward meaningful investments in schedules of production, manufacturing studies, educational orders, and the purchase of tooling and capital equipment to refurbish arsenals and train acquisition and industry personnel. Industrial mobilization planning remains an essential part of preparing for modern great power wars because it sets strategic assumptions critical for synchronizing the numerous parties indispensable to mobilization, guides investments to reduce production timelines, and strengthens deterrence credibility against both protracted conflicts and rapid attempts at a fait accompli.

Mobilization planning must be synchronized with protracted war plans. Industrial mobilization planning is essential because it remains intimately linked to a nation's grand strategy in protracted war. Allied strategy in World War II was largely dictated by mobilization requirements and timelines that favored a prolonged war centered on leveraging America's latent industrial advantage to eventually overwhelm the Axis powers with men and materiel. Given the enduring relationship between industrial capacity and protracted war strategy, mobilization planning must be integrated into contemporary

warfighting concepts in order to close existing operational–industrial gaps. Just as the industrial decisions and indecisions of 1939 to 1941 had significant impacts on the direction and outcome of World War II, the United States must today consider the long-term strategic and industrial implications of its responses to contemporary emergencies such as the Russia–Ukraine conflict. These responses will shape the industrial and in turn strategic options available to the nation in the event of a protracted war in the next decade or beyond. Thus, plans for fighting a protracted war and mobilizing industry are essential to balancing short- and long-term defense priorities. History proves that the United States is often wrong in its predictions about where and when it will fight its next war, but the only option worse than planning for the wrong war is not planning for any possibility of a protracted conflict that would require mobilization.

Determining requirements is the principal challenge but necessary first step of mobilization planning. Protracted war planning is essential because it is a prerequisite for determining the military requirements that drive industrial planning. During World War II, requirements and strategy were related, with changes to one dictating changes to the other. Questions pertaining to exactly what the armed forces needed and in what quantities were paramount to steering the industrial expansion that led to the Arsenal of Democracy. Similarly, determining U.S. military requirements for protracted great power war remains the vital prerequisite and essential challenge of modern mobilization planning. The military services must think more deeply and comprehensively about what they will require during a protracted war, even if current resources remain constrained. Requirements should maintain a degree of flexibility so the services can adapt to changes in the security environment and ongoing operations, but a basic estimate of military needs over the duration of a conflict is vital for enabling contemporary industrial planning.

Allies must be factored into mobilization requirements and plans. Throughout World War II, assessing and coordinating allied requirements was a constant source of frustration and tension for civilian and military officials. The support of allies through Cash and Carry and Lend–Lease both added to and detracted from America's ability to mobilize and equip its own forces for combat. Given the globalized nature of modern industry and defense production, the role of U.S. allies and partners in industrial mobilization may be even more critical today. Because American allies will likely rely on some U.S. weapons, these requirements must be built into U.S. plans in order to provide a coordinated demand signal and determine the total American industrial capacity needed to supply U.S. and allied forces. Numerous opportunities exist for industrial cooperation, including codevelopment or coproduction of military goods and the sourcing of inputs not produced domestically in large quantities. In developing these relationships, U.S. planners should consider the lines of communication vital to maintaining production during wartime and the potential burden that defending these supply lines might place on U.S. and allied forces.

Mobilization plans must consider threats to the U.S. homeland. Even during World War II, when the contiguous United States was relatively safe, the armed forces

and industry implemented various defensive measures. Today's potential adversaries have numerous capabilities they could use to interfere with U.S. critical infrastructure, degrade American war production, and attack industrial targets located throughout the homeland. Indeed, U.S. adversaries are already using "gray zone" tactics and unconventional warfare to disrupt Western defense production and critical infrastructure. Defending the homeland may take the form of hardened networks and infrastructure, measures to prevent espionage and sabotage, or air and missile defenses around critical nodes. These measures will draw on limited resources and low-density assets. For this reason, a renewed focus on homeland defense and civil defense is a critical element of industrial mobilization planning. The Department of Defense (DoD) must work with industry and interagency partners to eliminate vulnerable bottlenecks, disperse critical nodes, and harden weak points in defense production facilities.

Mobilization plans will influence U.S. military force design. In a protracted war, industrial mobilization plans will shape the U.S. military in two ways. First, the longer a conflict endures, the more essential it becomes to design and produce new systems alongside the production of existing ones. The U.S. military of 1945 was vastly different from the military of 1940: it was equipped with different platforms and weapons, was carrying out new missions, and contained a series of novel organizations. Second, the standing U.S. military must be capable of continuing the conflict until industry is sufficiently mobilized to replace losses and support the campaigns necessary for victory. Planners must consider how increased attrition and materiel shortages may affect concepts of operations and emphasize a force with not only sufficient capacity but also the modularity and flexibility to adapt to new missions and unforeseen countermeasures.

Mobilization plans may dictate design requirements and modifications for munitions and platforms. Industrial requirements and limitations may also shape the force produced by mobilization. During World War II, munition designs were often altered to accommodate supply chain and material allocation issues and to increase manufacturing efficiency. Industrialists increased the producibility of numerous defense goods by simplifying designs and improving manufacturing processes. The DoD should work with current suppliers of critical munitions to determine how their designs could be simplified for increased production through the reevaluation of requirements or process modernizations. Should the design of these weapons make them unsuitable for scaled production, then entirely new classes of weapons must be designed with producibility included as a design requirement in conjunction with performance requirements such as speed, range, and survivability. New systems must emphasize modularity, exportability, and commoditizing components to increase the number of potential manufacturers and ease the burden of industrial mobilization planning.

Industrial mobilization will take time but can be expedited. Although interwar planners and industrial leaders expected mobilization to require just 18 months, transforming America's economy into the Arsenal of Democracy took several years and a massive

national effort. Nevertheless, the interwar period reveals several ways mobilization could be expedited, from simplified contracting processes and waived regulations to government investments in capital equipment. Prewar planning and industrial engagement, such as the determination of requirements, identification of critical facilities, and funding of production studies or educational orders offers the greatest opportunity for the DoD to shorten mobilization timelines in the near term. Prevailing in a U.S.–China conflict will require these investments and preparations to be made in peacetime, well ahead of a crisis in the Indo-Pacific. In any case, one vital role of mobilization planning is estimating the length of these timelines so they can be built into defense planning.

Mobilization capacity is largely dependent on the existing industrial base. The massive expansion of war production during World War II was only possible because of America's preexisting industrial strength. Even where the nation lacked munition-specific production facilities, the government leveraged the broad pool of manufacturing expertise to build and staff new plants, most of which were constructed and operational before America's entrance into the war. The conflict's demands still required substantial expansion of the wider industrial base, including the production of steel, aluminum, rubber, and energy products. Today's U.S. economy and industrial base present a much different starting point for mobilization; the extent to which deindustrialization, reduced manufacturing capacity, and the transition to a service-focused economy would affect industrial mobilization is unclear. That said, there are numerous measures the U.S. government could take to bolster the American industrial base with an eye toward national defense and mobilization, from broad economic and trade policies to more surgical actions by the DoD and other agencies to support specific sectors of the defense industrial base. Defense production efficiency and capacity can be increased through advanced manufacturing, improving industrial processes with software, and decoupling weapon design from manufacture. The United States still has significant commercial industrial capacity that could be harnessed to support defense production.

Mobilization will not supersede politics. America's mobilization for World War II shows that even during a national security emergency resulting from a direct attack on the United States, domestic and international politics will not disappear; rather, they will shape what is achievable through mobilization. Interwar mobilization plans were built on faulty assumptions that led President Franklin Roosevelt to sideline them due to the political environment and his personal leadership style. Americans overwhelmingly banded together to create the Arsenal of Democracy, but domestic politics still created significant obstacles. Today, planners must not rely on the flawed assumption that a national emergency will sweep away restrictions and allow the DoD to execute a speedy mobilization without interference from competing political priorities. Mobilization plans must be based in political realities and flexible enough to account for the domestic and international political environments as conflict approaches.

Mobilization will require increased funding and acceptance of risk. Although politics will always influence mobilization planning and execution, any successful effort to mobilize American industry will require prioritization of resources and expenditure of political capital. Creating the Arsenal of Democracy required increasing defense spending 15 times from 1941 to 1945. A similar increase in spending today would see a defense budget north of $27 trillion. As in World War II, industrial mobilization may require placing military and industrial concerns over competing policies related to antitrust prosecution, environmental protection, revenue generation, labor regulation, and foreign sourcing of material. Moreover, efforts to increase the mobilization potential of the U.S. defense industrial base in peacetime will inevitably create excess capacity and are unlikely to be pursued by commercial firms absent incentives from the DoD. In short, the DoD must foot the bill and take on the financial risks associated with investments in excess capacity to increase the industrial base's readiness for great power war. This reflects the American experience in World War II, when the U.S. government funded nearly all expanded production in munitions and in several other industries lacking commercial demand.

Mobilization may require novel approaches to acquisition. The scale of industrial requirements during World War II required procurement officials to develop a variety of innovative methods to purchase the equipment they needed and expand production, from the recruitment of so-called "dollar-a-year men" to modified tax codes and the establishment of government-owned, contractor-operated munition plants. Likewise, Cash and Carry and Lend–Lease were creative ways to supply allies despite neutrality restrictions and without relying on politically unpopular loans. A successful contemporary industrial mobilization might require similarly innovative approaches to military procurement and industrial policy that would rebalance the distribution of financial risk among the U.S. government, American allies and partners, and industry.

Mobilization for great power war is competitive. Industrial mobilization is inherently competitive. Belligerents attempt to bring their national resources to bear and provide their forces with the firepower necessary to outmatch their opponent. World War II's industrial mobilization at home was paired with diplomatic and military campaigns to degrade the production capacity and supply lines of the Axis powers. Today, industrial mobilization for great power war would be a similarly competitive endeavor. Efforts to expand war production could be accompanied by campaigns to degrade an adversary's ability to maintain their war economy and supply their military forces. These efforts might include disrupting enemy supply lines via economic sanctions, diplomatic pressure, or maritime interdiction, degrading enemy transportation networks via nonkinetic or kinetic attacks, or strikes against enemy military–industrial facilities. Conducting these operations may require a different set of offensive capabilities than striking military forces or halting an invasion force, and military planners should consider various methods of imposing costs on and impeding adversary war production over the duration of a protracted conflict.

Industrial mobilization typically occurs alongside a broader national mobilization. Policymakers must remember that the Arsenal of Democracy was the result not only of expanding America's defense production but also of mobilizing the nation's entire economy, workforce, and resources toward the war effort. Roosevelt's limited prewar efforts laid the foundation for later growth, but the production gains achieved during the war required a national mobilization effort that was only politically viable after Pearl Harbor. Even with the entire country on a war footing, mobilization officials were still constrained by the limits of the nation's total resources and were forced to make numerous tradeoffs and adjustments to their strategic plans. Industrial mobilization would today require comparable levels of national effort, and even limited initiatives to expand key sectors of the defense industrial base may require broader economic measures and expansion of the wider U.S. industrial base. Any such efforts would require increased conversation and debate at the national level about the security challenges facing the United States. This reflects the fact that preparing the nation's defense industry for great power conflict and bolstering its mobilization potential are key elements of long-term strategic competition, not short-term pursuits confined to the DoD or a single combatant command.

Mobilization plans and protracted war strategy must leverage the nation's competitive advantages. Finally, planners must consider the enduring competitive advantages of the United States relative to its great power adversaries. The nation is no longer the world's leading commercial manufacturer, and planners should not build their strategies to be reliant on bygone strengths. Prevailing in a war against the PRC will require a military–industrial strategy that leverages America's present advantages to their full effect. This study highlights three qualities commonly cited as U.S. advantages: an innovative free market system, advanced defense and manufacturing technologies, and a global network of allies and partners.

The **free market system** and the innovation it encourages were essential factors in creating the Arsenal of Democracy. Today, they are often named as enduring advantages the United States holds over its authoritarian competitors. Prevailing in industrialized warfare requires nations to convert national resources and industrial capacity into the weapons and platforms necessary for military campaigns. Historically, the American free market system has proven the superior approach to doing this because it balanced centralized coordination and deconfliction with decentralized action that leveraged individual mandates and innovation. During World War II, the Roosevelt administration deliberately used the free market system to incentivize speed and maximize output using profit motives, which encouraged business and technological innovation on all fronts. This approach balances the civilian and military economies, recognizes that the DoD does not possess the capacity or expertise to direct the nation's industries, and plays to the ideological element of strategic competition between Western democracies and authoritarian nations. As the previous three decades have shown, however, overreliance on the free market and free trade system can produce outcomes detrimental to national defense, such as the outsourcing of critical supply chains and the elimination of excess capacity. It remains up to the U.S. government to mitigate

these risks through financial incentives and shouldering a larger portion of the business risk associated with investing to expand production capacity.

The free market has traditionally played a large role in encouraging the innovation critical to maintaining a second U.S. advantage: decades of **leadership in cutting-edge commercial and defense technologies**. Although the Chinese government is actively contesting American technological leadership, the U.S. defense industrial base continues to dominate in areas such as undersea and low-observable technologies, and U.S. defense technologies remain the envy of the world. Today's problem is less about the quality of technology in U.S. weapons and more about the scale at which these cutting-edge technologies can be produced. U.S. military planners must avoid relying on "technological fetishism" to replace strategy or avoid hard choices, including the need to expand industrial capacity and increase defense expenditures. Instead, the focus must be on maintaining and expanding current areas of advantage while simultaneously working to scale industry to meet today's challenges. To produce advanced technologies in sufficient quantity, the United States should rebuild its defense industrial base with advanced manufacturing technologies. Similar advances in mass production were critical to the Arsenal of Democracy, and modern innovations in production such as improved automation, 3D printing techniques, software-defined manufacturing, and the decoupling of system design and production may be the key to building weapons and platforms at rates previously thought impossible.

Finally, the United States enjoys close diplomatic, military, and industrial ties with a number of the world's leading economies, which, considered together, rival the PRC across many metrics. This **global network of allies and partners** may encourage the United States to rely on an Arsenal of Democracies rather than being the sole Arsenal of Democracy. As China and Russia intensify their military and economic cooperation and the world moves toward selective, bloc-aligned trading partnerships, it is incumbent on the United States to ensure its allies and partners remain aligned with the United States, particularly for military goods and their industrial inputs. Allies can ease the industrial mobilization burden in many ways, from adding diversity and resilience to U.S. supply chains to sharing defense technologies and innovations. In today's globalized economy, the United States must consider how to utilize these relationships in ways that maximize their benefits and minimize the risks associated with foreign dependencies. Mobilization planning should track the capacities of major foreign sources of critical defense materials and conduct supply chain analysis to examine how disruption of these sources might affect defense production during peacetime and conflict. In today's threat environment, a coalition-based industrial strategy requires the DoD to go beyond merely tracking dependencies and actively prepare for supply chain disruptions and adversary interference. It may also signal that the United States should rebuild its Merchant Marine to maintain the ability to import inputs and to exchange materials and finished goods with its allies and partners in overseas theaters.

The U.S. munitions industry and the broader defense industrial base have evolved significantly alongside the U.S. military since the beginning of the 20th century. Despite

Americans' fond remembrance of the Arsenal of Democracy and the many lessons the era holds for today's planners and policymakers, there is no returning to the defense industrial base of previous eras. America's mobilization for World War II was a unique product of the circumstances and national capacities of the period. Today's military–industrial strategy and mobilization plans must be forward looking. Preparing the munitions industrial base for protracted war will require the combined effort of the DoD and its industrial partners. Just as strategy and production enjoyed a reciprocal relationship during World War II, the DoD must incentivize the production base it desires while working with industry to inform and refine its mobilization plans for protracted war. The U.S. military and the defense industry have evolved significantly over the decades, but the interplay between strategy and production is an enduring feature of American military–industrial relations.

The dangers of failing to prepare for industrial mobilization are numerous and serious, from leaving U.S. forces with empty magazines to forcing decision makers to rely on the threat of nuclear weapons. Should the U.S. military decrease in size or capability, then planning for mobilization and the reconstitution of forces takes on an even greater importance—just as in the interwar period. The actions of America's adversaries show how seriously they consider protracted warfare and industrial mobilization. In many respects, they are well ahead of the United States in preparing for such measures.

The DoD and the defense community appear to be coming around to the possibility of protracted war and the need for dedicated planning for industrial mobilization. The recent National Defense Industrial Strategy and numerous studies of defense supply chains and the industrial base are steps in the right direction and champion many of the points made throughout this monograph. These efforts amount to a call for action that must be followed with continued focus, detailed planning, and sustained investments. Rebuilding American defense industrial capacity after decades of neglect will be a national project extending well into the future, but the military–industrial feats of 1938 to 1945 stand as inspirational reminders of what the United States is capable of with sufficient unity and purpose.

CHAPTER 1

Introduction

> For almost twenty years we had all the time and almost none of the money; today we have all of the money and no time.
>
> —General George C. Marshall, Chief of Staff of the Army, July 1940[1]

> We are out of time. We can no longer regard conflict as a distant probability or a future problem that we might have to confront. The risk of conflict is here now and that risk will increase with time.
>
> —Frank Kendall, Secretary of the Air Force, February 2024[2]

Despite being made nearly 85 years apart, the above epigraphs express remarkably similar sentiments about the U.S. military's readiness for great power conflict. Both Marshall and Kendall sought to convey the imminent threat of war and the dire need for increased military readiness. A driving factor behind these statements was the poor state of U.S. munition stockpiles and the munitions industrial base. As Europe descended into war in spring 1940, American capacity to produce weapons and equip U.S. and allied forces remained insignificant.

In 2025, the U.S. military is similarly finding its stockpiles of and capacity to produce critical precision-guided munitions (PGMs) woefully undersized for a potential great power war with the People's Republic of China (PRC) or Russia, particularly a conflict that lasts more than a few weeks. Expenditure rates in the Russia–Ukraine conflict have highlighted the voracious munition demands of modern warfare and called into question assumptions about munition requirements for protracted war. Concurrently, the U.S. military has expended an enormous number of weapons—many of them expensive, exquisite, and hard

1 Quoted in "Marshall and the Invasion of Poland," The George C. Marshall Foundation, August 30, 2023, https://www.marshallfoundation.org/articles-and-features/marshall-invasion-poland/.

2 Quoted in Michael Marrow and Theresa Hitchens, "Air Force Launches Reorganization, as Kendall Warns 'We Are Out of Time' to Match China," *Breaking Defense*, February 12, 2024, https://breakingdefense.com/2024/02/air-force-reorganization-frank-kendall-china/.

to manufacture—in operations in the Red Sea and transferred other PGMs to U.S. allies and partners such as Israel. To make matters worse, supporting these conflicts has also shown the munition stocks of many U.S. allies in Europe to be worse off than those of the United States.[3]

These shortages have led to calls for the United States to mobilize its defense industry and rapidly expand weapon production, with many hearkening back to America's role as the "Arsenal of Democracy" in World War II. Numerous policymakers and commentators, including former president Joseph Biden, have called for the United States to become a 21st-century Arsenal of Democracy by mobilizing the American munitions industrial base, rapidly increasing PGM production, and expanding the U.S. supply of weapons to allies and partners around the globe.[4]

The motivation behind these references is well founded. The United States and its allies urgently require more PGMs and the capacity to produce them at scale. These calls resonate strongly with Americans precisely because they point to one of America's great 20th-century achievements: a period of industrial mobilization that unleashed the massive manufacturing power of the United States, equipped American soldiers as they rolled back Axis forces across the globe, and ultimately enabled Allied victory in World War II.

But the same pride and nostalgia that make references to the Arsenal of Democracy so powerful have, at times, obscured the true cost, scale of effort, and length of time required to mobilize U.S. industry for World War II. Today, any protracted great power war will likewise require some degree of national mobilization, and it is imperative that policymakers begin to seriously contemplate industrial mobilization in their efforts to prepare the nation to compete with and deter China and Russia.

As the United States begins considering mobilization in the 21st century, should it view the Arsenal of Democracy as a model to be imitated or merely an achievement to admire? Policymakers must maintain a clear-eyed perspective on past achievements. Rather than playing into nostalgia, the United States requires a more comprehensive understanding

3 See, for example, Joshua Posaner and Laura Kayali, "Europe's Arms Production Is in 'Deep Shit,' Says Belgian Ex-General," *Politico*, February 8, 2024, https://www.politico.eu/article/europes-arms-production-is-in-deep-shit-says-belgian-ex-general/.

4 Joseph R. Biden, quoted in "Remarks by President Biden on the United States' Response to Hamas's Terrorist Attacks against Israel and Russia's Ongoing Brutal War against Ukraine," *The White House*, October 20, 2023, https://www.whitehouse.gov/briefing-room/speeches-remarks/2023/10/20/remarks-by-president-biden-on-the-unites-states-response-to-hamass-terrorist-attacks-against-israel-and-russias-ongoing-brutal-war-against-ukraine/; Paul Krugman, "America, Again the Arsenal of Democracy," *New York Times*, April 28, 2022, https://www.nytimes.com/2022/04/28/opinion/russia-ukraine-biden-aid.html; Cynthia Cook, *Reviving the Arsenal of Democracy: Steps for Surging Defense Industrial Capacity* (Washington, DC: Center for Strategic and International Studies, March 14, 2023), https://www.csis.org/analysis/reviving-arsenal-democracy-steps-surging-defense-industrial-capacity; Michael Brown, "A Plan to Revitalize the Arsenal of Democracy," *War on the Rocks*, May 10, 2024, https://warontherocks.com/2024/05/a-plan-to-revitalize-the-arsenal-of-democracy/; and Elliot Ackerman, "The Arsenal of Democracy Is Reopening for Business," *The Atlantic*, March 9, 2023, https://www.theatlantic.com/ideas/archive/2023/03/american-defense-manufacturing-ukraine-aid-arkansas/673327/.

of World War II's industrial mobilization and the lessons it might hold for today's military and industrial base. Rather than basing plans on outdated assumptions related to national mythology, the United States must consider the advantages and limitations of today's weapons industrial base as it seeks to rejuvenate the spirit of the Arsenal of Democracy.

Report Purpose and Scope

This monograph revisits U.S. industrial mobilization for World War II to identify enduring lessons and cautions for contemporary industrial mobilization planning. To accomplish this, it recounts the history of mobilization to separate mythology from fact, examines the evolution of the munitions industrial base since the 1940s, and draws lessons from the development of the Arsenal of Democracy for today's policymakers and defense planners.

The Center for Strategic and Budgetary Assessments (CSBA) has examined potential munition requirements for great power conflict and has, in numerous publications, recommended expanding the weapons industrial base and pointed to the need to begin contemplating industrial mobilization in the modern era.[5] The U.S. government has similarly assessed the health of the defense industrial base in several studies and pursued efforts to expand munitions production capacity through increased demand, multiyear procurements, and other industrial policy initiatives.[6] These efforts have led to gains in some areas, but they focus primarily on incrementally growing capacity for several munitions in the near term.

5 Although outside the scope of this monograph, CSBA has previously noted that another essential piece of preparing for great power conflict is matching novel concepts of operation with technological and industrial capabilities. Concepts of operation must evolve alongside industrial capacity and new technological developments. See Tyler Hacker, *Beyond Precision: Maintaining America's Strike Advantage in Great Power Conflict* (Washington, DC: Center for Strategic and Budgetary Assessments, June 2023), https://csbaonline.org/research/publications/beyond-precision-maintaining-americas-strike-advantage-in-great-power-conflict; Thomas G. Mahnken and Tai Ming Cheung, *The Decisive Decade: United States-China Competition in Defense Innovation and Defense Industrial Policy in and Beyond the 2020s* (Washington, DC: Center for Strategic and Budgetary Assessments, May 2023), https://csbaonline.org/research/publications/the-decisive-decade-united-stateschina-competition-in-defense-innovation-and-defense-industrial-policy-in-and-beyond-the-2020s; Thomas G. Mahnken, *Forging the Tools of 21st Century Great Power Competition* (Washington, DC: Center for Strategic and Budgetary Assessments, March 2020), https://csbaonline.org/research/publications/forging-the-tools-of-21st-century-great-power-competition; and Mark Gunzinger and Bryan Clark, *Sustaining America's Precision Strike Advantage* (Washington, DC: Center for Strategic and Budgetary Assessments, June 2015), https://csbaonline.org/research/publications/sustaining-americas-precision-strike-advantage.

6 Studies include Department of Defense, *Fiscal Year 2021 Annual Industrial Capabilities Report to Congress* (Washington, DC: Department of Defense, March 2023), https://www.businessdefense.gov/docs/resources/FY2021-Industrial-Capabilities-Report-to-Congress.pdf; and Department of the Army, *Surge Capacity in the Defense Munitions Industrial Base* (Washington, DC: Department of the Army, September 2023), https://asb.army.mil/Portals/105/Reports/2020s/ASB%20FY%2023%20DMIB%20Report%20(E).pdf. For examples of Department of Defense industrial initiatives, see Ashley Roque, "House, Senate Defense Authorizers Agree to Multi-year Munitions Buys," *Breaking Defense*, December 7, 2022, https://breakingdefense.com/2022/12/house-senate-defense-authorizers-agree-to-multi-year-muntion-buys/; Abraam Dawoud, "U.S. Army and Industry Partners Mobilize to Boost U.S. Artillery Production," *Army.mil*, February 8, 2024, https://www.army.mil/article/273152/us_army_and_industry_partners_mobilize_to_boost_us_artillery_production; and Jen Judson, "How Companies Plan to Ramp Up Production of Patriot Missiles," *Defense News*, April 9, 2024, https://www.defensenews.com/land/2024/04/09/how-companies-plan-to-ramp-up-production-of-patriot-missiles/.

Efforts to significantly increase production of critical PGMs or prepare for industrial mobilization in case of a protracted war remain embryonic. This study fills this gap and explores questions related to contemporary industrial mobilization:

1. How did the United States plan for industrial mobilization during the interwar period, and were these efforts useful when mobilization began in the late 1930s?

2. What was required to build a munitions industrial base capable of meeting Allied demands during World War II? What amounts of time, resources, prioritization, and public will were necessary to create the Arsenal of Democracy?

3. How have strategic, economic, industrial, and technological trends since the 1940s affected the prospect of mobilizing today's weapons industrial base?

4. What lessons can contemporary policymakers, military planners, and industrial leaders draw from the U.S. mobilization for World War II?

Answering these questions will help planners develop effective competitive strategies that draw upon systemic U.S. advantages and exploit adversary weaknesses, an essential aspect of engaging China in long-term strategic competition and preparing for potential conflict. Fundamental to developing these strategies are net assessments of U.S. and Chinese capabilities and capacities. Any net assessment requires accurate estimates of one's own national strengths and weaknesses and those of competitors. By examining the history of American industrial mobilization, U.S. defense industrial trends since 1945, and potential U.S. enduring advantages, this study contributes to ongoing efforts to assess the U.S.–Chinese military–industrial balance and the trends affecting its future trajectory.

Why Focus on the Munitions Industrial Base?

Industrial mobilization is an immense topic that reaches far beyond military strategy to require a concomitant examination of commercial industry, manufacturing, economics, and other dimensions of total national power and strategic competition. For challenges as broad as industrial mobilization, it is useful to focus on more tractable topics. Thus, this study broadly discusses industrial mobilization but focuses on expanding the munitions industrial base.

Three considerations make the munitions industrial base an ideal starting point for thinking about mobilization. First, numerous assessments have highlighted PGMs and the ability to produce them as critical shortfalls of the U.S. military and industrial base. The United States and its allies and partners are seeking to expand their weapons production capacity. Unlike other defense systems, munitions are expendable. Large numbers of them would be required in conflicts against several different potential adversaries. These demands favor mobilization because they may quickly outstrip surge capacity and maintaining 100 percent of necessary wartime production capacity will never be fiscally or industrially practical during

peacetime. The historical record repeatedly illustrates these demands, and current conflicts are reinforcing them.

Second, military planners have long assumed future wars would be rapid, decisive, and therefore mostly reliant on existing stockpiles of weapons.[7] Conflicts like Desert Storm reinforced the idea that a war would be over before industrial capacity would play a role. Current events, however, have shown this assumption to be flawed. Operations from Ukraine to the Red Sea have been protracted, so they have significantly drawn down U.S. and allied munition inventories. A war between the United States and China is likely to be similarly protracted.[8] The production of some weapons has increased in recent years, but these improvements pale in comparison to the production gains of World War II and the increases that might be required in a contemporary great power war.

Third, production of munitions, although increasingly complex, likely remains easier to expand than larger, more exquisite weapon systems such as fifth-generation aircraft or warships. Moreover, expanding munitions production would be a prerequisite to equipping these platforms for combat: If production of munitions cannot be scaled alongside the production of delivery platforms, then these systems would be of limited utility.

Recent Department of Defense (DoD) investments in the weapons industrial base, although small in scale and limited in scope, are a promising start to tackling this challenge. Developing and producing munitions offers numerous opportunities for continued expansion of the U.S. defense industrial base.

Why Focus on World War II?

Eighty years have passed since America's mobilization for World War II. As this monograph will explore, a number of trends make the present U.S. military–industrial ecosystem vastly different from that of the 1940s. Given these dissimilarities, why should today's policymakers look to that era for lessons on industrial mobilization?

This study focuses on the U.S. experience in World War II for several reasons. Most simply, it remains the last time great powers mobilized for protracted war with other great powers. With World War I ending before U.S. industrial mobilization was completed, World War II remains the only time the United States conducted a national mobilization to fight an ongoing, protracted great power war. Historical data collected during the war allows

7 This assumption and its impact will be more thoroughly explored in Chapter 4.

8 See, for example, Hal Brands, *Getting Ready for a Long War with China: Dynamics of Protracted Conflict in the Western Pacific* (Washington, DC: American Enterprise Institute, July 25, 2022), https://www.aei.org/research-products/report/getting-ready-for-a-long-war-with-china-dynamics-of-protracted-conflict-in-the-western-pacific/; Andrew F. Krepinevich, Jr., *Protracted Great-Power War: A Preliminary Assessment* (Washington, DC: Center for a New American Security, January 2020), https://apps.dtic.mil/sti/pdfs/AD1147652.pdf; and Iskander Rehman, *Planning for Protraction: A Historically Informed Approach to Great-Power War and Sino–U.S. Competition* (London: Routledge, 2023).

industrial mobilization progress to be tracked alongside military demands and expenditures in campaigns from 1941 to 1945. Mobilization and expanded defense production for the Korean and Vietnam conflicts, strategic competition with the Soviet Union, and more recent conflicts in the Middle East did not approach the scale and depth of World War II. The limited mobilization efforts pursued during each of these periods may also hold valuable lessons for contemporary policymakers and are worthy of future examination. Only World War II, however, features the expansion of war production on the scale that might be necessary in a prolonged conflict between the United States and the PRC.

Perhaps most importantly, contemporary policymakers and analysts consistently refer to World War II and the Arsenal of Democracy. These analogies invite a reexamination of the period to determine its applicability to today's strategic environment and defense industrial base.

Report Outline

To reassess the Arsenal of Democracy and glean lessons for the current era of great power competition, this monograph proceeds as follows:

Chapter 2 recounts World War II industrial mobilization, from interwar planning through the production achievements of 1943–1945, to establish a point of departure for later chapters.

Chapter 3 builds on this narrative by exploring more deeply the time, resources, and public support that were necessary to expand war production during World War II. It examines how mobilization efforts aligned with both prewar objectives and wartime demands, how production timelines shaped military strategy and operations, and how mobilization efforts were perceived by the U.S. military and public at the time.

Chapter 4 outlines how broad strategic, economic, industrial, and technological trends have altered the prospects of industrial mobilization in the decades since World War II.

Chapter 5 synthesizes these analyses to extract relevant lessons for contemporary policymakers as they grapple with preparing today's industrial base for protracted great power conflict.

The study concludes in Chapter 6 by highlighting three qualities commonly cited as competitive advantages of the United States in military–industrial competition with its authoritarian adversaries: the free market system, continued leadership in defense technology, and a robust network of allies and partners. This final chapter questions the enduring nature of these advantages and explores how the United States might leverage them in future competition and conflict.

CHAPTER 2

Revisiting the Arsenal of Democracy

> Complicated weapons and machines are used up rapidly in war. Armies and navies must not only be well supplied initially, but maintenance must be adequate and continuous. Thus, the success of a modern fighting force is directly and immediately dependent upon the ability of the Nation's resources to satisfy promptly its requirement in munitions.
>
> —*Industrial Mobilization Plan*, 1933[9]

The mobilization of U.S. industry to supply immense quantities of weaponry for World War II stands as a remarkable feat of national organization and productivity. As of May 1940, with Hitler's forces storming across the Low Countries and France, the U.S. Army's Ordnance Department reported it had just under 12 thousand 500 lb bombs and around 43 hundred 1,000 lb bombs in its entire inventory.[10] Between July 1940 and August 1945, the Army would procure over 33 million aircraft-delivered bombs.[11] The production of artillery shells, tank rounds, anti-aircraft shells, mines, grenades, rockets, and other types of munitions used across the European and Pacific theaters grew by similar magnitudes. The expansion of munitions production from a trickle in 1938 to a flood in 1943 is a military–industrial achievement on a scale that had never been realized before and has not been attempted since.

This chapter provides a historical overview of the planning and execution of World War II's industrial mobilization to establish a point of departure for the remainder of the monograph. It examines the U.S. defense industrial base of the 1930s, explores mobilization

9 Joint Army and Navy Munitions Board, *Industrial Mobilization Plan, Revised—1933* (Washington, DC: Joint Army and Navy Munitions Board, 1933), p. vii.

10 Harry C. Thomson and Lida Mayo, *The Ordnance Department: Procurement and Supply*, (Washington, DC: U.S. Army Center of Military History, 1991), p. 2.

11 Thomson and Mayo, *Ordnance Department*, p. 152.

planning in the interwar period, and outlines how mobilization played out as war spread throughout Europe.

Interwar Mobilization Planning: The Bad, the Good, and the Ugly

Despite growing significantly during World War I, the American munitions industrial base was unprepared for conflict by the end of the 1930s. Limited demand and accusations of war profiteering after the conflict led many corporations to exit the munitions industry, and longstanding government-owned arsenals lacked the capacity to supply weapons for a major war. With munition stockpiles neglected throughout the Great Depression, the United States relied upon dormant commercial industry as its primary reserve in the years before World War II—leaving it unprepared in the short term but ripe for mobilization. This section follows each of these developments in turn to establish the basis for World War II industrial mobilization.

The Bad: A Declining Munitions Industry

For much of American history, munitions were produced primarily by a small number of federal arsenals.[12] America's involvement in World War I led to the expansion of private U.S. munitions suppliers by war's end. Centered on the production of artillery shells and other explosives, American capacity to produce gunpowder and TNT in 1918 outmatched that of Britain and France combined.[13] The DuPont Company alone produced 40 percent of the smokeless powder used by the Allies during the war.[14] America's entry into the war in 1917 was followed by the rapid expansion of the U.S. Army to a force of over four million men. At the time, however, the Army had no significant reserves of equipment or ammunition, and Army supplies were not widely standardized.[15] Moreover, the service lacked detailed information on wartime munition requirements and the industrial capacity to produce military goods.[16] No plan for a coordinated mobilization of American industry existed.

12 Although finished munitions were typically assembled at government arsenals, the United States enjoyed a robust gunpowder and explosives industry after the Revolutionary War. See, for example, "Gunpowder and its Manufacture. Where and How it is Made—The Materials—Where Found—A New Discovery in Cannon Powder," *New York Times*, August 10, 1861, https://www.nytimes.com/1861/08/10/archives/gunpowder-and-its-manufacture-where-and-how-it-is-made-the.html.

13 Arthur Herman, *Freedom's Forge: How American Business Produced Victory in World War II*, (New York: Random House, 2013), p. 81.

14 George Sweeting noted the major American contributions to WWI were "raw materials, explosive powder, and agricultural goods." See "DuPont Company," U.S. Department of Energy Office of History and Heritage Resources, https://www.osti.gov/opennet/manhattan-project-history/People/CivilianOrgs/dupont.html; and George Vincent Sweeting, *Building the Arsenal of Democracy: The Government's Role in Expansion of Industrial Capacity 1940 to 1945* (New York: Columbia University, 1994), p. 25.

15 R. Elberton Smith, *The Army and Economic Mobilization* (Washington, DC: U.S. Army Center of Military History, 1991), p. 35.

16 Smith, *Army and Economic Mobilization*, pp. 35–37.

The resulting efforts to equip U.S. troops were chaotic and inefficient, leading President Woodrow Wilson to establish the War Industries Board (WIB) to centralize authority in 1917.[17] The WIB would eventually be chaired by financier Bernard Baruch.[18] Industrial mobilization, however, began too late to equip U.S. troops sent to Europe—it would have peaked around 1919 or 1920.[19] The armistice in 1918 came ahead of allied timetables as the fruits of centralized authority, industrial conversion, and expanded facilities were only just being realized.[20] With U.S. industry still tooling up to produce military goods through 1918, American forces relied on British and French weapons to support their campaigns in Europe.[21] Perhaps the greatest lesson for military planners from World War I was that in the industrial era, mobilizing war production to equip and supply men-at-arms would take significantly longer than mustering and training the men themselves. The services entered the 1920s believing that expanding production for future conflicts would require detailed planning and "the subjection of the entire economy to a regime of extensive controls."[22] The World War I experience with industrial mobilization—too little, too late—colored the Army and Navy's interwar efforts to plan for future contingencies.

The WIB's recommendations to maintain a small munitions industry and develop domestic sources of materials critical to the production of weapons went unheeded.[23] With the end of hostilities, much of U.S. war production was considered wasteful surplus; it would be a source of embarrassment for the Army for much of the interwar period.[24] Existing stockpiles would go on to support U.S. military training for at least a decade—greatly reducing the demand for new production of munitions and their energetic ingredients.[25] In the decades following, lack of demand joined with criticism of World War I mobilization and widespread isolationist feelings to hollow out much of the commercial weapons industry built for the war.[26] In the mid-1930s, the Nye Committee investigated World War I munitions

17 Michael England characterized the WIB as "the first centralized agency in U.S. history responsible for the integration of economic mobilization and military mobilization." Michael T. England, *U.S. Industrial Mobilization 1916–1988: An Historical Analysis* (Wright-Patterson Air Force Base, OH: Air Force Institute of Technology, Air University, September 1989), p. 27, https://apps.dtic.mil/sti/tr/pdf/ADA214948.pdf.

18 This was followed by the passing of the Overman Act in May 1918, which gave the WIB enhanced statutory authorities. Smith, *Army and Economic Mobilization*, p. 37; and England, *U.S. Industrial Mobilization 1916–1988*, pp. 27–28.

19 Sweeting, *Building the Arsenal of Democracy*, p. 24.

20 Smith, *Army and Economic Mobilization*, p. 38.

21 Frank N. Schubert, *Mobilization: The U.S. Army in World War II* (Washington, DC: U.S. Army Center of Military History), p. 3.

22 Smith, *Army and Economic Mobilization*, p. 39.

23 England, *U.S. Industrial Mobilization 1916–1988*, p. 43.

24 In some ways, post-WWI attitudes toward excess production capacity mirrored those of the immediate post-Cold War era, which will be explored in detail in Chapter 4. Smith, *Army and Economic Mobilization*, p. 123.

25 Schubert, *Mobilization,* pp. 4–7.

26 Sweeting, *Building the Arsenal of Democracy*, p. 28.

manufacturers and accused large firms of war profiteering as "merchants of death."[27] Although the committee's recommendation to nationalize the arms industry went unheeded, the addition of onerous new taxes and regulations pushed large corporations such as DuPont and Bethlehem Steel to close production facilities built for World War I.[28] Congress also passed laws mandating military purchases from government-owned factories and arsenals before commercial producers.[29] These actions, coupled with uncertain demand, combined to make munitions production unattractive for businesses in the interwar period and popularized the idea that preparing industry for conflict would be a self-fulfilling enterprise.[30]

In keeping with American tradition, government-owned arsenals were left as the primary source of U.S. munitions.[31] These institutions, however, were never intended to meet the wartime demands of the U.S. military. With trouble on the horizon in the late 1930s, the Army estimated that arsenals could produce no more than "5 percent of the Army's requirements for war."[32] They were instead maintained as sources of knowledge and masters of specific production techniques, meant to train workers and assist in the conversion of private industry to wartime production. Even so, the meager defense budgets of the interwar period left many federal arsenals in poor condition, with aging tools and outdated manufacturing techniques.[33] In 1939, around 80 percent of arsenal machine tools were more than 18 years old. One senator commented after a tour in early 1940, "They looked like we were going into a plant that had been abandoned for about 20 years, and then a bunch of men were feverishly trying to get them back in shape to start production."[34] As late as July 1940, the entire U.S. munitions industry could produce only 30 tons of smokeless powder and 12 tons of TNT per day—less than one tenth of what a single plant would produce during the war and far from the quantity that would be necessary to fight any major campaign.[35]

27 Herman, *Freedom's Forge*, p. 6.

28 DuPont cut munitions production to less than 2 percent of its total operations. Herman, *Freedom's Forge*, pp. 6, 79–80.

29 Buford Rowland and William B. Boyd, *U.S. Navy Bureau of Ordnance in World War II* (Washington, DC: U.S. Government Printing Office, 1954), p. 450.

30 As late as 1937, polls showed 82 percent of Americans favored a "prohibition on private companies selling munitions." In 1940, "59 percent of businessmen were hesitant to enter the defense industry." Hunter DeRensis, "Merchants of Death," *The American Conservative*, November 8, 2021, https://www.theamericanconservative.com/merchants-of-death/.

31 Sweeting, *Building the Arsenal of Democracy*, p. 28.

32 Thomson and Mayo, *Ordnance Department*, pp. 12–13.

33 Thomson and Mayo, *Ordnance Department*, p. 22.

34 Thomson and Mayo, *Ordnance Department*, p. 22; and U.S. Senate, *Military Establishment Appropriations Bill for 1941: Hearings before the Subcommittee of the Committee on Appropriations*, 76th Cong., 3rd sess., 1940, p. 34.

35 At its peak, the West Virginia Ordnance Works in Point Pleasant, WV, would produce an average of 125 tons of TNT per day. Thomson and Mayo, *Ordnance Department*, p. 32; and "Five-Year Review Report, West Virginia Ordnance Works, Point Pleasant, West Virginia," *U.S. Environmental Protection Agency*, January 30, 1995, p. 2, https://semspub.epa.gov/work/03/137780.pdf.

The Good: Mobilization Planning and the Commercial Manufacturing Base

As production capacity declined throughout the interwar period, military planners extensively studied the World War I mobilization experience and formulated plans for future industrial expansion in hopes of avoiding its repetition. Work began after the 1920 National Defense Act directed the assistant secretary of war to plan for industrial mobilization, should it be necessary.[36] The Office of the Assistant Secretary of War (OASW) established a Planning Branch, which would be crucial to assessing World War I mobilization and contemplating future efforts. The branch immediately saw that comprehensive industrial planning would require the involvement of the Department of the Navy in addition to the War Department.[37] Accordingly, the Joint Army and Navy Board established the Joint Army and Navy Munitions Board (ANMB) in 1922, in part to coordinate and plan industrial mobilization for the armed services.[38] These organizations established that developing military requirements and procurement plans would be a prerequisite for any industrial mobilization plans.[39]

Accordingly, the Planning Branch and the ANMB spent the better part of the 1920s working on these requirements: What would the armed forces need in a future contingency, and in what quantities? With limited personnel and resources, they focused their efforts on items believed to present the greatest acquisition challenges due to complexity, lead time, limited availability of manufacturers, or the great quantities needed.[40] The identification of these goods led to the creation of a prioritization system, with top priority items designated "Section I" and becoming the primary focus of interwar planning. Eventually, around 1,200 items were classified as Section I and became the subject of detailed procurement plans.[41]

By the end of the 1920s, the OASW and the ANMB began using these procurement plans to drive industrial planning.[42] The result was a series of industrial mobilization plans (IMPs),

36 At the time, the Army acknowledged that Congress' decision to place mobilization planning in the hands of the assistant secretary of war was meant to ensure civilian leadership of the effort because "activities relating to large-scale procurement required a great deal of business experience and knowledge, and should therefore be handled by an individual prominent in the business world." *An Act To Amend an Act Entitled "An Act for Making Further and More Effectual Provision for the National Defense, and for Other Purposes," Approved June 3, 1916, and to Establish Military Justice*, Pub. L. 242, *U.S. Statutes at Large* 41 (1919–1921), pp. 764–765, https://www.history.army.mil/faq/branches/medical/Act_of_Congress_4_June_1920_(National_Defense_Act).pdf; and Harry B. Jordan, "A School of Supply Strategy: The Aims and Methods of the Army Industrial College," *Army Ordnance* 19, no. 110, September–October 1938, p. 76, https://www.jstor.org/stable/45376661.

37 Because of the lead times involved in building ships and the relatively higher state of peacetime readiness maintained by the Navy, the service was less interested in mobilization planning than the War Department during this period. See Smith, *Army and Economic Mobilization*, p. 41.

38 John W. Maenhardt, *The Effectiveness of the Army and Navy Munitions Board during the Interwar Period* (Fort Leavenworth, KS: U.S. Army Command General Staff College, 2008), p. 4, https://apps.dtic.mil/sti/pdfs/ADA483049.pdf.

39 Smith, *Army and Economic Mobilization*, p. 46.

40 Smith, *Army and Economic Mobilization*, p. 48.

41 Of these items, 578 belonged to the Ordnance Department. Smith, *Army and Economic Mobilization*, pp. 48–49.

42 Smith, *Army and Economic Mobilization*, pp. 41–42.

released in 1930, 1933, 1936, and 1939, with General Douglas MacArthur briefing members of Congress and the executive branch beginning in 1930.[43] Although the IMPs were relatively brief, they outlined proposed emergency agencies and their roles, additional authorities and economic control measures to be requested, lists of critical and strategic materials, and estimated raw material requirements.[44] With World War I fresh in the minds of military planners, the IMPs envisioned centralizing authority in a war resources administrator who would report to the president and oversee an advisory council consisting of the heads of all civilian emergency agencies.[45] The ANMB would serve as a transitional agency to control mobilization until the president established a series of civilian "superagencies" to consolidate and lead the effort.[46] The military's efforts were complicated by the fact that the civilian agencies described in the IMPs were purely notional; it was unclear how a future president might organize the executive branch for mobilization or what authorities he might delegate to the War Department and other agencies.[47]

Because of the organizational question and the many other unknowns surrounding a future war, flexibility was built into the interwar IMPs. The Army lacked political and strategic guidance from the president, and military planners understood they could not predict the exact nature, adversaries, or theaters of the next conflict. Instead, they tried to account for a wide range of tactical, strategic, and economic factors.[48] The War Department assumed mobilization plans would be modified and refined during a period of "strained relations" leading to the outbreak of war, and it strove to maintain the plans' currency in the evolving geostrategic environment.[49]

By the mid-1930s, the War Department had established the key elements of the mobilization plans. The IMPs centered around a mobilization day or "M-Day," a time—presumably after the commencement of hostilities—when the government would establish the proposed civilian superagency to wield broad authorities and direct the nation's resources toward the purpose of war. The plans identified key military goods for which production would need to expand and included detailed specifications and production studies of many top priority

43 "MacArthur on Industrial Mobilization: An Editorial," *Ordnance* 36, no. 187, July–August 1951, p. 99, https://www.jstor.org/stable/45359856.

44 Smith, *Army and Economic Mobilization*, pp. 74–76.

45 Smith, *Army and Economic Mobilization*, p. 80.

46 U.S. Army Center of Military History, *Logistics in World War II: Final Report of the Army Service Forces* (Washington, DC: U.S. Army Center of Military History, 1993), p. 4.

47 Smith, *Army and Economic Mobilization*, pp. 73–75.

48 Kerry E. Irish, "Apt Pupil: Dwight Eisenhower and the 1930 Industrial Mobilization Plan," *The Journal of Military History* 70, no. 1, January 2006, p. 36, https://www.jstor.org/stable/3396807; and Smith, *Army and Economic Mobilization*, pp. 50–52.

49 Smith, *Army and Economic Mobilization*, p. 61.

(Section I) items.[50] They also divided the United States into procurement districts, within which military supply organizations such as the Ordnance Department were charged with surveying and tracking total available industrial capacity.[51] Finally, the plans identified critical raw materials for which the United States was dependent on foreign suppliers and advocated domestic stockpiling.[52]

Despite the uncertainties inherent in contingency planning, the IMPs were essential for driving engagement between the War Department and industry during the interwar period. Items identified as priorities during mobilization planning were the subject of various preparatory measures, including schedules of production, production studies, and educational orders. Within the procurement districts, surveys collected vital information about factories and their equipment, workforces, and ability to produce military goods in the event of conflict.[53] Planners used this information to develop schedules of production and allocations, which marked individual commercial facilities for the production of specific military items during wartime.[54] To gain further insight into a plant's emergency potential, the Ordnance Department also commissioned production studies. These studies, a "necessary preliminary to any manufacturing order either in time of peace or in time of war," were intended to identify potential bottlenecks and reduce the time needed to convert commercial lines to produce military goods.[55]

For items deemed especially difficult to produce, the Ordnance Department went a step further and purchased low-quantity "educational orders" to ensure plants had the equipment and know-how to produce an item to military standards. Although requested in 1937, limited educational orders were only approved and funded by Congress in the following year.[56] They were, however, highly valued by military planners and industrialists.[57] Procurement officials assessed that the Army received military goods and manufacturing equipment worth roughly 85 percent of the order's value, with the remaining 15 percent used to train plant personnel.[58] The orders were focused on the more complicated components of munitions at

50 These specifications were meant to help manufacturers transition to military production and included general data and drawings, lists of necessary machine tools, estimates of labor requirements, total material requirements, and inspection procedures. Over 700 plans were created for priority items by the end of 1937. Smith, *Army and Economic Mobilization*, pp. 51–62, 66.

51 Smith, *Army and Economic Mobilization*, p. 55.

52 U.S. Army Center of Military History, *Logistics in World War II*, p. 4; and Smith, *Army and Economic Mobilization*, p. 87.

53 Thomson and Mayo, *Ordnance Department*, p. 17.

54 Allocations and production schedules represented a voluntary agreement between the manufacturer and the government. They did not commit a firm to production but "indicated the firm's willingness and ability in an emergency to produce the desired items in the quantities and time period specified." By 1926, the War Department established over 20,000 allocations. Smith, *Army and Economic Mobilization*, pp. 56–58, 61.

55 Major General Charles T. Harris, Jr., quoted in U.S. Senate, *Military Establishment Appropriations Bill for 1941*, p. 133.

56 U.S. Army Center of Military History, *Logistics in World War II*, p. 1.

57 Thomson and Mayo, *Ordnance Department*, pp. 19-20.

58 U.S. Senate, *Military Establishment Appropriations Bill for 1941*, p. 131.

the time, such as bomb cases and fuzes.[59] Industrial surveys, production studies, and educational orders were all measures that planners trusted to reduce mobilization timelines and were achievable in the constrained budget environment of the 1930s.

Finally, the War Department established the Army Industrial College in 1924. It sought to educate military officers on "the basic industrial, economic, political, administrative, and other aspects of the total task of harnessing national resources in modern war."[60] The Army emphasized the college was a "direct and necessary development of World War [I] experience" and was meant to train a cadre of officers capable of assisting the assistant secretary of war in the development of mobilization plans.[61] In this respect, it represented the institutionalization of the lessons learned during the Army's World War I mobilization. Moreover, the college was the only such military–industrial institution in the world at the time.[62]

The Army Industrial College collaborated closely with the Planning Branch and the ANMB on the development and refinement of IMPs throughout the 1930s.[63] The school's curriculum evolved alongside mobilization planning and tasked students with solving real-world procurement and mobilization problems.[64] In doing so, the college sought to train a body of military officers who would be better equipped to align strategic plans with industrial considerations in order to prevent the adoption of war plans with infeasible industrial requirements.[65] The Army also believed that by educating military personnel on industrial matters, the service would be better equipped to prevent future mobilizations from being controlled by civilian business leaders, as had happened with World War I's WIB.[66] Around 1,000 military officers attended the Army Industrial College before the United States entered World War II.[67] As conflict reignited in Europe, the War Department had spent the better part of two decades contemplating industrial mobilization and preparing plans that would unmistakably influence America's contribution to World War II.

59 Thomson and Mayo, *Ordnance Department*, p. 6.

60 The Army Industrial College became the Industrial College of the Armed Forces (ICAF) in 1946. The institution was reorganized under the National Defense University in 1976 and renamed the Dwight D. Eisenhower School for National Security and Resource Strategy in 2012. Smith, *Army and Economic Mobilization*, p. 43.

61 Irving J. Carr, "The Army Industrial College: A New General Service School," *Army Ordnance* 9, no. 51, November/December 1928, p. 167, https://www.jstor.org/stable/45482589; and Jordan, "School of Supply Strategy," p. 77.

62 Carr, "Army Industrial College," p. 167; and Jordan, "School of Supply Strategy," p. 78.

63 Many of the college's instructors were also members of the Planning Branch. Smith, *Army and Economic Mobilization*, p. 44; and Carr, "Army Industrial College," p. 169.

64 Carr, "Army Industrial College," p. 168; and Jordan, "School of Supply Strategy," p. 78.

65 As later sections will explore, the college was not able to completely prevent this outcome, leading to the feasibility debates during the mobilization for World War II. Jordan, "School of Supply Strategy," p. 77.

66 Terrence J. Gough, "Origins of the Army Industrial College: Military–Business Tensions after World War I," *Armed Forces & Society* 17, no. 2, Winter 1991, p. 260, https://www.jstor.org/stable/45305241.

67 Fifteen percent of these officers belonged to the Navy and Marine Corps. Alan L. Gropman, "Industrial College of the Armed Forces: A Primer," *National Defense* 92, no. 650, January 2008, p. 23, https://www.jstor.org/stable/45370072.

Most importantly for the United States overall, however, was that despite the atrophy of the defense industrial base during the interwar period, the U.S. commercial manufacturing base remained the largest in the world. The Great Depression reduced the output of American manufacturing by one third, but much of this capacity remained dormant, ready to be revived for wartime production.[68] As historian Arthur Herman summarized: "Despite a decade of depression and high unemployment, the U.S. economy was still the most productive in the world. Its steel mills had produced an impressive 28 million long tons of steel—although that was less than half of what it produced in 1929. Nonetheless, America still produced more steel, aluminum, oil, and cars than all the world's great powers put together—almost three million cars in 1939 alone."[69]

What the United States lacked in munitions production it made up for in raw industrial capacity. Between 1936 and 1938, the nation "manufactured almost one-third of the world's products."[70] At the beginning of World War II, it produced two thirds of the world's petroleum[71] and was "the world's greatest owner, producer, seller and consumer of minerals."[72] The United States was truly a manufacturing giant, with "one out of every twenty Americans employed directly or indirectly" by the automobile industry alone.[73] Car manufacturing "made Americans machine minded and made American industry oriented to mass production techniques."[74] Although it lacked enough plants to produce propellants and explosives or factories to produce munitions, the nation had a massive engineering and mechanical workforce and the capacity to extract and refine many of the raw materials necessary for munitions production. In sum, the United States enjoyed the greatest military–industrial reserve capacity in the world. The challenge would be mobilizing that capacity into active production of military goods.[75] The main obstacle to overcoming this challenge would be time.

68 Herman, *Freedom's Forge*, p. 5.

69 Herman, *Freedom's Forge*, p. 71.

70 Alan L. Gropman, *Mobilizing U.S. Industry in World War II: Myth and Reality* (Washington, DC: National Defense University Institute for National Strategic Studies, 1996), pp. 134-135.

71 Williamson Murray and Allan R. Millett, *A War to Be Won: Fighting the Second World War* (Cambridge, MA: Harvard University Press, 2001), p. 527.

72 Charles K. Leith quoted in Gregory Wischer, "The U.S. Military and NATO Face Serious Risks of Mineral Shortages," *Carnegie Endowment for International Peace*, February 12, 2024, https://carnegieendowment.org/2024/02/12/u.s.-military-and-nato-face-serious-risks-of-mineral-shortages-pub-91602.

73 Herman, *Freedom's Forge*, p. 111.

74 Gropman, *Mobilizing U.S. Industry*, p. 59.

75 Military leaders were well aware of these facts during the interwar period. Army Chief of Staff Charles P. Summerall commented in 1927 that given the nation's vast industrial power and access to raw materials, "this country should eventually exceed any probable enemy in production, provided we are not crippled before we develop our industrial potentialities." See "The Army Industrial College: An Unique Institution Where Officers of the Services Study the Economic Phases of War," *Army Ordnance* 8, no. 43, July/August 1927, p. 8, https://www.jstor.org/stable/45481932.

The Ugly: U.S. Military Readiness on the Eve of World War II

As war spread through Europe and Asia in 1939 and 1940, it was not clear that U.S. and allied militaries could hold out long enough to give American industry time to mobilize. American munition stockpiles were woefully insufficient for the coming conflict. World War I surpluses had been expended in training in the 1920s, and a lack of military spending during the Great Depression had limited the armed services' ability to purchase and stock new munitions.[76] In the mid-1930s, MacArthur, now Army chief of staff, was unsuccessful in his attempts to procure ammunition stocks for 30 days of operations for the small peacetime Army of roughly 119,000 men.[77] Secretary of War Henry Stimson would comment in 1943 that as of 1940, "We didn't have enough powder in the whole United States to last the men we now have overseas for anything like a day's fighting."[78] Indeed, the Army's total inventory in 1941 contained just 16,000 tons of bombs and 450 million rounds of small arms ammunition—quantities that would later be expended every two months in France alone.[79]

After German forces invaded Denmark and Norway in April 1940, Congressional hearings revealing the military's unpreparedness shocked the American public. Despite Army Chief of Staff George Marshall assuring Congress that everything possible was being done to reduce the Army's mobilization timeline, one senator lambasted the service: "Their ambition is to get ready in a period of 18 or 24 months, when we are living in a period of wars being settled in 30 days."[80] War Department officials countered, saying: "This deficit has not occurred suddenly but…is the cumulative result of years of failure to provide adequately for procurement and replacement. Ten years of relative stagnation…cannot, under any circumstances, be overcome instantaneously."[81] Just two months later, the Army would adopt a munitions program that called for the construction of factories to equip and support over four million troops by October 1941.[82] Only mobilizing the nation's industry would allow it to attain these goals.

Mobilizing the Munitions Industrial Base

Despite the U.S. military's apparent unpreparedness, the seeds of industrial mobilization had already been sown through incremental steps taken by the Roosevelt administration. In contrast with the early IMPs, which envisioned mobilization beginning on M-Day after hostilities started, mobilization began gradually after the Munich Agreement and sustained

76 Lonnie B. Adams III, *The Interwar Period: Lessons from the Past* (Carlisle, PA: U.S. Army War College, 1992), pp. 27–28.

77 Smith, *Army and Economic Mobilization*, p. 124; Mark Skinner Watson, *United States Army in World War II: Chief of Staff: Prewar Plans and Preparations* (Washington, DC: Department of the Army Historical Division, 1950), p. 25.

78 Henry L. Stimson quoted in Thomson and Mayo, *Ordnance Department*, p. 104.

79 U.S. Army Center of Military History, *Logistics in World War II*, pp. 11–12.

80 U.S. Senate, *Military Establishment Appropriations Bill for 1941*, p. 191.

81 War Department spokesmen quoted in Smith, *Army and Economic Mobilization*, p. 124.

82 Schubert, *Mobilization*, p. 12.

German aggression in 1938 and 1939. American defense suppliers expanded in the late 1930s with orders from Britain and France, continued growing as U.S. defense budgets increased from 1939 to 1941, and expanded rapidly after Pearl Harbor. Still, munitions production would only peak in 1943 and 1944, nearly five years after the European powers met in Munich.

Early Steps Toward Mobilization

Hitler's aggression against Czechoslovakia and continued claims on the Polish Corridor raised the specter of widespread European conflict in summer 1939. Politics—namely the American public's reluctance to be entangled in another foreign war—constrained Roosevelt's options for readying the U.S. military. Nevertheless, Roosevelt appointed a War Resources Board in August 1939 to assess the adequacy of the existing IMP. The board was disbanded in November after completing its evaluation. It recommended the IMP's implementation but found fault with its proposed organizational scheme and suggested it lacked sufficient input from industry.[83] Roosevelt was no proponent of the plan, believing it politically unviable because it ignored the need to balance military and consumer production and abdicated too much of the president's authority to civilian and military administrators.[84] Despite events abroad, the president believed the American public was not yet ready for talk of mobilization and knew any preparedness efforts would need to strike a complex balance between industrial and business interests, military necessity, and the concerns of organized labor and New Deal politicians.[85]

German forces invaded Poland on September 1, 1939, and the UK and France declared war on Germany two days later. These events led Roosevelt to establish the Office for Emergency Management (OEM) in the Executive Office of the President using authorities granted to him by the Reorganization Act, which Congress had passed earlier that year.[86] The OEM would be the first of a series of executive bodies charged with managing mobilization and preparing the United States for war.

The OEM was followed in May 1940 by the reestablishment of the National Defense Advisory Commission (NDAC).[87] With Roosevelt campaigning for a third term and seeking the passage of a new selective service act (the first peacetime draft in the United States), reviving the NDAC was one action he could take without additional legislation or controversy.[88] Composed of a mix of advisors from business, labor, and agricultural backgrounds,

83 U.S. Army Center of Military History, *Logistics in World War II*, p. 5; and England, *U.S. Industrial Mobilization 1916-1988*, p. 57.

84 Maury Klein, *A Call to Arms: Mobilizing America for World War II* (New York: Bloomsbury Press, 2013), pp. 30–32.

85 Klein, *A Call to Arms*, pp. 32–33.

86 Smith, *Army and Economic Mobilization*, pp. 100–101.

87 The NDAC was originally established as the Council of National Defense by the U.S. Congress in 1916. See 10 U.S.C. § 1-5.

88 Smith, *Army and Economic Mobilization*, p. 103.

the stand-up of the NDAC clearly indicated Roosevelt had no intention of following the IMP's organizational proposals.[89] Despite its contributions to early efforts to expand war production, the NDAC lacked sufficient resources and authorities, leading President Roosevelt to replace it with the Office of Production Management (OPM) in January 1941.[90] The OPM would lead crucial prewar mobilization efforts in the months before Pearl Harbor, particularly to assist America's allies.

Priming Industry: Allied Demand and Expanding Defense Budgets

Beginning in the late 1930s, the American defense industrial base was readied for expansion not by U.S. military demand but by European allies' purchases. British rearmament started around 1934 with the establishment of the Defence Requirements Committee and its recommendations for vast increases in British naval and air forces.[91] Although also hampered by limited defense spending throughout much of the decade, both Britain and France were actively preparing their armed forces for potential war by the late 1930s.[92] As they did, they turned to American industry to supplement domestic production, particularly of aircraft. After Roosevelt's declaration of emergency, the passage of the Neutrality Act of 1939 lifted restrictions on U.S. arms sales on a "cash and carry" basis, further boosting exports.[93]

American production of aircraft for the UK and France primed industry for later expansions at a time when U.S. demand was still lagging.[94] In 1938, allied purchases of aircraft were five times U.S. orders.[95] Allies were even willing to foot the bill for the construction of new U.S. factories for products like aircraft engines.[96] British acquisition continued through America's entrance into the war and beyond, with British demand for military hardware becoming especially acute after the evacuation of Dunkirk at the end of May 1940.[97]

89 Klein, *Call to Arms*, p. 38.

90 Smith, *Army and Economic Mobilization*, p. 103.

91 Malcolm S. Smith, "Rearmament and Deterrence in Britain in the 1930s," *Journal of Strategic Studies* 1, no. 3, 1978, pp. 314–15.

92 Richard Overy, *The Origins of the Second World War* (New York: Routledge, 2017), pp. 51–54.

93 Although a vital stimulant to U.S. industry and necessary for the support of U.S. allies, "cash and carry" purchases initially caused increased competition between U.S. and allied procurements, resulting in higher prices for military goods. Rowland and Boyd, *U.S. Navy Bureau of Ordnance in World War II*, p. 4.

94 Despite early purchases by allies, U.S. industry still required around two years to fulfill these orders, with only a fraction of aircraft delivered by the German invasion of France in May 1940. Mark F. Cancian, Adam Saxton, Owen Helman, Lee Ann Bryan, et al., *Industrial Mobilization: Assessing Surge Capabilities, Wartime Risk, and System Brittleness* (Washington, DC: Center for Strategic and International Studies, January 2021), p. 12; and Gropman, *Mobilizing U.S. Industry*, p. 34.

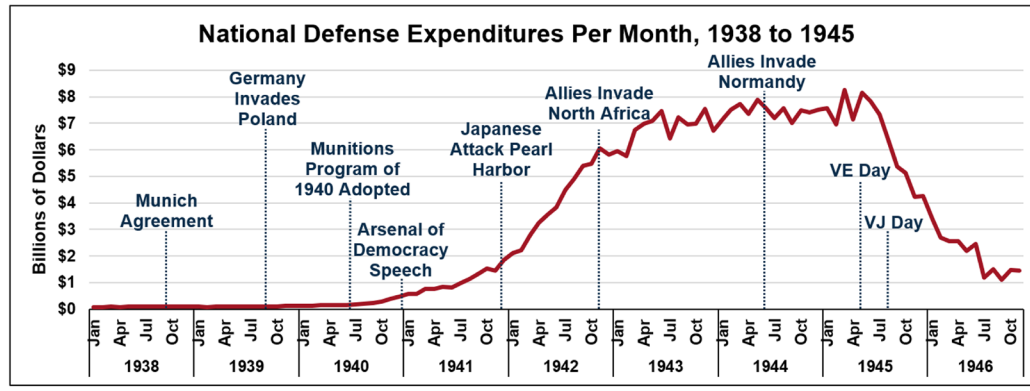
95 Herman, *Freedom's Forge*, p. 86.

96 Sweeting, *Building the Arsenal of Democracy*, p. 73.

97 Klein, *Call to Arms*, p. 22.

Although American rearmament trailed that of some allies, events in Europe led Congress to significantly increase defense appropriations beginning in 1939, starting the flow of funds that would support industrial mobilization and the expansion of munitions production. The Army alone received over $34 billion before Pearl Harbor—more than the United States spent in all of World War I.[98] These appropriations enabled the Munitions Program of June 1940, a $6 billion effort to equip a force of 1.2 million men and build factories that could equip a force of four million.[99] The Army Ordnance Department saw its expenditures rise from $25 million in Fiscal Year 1938 to $50 million in 1939 to around $150 million in 1940.[100] Although isolationism among the American public prevented full-scale mobilization prior to Pearl Harbor, defense spending increased more quickly than the services could absorb it.

FIGURE 1: U.S. GOVERNMENT EXPENDITURES FOR WAR ACTIVITIES, 1938–1945



Source: Created by CSBA using data from U.S. Treasury Bulletins from January 1939 to January 1947, available at https://fraser.stlouisfed.org/title/treasury-bulletin-407?browse=1930s.

Funding quickly flowed to renovate and expand government-owned arsenals.[101] Already in 1938, Congress had appropriated funds to purchase additional specialized equipment for munitions production based on interwar mobilization plans.[102] Drawing on the War Department's standing procurement plans, spending centered on acquiring items with long lead times such as ammunition, some small arms, and artillery systems.[103] In this environment, the challenge shifted from the insufficient funding of the interwar period to insufficient time to mobilize industry, expand production, and equip the growing U.S. military.

98 Schubert, *Mobilization*, p. 12.

99 Schubert, *Mobilization*, p. 13.

100 Thomson and Mayo, *Ordnance Department*, p. 10.

101 U.S. Senate, *Military Establishment Appropriations Bill for 1941*, p. 196.

102 Thomson and Mayo, *Ordnance Department*, pp. 11-12.

103 Smith, *Army and Economic Mobilization*, p. 128.

Determining Munition Requirements and Mobilization Timelines

With funding secured, the primary questions for mobilization planners centered on requirements: which weapons did the Army and Navy require, in what quantities, and when could they be produced? The events of spring 1940 clarified the likely adversaries and potential battlegrounds, but determining updated U.S. and allied munition needs proved difficult.[104] The United States still lacked national objectives and a war strategy that, in coordination with U.S. allies, would determine the extent of U.S. military operations and, in turn, the types and magnitudes of munitions required.[105] With these crucial questions remaining unanswered, the War and Navy Departments struggled to provide the definite, long-term requirements desired by the NDAC and industry to set production goals and organize resources.

The confusion was compounded by Roosevelt's declaration in May 1940 that the United States would mobilize to build 50,000 aircraft per year.[106] The president's rhetoric seemed to conflict with the military's actual requirements. Producing that many aircraft was viewed as unachievable, and doing so would likely interfere with other elements of the military program, including items needed to employ the aircraft in combat, such as machine guns, bombs, and aviation fuel.[107] As the War Department sorted these conflicting priorities, industrial planners were left waiting for the military to determine how many aircraft it needed by type and model before they could begin expanding production capacity.[108]

Determining requirements and setting production goals was further complicated by the need to supply allied nations in addition to the U.S. armed services. Foreign requirements proved equally challenging, with War Department leaders suspicious that allies were asking for "what they thought the United States would give them" rather than what they realistically needed.[109] The acting chief of ordnance summarized the requirements challenge at length:

> There has not been since the beginning of the Defense Program a comprehensive long-range Schedule of Ordnance Requirements which would permit planning for adequate production capacity. On the contrary, the program has been changed at least seven times in the last fifteen months for most items.... It is impracticable to create production capacity without definite orders, especially if extensive subcontracting is to be used in accordance with

104 Smith, *Army and Economic Mobilization*, p. 128.

105 Interwar plans such as War Plan ORANGE assumed the United States would operate without allies. Later strategic documents, such as the Plan Dog Memorandum, only came about after the events of May and June 1940. See Thomas G. Mahnken, "U.S. Grand Strategy, 1939–1945," in John Ferris and Evan Mawdsley, eds., *The Cambridge History of the Second World War,* vol. 1, *Fighting the War* (Cambridge: Cambridge University Press, 2015), pp. 191–195.

106 Franklin D. Roosevelt, "Address Before a Joint Session of the Senate and House of Representatives Asking for Additional Appropriations for National Defense," *Air Force Magazine*, May 16, 1940, p. 4, https://www.airandspaceforces.com/PDF/MagazineArchive/Documents/2009/June%202009/0609keeperfull.pdf.

107 Smith, *Army and Economic Mobilization*, p. 141.

108 Gropman, *Mobilizing U.S. Industry*, p. 35.

109 Major General Richard C. Moore, quoted in Thomson and Mayo, *Ordnance Department*, p. 63.

> existing instructions of the War Department. Defense Aid [allied] orders have been even more varied, repetitive, unpredictable, and apparently understudied than the United States orders, and action in filling the orders has been correspondingly difficult and unsatisfactory. The Ordnance Department believes strongly that a carefully studied, long-range program of munitions requirements for the democracies should be determined as soon as possible and thereafter adhered to with a minimum of change.[110]

As the War Department struggled to gain visibility into allied demands, the combination of U.S. and allied orders quickly caused material shortages and delayed output. The passage of the Lend–Lease Act in March 1941 provided additional funds for allied acquisition and allowed the U.S. military to transfer aging platforms to allies, but it also increased competition and threatened to derail the U.S. military's own procurement program.[111]

Ultimately, Roosevelt established the OPM in January 1941 in part to compile and refine competing requirements from different U.S. and allied sources.[112] The OPM was the latest evolution in the mobilization bureaucracy, but authority remained split between its codirectors: industry leader William S. Knudsen and labor leader Sidney Hillman. Roosevelt himself retained decision-making power and resolved disputes between the two men.[113] Even with firm direction, the OPM and the military departments lacked enough personnel with experience estimating the vast requirements of the coming war.[114] Despite interwar experimentation and the maneuver tactics showcased by the Germans across Europe, few officers understood how these changes in warfare would be reflected in the U.S. military's wartime procurement needs. Influential leaders such as Dwight D. Eisenhower (who played a key role in authoring the 1930 IMP) and George S. Patton, Jr., foresaw the importance of motorized and armored units in the coming war, but organizational resistance resulted in the U.S. Army standing up the First Armored Brigade only after witnessing the fall of France in spring 1940.[115]

World events continued to drive the refinement of requirements. Operation Barbarossa led Roosevelt in August 1941 to ask the military departments to provide "over-all production requirements to defeat our potential enemies."[116] Marshall directed the War Plans Division of the General Staff to develop plans for the military forces required to defeat Germany, Italy,

110 Major General Charles T. Harris, Jr., quoted in Thomson and Mayo, *Ordnance Department*, pp. 57–58.

111 Smith, *Army and Economic Mobilization*, p. 133.

112 Gropman, *Mobilizing U.S. Industry*, p. 36.

113 Smith, *Army and Economic Mobilization*, p. 104.

114 Smith, *Army and Economic Mobilization*, p. 119.

115 Several experimental armored forces were disbanded or folded into other formations during the interwar period. Thomas G. Mahnken, "Beyond Blitzkrieg: Allied Responses to Combined-Arms Armored Warfare during World War II," in Emily O. Goldman and Leslie C. Eliason, eds., *The Diffusion of Military Technology and Ideas* (Stanford, CA: Stanford University Press, 2003), pp. 259–61; and Irish, "Apt Pupil."

116 U.S. Army Center of Military History, *Logistics in World War II*, p. 3; and Smith, *Army and Economic Mobilization*, p. 135.

and Japan. The chief of the division delegated this task to Major Albert Wedemeyer, who sequentially developed an outline of the nation's probable wartime objectives, the strategy to accomplish these aims, the Army forces he believed necessary to execute this strategy, and the proposed composition of these forces.[117] Wedemeyer's assessment of the Army's needs proved highly prescient; it was informed by time he spent observing German maneuver tactics as an exchange student at the Kriegsakademie in the mid-1930s.[118] Accordingly, Wedemeyer envisioned a restructured U.S. Army emphasizing armor and air power to increase the effectiveness of American ground forces, which would be limited in manpower by the labor requirements of the war industries.[119] He submitted his estimated troop basis to the Army G-4 to determine the total amount of equipment and weapons required by the service. Although this new troop basis fell short of a comprehensive war strategy, it provided the Production Planning Board of OPM the figures it needed about the eventual size and makeup of U.S. forces to begin generating equipment and munition requirements.[120] Barbarossa also added another source of demand for U.S. weapons—the Soviet Union—to total requirements, which now included the combined forces of the United States, UK, Soviet Union, China, and Latin America.[121]

Throughout this process, computing requirements for expendable munitions proved particularly elusive. The Ordnance Department identified this challenge early in the mobilization process, describing ammunition as altogether different from other expendables "because its rate of consumption was irregular and unpredictable."[122] In theory, multiplying the expected expenditures of a given unit by the number of units to be mobilized would yield production requirements for industry, but no real methodology or data existed for predicting these expenditures.[123] For the first two years of mobilization, planners relied mostly on "guesswork" and "obsolete data obtained from the last war" to estimate munition requirements.[124] The lack of long-term requirements led the chief of the Ammunition Division to remark, "We are in the position of an automobile company which takes no action as regards the procurement and production of new equipment, raw materials, and parts in planning the coming year's production, when the standard practice in that industry is to start such activity 18 to

117 Charles E. Kirkpatrick, "Strategic Planning for World War II: The Victory Plan in Context," *Army History*, no. 16, Fall 1990, pp. 17–18, https://www.jstor.org/stable/26302531?seq=1.

118 See Charles E. Kirkpatrick, *An Unknown Future and a Doubtful Present: Writing the Victory Plan of 1941* (Washington, DC: U.S. Army Center of Military History, 1992), pp. 9–33.

119 Kirkpatrick, *An Unknown Future*, pp. 83–87.

120 Smith, *Army and Economic Mobilization*, p. 134.

121 Harry Hopkins, one of President Roosevelt's personal advisors, visited Moscow in August 1941 to meet with Joseph Stalin and obtain a preliminary assessment of Soviet requirements. Smith, *Army and Economic Mobilization*, pp. 136–37.

122 Thomson and Mayo, *Ordnance Department*, p. 48.

123 Thomson and Mayo, *Ordnance Department*, p. 55.

124 Thomson and Mayo, *Ordnance Department*, pp. 48–49.

24 months before the model is announced."[125] In the end, estimation of munition requirements proved most challenging during this preconflict period, before the determination of concrete strategic plans and the garnering of operational experience from which to predict consumption rates.[126]

The new assessment of total requirements was completed through September and October 1941 and became known as the Victory Program. It included information from Stacy May, an economist in OPM, on total raw material requirements for military and civilian production, as well as data from the Navy regarding the merchant shipping capacity that would be required to transport U.S. war production to overseas theaters.[127] At a time when political and strategic guidance remained sparse, the Victory Plan translated Marshall and the War Department's intent into military requirements that considered the limitations and needs of industry, the labor pool, and the broader U.S. economy.[128] In this way, the plan was an essential stepping stone for turning existing industrial and mobilization plans into actionable guidance suited for the contemporary political environment.

Marshall then asked the OPM to evaluate the Victory Program's feasibility given its immense demands for industrial capacity and raw materials. This was the first attempt to reconcile the requirements of the coming war with estimates of total national resources.[129] Despite remaining no more than a plan through the end of November 1941, the program was leaked to newspapers on December 4. Its immense manpower and production goals, headlined as "F.D.R.'s War Plans," along with OPM's assessment that the plan was only feasible with a centrally controlled wartime economy, sparked significant controversy among isolationists in the public and Congress and threatened to end mobilization efforts.[130]

Japan's surprise attack on Pearl Harbor on December 7 ended these political debates about the Victory Program. The attack and subsequent U.S. declaration of war, followed closely by Germany's declaration of war on the United States, justified America's involvement in the conflict and loosened the reins that had constrained Roosevelt's mobilization efforts. Although the nation entered the war with its industries in the initial stages of mobilization, the Victory Program provided the initial objectives and requirements to fuel further production expansions. To pursue these objectives, Roosevelt replaced OPM with the War

125 Thomson and Mayo, *Ordnance Department*, p. 142.

126 Smith, *Army and Economic Mobilization*, p. 173.

127 Jim Lacey, *Keep from All Thoughtful Men: How U.S. Economists Won World War II* (Annapolis, MD: Naval Institute Press, 2011), p. 68; and Smith, *Army and Economic Mobilization*, p. 137.

128 Wedemeyer's estimates had several significant flaws, such as overestimating the number of armored divisions the United States would field. Still, Army historian Charles Kirkpatrick concluded, "As a logistics estimate, the Victory Plan…served its purpose." Kirkpatrick, "Strategic Planning for World War II," pp. 19–20.

129 Smith, *Army and Economic Mobilization*, p. 138.

130 Kirkpatrick, *Unknown Future*, p. 116; Lacey, *Keep from All Thoughtful Men*, p. 69; and Smith, *Army and Economic Mobilization*, p. 139.

Production Board (WPB) in January 1942, a reorganization that more closely mirrored the mobilization superagency envisioned by the IMP.[131]

With military planning and mobilization kicked into overdrive, the services looked to the WPB and industry to determine when production would be sufficient to support the overseas campaigns they envisioned.[132] For most of the 1930s, mobilization plans assumed an 18-month timeline.[133] Knudsen, the former chairman of the OPM now commissioned as a lieutenant general and appointed director of production in the Office of the Under Secretary for War, had reiterated the need for an 18-month industrial mobilization phase throughout his service.[134] Even with clear requirements and abundant funding, time was needed to upgrade existing plants, build new factories, and convert commercial lines to military production. The Victory Plan was estimated to require $150 billion and reach completion in spring 1944.[135] To reach output goals on the predicted timeline, industrial mobilization would continue along two tracks: the construction of an entirely new munitions industry and the conversion of commercial factories to weapons production.

Laying the Foundation: Construction of New Munition Plants

Drawing on its World War I experience, the Army's Ordnance Department understood that expanding munitions production would be inherently different from increasing production of tanks, aircraft, ships, and other military goods that closely resembled commercial products in their manufacturing inputs and processes.[136] The quantity of weapons demanded made existing facilities insufficient even at maximum capacity, and the unique military nature of munitions meant commercial factories could not easily be converted.[137] Increasing weapons production would therefore require the construction of entirely new plants. Additionally, the cyclical, conflict-driven nature of munition demand meant attracting private investment would be difficult—government funding was needed to expeditiously build new munitions plants.[138] Once built, the government would turn the facilities over to experienced commercial manufacturers to administer day-to-day operations. The Ordnance Department recognized this project as a novelty in American industry: "a vast interlocking network of ammunition plants owned by the government and operated by private industry."[139]

131 Smith, *Army and Economic Mobilization*, p. 105.

132 Schubert, *Mobilization*, p. 14.

133 Thomson and Mayo, *Ordnance Department*, p. 33.

134 Herman, *Freedom's Forge*, p. 146.

135 Smith, *Army and Economic Mobilization*, p. 137.

136 At the time, the Army Ordnance Department and Navy Bureau of Ordnance were the organizations charged with procuring munitions for the armed services.

137 Sweeting, *Building the Arsenal of Democracy*, pp. 103-04.

138 This was a key lesson of WWI for the Ordnance Department. See Thomson and Mayo, *Ordnance Department*, pp. 11, 33.

139 Thomson and Mayo, *Ordnance Department*, p. 105.

With increased funding in summer 1940, the Ordnance Department began contracting for the construction of these plants with an award to DuPont to build a $26 million smokeless powder plant.[140] By the end of 1940, construction of 22 new facilities had begun. The department signed $576 million worth of contracts before July 1941; at the end of 1941, it had at least "one of every essential type of government-owned ammunition plant in operation, including TNT, DNT, tetryl, toluene, anhydrous ammonia, smokeless powder, bag loading, and shell loading."[141] It would ultimately invest around $3 billion to build over 60 government-owned, contractor-operated (GOCO) munition factories through 1942. The Navy's Bureau of Ordnance pursued a similar arrangement and would construct an additional ten plants at a cost of more than $150 million.[142] The war effort led to the creation of an almost entirely new munitions industry in these years, with the average construction of a shell-loading plant taking only nine months.[143] Considering that no British ordnance plant had been built in less than a year, this was a significant American industrial achievement.[144]

To staff and run these new factories, the military relied on private businesses, most with no prior munitions experience. Familiar names such as Quaker Oats, Sherwin-Williams, and Procter and Gamble operated bomb- and shell-loading plants throughout the nation.[145] Rather than privileging a firm's previous work with explosives or ordnance, the Army "gave first consideration to their managerial ability, reputation for efficient operation, integrity, and financial stability."[146] In short, these facilities were able to begin production quickly because they could rely on an existing pool of skilled manufacturing managers and laborers.

With funds remaining relatively limited before Pearl Harbor, the munitions industry was the primary beneficiary of increases in Army and Navy spending at a time when the entire defense industrial base was facing demand that far exceeded capacity. Until the Japanese attack, sectors like aviation relied on allied demand and government incentives such as revised tax regulations to spur private investment in new production facilities.[147] Initially, the Army received widespread criticism for funding the construction of additional powder and shell-loading plants before fully utilizing and expanding existing operations. These condemnations ceased with Japan's attack on Pearl Harbor, after which the service's earlier investments appeared inadequate rather than excessive.[148] By the time the United

140 Thomson and Mayo, *Ordnance Department*, p. 27.

141 Thomson and Mayo, *Ordnance Department*, pp. 32, 43.

142 The Navy also relied extensively on the Army for ordnance production, with around 80 percent of its smokeless powder, rocket motors, TNT, explosive D, and RDX supplied by War Department plants. Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, pp. 5, 191–192.

143 Thomson and Mayo, *Ordnance Department*, p. 112.

144 Thomson and Mayo, *Ordnance Department*, p. 33.

145 Thomson and Mayo, *Ordnance Department*, pp. 112–113.

146 Thomson and Mayo, *Ordnance Department*, p. 113.

147 Gropman, *Mobilizing U.S. Industry*, p. 34.

148 Thomson and Mayo, *Ordnance Department*, pp. 32-33.

States entered the war, 57 percent of the War Department's new plant construction was already complete.[149]

In funding the construction of new factories rather than maximizing the outputs of existing infrastructure, the military deliberately chose a mobilization approach over a surge approach for increasing munitions production.[150] Spending on new facilities directly competed for scarce resources with outlays on existing facilities and weapons production. Between 1940 and 1942, the U.S. government invested over $14 billion in the construction of new factories for defense production.[151] Delivery of most types of munitions, however, would only peak in late 1943 into 1944.[152] This longer term investment paid off in massive production increases that enabled the allied war effort in two theaters but required several years to allow industrial mobilization and new plant construction. As such, the government's choice to invest in new factories represented an implicit choice of military strategy—the U.S. military would not have the weapons needed to fight at full capacity until late 1943.

Full Speed Ahead: Converting Commercial Production to Military Production

Government-owned facilities produced many of the munition-specific components and assembled finished weapons, but many other inputs were sourced from commercial producers. For these parts, the Army and Navy would lean on the conversion of existing commercial industry to support munitions production. Historians have long noted the conversion of the automobile industry—America's largest industrial sector at the time and "equal to the total industry of most of the countries in the world"—as one of the largest contributors to war production.[153] After the Roosevelt administration decided to cease civilian car production in February 1942, the automobile industry joined in munitions production. Car manufacturers produced almost 90 percent of all air-delivered bombs during the war.[154]

Moreover, the halting of car production left tens of thousands of subcontractors in the industry available to make munition components, particularly metal parts. U.S. Steel

149 U.S. Army Center of Military History, *Logistics in World War II*, pp. 7, 14.

150 The United States had the luxury of choosing between a surge and mobilization strategy because it had the advantage of both time and sanctuary. It began increasing war production before entering the war, was able to choose when and where to commit forces once involved, and its war industry was safe in the continental United States. As Chapter 4 will discuss, these advantages may not be enduring.

151 Gropman, *Mobilizing U.S. Industry*, p. 98.

152 Richard M. Leighton and Robert W. Coakley, *Global Logistics and Strategy: 1940–1943* (Washington, DC: United States Army Center of Military History, 1955), p. 728, https://history.army.mil/Portals/143/Images/Publications/Publication%20By%20Title%20Images/G%20Pdf/CMH_Pub_1-5.pdf; and Robert W. Coakley and Richard M. Leighton, *Global Logistics and Strategy: 1943–1945* (Washington, DC: U.S. Army Center of Military History, 1969), p. 832, https://history.army.mil/Portals/143/Images/Publications/Publication%20By%20Title%20Images/G%20Pdf/CMH_Pub_1-6.pdf.

153 Gropman, *Mobilizing U.S. Industry*, p. 59.

154 Herman, *Freedom's Forge*, p. 217.

produced artillery shells, and numerous brass and copper companies began to make munition casings.[155] International Silver—a Connecticut-based producer of tableware—converted to manufacturing bazooka components, bomb casings, and shells for various types of ammunition.[156]

The Ordnance Department promoted industrial conversion in several ways. With America's largest companies serving as the prime contractors for aircraft, ships, and military vehicles, the manufacture of weapon components favored smaller businesses spread throughout the country. Each Ordnance District established exhibits with samples and pictures of various war materiel and their components so businessmen and manufacturers could visit and learn what they might produce for the war effort. In 1941, the department toured similar exhibits across the nation in special trains to extend their reach and harness as much civilian manufacturing capacity as possible.[157] The Research Institute of America published a 500-page guide to help business owners determine what war materiel they could produce, how to acquire government contracts, and how to navigate the various restrictions and controls of the wartime economy.[158]

The Results of Industrial Mobilization

By late 1943, the combination of existing arsenals, newly built GOCO facilities, and converted commercial infrastructure was turning out munitions at unprecedented rates. The main phase of plant construction was completed in summer 1942, opening the floodgate of weapons in the months following. The military's focus on the early expansion of industrial facilities over production alone began to pay dividends as U.S. war production surged past the combined output of Germany, Italy, and Japan.[159]

The United States would ultimately produce almost a billion rounds of medium-caliber and artillery ammunition, over 100 million grenades and mines, and over 33 million bombs.[160] The Navy estimated that wartime output of ammunition "would have overflowed a freight train stretching from Boston to Los Angeles."[161] Munitions procured by the Army's Ordnance Department "exceeded the output of all the other technical services of the Army combined, and in cost they rivaled that for the aircraft and ships with which with

155 Thomson and Mayo, *Ordnance Department*, p. 27.

156 "November 19: The International Silver Company Founded in Meriden," Today in Connecticut History, November 19, 2018, https://todayinthistory.com/2018/11/19/november-19-the-international-silver-company-is-born-in-meriden/; and Gropman, *Mobilizing U.S. Industry*, p. 60.

157 Thomson and Mayo, *Ordnance Department*, p. 41.

158 See Leo M. Cherne, *Your Business Goes to War* (Boston: Houghton Mifflin Company, 1942).

159 Herman, *Freedom's Forge*, p. 200.

160 Thomson and Mayo, *Ordnance Department*, p. 105.

161 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 186.

the war was fought."[162] Ammunition required more facilities expansion than any other item produced during the war.[163] Beyond munitions, American industry had produced two thirds of all weaponry used by the Allied nations—wholly fulfilling Roosevelt's 1940 vision of the Arsenal of Democracy.[164] In the eight decades since World War II, this record has led historians to recognize American industrial might as one of the driving factors behind the Allies' victory.[165]

By these metrics, U.S. industrial mobilization was a smashing success. The quantified results of American war production remain a national achievement and a manufacturing feat not replicated by any nation since. Removing the benefit of hindsight, however, was mobilization a success by other metrics? Did U.S. production of munitions keep pace with the demands of U.S. and allied militaries in the conflict's varied campaigns? How did war production and the need for mobilization constrain Allied strategic planning and limit forces in combat? Moreover, what were the costs—fiscal and otherwise—of U.S. industrial mobilization? The next chapter assesses mobilization planning and execution by these standards to provide today's policymakers and planners renewed perspective on the creation of the Arsenal of Democracy.

162 Thomson and Mayo, *Ordnance Department*, p. vii.

163 Smith, *Army and Economic Mobilization*, p. 203.

164 Herman, *Freedom's Forge*, p. ix.

165 Richard Overy, *Why the Allies Won* (New York: W.W. Norton & Company, 1997); and Raymond W. Goldsmith, "The Power of Victory: Munitions Output in World War II," *Military Affairs* 10, no. 1 (Spring 1946), pp. 69–80.

CHAPTER 3

Separating Myth from Reality

> Myths provoked by sentimentality regarding United States munitions production have evolved in the half century since the war ended, and these have become a barrier to comprehending the lessons of that era.
>
> —Alan L. Gropman, *Mobilizing U.S. Industry in World War II*, 1996[166]

American fondness for the Arsenal of Democracy sometimes obscures the reality of industrial mobilization and emphasizes its results—massive increases in war production—without acknowledging the level of resourcing required, the many obstacles that had to be overcome, and the very real costs the American people paid. This chapter looks past nostalgia to assess World War II's industrial mobilization beyond production gains alone. It explores four main questions relevant for considering industrial mobilization in the modern era:

1. Was interwar mobilization planning and preparation useful, and to what degree did it contribute to industrial mobilization once it began in 1940?
2. Did industrial mobilization keep pace with military demands during the war?
3. What were the costs associated with industrial mobilization?
4. What factors were most essential to the success of industrial mobilization?

As policymakers and planners consider reviving the Arsenal of Democracy in the 21st century, it is essential that they objectively consider the history of mobilization beyond national mythology. Identifying the requirements and costs of World War II's industrial mobilization is vital to understanding the resources necessary and risks inherent in any contemporary effort to rapidly expand munitions production.

166 Gropman, *Mobilizing U.S. Industry*, p. 2.

Was Mobilization Planning Successful?

The mobilization plans of the interwar period provide an opportunity to examine the extent to which implementation followed planning. As the previous chapter revealed, the IMPs prepared throughout the 1930s were only partially used during the mobilization period, with the Roosevelt administration drawing on some elements and dispensing of others. This section takes a closer look at the flaws and successes of the IMPs.

Flaws of Interwar Mobilization Planning

The primary weaknesses of the IMPs were faulty assumptions about timing, authorities, and requirements.

Fixation on a defined Mobilization Day. Until 1939, mobilization plans hinged on a definite mobilization day after which the military would be given broad authority to execute its prepared plans to muster conscripts, expand procurement, and take control of the American economy. This rigid M-Day view of mobilization—akin to "throwing a switch"—oversimplified the complex process of marshalling resources and converting civilian manufacturing to military production.[167] This binary mindset precluded the military from planning for a gradual mobilization of industry that might be conducted well ahead of war to account for the long lead times of certain weapons while maintaining a functioning civilian economy.[168] Beyond its oversimplification of the process, the domestic politics of the late 1930s and Roosevelt's own concerns with reelection made any declaration of a definite M-Day politically infeasible. Popular works such as *Merchants of Death* and *War Is a Racket*, published in 1934 and 1935, backed ideas promoted by isolationist leaders that M-Day would usher in a military dictatorship bent on pushing the United States into war in the name of industrial and financial profits.[169]

The focus on a mobilization day has been widely noted in postwar analyses as a flaw of interwar planning.[170] There were, however, good reasons for the military's focus on M-Day. Any mobilization plan required a start date to project timelines forward and track progress. Additionally, M-Day carried significance for mobilizing personnel as well as industry. As early as 1925, the War Department's plans acknowledged that the procurement of equipment may need to begin at a different time than drafting personnel even though "these two days should be brought as close together as possible."[171] As such, the military was reluctant to push ahead with industrial expansion before Congress passed the Selective Service Act in

167 Herman, *Freedom's Forge*, pp. 75–76.

168 Gropman, *Mobilizing U.S. Industry*, p. 22.

169 Smith, *Army and Economic Mobilization*, p. 83.

170 See, for example, Gropman, *Mobilizing U.S. Industry*, p. 19.

171 Smith, *Army and Economic Mobilization*, p. 82.

September 1940 and personnel could be mobilized alongside production.[172] In 1936, the War Department created a Protective Mobilization Plan alongside the IMP; this envisioned mobilizing and equipping a small defensive force during a crisis.[173] These plans remained nascent until 1939, when the War Department finally gave up on the M-Day concept after it was abundantly clear that industrial expansion would proceed without any formal declarations. With Europe already engulfed in conflict, the 1939 mobilization plan pursued the more gradual vision of industrial preparation that, in many respects, was already underway.[174]

Various dates could be cited as de facto M-Days, including the establishment of the OEM and NDAC in May 1940, the approval of the Munitions Program in June 1940, or even the days following the Japanese attack on Pearl Harbor in December 1941. None of these milestones, however, initiated the IMP in totality.

Assumptions of widely expanded and delegated authority. The real flaw with the M-Day concept lay not in its timing but in the War Department's planning assumption that on M-Day it would be granted additional authorities and comprehensive control over the American economy. Throughout the development of interwar plans, military officers assumed industrial mobilization would not take place without a broader national mobilization.[175] Like a formal M-Day declaration, an all-out mobilization and the delegation of power to mobilization authorities and the military were politically unviable prior to Pearl Harbor and ran anathema to Roosevelt's leadership style. He was especially skeptical of the need to establish an all-powerful War Resources Administration during a time of peace.[176] Roosevelt wanted to have direct control over preparedness efforts given the public's sensitivity and the competing political priorities of the time. Among these priorities were managing attacks from various pacifist groups; the opposing interests of labor, business, and the U.S. military; the pleas of allies in Europe; and an American public that was not yet willing to make sacrifices in the name of a war they wanted to remain distant from. As such, he was reluctant to grant any one entity more authority than necessary to achieve results on a timeline acceptable to the administration, which was juggling these factors in the run-up to the election of 1940.[177] Only after Pearl Harbor and the establishment of the WPB did Roosevelt delegate significant decision-making power to mobilization officials.[178] Put simply, the IMPs' assumptions about delegated authorities and the binary choice between peacetime

172 At this point, the act only allowed draftees to serve within the Western Hemisphere or in U.S. territories or possessions. Congress removed this restriction shortly after the attack on Pearl Harbor. Smith, *Army and Economic Mobilization*, p. 85; and Robert H. Rankin, "A History of Selective Service," *Proceedings*, U.S. Naval Institute, October 1951, https://www.usni.org/magazines/proceedings/1951/october/history-selective-service.

173 Smith, *Army and Economic Mobilization*, p. 55.

174 Schubert, *Mobilization*, p. 7.

175 Smith, *Army and Economic Mobilization*, pp. 46–47.

176 Smith, *Army and Economic Mobilization*, pp. 98–99.

177 Klein, *Call to Arms*, pp. 44, 114.

178 Klein, *Call to Arms*, p. 296.

and total mobilization were out of touch with the political environment of the day. Army leaders appear to have recognized this flaw during the 1930s but were slow to adapt plans to reality.[179]

Lack of civilian input and buy-in. Even after the establishment of the Army Industrial College and engagement with industry in the late 1930s, the IMPs lacked sufficient input from business leaders, many of whom would go on to become dollar-a-year men during World War II. Although the Army intended for graduates of the Industrial College to increase military control of mobilization and obviate the need for civilian expertise, this proved unrealistic in the political environment of the day. Despite the school's contributions to mobilization planning, it suffered from lack of resources and prestige within an Army culture that favored combat arms over the supply and logistics services.[180]

As a result, the plans favored military over industrial concerns and ignored key aspects of mobilization such as the management of labor and the need to continue production of many civilian goods. Workforce shortages and conflicts with organized labor were a major obstacle throughout the war, but they were largely ignored in the IMPs.[181] With much of Roosevelt's presidency spent dealing with the Great Depression and championing the New Deal, he was also initially unwilling to invoke mobilization policies that were supported by the military and industry but might compete with or rollback the progressive achievements of his first two terms, such as limitations on work hours.[182] The IMPs assumed that most production of commercial goods would cease after M-Day in favor of military goods, a fact that was heavily criticized by members of the NDAC and OPM who understood that many elements of the civilian economy were also essential to enabling war production.[183] These oversights, along with the military origins of the plans, led many political and industrial officials to be skeptical of the IMPs from the outset of mobilization.[184]

Misestimations of requirements. Interwar planning was also hindered by the lack of reliable data available for estimating munition requirements. Planners had only outdated consumption rates from American forces in World War I. Given the massive changes in warfare and weaponry between the world wars—from the refinement of maneuver tactics to the increasing role of aerial bombing—military planners struggled to assess the

179 Army publications in the 1930s acknowledged, "The prepared plans may or may not be accepted by the superagencies," and "It is impossible to say in advance just what changes may occur in these plans or who will execute them. Much will depend upon the personality of the President, the temper of Congress, and the psychology of the people at the time. Meanwhile, it is the job of the Army and Navy to keep these plans for a superagency—a war resources administration—up to date and ready to submit to the consideration of Congress and the President at any moment." Jordan, "School of Supply Strategy," p. 76.

180 Gough, "Origins of the Army Industrial College," p. 269.

181 U.S. Army Center of Military History, *Logistics in World War II*, p. 68.

182 Klein, *Call to Arms*, p. 121.

183 Smith, *Army and Economic Mobilization*, pp. 102, 110.

184 U.S. Army Center of Military History, *Logistics in World War II*, p. 5.

requirements of large-scale combat operations in the 1930s or 1940s. For ammunition, this resulted in wildly overestimated requirements that would have been infeasible given industrial limitations and competing needs. The much-improved Victory Program was "only half the size of the maximum effort contemplated by IMP."[185] Inaccurate assessments of the types and quantities of military goods gave interwar estimates of raw material needs even less fidelity. For example, although the ANMB estimated that 25,000 tons of copper would be necessary to equip a four-million-man army for two years, doing so would actually require almost ten million tons of copper.[186]

Failure to consider the requirements of U.S. allies and partners. One factor adding to inaccurate requirements was the exclusion of potential coalition forces from prewar plans. Despite the fact that the U.S. armed forces had themselves depended upon arms supplied by allies in World War I, interwar planners failed to account for the needs of U.S. allies and partners in the IMPs.[187] Although allied demand played a crucial role in priming American industry for future expansion while U.S. defense spending remained low, providing equipment through Cash and Carry and Lend–Lease slowed the buildup of American forces and interfered with the achievement of the Victory Plan's objectives.[188] With industrial mobilization plans lacking any system for requesting and collating allied demand, collecting and vetting British, Soviet, and other foreign materiel requests proved immensely challenging for the duration of the war.[189]

Failure to align strategy with available resources. Most damningly, interwar mobilization plans vastly overestimated the industrial base's capacity to produce munitions and underestimated the time required to expand this capacity.[190] The plans failed to adequately link the nation's industrial capabilities to military strategies and plans. According to the Army's history, they wrongfully "assumed that production would adjust to strategic plans, expanding when necessary and contracting when not."[191] In part, these problems were indicative of the fact that most authors of the interwar plans were military officers with limited or no experience in business and manufacturing. As a result, IMPs were not adequately linked to any war plan or strategy that would provide the necessary details and assumptions to produce effective requirements and industrial preparation.

185 Smith, *Army and Economic Mobilization*, pp. 106–07.

186 Gropman, *Mobilizing U.S. Industry*, p. 45.

187 Gropman, *Mobilizing U.S. Industry*, p. 20.

188 Schubert, *Mobilization*, p. 15; and Gropman, *Mobilizing U.S. Industry*, p. 41.

189 Major General Richard C. Moore, the Army deputy chief of staff and later chief of the Requirements Section, remarked in 1942 that U.S. allies "guessed [their] requirements. They never had a true basis. They didn't have any foundation. They just reached up in the air and got what they thought the United States would give them." Quoted in Thomson and Mayo, *Ordnance Department*, p. 63.

190 Gropman, *Mobilizing U.S. Industry*, p. 60.

191 Schubert, *Mobilization*, p. 5.

Successes of Interwar Mobilization Planning

Despite these flaws, many elements of the IMPs proved valuable once mobilization began in the late 1930s.

Interwar planning provided a framework for industrial mobilization execution. Most importantly, although much of the executive-level organizational scheme was abandoned, many pieces of the IMPs provided the necessary mechanisms to turn presidential directives into procurements and industrial capacity. Roosevelt relied on a series of civilian advisory boards and superagencies, even if they lacked the authority of the IMP's War Resources Administration for much of the mobilization period. The basic relationship between these agencies and the military services contemplated in the IMPs held throughout the war, with the services remaining in charge of procurement and the civilian agencies overseeing industry, materials, and labor.[192] Other elements, such as the price control scheme, were drawn and implemented directly from the IMPs.[193] The material control measures and priorities system outlined in interwar plans would go on to become the basis from which mobilization authorities would order and allocate various material and industrial capacities throughout the war. The Controlled Materials Plan, implemented by the WPB in 1942 to centrally allocate raw materials to different manufacturers after the priorities system proved insufficient, can be traced to the pages of the IMPs.[194] A related area of utility was the drafted legislative proposals contained in an IMP appendix. When Roosevelt established various mobilization agencies in 1940, these proposals enabled Congress to quickly grant the new organizations the powers they requested and clear away many statutory obstacles that would have otherwise slowed mobilization.[195]

The IMP and its supporting procurement plans proved most valuable within the War Department itself. The ANMB, although partly undermined by the numerous civilian organizations established by the president, played a vital role in amalgamating and deconflicting the requirements of the services and allies.[196] Despite persistent challenges associated with estimating munition requirements, interwar planning left the Army prepared to interact with industry in a much more productive manner than during World War I. At the very least, its various supply organizations knew from the start where their needs could be produced—an improvement that greatly reduced disorder and saved time.[197] The work done by the Army to establish and assess procurement districts throughout the nation would enable "greater output, lower prices, improved quality of production, and a more even distribution of the

192 U.S. Army Center of Military History, *Logistics in World War II*, p. 5.

193 Smith, *Army and Economic Mobilization*, p. 95.

194 U.S. Army Center of Military History, *Logistics in World War II*, p. 67; and Smith, *Army and Economic Mobilization*, p. 92.

195 Smith, *Army and Economic Mobilization*, p. 70.

196 Smith, *Army and Economic Mobilization*, p. 43.

197 Smith, *Army and Economic Mobilization*, p. 67.

procurement load."[198] Assistant Secretary of War Louis A. Johnson wrote in 1940, "Without the benefits of plans perfected by twenty years of study the successful and timely execution of this program [industrial mobilization for war] would have been virtually impossible."[199]

Procurement planning and the IMPs spurred engagement between the military and industry during the interwar period. The industrial surveys, production studies, and educational orders that arose from interwar planning greatly reduced mobilization timelines and eased production bottlenecks. During the war, over 90 percent of ordnance contracts were given to firms that had been surveyed during the interwar period, and Army officials later estimated that production studies reduced mobilization timelines by at least three months.[200] Despite lacking funding until 1938, the educational orders completed in the following two years reduced production timelines for numerous difficult-to-manufacture goods. Almost 300 companies benefited from these limited orders, which provided valuable training for industrial workers and Army procurement officials.[201] Winchester would later estimate that educational orders for the M1 Garand rifle saved it a year's time in expanding production of the weapon.[202] Interwar planning also fostered the creation of the Army Industrial College, which helped train procurement officials, refine mobilization plans, and distribute educational materials throughout the supply services.[203] Many graduates of the college filled the ranks of the various mobilization agencies created during the war.[204]

Mobilization plans guided early investments that proved critical once mobilization accelerated. As Congress increased defense appropriations in the late 1930s, the Army's procurement and mobilization plans were essential to directing funding toward areas identified as priorities. Most notably, these blueprints led to the early acquisition of specialized equipment and additional machine tools to revamp government-owned arsenals.[205] The IMPs and the revised Protective Mobilization Plan were fundamental to the development of the June 1940 Munitions Plan, which supported early plant construction vital to the expansion of munition production.[206]

In sum, the interwar efforts of the War Department proved crucial to reducing the confusion associated with early industrial mobilization efforts and shortening the mobilization timelines of many critical items. Because Roosevelt never

198 Smith, *Army and Economic Mobilization*, p. 55.

199 Quoted in Irish, "Apt Pupil," p. 57.

200 Gropman, *Mobilizing U.S. Industry*, p. 24.

201 Smith, *Army and Economic Mobilization*, p. 64.

202 Thomson and Mayo, *Ordnance Department*, p. 20.

203 Smith, *Army and Economic Mobilization*, p. 44.

204 Gropman, "Industrial College of the Armed Forces," p. 23.

205 Thomson and Mayo, *The Ordnance Department*, pp. 11-12.

206 U.S. Army Center of Military History, *Logistics in World War II*, p. 2.

declared a formal M-Day but instead granted civilian and military agencies additional authorities piecemeal, many provisions of prewar planning were not utilized until after Pearl Harbor and others went unused altogether.[207] Still, the lack of a formal mobilization day did not prevent many of the IMPs' elements from being implemented, particularly the more granular aspects of procurement planning and industrial engagement. Although FDR's choice to forgo the IMP in its entirety has led some postwar historians to question the utility of the endeavor, the fact that military officials spent the better part of two decades contemplating industrial mobilization expedited the longer than expected process and left the United States in a far superior position than it had encountered when it entered World War I.

The blame for many of the IMPs' flaws cannot be assigned entirely to the War Department and the officers who labored during the interwar period. Until mobilization began in the late 1930s, military planners lacked the authority, funding, and political support needed to remedy many of the IMPs' problems. From the outset, the National Defense Act of 1920 charged the assistant secretary of war with planning for industrial mobilization but failed to bestow the position with any power beyond persuasion to compel other departments and agencies to participate in the effort.[208] Throughout the interwar period, lack of defense funding hamstrung many of the military's initiatives to engage with industry and improve the nation's mobilization capacity. War Department requests for appropriations to support production studies and educational orders were denied by Congress no less than four times throughout the 1920s and 1930s.[209] Congress also vetoed the military's efforts to establish strategic material stockpiles because of their cost and "the resistance of domestic producers."[210] Perhaps most importantly, the attitude of the American people throughout the interwar period strongly opposed U.S. involvement in foreign wars or even planning for a mobilization, which they believed would inevitably push the nation to enter a conflict.

In this light, the IMPs' biggest problem was that at its highest level, it failed to acknowledge the very real political and resource constraints of the day and lacked the flexibility to contend with these shifting constraints and the needs of different administrations. In the end, military and industry officials actually benefited from Roosevelt's gradual approach because they were able to commence industrial mobilization—even if limited in certain dimensions—more than 18 months before Pearl Harbor and the full-scale mobilization that followed.[211] Given the multitude of factors inhibiting military readiness in the 1930s, the degree to which the IMPs' and their supporting efforts reduced mobilization timelines remains an impressive contribution to the U.S. war effort and allied victory.

207 Unused provisions included the establishment of the War Resources Administration envisioned by the War Department and the facility allocation plans developed by the Army's supply services. U.S. Army Center of Military History, *Logistics in World War II*, p. 5.

208 Smith, *Army and Economic Mobilization*, p. 42.

209 Smith, *Army and Economic Mobilization*, pp. 6–63.

210 Smith, *Army and Economic Mobilization*, p. 87.

211 Smith, *Army and Economic Mobilization*, p. 98.

Did Mobilization Keep Up with Demand?

Despite its impressive record and America's glowing memory of industrial mobilization, the perceptions of mobilization and industry were often less generous during the conflict itself. Prior to Pearl Harbor, the Roosevelt administration and its executive agencies faced widespread criticism for slow mobilization progress amid a worsening situation in Europe.[212] The Army's own history of the war's logistics criticized peacetime mobilization efforts as "painfully slow," with production capacity only increasing one to two years after being funded.[213] Given the nearly insatiable demands of the rapidly expanding U.S. military, industry was slow to meet the requirements of the services and U.S. allies during the first two years of the conflict while mobilization was underway.

But as previous sections have shown, these critiques and the perceived leisureliness of industrial expansion were not entirely the fault of mobilization planners or executors. The administration and the military were constrained by domestic politics and the limited degree to which industry and the American public would tolerate emergency measures during peacetime. Moreover, officials quickly pushed up against the maximum speed at which the physical components of mobilization—moving tooling, building new plants, training staff, and other crucial tasks—could be accomplished. Given these limitations, this section explores these questions: Did industrial mobilization and manufacturing output keep up with U.S. and allied demand? How did mobilization timelines impact strategy and operations throughout the conflict?

Strategic Implications

With American defense production supplying U.S. and allied forces with the weapons and equipment vital to conducting large-scale campaigns to defeat the Axis powers, industrial mobilization and the gains it promised were crucial to the formulation of allied strategy. At the highest level, the grand strategy of the war hinged on America's ability to produce the necessary military goods and ship them to overseas theaters.[214] From the war's outset, the pace of industrial mobilization often dictated the focus of allied strategy, the timing of various campaigns, and the scope of military options available to allied leaders.[215] Throughout the war's duration, planners found their range of strategic choices constrained by decisions made while mobilizing industry—decisions often made years earlier under entirely different conditions and assumptions.[216] For this reason, Army historians called strategic and logistical planning for the war "two sides of the same coin," with the United

212 Klein, *Call to Arms*, p. 193.

213 U.S. Army Center of Military History, *Logistics in World War II*, p. 12.

214 U.S. Army Center of Military History, *Logistics in World War II*, p. 32.

215 U.S. Army Center of Military History, *Logistics in World War II*, pp. 32, 34.

216 Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 797.

States benefitting from a homeland sanctuary that provided the military two years to formulate and refine these plans before engaging in its most significant campaigns.[217]

In formulating strategy, allied leaders were forced to balance political and military imperatives with production realities. When the United States entered the war, it faced opponents in theaters on opposite ends of the globe. With industrial mobilization still in progress and output limited, however, war materiel and the ships to transport it remained inadequate. Roosevelt was faced with a choice between focusing American aid and forces on Europe or the Pacific until factories reached maximum production. Politically and militarily, it was most critical to support the UK and Soviet Union in their ongoing campaigns against Germany. With industrial mobilization still underway, however, focusing on "Germany first" precluded the United States from conducting large ground campaigns in the Pacific for the foreseeable future, and shipments of vehicles and weapons to the Soviets delayed the training of U.S. forces for the European theater.[218] This decision was also influenced by the shape of American industry at this stage in mobilization: it was concentrated east of the Mississippi River and thus closer to East Coast ports and the European theater.[219]

The potential production gains from industrial mobilization were a topic of heated debate between the U.S. military and Roosevelt's dollar-a-year men. With the Victory Plan calling for defense production on a previously unimaginable scale, industrialists doubted the ability of mobilization to support the military's demands and, in turn, the allied war strategy.[220] This dispute resulted in several reformulations of the military's strategy and objectives to modify requirements and reduce production objectives to feasible quantities.[221] For example, the feasibility debate forced the Army to decrease its planned end strength for 1943 and 1944 by 300,000 personnel, reduce the number of armored and mechanized divisions it intended to field, and issue units in training just half their allotted equipment.[222] In this way, strategy and industrial mobilization enjoyed a reciprocal relationship throughout the war, with the objectives and constraints of each imposing modifications on the other.[223]

217 Although the relative safety of the U.S. homeland was a major advantage during industrial mobilization, it also meant that all war materiel had to be transported thousands of miles to the war's combat zones. These distances created massive requirements for shipping assets and transportation and distribution infrastructure throughout the world. Coakley and Leighton, *Global Logistics and Strategy: 1943-1945*, pp. 796–797.

218 U.S. Army Center of Military History, *Logistics in World War II*, pp. 34–35.

219 Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, pp. 799–800.

220 General Marshall first posed the question of feasibility during the formulation of the Victory Plan in September 1941. Smith, *Army and Economic Mobilization*, p. 157.

221 In the end, inaccurate requirements generated using faulty data were partially responsible for the feasibility dispute. U.S. Army Center of Military History, *Logistics in World War II*, pp. 56–58; Smith, *Army and Economic Mobilization*, p. 150.

222 Smith, *Army and Economic Mobilization*, pp. 154–156.

223 During the debate over the Victory Plan's feasibility, economists in the WPB suggested the creation of a "super-organization" with the power to coordinate and reconcile military strategy with industrial production. To military leaders, this suggestion was an unacceptable encroachment on military responsibilities by civilian bureaucrats. The suggestion was abandoned during the debate's resolution. Lacey, *Keep from All Thoughtful Men*, pp. 106–13.

World War II confronted American leaders with a reality that was unfamiliar to the U.S. military since the American Civil War: the nation had limited resources. Prior to World War II, U.S. military planners had considered the nation's industrial capacity to be essentially unlimited once fully mobilized.[224] The scale of the war proved this assumption wrong and forced the Army to adapt to supply tradeoffs and shortages in order to balance military requirements with industrial means.[225] Even after achieving peak production, industrial workforce requirements conflicted with military demands for replacement personnel and created a manpower shortage that was only solved by the war's end.[226]

As the war progressed, production realities created numerous strategic tradeoffs and delays for military leaders in Europe and the Pacific. Limited quantities of available equipment confronted the planners of Operation Torch with a difficult choice: reduce the size of a fully equipped American invasion force or maintain a larger force equipped with half the equipment. Army planners chose the latter option because the forces were intended to be "primarily occupational," a decision that would affect the conduct of the North African campaign.[227] Soon after, the decision to invade Sicily and commit still limited quantities of defense materiel to the Italian campaign delayed preparations for the invasion of France and reduced the resources available in the Pacific.[228] This lack of materiel prevented the conduct of a major ground campaign in the Pacific for much of 1942.[229] Although not strictly related to munitions, perhaps the clearest constraint posed by war production on military operations was the shortage of landing craft, which dictated the scope and tempo of entire campaigns in 1943 and 1944.[230]

In addition to operational compromises, industrial mobilization confronted American leaders with a novel strategic tradeoff: the balance between building and equipping the U.S. military and supporting American allies and partners, who in many cases were actively engaged in bloody campaigns against the Axis powers. Production limitations meant that before 1943, weapons provided to U.S. allies reduced the equipment available to U.S. forces. Lend–Lease transfers significantly delayed the build-up and training of the Army Air Corps and reduced the number of armored divisions the Army was able to field.[231] The Army later estimated that it transferred equipment to allies sufficient to equip 101 American

224 U.S. Army Center of Military History, *Logistics in World War II*, p. 245.

225 Smith, *Army and Economic Mobilization*, p. 150.

226 By May 1945, the Army was utilizing all its combat units overseas and retained no strategic reserve of ground forces. Gropman, *Mobilizing U.S. Industry in World War II*, p. 52.

227 U.S. Army Center of Military History, *Logistics in World War II*, p. 36.

228 U.S. Army Center of Military History, *Logistics in World War II*, p. 38.

229 U.S. Army Center of Military History, *Logistics in World War II*, p. 46.

230 Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 805.

231 Schubert, *Mobilization*, p. 15; and Gropman, *Mobilizing U.S. Industry in World War II*, p. 41.

divisions.[232] In 1943, allied requirements for Ordnance Department items constituted almost two thirds of the Army's own demands.[233] Roosevelt and his advisors believed assisting allies would aid the war effort and reduce the burden on U.S. forces but acknowledged that taking weapons from American troops and giving them to allies could have disastrous consequences if those allies succumbed to Axis attacks.[234] The weight of this decision contributed to Roosevelt's desire to remain the sole decision maker on mobilization issues in the months before Pearl Harbor.[235]

Supplying allies also benefitted the American mobilization effort in several ways, the most obvious being their attrition of the Axis powers while U.S. industry and forces were still mobilizing. Equally important, allied orders primed U.S. industry for expanded production at a time when U.S. demand remained low.[236] Maintaining trade with the UK and its empire provided the United States a source of several strategic materials that it lacked, such as tin and nickel.[237] Cooperation with the British also resulted in technology exchanges that brought the United States the variable time fuze, radar technology, and developments in jet propulsion.[238]

The resulting strategic approach was predicated on mobilization and a protracted war. The lack of military and industrial preparedness, combined with the safety of the homeland and existence of massive reserve capacity, forced the United States to pursue a strategy that used time to leverage the nation's latent military–industrial power. American leaders understood that the war's decisive campaigns could not be conducted until 1943 or later.[239] By that time, the United States would be able to turn its industrial and manpower potential into the overwhelming firepower and logistics needed to triumph in a protracted multitheater war. Roosevelt sought to avoid committing American lives to combat until they could be properly supplied in the numbers required.[240] As a result, the Roosevelt administration and its mobilization agencies planned for a protracted war dependent on production from the outset.[241] Figure 2 illustrates the protracted nature of industrial mobilization and the military campaigns it enabled.

232 Gropman, *Mobilizing U.S. Industry in World War II*, p. 41.

233 Smith, *Army and Economic Mobilization*, p. 153.

234 Klein, *Call to Arms*, p. 39.

235 Klein, *Call to Arms*, p. 206.

236 Sweeting, *Building the Arsenal of Democracy*, p. 61.

237 Murray and Millett, *War to be Won*, pp. 528–29.

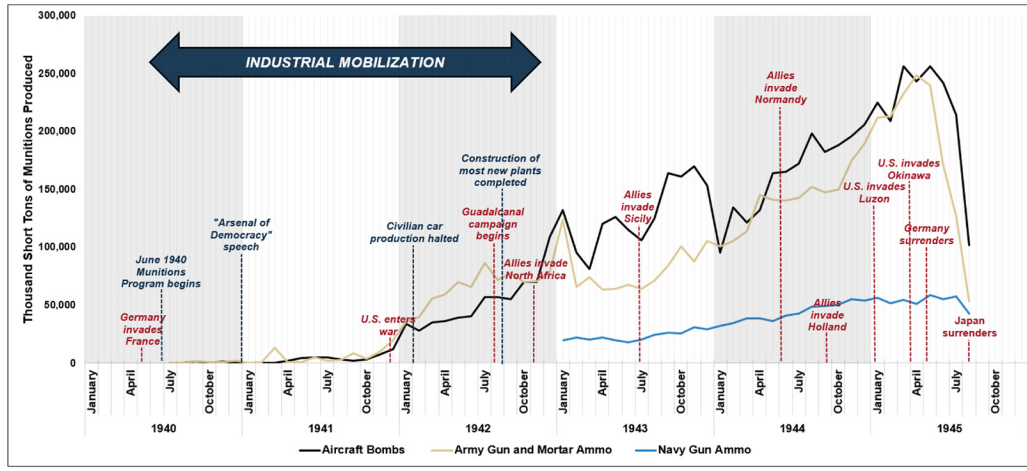
238 Herman, *Freedom's Forge*, p. 106.

239 U.S. Army Center of Military History, *Logistics in World War II*, p. 244.

240 Gropman, *Mobilizing U.S. Industry*, p. 5.

241 Klein, *Call to Arms*, p. 166.

FIGURE 2: MOBILIZATION OF MUNITIONS PRODUCTION FOR WORLD WAR II, 1940–1945



Source: Created by CSBA using data from *Official Munitions Production of the United States: By Months, July 1, 1940–August 31, 1945* (Washington, DC: Civilian Production Administration, May 1, 1947), pp. 166, 167, 216.

Once this strategy was agreed upon and the gears of industry were turning toward the production of specific quantities of goods, leaders were often limited in their ability to deviate from their chosen strategy. Mobilization decisions became de facto strategic decisions, with choices made in the years before Pearl Harbor narrowing the range of strategic choices available to decision makers once the United States entered the war.[242] In this way, American responses to the production emergencies of 1940 and 1941 significantly influenced the execution of campaigns through 1944 and 1945.[243]

Germany and Japan pursued very different strategies, each seeking decisive victory without totally mobilizing their own societies before the allies would be able to mobilize theirs. In doing so, they emphasized maximizing production from existing factories before expanding capacity, which boosted output in the short run but limited potential output in the long run.[244] Rather than constructing new plants, the Germans relied on additional means of production seized in their advance across Europe.[245] Economist Mark Harrison summarized the strategic divergences:

> The most important difference lay in the time horizon of the economic plans. German rearmament tended to emphasize the maximization of specific kinds of short-term military power, reflected in the acquisition of particular weapons and combat stocks for immediate campaigns. Her adversaries, unable to choose the time or place of battle or the direction of the attack, were forced to plan for a more protracted conflict and to prepare their forces to

242 Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 796.

243 Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 797.

244 Gropman, *Mobilizing U.S. Industry*, p. 34.

245 The German military seized numerous mines and factories in their march across France and Czechoslovakia. See Klein, *Call to Arms*, pp. 50, 155.

> fight under all conditions. Whether they rearmed at a low or a high level, their rearmament tended to display an all-round, long-range character in which an immediate increase of munitions production was combined with a military–industrial build-up aimed at maximizing military power across a wide range in some future year.[246]

This protracted approach was attacked by Roosevelt's domestic opponents, who criticized the administration and military services for constructing new plants before maximizing the output of existing ones.[247] In the end, however, the allied strategy centered on American industrial mobilization proved superior to the short-sighted approach of the Axis powers. Whereas German and Japanese war production increased arithmetically, American production rose exponentially to supply the multitheater war that ultimately defeated the Axis.[248]

Operational and Tactical Implications

In addition to dictating allied war strategy, the pace of industrial mobilization influenced the U.S. military's conduct of the various campaigns upon which it embarked. General shortages of weapons and ammunition were a feature of the mobilization period, with the Army's history of World War II logistics designating 1942 as "a year of shortages in all areas."[249] Producing sufficient munitions to dependably meet the demands of ongoing and upcoming operations proved particularly challenging. Inadequate plant capacity and shortages of copper led to massive shortages of ammunition early in the war that were only ameliorated by the slow pace of operations at the time.[250] This reality eased as production peaked in mid-1943, whereafter most shortages pertained to specialized goods rather than general deficiencies.[251] Despite the efforts of the armed services to forecast munition consumption rates, the unpredictable nature of military actions often led to unexpected needs and emergency requests to shift or increase production.[252] Even after the primary phases of industrial mobilization, the Army experienced several munition shortages in 1944 and 1945 that impeded operations.

One example of this was artillery munitions.[253] Predicted expenditure rates of artillery shells drastically underestimated what would be needed during the North Africa campaign,

246 Mark Harrison, "Resource Mobilization for World War II: The USA, UK, USSR, and Germany, 1938–1945," *Economic History Review* 41, no. 2, 1988, pp. 174–75.

247 This point was a key critique of the Truman Committee within the U.S. Congress. Thomson and Mayo, *Ordnance Department*, p. 32.

248 Gropman, *Mobilizing U.S. Industry*, pp. 48, 98.

249 Coakley and Leighton, *Global Logistics and Strategy 1943–1945*, p. 801.

250 Smith, *Army and Economic Mobilization*, pp. 207-208.

251 Coakley and Leighton, *Global Logistics and Strategy 1943–1945*, p. 802.

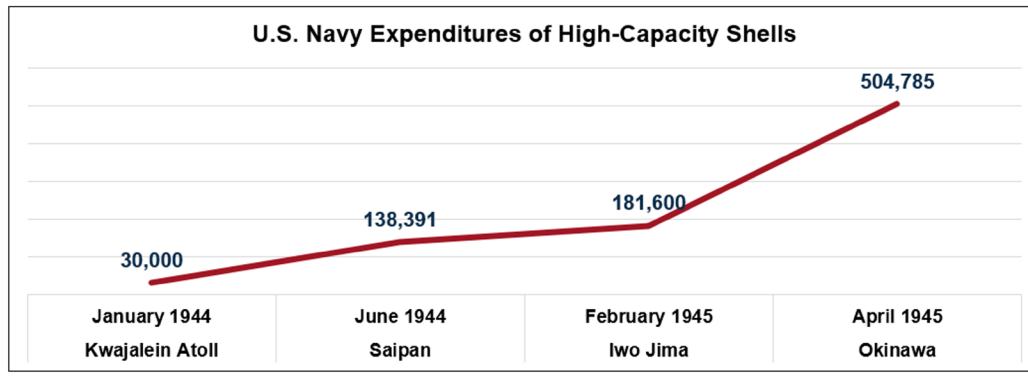
252 It also led to the build-up of theater surpluses of some munition types, particularly small arms ammunition, which benefited theater commanders and prevented future shortages. U.S. Army Center of Military History, *Logistics in World War II*, p. 99.

253 This example is drawn from U.S. Army Center of Military History, *Logistics in World War II*, p. 97.

leading to shortages and increased requirements for the invasions of Sicily and Italy. These forecasts again proved insufficient and were readjusted upwards. After the invasion of Normandy, shortages again led to calls for more munitions, which at this point exceeded the maximum capacity of available factories. The lack of heavy artillery ammunition was especially acute in the European theater in late 1944, leading to the rationing of shells and reduced firing rates.[254] Lower than expected expenditures of heavy artillery in the earlier campaigns led to production curtailments in favor of smaller artillery munitions and then delays in supply as manufacturing capacity was reestablished to meet increasing demands later in the war.[255] Additional plant capacity for the production of artillery ammunition was under construction all the way to the end of the war; it was only canceled after the German surrender.

The Navy faced similar difficulties producing and procuring enough high-capacity shells for shore bombardment. The latest models of these shells remained in development until late 1941, after which demand rose sharply as the Navy supported numerous amphibious landings in the Pacific Theater.[256] Figure 3 illustrates this increasing requirement with each successive landing, which necessitated the continued expansion of production facilities and culminated in 15 plants running continuous 24-hour operations to try to keep up with demand. Even so, naval operations in late 1944 were still affected by shortages of high-capacity shells.[257]

FIGURE 3: INCREASING DEMAND FOR NAVY HIGH-CAPACITY SHELLS, 1944–1945



Source: Rowland and Boyd, *U.S. Navy Bureau of Ordnance in World War II*, p. 61.

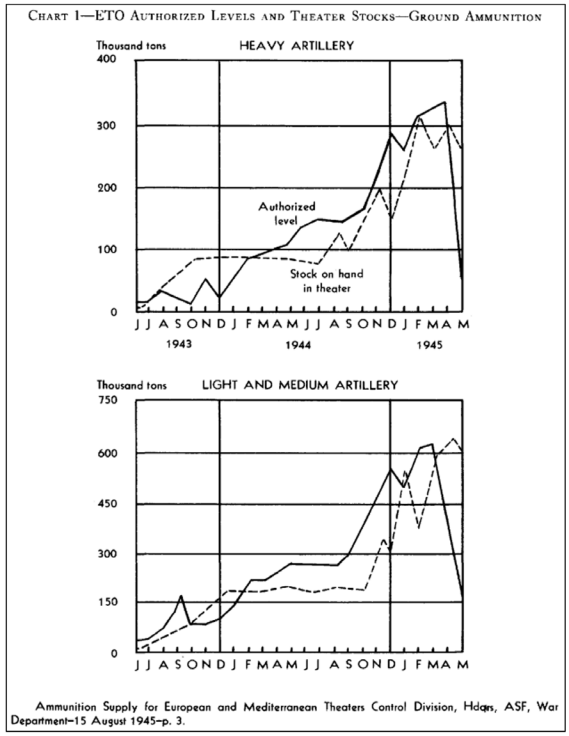
254 Thomson and Mayo, *Ordnance Department*, p. 148.

255 Thomson and Mayo, *Ordnance Department*, pp. 101–02, 145.

256 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 60.

257 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 66.

FIGURE 4: EUROPEAN THEATER AUTHORIZED LEVELS AND THEATER STOCKS OF SELECTED MUNITIONS



Source: Thomson and Mayo, *The Ordnance Department*, p. 149.

Barrage rockets presented another production challenge because, despite their growing popularity as the war progressed, initial industrial plans and expansions had not considered the relatively new weapons.[258] Factories ran at full capacity, but shortages required the chief of naval operations to allocate shipments of rockets between navy commands.[259]

Figure 4 displays the disparities between authorized levels of munitions and actual quantities on hand in Europe from 1943 to 1945. During many periods of sustained high-intensity fighting in 1944 and 1945, authorized munition quantities for the number of troops in theater far exceeded actual on-hand stocks. Although some shortages resulted from shipping and distribution problems rather than production insufficiencies, the Ordnance Department noted, "The fact that the campaign was a success does not prove that ammunition supply was adequate, for the fighting might have ended sooner and with fewer casualties had more ammunition been fired."[260]

258 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 323.

259 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, pp. 324–25.

260 Thomson and Mayo, *Ordnance Department*, pp. 148–150.

Mobilization Measures and Their Costs

The preceding analysis shows that, despite the success of the Arsenal of the Democracy, industrial mobilization efforts often fell short of military demands throughout the conflict. The massive supply of most munitions by 1945 and the impressive total output have largely obscured the shortages experienced earlier in the war.

These achievements were the result of the entirety of the nation being oriented to support the war effort. Industrial mobilization succeeded in the context of broader national and economic mobilization, and it must be judged in that light. Extraordinary production gains and national mobilization, however, were not without costs. Industrial mobilization required unprecedented political compromises and sacrifices from the American public. This section highlights several key factors and tradeoffs that enabled the massive increases in munition production during World War II, as well as their consequences.

Inefficient and Excess Production

The rush to manufacture munitions and expand production created significant inefficiencies and often led to wasteful construction and production, both of which received intense criticism during the war. FDR's reluctance to centralize authority in the initial phases of mobilization created "enormous logjams of goods and serious delays in production."[261] Despite the best efforts of organizations like the WPB, misallocation of resources and workers sometimes led to shortages or new facilities being constructed without the raw materials to supply them.[262] This was especially prevalent early in mobilization, when copper shortages resulted in many new munition plants running well below capacity.[263] Once shortages were resolved, the military found itself with a surplus of production capacity for many types of ammunition thanks to unexpected increases in efficiency and lower than expected rates of consumption. Indeed, many munition plants constructed early in the war did not operate long enough to reach peak efficiency, with some restricting production just months after opening.[264]

Inaccurate requirements and constantly shifting expenditure rates led to massive excesses in the production of small arms ammunition. Around the period of peak production, a War Department review board noted excessive stocks of ammunition piling up in overseas and domestic depots and implored the Army to "bring production of ammunition and stocks of ammunition into the realm of reality."[265] The Army later estimated that by war's end, only half of the 21 million tons of ammunition produced was shipped overseas, and less than a

261 Irish, "Apt Pupil," p. 55.

262 Gropman, *Mobilizing U.S. Industry*, p. 62–63.

263 Smith, *Army and Economic Mobilization*, pp. 207–08.

264 Thomson and Mayo, *Ordnance Department*, p. 129.

265 Smith, *Army and Economic Mobilization*, p. 159.

quarter of that was expended in combat.[266] Although militaries prefer excesses to shortages, these overages were the subject of much controversy among the American public.[267]

Conversion of civilian manufacturing to military production, although essential, also experienced problems. Mostly notably, changing the output of existing factories resulted in significant losses in productivity as firms produced goods they were not optimized for and workers gained familiarity with new products.[268] Many firms only had the equipment or know-how to produce one or two components of a complete munition. This required the Ordnance Department or a prime contractor to find and issue numerous contracts to smaller companies, many of which were producing items that bore little resemblance to their prewar product lines.[269] Even with conversion, weapons often relied on GOCO facilities for explosive material, filling, and final assembly.

In many cases, commercial manufacturers were forced to partially redesign components or entire items to be able to produce them using existing machinery and processes. The small scale of interwar production at U.S. arsenals had left its mark on many weapons, which were complex to produce and sometimes relied on outdated manufacturing techniques.[270] Redesigns altered the final product but often resulted in more efficient manufacturing processes that saved labor or material costs.[271] These design changes were not always well received by the military, but over time industry and the services learned to compromise on requirements to produce an acceptable product on a mutually agreeable timeline.[272] These innovations would pay off, with improved manufacturing methods cutting the time required to produce the 20 mm Oerlikon cannon from 132 to 35 hours.[273]

Expansion of Federal Authorities and Bureaucracy

With the U.S. industrial base providing the means for expanded munitions production, mobilization spawned a host of additional organizations and authorities to steer those means toward wartime ends. This effort manifested in a series of ever-larger bureaucracies within the Roosevelt administration that were granted increasingly far-reaching powers to direct national resources. These organizations began with the OEM and NDAC and continued with OPM. Once the United States formally entered the war, political consensus allowed

266 Smith, *Army and Economic Mobilization*, pp. 207–08.

267 U.S. Army Center of Military History, *Logistics in World War II*, p. 57.

268 Alexander J. Field, *The Economic Consequences of U.S. Mobilization for the Second World War* (New Haven, CT: Yale University Press, 2022).

269 Thomson and Mayo, *Ordnance Department*, p. 75.

270 Thomson and Mayo, *Ordnance Department*, p. 35.

271 For example, the Bofors anti-aircraft gun was heavily reengineered by Chrysler and Firestone. Thomson and Mayo, *Ordnance Department*, p. 77–78.

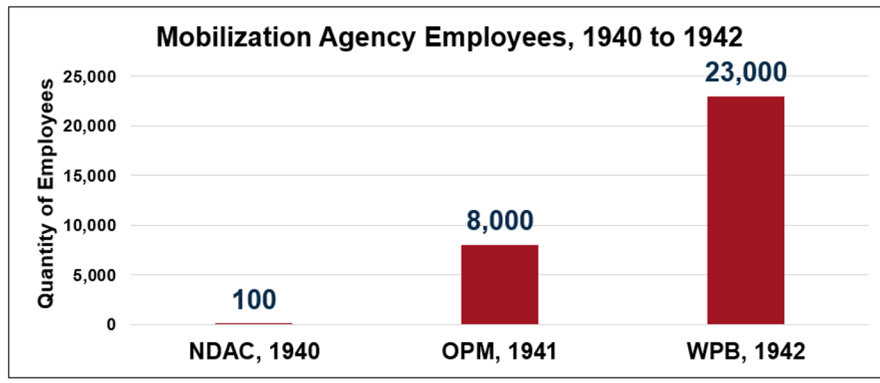
272 Herman, *Freedom's Forge*, pp. 95–99.

273 Gropman, *Mobilizing U.S. Industry*, p. 105.

Roosevelt to establish the WPB with expanded powers to prioritize production, allocate resources, and coordinate industrial policy within the executive branch.[274] The WPB, which would grow to employ over 20,000 people, eventually proved inadequate to manage mobilization by itself.[275] To further centralize mobilization efforts beyond industry to include the direction of the workforce and labor, Roosevelt established the Office of War Mobilization (OWM) in May 1943.[276] OWM's authority over the economy and national resources was so pervasive that its leader, James Byrnes, became known as the "assistant president."[277] These bureaucracies wielded vast wartime emergency authorities, including "control of industrial output, rationing of scarce materials through priorities, fixing of basic commodity prices, supervision of labor costs and supply, regulation of the flow of skilled labor, control of power, fuel and transportation, an increasing tax burden, the conversion of industrial facilities to military needs and the conservation of supplies, services, and materials."[278]

The evolution of wartime mobilization agencies involved an unprecedented growth in executive power and bureaucracy. This expansion broke with American tradition and far surpassed even the government's New Deal response to the Great Depression.[279] Indeed, World War II pushed the U.S. government to take on a new role and "become the controller and often the owner of [industrial] capital."[280] These measures, however, were deemed necessary to condense mobilization timelines and meet U.S. military demands for materiel.

FIGURE 5: NUMBER OF EMPLOYEES IN MOBILIZATION AGENCIES, 1940–1942



Source: Thomas D. Morgan, "The Industrial Mobilization of World War II: America Goes to War," *Army History*, no. 30 (Spring 1994), p. 33.

274 Schubert, *Mobilization*, p. 18.

275 Gropman, *Mobilizing U.S. Industry*, p. 56.

276 Schubert, *Mobilization*, p. 21.

277 Schubert, *Mobilization*, p. 21.

278 Leo M. Cherne, *Your Business Goes to War*, p. 7.

279 Gerald D. Nash, *The Great Depression and World War II: Organizing America, 1933–1945* (New York: St. Martin's Press, 1979), pp. 129–34.

280 Sweeting, *Building the Arsenal of Democracy*, p. 17.

Safeguarding Foreign Material Sources and Establishing Domestic Suppliers

Increased production demanded immense quantities of raw and refined materials. In addition to prioritizing and allocating resources, the Roosevelt administration sought to protect foreign sources of materials that were not naturally available in the United States and expand the domestic base for other critical materials. This effort began with the NDAC's identification of essential resources the United States imported from foreign suppliers, including rubber, tungsten, manganese, and magnesium.[281] The administration used all means available to safeguard these international supply chains, including bribery of foreign officials and hiring private blockade runners.[282] Throughout the war, maintaining and expanding these supply chains also required the U.S. military to significantly grow its overseas basing and logistics infrastructure. U.S. forces constructed airfields, ports, depots, railroads, and pipelines in the Caribbean, Central America, North Africa, the Middle East, and across the Pacific.[283]

For other materials, domestic extraction or processing was insufficient to meet the demands of wartime manufacturing. In these cases, mobilization authorities sought to incentivize the expansion of domestic supply, even for materials whose domestic production was not economically viable during peacetime. For instance, the U.S. government subsidized additional aluminum manufacturers and encouraged the growth of a domestic tin smelting industry.[284] During the war, over $500 million (equivalent to $8.7 billion in Fiscal Year 2024) was invested in aluminum production infrastructure alone.[285]

Enemy operations also broke some prewar supply chains, such as imports of rubber from Asia. With no large domestic source of natural rubber, the U.S. government turned elsewhere. At the time, synthetic rubber was experimental and considered too risky to attract private capital.[286] This pushed the government to fund the establishment of an entirely new industry to develop and manufacture synthetic rubber. By war's end, synthetic rubber plants were turning out over 1.4 million tons per year, with one plant producing more rubber in six months than the entire United States consumed in 1940.[287] The administration supplemented these supplies with recycled rubber and curtailed civilian consumption of the material through tire and gasoline rationing.[288] Whether by securing overseas sources, expanding domestic supply, or developing substitute products, mobilization required direct

281 Gropman, *Mobilizing U.S. Industry*, p. 48.

282 Herman, *Freedom's Forge*, pp. 74–75; and U.S. Army Center of Military History, *Logistics in World War II*, p. 14.

283 U.S. Army Center of Military History, *Logistics in World War II*, p. 7.

284 Cherne, *Your Business Goes to War*, p. 9.

285 Sweeting, *Building the Arsenal of Democracy*, p. 207.

286 Sweeting, *Building the Arsenal of Democracy*, p. 134.

287 Herman, *Freedom's Forge*, p. 202.

288 Gropman, *Mobilizing U.S. Industry*, p. 115.

government involvement in the maintenance, protection, and expansion of U.S. defense supply chains and the broader industrial base.

Prioritization of Speed and Output over All Other Considerations

Accomplishing America's impressive record of industrial mobilization between 1940 and 1943 required policymakers to consistently put speed and output above all other considerations, including cost savings, fairness, and labor. This prioritization had widespread impacts on federal regulation, taxation, and contracting procedures, but it was necessary to loosen the leash on American industry and incentivize companies to risk private capital on mobilization.

To encourage the expansion of industrial capacity and expedite war production, the Roosevelt administration and Congress modified or waived a host of regulations, policies, and statutes. These included restrictions on "the assignment of claims, the amendment of contracts, accountability of government property, patent rights and royalties, the delegation of powers, and countless other features of both governmental and private economic activity."[289] This began with corporate tax laws: legislation in 1940 reduced the amortization period for war-related investments from 16 to five years to encourage industry to finance additional capacity.[290] To further incentivize industrial cooperation toward wartime aims, Roosevelt suspended antitrust prosecution for businesses supporting the war effort.[291] This support extended beyond just ignoring antitrust policies to the Ordnance Department encouraging collaboration and collusion through industrial integration committees. On committees devoted to the production of a specific defense product, representatives from competing firms could "discuss their manufacturing problems, exchange ideas, and arrange for temporary loans of materials, machinery, or production experts."[292] In this way, many wartime policies were directly at odds with New Deal policies intended to regulate the profits of or otherwise control U.S. corporations.

The emphasis on speed extended to wartime contracting procedures. After receiving congressional approval in July 1940, military procurement agencies offered cost-plus contracts for military goods that did little to incentivize low costs and shifted the risk of cost overruns from the manufacturer to the government.[293] During the war, cost-plus-fixed-fee

289 Smith, *Army and Economic Mobilization*, p. 69.

290 These changes in the tax code, developed and supported by several members of the NDAC, were one way to encourage industrial expansion without direct government funding, which remained politically unviable in the summer of 1940. Lacey, *Keep from All Thoughtful Men*, p. 52; Sweeting, *Building the Arsenal of Democracy*, pp. 125–126; and Herman, *Freedom's Forge*, p. 198.

291 Herman, *Freedom's Forge*, p. 198.

292 Thomson and Mayo, *Ordnance Department*, p. 471.

293 Sweeting, *Building the Arsenal of Democracy*, p. 174.

contracts were standard, with fees ranging from 4 to 7 percent.[294] In government-owned plants, the U.S. government paid management on a "per-unit-of-output basis" in order to incentivize maximum output.[295] Competition between vendors for contracts was also eliminated, with direct negotiation between industry and procurement agencies becoming standard to reduce contracting timelines.[296] The National Defense Expediting Act, passed in July 1940, allowed the armed services to make advance payments of up to 30 percent of a contract's worth, something that had been prohibited.[297] The Army Supply Force worked to consolidate arcane acquisition procedures that filled 1,500 pages down to one document of only 100 pages.[298]

Although the ruthless pursuit of speed and output accelerated mobilization, it was not without cost. These measures, initially challenged by Roosevelt, were unprecedented in the degree to which they favored contractors and shunned traditional methods of incentivizing low costs.[299] The move to contract negotiation favored big corporations, with about 100 large U.S. companies dominating prime contracts during the war.[300] Estimates of profit on wartime government contracts range from 15 to nearly 49 percent.[301]

Impact on Civilian Life

Finally, government control of the economy and massively increased industrial output imposed significant sacrifices on the part of the American people and permanently altered civilian life in the United States. A series of tax bills passed from 1940 to 1944 raised taxes and expanded the number of Americans paying taxes from 3.9 million to 43 million.[302] Unlike previous conflicts in U.S. history, taxes did not dramatically fall at the end of the conflict.[303] The government also suspended worker protections, such as the limit on working hours for government contractors.[304] Industrial mobilization also brought many women—a

294 Gropman, *Mobilizing U.S. Industry*, p. 64; and Herman, *Freedom's Forge*, p. 103.

295 This practice differed from the British, who paid for the management of government-owned plants using fixed fees. American and British officials believed the different incentive schemes were responsible for significantly higher U.S. production rates. Smith, *Army and Economic Mobilization*, pp. 308–09.

296 Gropman, *Mobilizing U.S. Industry*, p. 64.

297 Smith, *Army and Economic Mobilization*, p. 220.

298 Smith, *Army and Economic Mobilization*, p. 230.

299 Herman, *Freedom's Forge*, p. 92–93.

300 Secretary of War Stimson justified this fact as necessary to win the war on the shortest possible timeline. Gropman, *Mobilizing U.S. Industry*, p. 65.

301 Paul A. C. Koistinen, "Mobilizing the World War II Economy: Labor and the Industrial–Military Alliance," *Pacific Historical Review* 42, no. 4 (November 1973), p. 469.

302 Sarah E. Kreps, *Taxing Wars: The American Way of War Finance and the Decline of Democracy* (Oxford: Oxford University Press, 2018), pp. 77, 99–102.

303 Kreps, *Taxing Wars*, p. 107.

304 Smith, *Army and Economic Mobilization*, p. 221.

previously underemployed portion of the population—into the workforce for the first time. Taxes and modified labor policies were paired with cutbacks on the production of consumer goods and the rationing of everyday products. Beyond ceasing civilian car manufacturing, "non-essential building and construction" was also halted, and key materials such as copper were removed from consumer products.[305] During the war, consumers would forgo new furniture, refrigerators, vacuum cleaners, and a host of other items deemed not essential to the war effort. At the start of 1944, the United States was dedicating 70 percent of its manufacturing capacity to military goods.[306]

Economic historian Robert Higgs challenged the widely held notion that the World War II industrial mobilization led to increased prosperity for Americans during the war. Higgs argued that because the wartime economy was largely directed by the U.S. government, economic statistics (unemployment rates, output, consumption, wages) do not accurately compare the prewar, midconflict, and postwar economies.[307] Higgs noted that during the war years, the average American was "working harder, longer, more inconveniently, and at greater physical risk" for limited quantities of consumer goods.[308] During the height of mobilization in 1941 and 1942, industrial deaths exceeded U.S. servicemembers killed in action, with one munitions incident in 1944 killing 250 people and injuring more than 1,000.[309] Industrial expansion also led to widespread domestic migration to staff new factories, a consequence that would have a significant impact on postwar society.[310]

The American memory of World War II as "the good war" blended with the postwar economic boom to render the civilian sacrifices of the war largely forgotten. Of course, any conflict as total as World War II is destined to impact civilian life, and America's citizenry suffered far less than that of the Soviet Union, Germany, or Japan. These facts are highlighted only as a reminder of the nationwide sacrifice required to mobilize industry for great power conflict—sacrifices that will need broad political support and buy-in from the American public.

Conclusion: Ingredients of the Arsenal of Democracy

With eight decades of hindsight, U.S. industrial mobilization stands as a resounding success and a key contributor to the ultimate triumph of the Allies over the Axis powers. This chapter's assessment, however, has revealed several facts that must be taken into account

305 Gropman, *Mobilizing U.S. Industry*, p. 46.

306 Herman, *Freedom's Forge*, p. 283.

307 Robert Higgs, "Wartime Prosperity? A Reassessment of the U.S. Economy in the 1940s," *The Journal of Economic History* 52, no. 1 (March 1992), pp. 41–60.

308 Higgs, "Wartime Prosperity?," p. 53.

309 Andrew E. Kersten, *Labor's Home Front: The American Federation of Labor During World War II* (New York: New York University Press, 2006), p. 168; and Thomson and Mayo, *Ordnance Department*, p. 131.

310 Murray and Millett, *War to be Won*, p. 545.

when considering how the United States was transformed into the Arsenal of Democracy. Industrial mobilization was not a miracle performed by industry, government, or the American people. Rather, it was a deliberate whole-of-nation effort with very real costs. This analysis highlights four factors essential to fueling U.S. industrial mobilization for World War II.

First, U.S. industrial mobilization relied heavily on existing infrastructure and America's prewar position as the world's leading manufacturing power. The foundation for mobilization was the existing U.S. industrial base, which already led the world in raw material processing and manufacturing in the decade prior to conflict. Given this starting point, historian Alan Gropman argued, "United States industrial production in World War II was no miracle."[311] He pointed to the latent industrial capacity in the wake of the Great Depression, noting: "The base on which the expanded production was measured was a depressed one."[312] He then compared the period of industrial mobilization to a similar period of peacetime growth, 1921–1925, to show that wartime gains in industrial output, although significant, were on par with other periods of economic expansion.[313]

The achievement of the Arsenal of Democracy, then, was mainly due to a superior technological and industrial foundation, a larger population, and the devotion of 40 percent of national output to war production.[314] Although less critical than Gropman, historian Arthur Herman also contended, "What made America productive wasn't the war or government dictates or a supreme sense of national urgency. It was the miracle of mass production, which, once turned loose, could overcome any obstacle or difficulty."[315] This economic miracle of mass production and manufacturing power was already more ubiquitous in the United States before the war than in any other nation. This advantage allowed the United States to outproduce its allies and adversaries even while mobilizing its industry and resources to a far lesser degree.[316]

These facts make it clear that the expansion of munitions production was heavily dependent on America's preexisting industrial might—a nearly bottomless well of reserve production capacity. America's capacity to extract, refine, or otherwise acquire and control raw materials such as steel and oil ensured that inputs for war production were available in sufficient quantities. Commercial industries such as auto manufacturers and their subcontractors could convert their lines to the production of weapons and their components. Where existing facilities were not available to produce munition-specific elements, such

311 Gropman, *Mobilizing U.S. Industry*, p. 134.

312 Gropman, *Mobilizing U.S. Industry*, p. 97.

313 Gropman, *Mobilizing U.S. Industry*, p. 97.

314 Gropman, *Mobilizing U.S. Industry*, pp. 97–98, 134.

315 Herman, *Freedom's Forge*, p. 337.

316 Harrison, "Resource Mobilization."

as energetic materials, experienced manufacturers and their workforces were capable of quickly constructing and operating new munition plants. Economist Raymond Goldsmith recognized this in his 1946 comparison of munitions production between World War II participants:

> The munitions production of the major belligerents at full mobilization was roughly proportional to the size of their prewar industrial labor force combined with the prewar level of productivity in industry. This is hardly an astonishing result, but one which confirms the belief that basic economic factors rather than accidental developments or sudden changes in elementary economic relationships—more familiar under the names of "secret weapons" and "miracles of production"—have determined the course of munitions production.[317]

Even with the preexisting strength of U.S. industry, mobilization still required a nationwide effort to convert commercial manufacturing to military production.

Second, industrial mobilization required massive increases in defense spending and government-funded construction of entirely new production facilities at several levels of munition supply chains. The lack of commercial analogues for munitions meant conversion of commercial production capacity could only go so far. Building weapons required the construction of additional facilities, often through direct government funding and ownership. In addition to munition-specific infrastructure, voracious demand for manufacturing inputs pushed the government to support the expansion of the broader U.S. industrial base, including raw and refined materials such as petroleum, rubber, aluminum, steel, and other essential inputs. By the end of the war, the U.S. government had spent $12.7 billion to construct around 1,600 new factories.[318] In total, the United States invested between $25 and $27 billion in increased production capacity, a sum equal to nearly three quarters of the value of all tangible capital assets of U.S. manufacturers in 1939.[319] Historian George Sweeting called these investments "a special case confined to supreme emergency," with the federal government left at war's end in possession of "approximately 25 percent of all capital assets in the manufacturing sector, on a gross basis."[320]

Third, industrial mobilization occurred within a broader national and economic mobilization that put the entire United States on a "war footing." The U.S. effort in World War II was total to a degree that makes it unique in American history. Increases in production were the result of not only government investment but also broader economic changes such as increased labor force participation, the shifting of labor from

317 Goldsmith, "Power of Victory," p. 79.

318 Roderick L. Vawter, *Industrial Mobilization: The Relevant History* (Washington, DC: National Defense University, 1983), p. 7.

319 Sweeting, *Building the Arsenal of Democracy*, p. 1.

320 Sweeting, *Building the Arsenal of Democracy*, pp. vii, 2.

low-wage to high-productivity jobs, and increased work hours.[321] The level of government control over national resources and the economy has led some economists to define the wartime economy as more like a command economy than a free-market system, albeit with liberal use of capitalist incentives to drive industrial output and expansion.[322] For example, the reorientation of thousands of subcontractors in the auto industry to defense production was only possible because the U.S. government halted car production. For these reasons, U.S. industrial policy between 1939 and 1945 cannot be remembered in isolation but must be considered alongside the broader economic controls implemented by the U.S. government, including price setting, resource allocation, material rationing, increased taxes, and control of labor. In the end, mobilization resulted not only in the increased manufacture of military goods but also "reshaped the structure of [the U.S.] economy" and massively expanded all aspects of American industry, from steel and aluminum production to petroleum and mineral extraction.[323]

Fourth and finally, even with the transition to a war footing and the U.S. entrance into the conflict, industrial mobilization required more than two and a half years to reach peak production.[324] As the Army's history of the war's logistics noted, "The two years prior to 7 December 1941 were spent in preparation for production rather than in the actual production of war materiel."[325] This timeline had serious implications for U.S. military operations and allied grand strategy. Insufficient materiel constrained U.S. military operations in 1942 and early 1943. The time required for mobilization also dictated U.S. strategy by favoring a protracted conflict that allowed the U.S. military to wait for increased production before engaging in the most intense combat operations of the war. The Army's official history of mobilization characterized American success as dependent on "the happy conjunction of circumstances offered by idle resources, the protection provided by its insular position, and the heroic resistance of its Allies."[326]

The above factors are often lost among the impressive statistics detailing U.S. production gains during the war. But industrial mobilization was just one facet of U.S. involvement in World War II, an endeavor that had far-reaching impacts on the entire nation. These essential ingredients and the scale of nationwide sacrifice must be kept in mind in any examination of how the munitions industrial base has evolved in the years since World War II and its potential for mobilization at present.

321 Hugh Rockoff, "The United States: From Ploughshares to Swords," in Mark Harrison, ed., *The Economics of World War II: Six Great Powers in International Comparison* (Cambridge: Cambridge University Press, 1998), p. 117.

322 Higgs, "Wartime Prosperity?," pp. 55–58.

323 Smith, *Army and Economic Mobilization*, p. xi; and U.S. Army Center of Military History, *Logistics in World War II*, p. 13.

324 Roughly two and half years separated the adoption of the munitions program in June 1940 from peak production in the fall of 1943. These two and a half years exclude the earlier priming of U.S. industry through foreign orders.

325 U.S. Army Center of Military History, *Logistics in World War II*, p. 12.

326 Schubert, *Mobilization*, p. 22.

CHAPTER 4

The Munitions Ecosystem Since World War II

> As the United States learned to its peril, there was a wide and dangerous gulf between "economic potential" and the capacity to deliver specific munitions in the quality, quantity, and time needed to win a major war.
>
> —R. Elberton Smith, *The Army and Economic Mobilization*, 1991[327]

In the early 1940s, transforming the American industrial base into the Arsenal of Democracy required several years and a whole-of-nation effort. Building upon the previous chapters' analyses of how mobilization was carried out and what it required, this chapter uses World War II as a point of departure and considers the decades since to explore the following questions:

1. How have the U.S. economy, defense industrial base, and munitions themselves changed since the 1940s?
2. How do these trends affect the prospect of expanding or mobilizing production capacity for today's critical munitions?

This chapter traces how the United States arrived at its present-day weapons industrial base. In doing so, it highlights various strategic, economic, industrial, and technological shifts—some outside the realm of U.S. control and others the result of intentional policy decisions—that affect America's ability to mobilize munitions production in the 21st century.

327 Smith, *Army and Economic Mobilization*, p. 3.

Broad Strategic and Economic Trends

Contemporary industrial mobilization would confront an altogether different strategic and geoeconomic environment than that of the 1940s. This section details how the U.S. military, the threat environment, and America's industrial power have changed in the decades since World War II and how these changes might affect America's ability to mobilize industry for great power conflict.

Lack of a Mobilization Period in War Plans

Prior to the Cold War, the U.S. Army did not maintain sizeable standing forces or equipment reserves; instead, it relied on conscription and mobilization to generate forces for a large conflict.[328] Small standing forces were retained to manage the American frontier and newly acquired territories, respond to small crises, and function as a cadre to train and command mobilized personnel. Larger engagements like the American Civil War, Spanish–American War, and World Wars I and II relied on the mobilization of new volunteers and conscripts. This model meant a mobilization period was needed for new troops to be mustered and trained before U.S. forces could embark on large-scale campaigns. The period between the start of hostilities and the deployment of U.S. forces also allowed time for industry to mobilize to equip and supply the rapidly expanding military. In short, a mobilization period was inherent to all U.S. military planning for conflicts of significant size or duration.

After World War II, the Cold War with the Soviet Union created a persistent threat of intercontinental strike. This threat, combined with the presence of U.S. forces at new overseas bases and the ability to rapidly transport military forces around the globe, spurred the maintenance of a standing force larger than ever before in American history. After the Vietnam War and the end of conscription, the transition to the all-volunteer force further reduced the time required for the U.S. military to conduct large-scale combat operations. Although significant engagements still require mobilization of the reserve component, active-duty forces are available for rapid employment, and reserve forces can be mustered and deployed much more quickly than a draft could be implemented and conscripts readied for war. These developments have greatly reduced or, in many scenarios, eliminated the mobilization period that was built into American military planning before the Cold War. As such, American industry would no longer enjoy a period of months or years to mobilize itself before U.S. forces would be engaged in high-intensity combat operations that demand immense quantities of munitions. Even so, the potential for conflict between NATO and the Warsaw Pact in Europe drove industrial preparedness planning during the Cold War.[329]

328 Smith, *Army and Economic Mobilization*, p. 81.

329 Ivars Gutmanis and John F. Starns, "Whatever Happened to Defense Industrial Preparedness?," *Joint Force Quarterly*, Summer 1997, p. 28, https://ndupress.ndu.edu/portals/68/Documents/jfq/jfq-16.pdf.

The ability to rapidly commit the all-volunteer force is now paired with a post-Cold War preference for short conflicts in which the U.S. military relies on overwhelming firepower to rapidly achieve victory.[330] Pursuit of a rapid victory, however, could exhaust U.S. stocks of PGMs in a matter of days or weeks.[331] The focus on short, decisive wars contrasts with U.S. military planning for World War II, which was predicated on an extended mobilization period of more than a year before engaging in large, intense campaigns in the Pacific and European theaters. With the combatant commands conducting contemporary U.S. war planning, the requirement for and the implications of industrial mobilization are absent from modern operation plans. Higher level doctrine and plans, such as the Joint Warfighting Concept, remain vague and lack the specificity to coordinate a protracted great power war and guide industrial mobilization planning.

Global Threats to the U.S. Homeland

Paired with the disappearance of time for industrial mobilization is a lack of sanctuary. During World War II, American industry benefited from the relative safety of the contiguous United States, particularly compared to other belligerents whose industrial assets were gained and lost with territory or were the targets of strategic bombing.[332] Distant from the German and Japanese threat, the U.S. homeland was a sanctuary that provided the nation time and space to mobilize before engaging in the most demanding overseas campaigns. The Victory Plan did dedicate forces for homeland defense, and American war industries took precautions such as camouflaging facilities to confuse enemy aircraft, but German and Japanese capability to attack the contiguous United States was minimal.[333]

Today, several potential U.S. adversaries can threaten industrial sites throughout the United States with cyberattacks, sabotage, and nuclear and conventional precision strikes.[334] Many of these capabilities could be employed before the start of a conflict to disrupt ongoing production and mobilization and during a conflict to destroy American industrial capacity.

330 See Russell F. Weigley, *The American Way of War: A History of United States Military Strategy and Policy* (New York: Macmillan Publishing, 1973), chap. 17; and Andrew Metrick, *Rolling the Iron Dice: The Increasing Chance of Conflict Protraction* (Washington, DC: Center for a New American Security, November 2023), pp. 7–13, https://www.cnas.org/publications/reports/rolling-the-iron-dice.

331 Hacker, *Beyond Precision*, pp. 51–53.

332 Throughout mobilization and the conduct of the war, industrial sabotage remained a critical concern.

333 For example, Boeing and Lockheed aircraft plants along the West Coast were extensively camouflaged and made to look like suburban neighborhoods from the air. See Miguel Ortiz, "This aircraft factory was disguised as a suburban neighborhood during WWII," *We Are the Mighty*, March 14, 2023, https://www.wearethemighty.com/articles/this-aircraft-factory-was-disguised-as-a-suburban-neighborhood-during-wwii/; and Lockheed Martin, "Lockheed During World War II: Operation Camouflage," October 1, 2020, https://www.lockheedmartin.com/en-us/news/features/history/camouflage.html.

334 "Statement of General Gregory M. Guillot, United States Air Force, Commander, United States Northern Command and North American Aerospace Defense Command," U.S. Senate Armed Services Committee, March 14, 2024, p. 3, https://www.armed-services.senate.gov/imo/media/doc/guillot_statement_31424.pdf; and RAND, *Commission on the National Defense Strategy* (Santa Monica, CA: RAND, 2024), p. 11, https://www.rand.org/nsrd/projects/NDS-commission.html.

Unlike the 1940s, much of the current U.S. defense industrial base is consolidated (as the next section will explore further), geographically concentrated, and thus increasingly vulnerable to attacks that exploit supply chain chokepoints and single points of failure. A 2024 study by Govini estimated that with "just 25 well-constructed attacks, using any of a variety of means, an adversarial military planner could cripple much of America's manufacturing apparatus for producing advanced weapons."[335] As a result, contemporary industrial mobilization conducted during peacetime or wartime would no longer enjoy the safety afforded to American industry during World War II. The absence of time and sanctuary for industrial expansion makes the unthreatened mobilization period of 1940–1942 highly unlikely in today's global threat environment.

Globalization and Deindustrialization

The total U.S. industrial base, from raw material extraction and processing to commercial manufacturing, was essential for facilitating industrial mobilization during World War II. The United States enjoyed the world's most robust industrial capacity along several dimensions as mobilization began in the late 1930s. In decades since, however, economic globalization has led to a significant deindustrialization of the United States, particularly relative to the PRC. In many respects, the Arsenal of Democracy represented the apogee of American manufacturing.[336]

The United States and its allies no longer lead the world in raw material production. Although the United States remains proficient in the production of many finished defense and aerospace goods, its domestic capacity to extract and refine many basic commodities essential for scaling up war production has been far surpassed by competitors since the early 2000s. In 2023, China produced over 12 times as many metric tons of steel as the United States and double the combined steel production of the United States, Japan, South Korea, Australia, and all NATO members.[337] Over the same period, estimated Chinese output of primary aluminum was nearly 1.7 times that of the rest of the world combined.[338] Chinese chemical sales in 2022 were nearly four times that of the United States and 1.4 times that

335 Govini, *Numbers Matter: Defense Acquisition, U.S. Production Capacity, and Deterring China*, Govini, p. 1, https://www.govini.com/insights/numbers-matter-defense-acquisition-u-s-production-capacity-and-deterring-china.

336 Alexander J. Field, "The Decline of U.S. Manufacturing Productivity between 1941 and 1948," *Economic History Review* 76, no. 4, January 16, 2023, pp. 1163–90.

337 China produced 1019.1 million metric tons versus a combined output of 408.4 million metric tons. This figure includes steel production from Sweden and Finland, despite Sweden not officially joining NATO until 2024. The steel production of Albania, Bulgaria, Croatia, Denmark, Estonia, Greece, Hungary, Iceland, Latvia, Lithuania, Montenegro, North Macedonia, Norway, and Slovenia in 2023 were negligible and not included in this figure. "World Steel in Figures 2024," World Steel Association, May 27, 2024, p. 9, https://worldsteel.org/wp-content/uploads/World-Steel-in-Figures-2024.pdf.

338 This was 41,666 thousand metric tons versus 24,866 thousand metric tons. International Aluminum, "Statistics," August 20, 2024, https://international-aluminium.org/statistics/primary-aluminium-production/.

of the United States, European Union, Japan, and South Korea combined.[339] Most concerningly, China's production of many of these materials continues to grow while American and European outputs trend down.

The United States has suffered a similar decline in its capacity to domestically mine and refine many critical minerals. In the late 1930s, the United States and the UK controlled almost 75 percent of world mineral production, whereas Germany and Japan lacked sufficient sources of key materials such as iron and copper.[340] In 2020, the U.S. Geological Survey described the United States as "highly net import reliant for a large and growing number of mineral commodities."[341] A 2023 assessment of U.S. critical mineral stockpiles found the U.S. military would likely experience shortfalls in 69 different materials during a "base case national emergency scenario," with current stockpiles only covering about 38 percent of these shortfalls.[342] Analysts noted that if the "base case military conflict scenario were to markedly increase in intensity and/or duration, stockpile requirements may increase significantly."[343] For comparison, national defense stockpile inventories in 2023 represent "just 1.2 percent of the stockpile's 1962 value."[344] As shown in Figure 6, the United States is increasingly reliant on China, particularly for rare earth elements essential to the production of many advanced defense products. China has over half the world's rare earth mining operations and dominates rare earth refinement and processing.[345] The United States does have significant rare earth deposits, but American firms have struggled to compete against overseas producers and refiners.[346]

339 European Chemical Industry Council, "2023 Facts and Figures of the European Chemical Industry," https://cefic.org/a-pillar-of-the-european-economy/facts-and-figures-of-the-european-chemical-industry/profile/.

340 C. K. Leith, "The Struggle for Mineral Resources," *The Annals of the American Academy of Political and Social Science* 204, July 1939, pp. 42–48.

341 Nedal T. Nassar, Elisa Alonso, and Jamie L. Brainard, *Investigation of U.S. Foreign Reliance on Critical Minerals—U.S. Geological Survey Technical Input Document in Response to Executive Order No. 13953 Signed September 30, 2020* (Washington, DC: Department of the Interior, December 2020), p. 24, https://pubs.usgs.gov/of/2020/1127/ofr20201127.pdf.

342 Cameron M. Keys, *Emergency Access to Strategic and Critical Materials: The National Defense Stockpile* (Washington, DC: Congressional Research Service, November 2023), p. 9, https://crsreports.congress.gov/product/pdf/R/R47833.

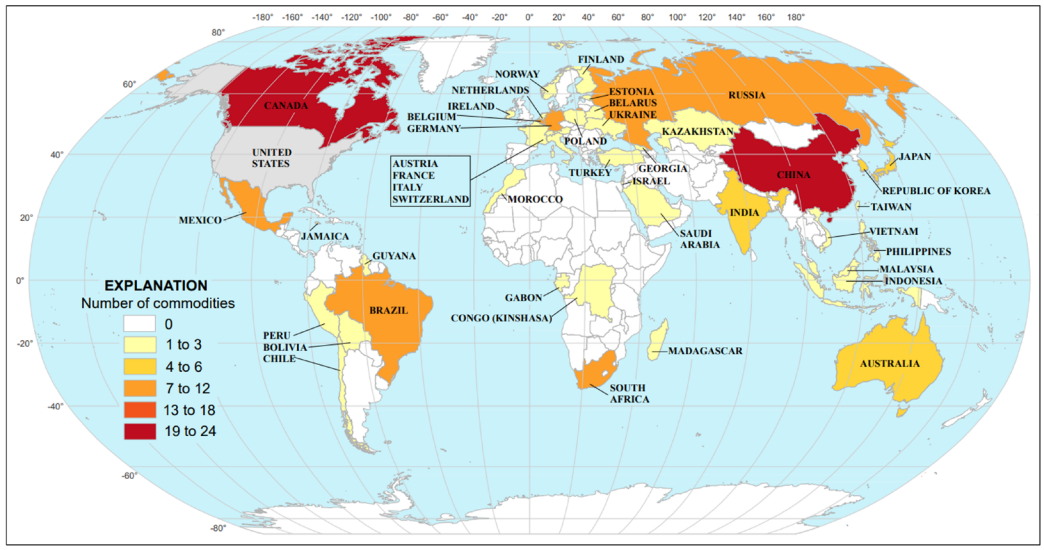
343 Keys, *Emergency Access,* p. 9., footnote 47.

344 Wischer, "U.S. Military and NATO Face Serious Risks."

345 Mikayla Easley, "U.S. Begins Forging Rare Earth Supply Chain," *National Defense*, February 10, 2023, https://www.nationaldefensemagazine.org/articles/2023/2/10/us-begins-forging-rare-earth-supply-chain.

346 For example, Will Walkey, "Massive Rare Earth Discoveries Could Mean a New Mining Rush in the Mountain West," *Wyoming Public Radio*, May 26, 2023, https://www.wyomingpublicmedia.org/open-spaces/2023-05-26/massive-rare-earth-discoveries-could-mean-a-new-mining-rush-in-the-mountain-west.

FIGURE 6: LEADING IMPORT SOURCES (2019–2022) OF NONFUEL MINERAL COMMODITIES FOR WHICH THE UNITED STATES WAS GREATER THAN 50 PERCENT NET IMPORT RELIANT



Source: *Mineral Commodity Summaries 2024* (Reston, VA: U.S. Geological Survey, 2024), p. 8, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf.

Petroleum remains an essential resource for powering the civilian and defense economies. Command of fossil fuels was key to allied victory in World War II, when the United States, UK, Netherlands, and Soviet Union together controlled the vast majority of the world's petroleum and coal supplies.[347] The United States is still a leading oil producer, although its share of world production has fallen from over 60 percent to around 22 percent.[348] China remains reliant on imports of oil and natural gas, and energy supply is a favorable and growing strategic asymmetry in U.S.–China competition.[349] Even so, electricity generation remains a key input for heavy industry, with mobilization causing electricity demand in the United States to grow from "16.3 billion kilowatt hours in 1939 to 279.5 billion in 1944."[350] Since 2000, however, U.S. electricity production has remained relatively flat while Chinese production has grown by over six times and is now more than double that of the United States.[351]

347 Plentiful oil and coal were also essential to enabling the production of "synthetic rubber, durable plastics, and synthetic fibers that substituted for raw materials in short supply such as cotton and silk." Murray and Millett, *War to Be Won*, pp. 527–28.

348 U.S. Energy Information Administration, "Frequently Asked Questions (FAQS)," April 11, 2024, https://www.eia.gov/tools/faqs/faq.php?id=709&t=6.

349 See Christopher Bassler and Ben Noon, *Mind the Power Gap: The American Energy Arsenal and Chinese Insecurity* (Washington, DC: Center for Strategic and Budgetary Assessments, August 2021).

350 Gropman, *Mobilizing U.S. Industry*, p. 116.

351 Enerdata, "World Energy & Climate Statistics—Yearbook 2024," https://yearbook.enerdata.net/electricity/world-electricity-production-statistics.html.

Beyond raw materials and energy, U.S. capacity for manufacturing finished goods has also significantly declined in the decades since World War II. Even before converting to military production, the United States produced nearly three times as many commercial goods as Germany and ten times as many as Japan.[352] Although the United States still accounts for roughly 16 percent of global manufacturing, since 2010 China has led the world in manufacturing and today produces 29 percent of the world's finished goods.[353] Only with the inclusion of U.S. allies in Asia and Europe do combined output and global share of manufacturing surpass China.[354] The United States remains a leader in research and development and computer systems design, but it has experienced a significant decrease in its capacity to mass produce finished goods, precision tooling, and vital electronic components such as semiconductors.[355]

This decline has manifested in the American workforce, where the share of employees in manufacturing has steadily decreased since World War II (see Figure 7). Since January 1990, the United States has lost over 4.8 million manufacturing jobs, with China being the "single biggest offshoring destination for U.S.-based firms."[356] China also leads the world in many aspects of industrial automation, with over 50 percent of global industrial robot installations in 2022 taking place in China.[357]

352 Gropman, *Mobilizing U.S. Industry,* pp. 134–35.

353 These percentages account for production in terms of value added and exclude intermediate inputs. Darrell M. West and Christian Lansang, "Global Manufacturing Scorecard: How the U.S. Compares to 18 Other Nations," Brookings, July 10, 2018, https://www.brookings.edu/articles/global-manufacturing-scorecard-how-the-us-compares-to-18-other-nations/; and Richard Baldwin, "China Is the World's Sole Manufacturing Superpower: A Line Sketch of the Rise," Centre for Economic Policy Research, January 17, 2024, https://cepr.org/voxeu/columns/china-worlds-sole-manufacturing-superpower-line-sketch-rise.

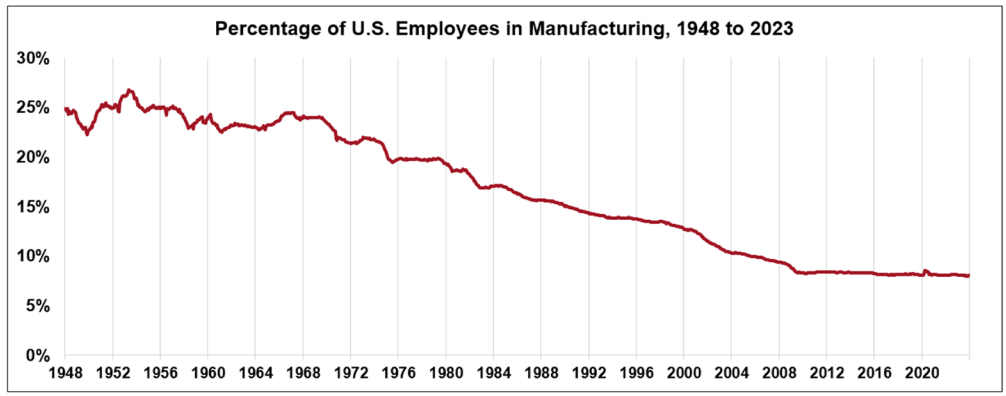
354 A bloc including the United States, Japan, South Korea, Germany, France, Italy, the United Kingdom produces about 37 percent of the world's finished goods. West and Lansang, "Global Manufacturing Scorecard."

355 McKinsey Global Institute, "Building a More Competitive U.S. Manufacturing Sector," McKinsey & Company, April 15, 2021, https://www.mckinsey.com/featured-insights/americas/building-a-more-competitive-us-manufacturing-sector.

356 U.S. Bureau of Labor Statistics, "Industries at a Glance," accessed on August 26, 2024, https://www.bls.gov/iag/tgs/iag50.htm; and Alexander Hammer, "The Size & Composition of U.S. Manufacturing Offshoring in China," *USITC Executive Briefings on Trade*, June 2017, https://www.usitc.gov/publications/332/executive_briefings/sizecompositionebot.pdf.

357 William Langley and Gloria Li, "Chinese Robot Maker Says Protectionism Will Not Stop Its March," *Financial Times*, April 4, 2024, https://www.ft.com/content/0cdf78f9-e2cc-48ff-ba65-027f1cf83334.

FIGURE 7: PERCENTAGE OF U.S. EMPLOYEES IN MANUFACTURING, 1948–2023



Source: U.S. Bureau of Labor Statistics, *Labor Force Statistics*, as of August 26, 2024, https://data.bls.gov/dataViewer/view/timeseries/LNS12000000;jsessionid=CC10FF09064E0467208A956AB8AA9D1F; and U.S. Bureau of Labor Statistics, *Industries at a Glance*, as of August 26, 2024, https://www.bls.gov/iag/tgs/iag50.htm.

Identifying the causes of globalization and offshoring is well outside the scope of this monograph. To be clear, the United States still has significant manufacturing and industrial capacity. Global economic trends since World War II, however, have created two major differences between today's U.S. economy and that of the Arsenal of Democracy. First, U.S. output in many industrial sectors has declined in absolute terms. Compared to World War II or Cold War peaks, the United States has diminished total capacity in many sectors that were crucial to supporting industrial mobilization. Second, the United States and its allies now control a smaller share of many industrial sectors in the global market. As U.S. control over these areas has weakened, America's foremost strategic competitor, China, has significantly increased its command over these same sectors. An economy focused on services and information has made the United States the wealthiest nation in the world by many metrics, and many long-term economic trends favor the United States over China.[358] These services and measures of wealth, however, do not automatically translate into increased capacity to produce weapons or mobilize industry to support a great power conflict.

For that reason, it is essential that policymakers and military planners consider how these trends affect America's ability to expand production of military goods. The contemporary geoeconomic landscape and U.S. shift away from a manufacturing-centric economy have several implications for industrial mobilization:

1. Absent significant investment, the United States would rely on allies, partners, and third-party nations for access to raw materials and other industrial inputs rather than exerting control over many critical materials and their supply chains. Increasingly global supply chains may be more difficult to secure than domestic sources and are subject to international politics, increasing the complexity of mobilization planning.

358 See, for example, Josh Mitchell, "U.S. Economy Again Leads the World, IMF Says," *Wall Street Journal*, October 22, 2024, https://www.wsj.com/economy/global/u-s-economy-again-leads-the-world-imf-says-39578275?mod=economy_lead_pos3.

2. The reduction in domestic manufacturing capacity reduces the amount of commercial industrial capacity available to support military production as subcontractors or via conversion.

3. Should the United States seek to expand existing defense production or convert commercial manufacturing to military production, its decreased capacity to extract and process materials may require significant investments in and expansions of U.S. industrial capacity along entire supply chains from raw materials (steel, aluminum, etc.) to intermediate inputs (fabricated parts, electronics, etc.). In other words, the base of America's industrial pyramid may need to be grown to support an expanded capstone of defense production.

4. Any significant expansion of U.S. industrial capacity may be hindered by today's smaller manufacturing workforce.

Together, these factors complicate contemporary industrial mobilization planning and may increase the level of investment and amount of time required to significantly expand defense production.

The Evolving American Defense Industry

In the 21st century, most U.S. precision munitions are produced by a few major defense contractors. As a result, munitions production is closely tied to the health of these firms and of the broader U.S. defense industrial base. Whereas the previous section outlined economic trends that have affected the American defense industry, this section highlights some trends specific to today's military–industrial sector.[359]

The Existing Commercial Defense Industry

The starkest contrast between the defense industrial landscape of the 1940s and today is the presence of a large, permanent, and private defense sector to supply today's standing U.S. military.[360] Prior to World War II, commercial firms were mostly limited to the subtiers

359 More in-depth analysis and assessment of the current defense industrial base can be found in National Defense Industrial Association, *Vital Signs 2024: The Health and Readiness of the Defense Industrial Base* (Arlington, VA: National Defense Industrial Association, April 2024), https://www.ndia.org/policy/publications/vital-signs; Department of Defense, *National Defense Industrial Strategy* (Washington, DC: Department of Defense, November 2023), https://www.businessdefense.gov/NDIS.html; Department of Defense, *State of Competition within the Defense Industrial Base* (Washington, DC: Department of Defense, February 2022), https://media.defense.gov/2022/Feb/15/2002939087/-1/-1/1/state-of-competition-within-the-defense-industrial-base.pdf; Luke A. Nicastro, *The U.S. Defense Industrial Base: Background and Issues for Congress* (Washington, DC: Congressional Research Service, October 2023), https://crsreports.congress.gov/product/pdf/R/R47751; and Barry D. Watts, *The U.S. Defense Industrial Base: Past, Present and Future* (Washington, DC: Center for Strategic and Budgetary Assessments, October 2008), https://csbaonline.org/research/publications/the-us-defense-industrial-base-past-present-and-future.

360 The standing defense industry developed mainly to supply the large standing military maintained during the Cold War, itself a deviation from American tradition to that point.

of weapon supply chains. With some notable exceptions, the vast majority of munitions procured during peacetime were produced in government-owned and -operated arsenals. Today's munitions industrial base is reversed, with government-owned facilities sometimes providing components or materials and private firms responsible for the overall development and production of modern PGMs.[361]

The DoD's reliance on the commercial defense industry has implications for industrial mobilization. The contemporary defense industrial base provides the U.S. military significantly more active munitions production capacity than was available prior to mobilization in the late 1930s. American companies make up 12 of the world's top 25 defense firms ranked by revenue from military goods.[362] With the development of a standing defense industry, however, much leading technological innovation has migrated to the private sector.[363] In many cases, this has shifted weapons-related intellectual property from government to private ownership. During World War II mobilization, government arsenals conducted research and retained the latest munition technologies, designs, and manufacturing know-how.[364] Their actual manufacturing capacity, however, remained limited. A key function of the arsenals (in conjunction with the Army and Navy ordnance branches) was the distribution of design and manufacturing data to commercial manufacturers and new plants. Today, weapon design and manufacturing are typically combined within firms in the commercial defense industry. Balancing protection of privately owned intellectual property—a key driver of competition and innovation in today's defense industrial base—with the need to distribute weapon technologies and designs to additional manufacturers adds complexity to mobilization planning in the modern era.[365]

Defense Industrial Consolidation

As the U.S. military has become smaller since the 1980s, so has the industry that equips it. Since its Cold War peak, the defense industrial base has decreased in total size and in the diversity of firms it contains. Many U.S. firms have fled the defense sector altogether, including large companies with once-significant roles in munitions production such as Magnavox, Texas Instruments, and Ford Aerospace.[366] At the same time, few nondefense

361 This reversal largely occurred during the early Cold War, with arsenals responsible for less than 10 percent of U.S. weapons production by 1958. Watts, *U.S. Defense Industrial Base*, pp. 14–15.

362 Chris Martin, "The Top 100 Is Here: Find Out How Defense Companies Performed in FY23," *Defense News*, August 6, 2024, https://www.defensenews.com/top-100/2024/08/06/the-top-100-is-here-find-out-how-defense-companies-performed-in-fy23/.

363 Watts, *U.S. Defense Industrial Base*, p. 56; and National Defense Industrial Association, *Vital Signs 2024*, p. 31.

364 Thomson and Mayo, *Ordnance Department*, p. 28.

365 A more detailed examination of intellectual property and data in defense procurement can be found in Department of Defense, *State of Competition*, pp. 7–12.

366 Jacques S. Gansler, *Democracy's Arsenal: Creating a Twenty-First-Century Defense Industry* (Cambridge, MA: The MIT Press, 2013), p. 34.

firms have entered the industry, resulting in a mostly separate, highly specialized industrial base.[367]

In response to reduced demand for military goods after the Cold War, the remaining defense firms consolidated into several large prime contractors. The 1990s saw the number of top defense suppliers fall from 36 to eight, with the number of contractors involved in production of tactical missiles decreasing from 13 to just three.[368] These mergers and acquisitions allowed firms to cut costs, operate more efficiently, and survive periods of reduced defense procurement.[369] For instance, Raytheon's consolidation of missile production in Arizona reduced weapon prices by up to 25 percent and saved the Defense Department over $2 billion on long-term missile procurement.[370] Unfortunately, consolidation hurt many midsized defense firms and increased the barriers to entering the defense market, with the proportion of contracts awarded to second tier firms shrinking from 50 percent to 30 percent between 1995 and 2004.[371]

In many cases, the government accepted or even encouraged these consolidations, with the most notable example being Deputy Secretary of Defense William Perry's "last supper" meeting with industry executives in 1993.[372] Consolidation extended to government-owned industrial facilities as well, with the desire to eliminate excess capacity driving the closure of facilities and workforce reductions.[373] The net result of this shrinkage and consolidation, however, is less total defense industrial capacity, particularly in the subtiers of many supply chains. The remaining firms rely on defense spending to stay afloat, with defense making up 80 percent or more of revenue for Lockheed Martin, Northrop Grumman, General Dynamics, BAE Systems, and L3Harris Technologies.[374]

Emphasis on Efficiency and Elimination of Excess Capacity

Alongside consolidation, an increased focus on efficient and lean business practices has further winnowed defense production capacity. Analyst Barry Watts described this long-term shift in 2008: "Since the 1970s, American defense firms have increasingly adopted

367 Watts, *U.S. Defense Industrial Base*, pp. 42–43.

368 Gansler, *Democracy's Arsenal*, p. 32; and Department of Defense, *State of Competition*, p. 5.

369 Cancian et al., *Industrial Mobilization,* p. 22.

370 Gansler, *Democracy's Arsenal*, p. 35.

371 Defense Science Board Task Force on Defense Industrial Structure for Transformation, *Creating an Effective National Security Industrial Base for the 21st Century: An Action Plan to Address the Coming Crisis* (Washington, DC: Department of Defense, July 2008), p. 24, https://apps.dtic.mil/sti/citations/ADA485198.

372 Luke A. Nicastro, *The U.S. Defense Industrial Base: Background and Issues for Congress*, p. 5; and John Mintz, "How a Dinner Led to a Feeding Frenzy," *Washington Post*, July 3, 1997, https://www.washingtonpost.com/archive/business/1997/07/04/how-a-dinner-led-to-a-feeding-frenzy/13961ba2-5908-4992-8335-c3c087cdebc6/.

373 Nicastro, *U.S. Defense Industrial Base*, p. 5.

374 This contrasts with many of the top Chinese defense firms, which are large state-owned conglomerates and less reliant on defense goods for revenue. See Martin, "The Top 100 Is Here."

management practices from the commercial sector. These practices have resulted in the strategic goals of many defense firms more closely resembling those of commercial firms. Top managers of many defense firms have found themselves concentrating more and more on bottom-line financial returns for their shareholders, increasing their share of the market, and eliminating competition."[375]

For any business, excess capacity increases overhead costs and is inherently inefficient. Stocks of extra materials and components, additional tooling, or underutilized production lines are expensive to maintain, tie up company funds, and are at risk of obsolescence. Accordingly, absent external incentives or support, the commercial defense industry has sought to rid itself of excess capacity whenever possible. This effort directly conflicts with the interests of the DoD, which wants excess capacity to compensate for fluctuations in demand, enable surge production, and support mobilization during wartime.[376] The government has been unwilling, however, to pay to maintain significant excess capacity within the munitions industrial base.[377] Although the emphasis on efficiency has allowed many firms in the defense industry to stay in the defense market and remain competitive, it has also eliminated much of the surge production capacity that had been present during the Cold War.[378]

Increased Reliance on Foreign Sources

Like the broader U.S. economy, the defense industry has not been entirely shielded from the effects of globalization. Although the defense industrial base is subject to legislative and executive restrictions on where it purchases its inputs, today's defense supply chains are more reliant on foreign sources than those of the 1940s.[379] America's defense production had few significant supply chain dependencies on the Axis powers, but many of today's defense supply chains are intermingled with or reliant on Chinese sources. For example, analysts estimate that over 40 percent of semiconductors in U.S. weapons and infrastructure depend on Chinese suppliers.[380] Figure 8, drawn from a 2024 Govini assessment, shows dependencies on Chinese suppliers in several critical U.S. PGM programs. Raytheon Technologies chairman Greg Hayes stated that completely decoupling his company's supply chains from China would be "impossible" and that "if we had to pull out of China, it would take us many many years to reestablish that capability either domestically or in other friendly countries."[381]

375 Watts, *U.S. Defense Industrial Base*, pp. 2–3.

376 Watts, *U.S. Defense Industrial Base*, p. 58.

377 Watts, *U.S. Defense Industrial Base*, pp. 54–55; and National Defense Industrial Association, *Vital Signs 2024*, p. 41.

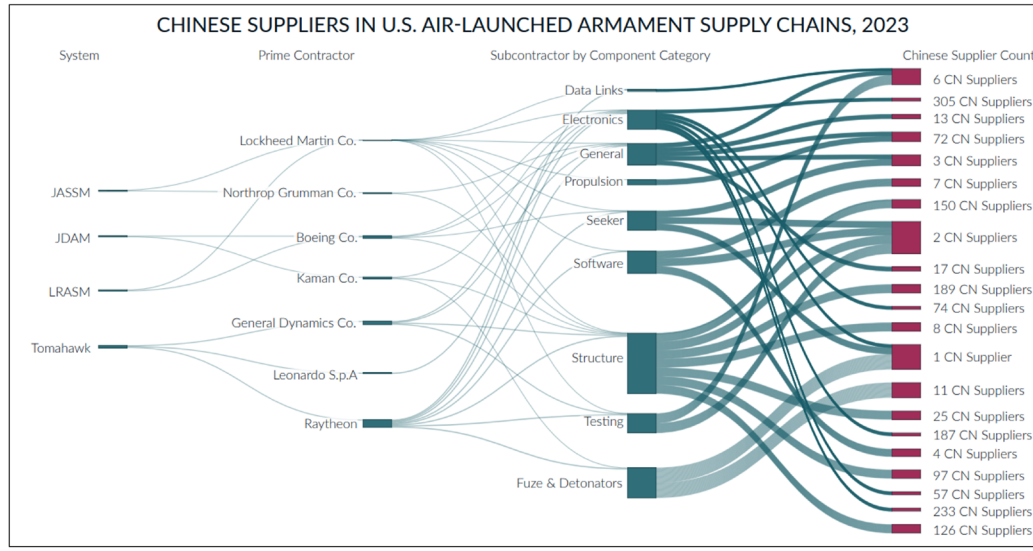
378 Cancian et al., *Industrial Mobilization*, p. 21.

379 Gansler, *Democracy's Arsenal*, p. 17.

380 Govini, *Numbers Matter*, p. 4.

381 Quoted in Sylvia Pfeifer, "'We Can De-risk but Not Decouple' from China, Says Raytheon Chief," *Financial Times*, June 19, 2023, https://www.ft.com/content/d0b94966-d6fa-4042-a918-37e71eb7282e.

FIGURE 8: ANALYSIS OF CHINESE SUPPLIERS IN U.S. PGM SUPPLY CHAINS



Source: Govini, *Numbers Matter: Defense Acquisition, U.S. Production Capacity, and Deterring China*, p. 7.

Dependence on foreign suppliers is increasingly unavoidable due to the lack of domestic sources for some key inputs. In a 2024 survey, private sector defense firms cited suppliers going out of business or leaving the U.S. defense industrial base as the top two reasons for lost sources.[382] To cite one example, as of January 2024 the United States did not produce significant quantities of TNT domestically and instead relied on imports from Poland, Australia, and India.[383] The Army's recent efforts to ramp up artillery shell production have led it to pursue the establishment of a domestic source for TNT.[384]

In response to the lack of domestic suppliers, many U.S. firms have attempted to "friend-shore" by moving from Chinese sources to suppliers in allied or partner nations. Unfortunately, many of these nations are vulnerable to political pressure from the PRC or rely on intermediate inputs from China.[385] The National Defense Industrial Association (NDIA) noted in its 2024 annual assessment that "a significant percentage of the value of those increased imports from Vietnam and Mexico"—two popular friendshoring nations—"actually consisted of inputs originally sourced in China.[386] As the complexity of military systems grow, it is increasingly difficult for defense contractors to gain visibility into the full

382 National Defense Industrial Association, *Vital Signs 2024*, pp. 46–47.

383 Jen Judson, "U.S. Army Hunts for Explosives to Meet Increased Munitions Output Goals," *Defense News*, February 6, 2024, https://www.defensenews.com/land/2024/02/06/us-army-hunts-for-explosives-to-meet-increased-munitions-output-goals.

384 Judson, "U.S. Army Hunts."

385 National Defense Industrial Association, *Vital Signs 2024*, p. 45.

386 National Defense Industrial Association, *Vital Signs 2024*, p. 45.

depth of their supply chains. Over one third of commercial defense firms reported they have a high degree of visibility into only 25 percent or less of their total supply chain.[387]

A Smaller, Older Workforce

Today's defense industry also suffers from a shrinking and aging workforce among skilled production workers and design and engineering staff. The availability of skilled labor has decreased alongside reductions in the broader U.S. manufacturing workforce. As the defense industrial base shrunk and consolidated in the post-Cold War era, so has its cadre of workers with specialized skills. The defense industrial workforce decreased from three million employees in 1985 to 1.1 million in 2021.[388] Skilled trade workers are increasingly hard to recruit and retain in sufficient numbers, with defense firms citing tough working conditions as the primary cause of worker attrition.[389] For engineers and other positions requiring advanced degrees, the defense industry now competes with commercial technology firms for the most qualified personnel.[390] The commercial sector is often more appealing to these employees than the defense industry due to higher compensation, more attractive benefits, and more opportunities for remote work.[391]

Hiring is further complicated in the defense industry by the need for personnel to acquire and maintain security clearances, a requirement that largely did not exist during World War II. Among defense firms surveyed in 2024, 38 percent said they had too few cleared workers to sustain current production rates, let alone expanded production.[392] The federal government has significantly reduced the average time to process security clearances in recent years, with a top secret investigation requiring an average of 115 days at the end of Fiscal Year 2023.[393] Despite these improvements, a clearance process requiring three to four months is an additional obstacle to rapidly expanding munitions production.

Increased Regulation

Finally, American industries—particularly those in the defense industrial base—are now subject to significantly more regulation than those involved in the Arsenal of Democracy.[394] Modern regulations span from environmental and security rules to sourcing mandates

387 National Defense Industrial Association, *Vital Signs 2024*, p. 47.

388 National Defense Industrial Association, *Vital Signs 2024*, p. 38.

389 National Defense Industrial Association, *Vital Signs 2024*, pp. 39–40.

390 Watts, *U.S. Defense Industrial Base*, pp. 19–20.

391 National Defense Industrial Association, *Vital Signs 2024*, pp. 39–40.

392 National Defense Industrial Association, *Vital Signs 2024*, p. 42.

393 Jared Serbu, "Average Security-Clearance-Processing Speed Hits a Speed Bump," *Federal News Network*, November 28, 2023, https://federalnewsnetwork.com/workforce/2023/11/average-security-clearance-processing-speed-hits-a-speed-bump/.

394 Watts, *U.S. Defense Industrial Base*, p. 22.

and export restrictions.[395] Regardless of the reasons for their existence, the second order effects of these regulations include increasing segregation between commercial and defense firms, pushing firms to leave the defense industrial base, and reducing the speed at which industry can respond to changes in demand and expand production. In surveys conducted by the NDIA, defense firms consistently cite "overbearing regulation" as a barrier to expanding production and a primary reason suppliers choose to exit the defense market.[396] The DoD noted onerous regulation as a significant barrier to competition in priority industrial sectors such as castings and forgings, and repeatedly cited China's lax environmental and labor regulations as advantages that allow Chinese industry to dominate some industrial markets.[397]

Summary

Together, these shifts in the U.S. defense industrial base have two main implications for thinking about industrial mobilization in the modern era. First, like commercial supply chains, defense supply chains are more challenging to secure in the 21st century. In addition to the difficulty associated with gaining visibility into increasingly complex and globalized military supply chains, they are also more vulnerable to disruption from political warfare. Even friendshored sources may require the United States to exert political pressure to obtain supplies or physically secure lines of transportation between the United States and its allies, just as the United States did in World War II.[398]

Second, surge and mobilization timelines for much of today's defense equipment are likely to be significantly longer than during World War II. The record of World War II mobilization contains a plethora of examples of production lines or entire factories being constructed and staffed in under a year.[399] These timelines would be exceedingly difficult to achieve in the 21st century. Due to the factors described in this section, the Army estimates that

395 Many of these regulations are the result of well-meaning policies. For example, the U.S. Forest Service noted that during the operation of the Joliet Army Ammunition Plant in Illinois during World War II, TNT production heavily disturbed the local creek and caused the water to run red. U.S. Forest Service, "The Joliet Army Ammunition Plant," accessed November 12, 2024, https://www.fs.usda.gov/detail/midewin/learning/history-culture; and U.S. Environmental Protection Agency, "Joliet Army Ammunition Plant (Manufacturing Area) Joliet, IL: Contaminant List," accessed May 6, 2025, https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.contams&id=0501179.

396 For example, National Defense Industrial Association, *Vital Signs 2024*, pp. 41–42.

397 Department of Defense, *State of Competition*, pp. 18, 19, 22.

398 The challenge of relying on allies and partners for critical supply chains was displayed during the COVID-19 pandemic, when many close U.S. allies and trade partners placed export restrictions on in-demand medical supplies such as surgical masks. See, for example, Jung Min-kyung, "South Korean Government Takes Full Control of Face Mask Supply, Bans Exports," *Korea Herald*, March 5, 2020, https://www.koreaherald.com/view.php?ud=20200305000730; and Jan Dahinten and Matthias Wabl, "Germany Faces Backlash from Neighbors over Mask Export Ban," *Bloomberg*, March 9, 2020, https://www.bloomberg.com/news/articles/2020-03-09/germany-faces-backlash-from-neighbors-over-mask-export-ban.

399 One steel plant funded in March 1942 was operational by the end of that year, the Detroit Arsenal Tank Plant was constructed in seven months, and the average construction timeline for a shell-loading plant from 1940–1942 was just nine months. See Herman, *Freedom's Forge*, pp. 211–13, 98; and Thomson and Mayo, *Ordnance Department*, p. 112.

constructing a domestic TNT factory could take up to four years.[400] Waiving regulations or restrictions may help, but rapid expansion of PGM production may be fundamentally limited by a smaller total industrial base, reduced manufacturing workforce, and dependencies on foreign sources.

Not Your Grandad's Bombs: Trends in Munition Design

Finally, the product of the weapons industrial base—munitions—is fundamentally different in the 21st century than in the 1940s. Changes in weapon design and performance have shaped the industries that develop and manufacture them and altered the prospects for future mobilization.

Most munitions produced to fight World War II were simple cartridges, shells, freefall bombs, and ballistic rockets. Although there were numerous sizes and types of shells and bombs, many were similar from a production standpoint because they consisted of two primary parts: metal casings and explosive filling.[401] Casings were manufacturable using machine tools found in factories around the nation, and energetics required the construction of specialty factories. These designs allowed for a bifurcation of munitions production between private industry for metal casings and government-owned facilities for explosive filling. Even so, the Army's Ordnance Department estimated that 105 mm howitzer shells traveled more than 10,000 miles between factories before they were assembled, inspected, and packed for shipping.[402] Other projectiles, such as armor-piercing shells for naval use, were subject to longer lead times, but these munitions were required in lower quantities that did not need massive expansions of production capacity.[403]

The most complex component of most WWII munitions was the fuze, which the Army likened to the mule and dubbed "ornery but necessary."[404] These difficulties increased with the introduction of the variable time fuze, which posed "unparalleled challenges to both developers and producers" and required an expansion of the American electronics and vacuum tube industry.[405] For the U.S. Navy, torpedoes were the most complex munition to manufacture. Their intricate designs created unforeseen production bottlenecks, with some torpedoes taking longer to produce than the patrol boats that carried them.[406] Although next-generation weapons such as longer range rockets and radio-guided weapons

400 Judson, "U.S. Army Hunts."

401 The Army's Ordnance Department noted that there "were only twenty different sizes of artillery shell used in World War II, but there were more than a dozen types of shell for each caliber." Thomson and Mayo, *Ordnance Department*, p. 106.

402 Thomson and Mayo, *Ordnance Department*, p. 107.

403 Armor-piercing shells could require up to six months from pouring to delivery. Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 59.

404 Thomson and Mayo, *Ordnance Department*, p. 121.

405 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, pp. 279, 284.

406 Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, pp. 90, 124, 129.

were developed during the war, these munitions were only produced and employed in small quantities.

Since World War II, technology has enabled two developments that complicate contemporary munition design and production: increased range and precision guidance.[407] Today, long-range PGMs are critical for potential great power conflict scenarios. Whereas the unguided weapons of World War II contained little more than a warhead and fuze, today's PGMs execute many of the functions previously performed by pilots, aircraft, and other platforms, including propulsion, navigation, and target finding. These functions require engines and motors, control surfaces, advanced sensors, and navigation and guidance computers to be included in modern weapons. In short, the line between munition and platform is increasingly blurry in terms of design complexity and the number of major subsystems and components.

From an industrial standpoint, these developments have radically altered the distribution of difficult-to-manufacture components between munitions and their delivery platforms. In World War II, complex components remained mostly confined to reusable aircraft, naval vessels, and ground vehicles that delivered or fired munitions. Although aircraft like the B-25 or B-17 were incredibly complex to build at the time, they (and their complex components) were required in smaller quantities relative to the number of munitions produced.[408] Today, the systems that drove complexity in manufacturing World War II platforms such as engines and navigation systems are contained in each munition and expended with every shot. Complex inputs that did not yet exist in World War II, such as microelectronics, are now in every precision-guided weapon.[409] This makes modern PGMs significantly more challenging to produce at scale. They require more inputs from a greater number of subcontractors, draw on increasingly complex supply chains, and are more difficult to inspect and test.

The net result of this complexity is that more time is required to design, manufacture, and expand production of modern munitions. This time requirement has revealed itself in recent efforts to grow PGM production. Despite munition prime contractors investing in capacity, they are often constrained by the maximum production rates of their many suppliers.[410] Even if component suppliers want to expand, time is required for investment to flow

407 For a more thorough exploration of the development of precision strike capabilities, see Hacker, *Beyond Precision*, pp. 10–13.

408 A B-25 had around 165,000 individual parts, and B-29 production required the management of 1,400 subcontractors. Herman, *Freedom's Forge*, pp. 117, 300.

409 As early as the Korean War, the Navy's Bureau of Ordnance noted the increasing complexity and cost associated with individual munitions. At the same time, aircraft production for the Korean War required "four times the effort" as planes for World War II, with the longest lead time shifting from the airframe itself to electronic components. See Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, pp. 512–14; and England, *U.S. Industrial Mobilization*, pp. 120–21.

410 Megan Eckstein, "Supplier Bottlenecks Threaten U.S. Navy Effort to Grow Arms Stockpiles," *Defense News*, February 6, 2024, https://www.defensenews.com/naval/2024/02/06/supplier-bottlenecks-threaten-us-navy-effort-to-grow-arms-stockpiles.

down supply chains from government to prime contractor to subcontractor and so forth. One illustration of the challenges of expanding production of modern munition components is Australia's effort to domestically produce the Guided Multiple Launch Rocket System (GMLRS). Lockheed Martin Australia estimates it may take five to 10 years to develop the domestic capacity to produce GMLRS seekers.[411]

Considering Industrial Mobilization in the 21st Century

Considered in aggregate, these changes make contemporary industrial mobilization a vastly different task than the one undertaken in 1940. The U.S. industrial base that became the Arsenal of Democracy no longer exists, and the global and U.S. economies of today are fundamentally different. Neither industry nor government can be wholly blamed for these shifts. They are the combined result of global trends, DoD requirements and policy, congressional funding levels, the decisions of industry leaders, and other factors. To highlight several key differences:

1. Today's munitions industrial base has substantial expertise and active production capacity that was not available before mobilization in World War II.
2. The timelines for surging available production or expanding (mobilizing) production are likely significantly longer than in 1940.
3. Today's smaller U.S. industrial base creates less certainty about reserve industrial capacity and its potential to be mobilized to increase munitions output.
4. The production of some PGMs may be exceedingly difficult to scale up without significant requirement and design changes, which would add to the time needed to expand production.
5. The contemporary strategic environment is unlikely to allow a prolonged, unthreatened mobilization period.

Given the changes of the last eight decades, the Arsenal of Democracy may be more useful as an aspiration than as a model for modern industrial mobilization. Even so, the planning and execution of World War II's industrial mobilization contains echoes of many of the challenges faced by the U.S. military and defense industry today. The next chapter extracts lessons from World War II for today's planners as they contemplate mobilizing the nation for a great power conflict.

411 Gordon Arthur, "Australia Aims to Boost Local Arms Production. So Far It's Leaning Foreign," *Defense News*, July 1, 2024, https://www.defensenews.com/global/asia-pacific/2024/07/01/australia-aims-to-boost-local-arms-production-so-far-its-leaning-foreign/.

CHAPTER 5

Lessons for 21st-Century Industrial Mobilization

> My experience in two world wars, the aftermaths, and the endeavors to make a lasting peace, makes me marvel at the regularity with which errors are repeated. One of the errors that most frequently recurs is failure to study and understand the records of the past.
>
> —Bernard Baruch, Chairman of the WWI War Industries Board[412]

Given the differences between 1945 and 2025, what can be learned from the Arsenal of Democracy? Clearly the substance and circumstances of a contemporary mobilization—the essential weapons, key industrial sectors, critical materials, and the global economic and security environment—are all much changed from 1940. Despite the changes in weapons, industry, and American geoeconomic power, the history of industrial mobilization for World War II is replete with instructive lessons for today's planners and policymakers as they confront the challenges of preparing the nation for strategic competition and, potentially, great power war. Given the enduring nature of industrialized warfare, many of the fundamental planning considerations, tradeoffs, and risks inherent to industrial mobilization in the United States remain unchanged. This chapter builds on the historical analysis presented previously in the monograph to identify continuing lessons for industrial mobilization in the 21st century.

This chapter proceeds in two sections. The first outlines a series of ways that interwar planning for industrial mobilization may be instructive for contemporary military planners charged with readying the munitions industrial base for great power conflict. The second section highlights a number of principles for today's policymakers related to conducting industrial mobilization. These two facets of the Arsenal of Democracy story—the lessons gained through experience during its planning and execution—transcend nostalgia and

412 Quoted in Klein, *Call to Arms*, p. 45.

remain valuable as the United States confronts the renewed threat of great power conflict in the modern era.

Lessons for Mobilization Planning

Industrial Mobilization Planning Is Difficult But Essential

The supreme lesson of the Arsenal of Democracy is the need for detailed preconflict planning and preparation for industrial mobilization and protracted war. Despite myriad problems with interwar plans and Roosevelt's reluctance to utilize the IMP, the efforts of the War Department in the 1920s and 1930s were invaluable to expanding military production from 1939 to 1943. Although eschewed by many civilian and industrial leaders, the military's mobilization plans and their supporting documents provided the foundation upon which mobilization officials began expanding American military–industrial capacity. For munitions, these plans identified priority goods, materials, and chokepoints; drove industry engagement and investment well in advance of conflict; and decreased the amount of time needed to expand the production of key munitions.[413]

One reason the IMPs were useful was that they spawned preparatory measures such as schedules of production, manufacturing studies, educational orders, the purchase of tooling and capital equipment, and training military and industrial personnel. In this way, the IMPs were more than just paper plans. They guided military-industrial engagement during the interwar period, even if it was severely limited by available funding and time. Prewar planning also guided the refurbishment of government-owned arsenals, which played an essential role in industrial mobilization despite their initially outdated equipment and limited capacity.[414]

Today, government planning for industrial mobilization may be more crucial than ever for deterring or succeeding in a great power war. Many aspects of the happy conjunction of circumstances that enabled the Arsenal of Democracy no longer exist, and in some ways the strategic and economic positions of the United States and China are reversed from those of the United States and the Axis powers. But as this monograph has shown, those charged with industrial mobilization in 1940 also confronted and overcame numerous challenges, including unclear strategic objectives, competing priorities, political constraints, inadequate funding, insufficient authorities, and a public attitude that often associated preparing for war with deliberately seeking war.

Industrial mobilization planning remains an essential part of preparing for modern great power wars for three reasons: it sets critical strategic assumptions, reduces mobilization timelines, and strengthens deterrence credibility. DoD guidance on industrial mobilization

413 Thomson and Mayo, *Ordnance Department*, p. 468.

414 Thomson and Mayo, *Ordnance Department*, pp. 466–67.

remains important for synchronizing key planning assumptions across the numerous parties indispensable to successful mobilization, including the armed services, executive agencies, industrial base, and Congress. These strategic planning factors may include:

1. the quantity and geography of potential conflict theaters;[415]
2. key allies and partners and their potential contributions and requirements;
3. critical lines of communication (LOCs) and transport capacity requirements;
4. assignment of responsibilities and authorities for industrial and economic mobilization;
5. procedures for using emergency powers and additional measures that might be requested;
6. critical domestic and overseas facilities, firms, industrial sectors, and material sources; and
7. estimated timelines for expanding production of key military goods.

These assumptions play a role in peacetime decisions about requirements, procurement, and other military–industrial interactions that shape the munitions industry and, if done properly, set the stage for its mobilization during wartime. Moreover, these assumptions are key to building and maintaining a standing force capable of providing the security required for mobilization and, if necessary, fighting until industry can supply follow-on operations and campaigns. Just as funding and allocation decisions made in 1939 and 1940 affected which weapons would reach maximum output in 1943 and 1944, today's policy and procurement decisions shape America's future production options. Of course, peacetime plans and the choices they influence must emphasize flexibility to account for the many unknowns associated with future conflict. Like the IMPs, mobilization plans and the assumptions enumerated therein must be constantly updated or risk becoming irrelevant.

Second, mobilization planning is essential for reducing the time needed to expand the production of modern weapons. With many wargames and vignettes of contemporary great power war envisioning rapid, high-intensity combat operations that quickly exhaust the inventories and forces of both sides, the ability to continue fighting and prevail in great power war depends on which nation can bring the preponderance of its national

415 Interwar planners mistakenly assumed that like World War I, a future war would center on a single theater and front, which complicated the implementation of plans in the run-up to World War II. Gropman, *Mobilizing U.S. Industry*, p. 22; and Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 795.

resources to bear first.[416] The Army itself drew this lesson from its experience in World War II: "If any indisputable logistic lesson can be drawn from World War II, it is that in any major war involving industrial powers no nation can hereafter emerge victorious without substantial superiority over its enemy in the quality and quantity of its weapons and supporting equipment."[417]

As Chapter 4 illustrated, however, the complexity of modern defense supply chains and America's reliance on other nations for goods and materials have greatly increased the time required to expand the production of many of today's critical weapons and platforms. The PRC, on the other hand, has many of the economic and manufacturing advantages the United States enjoyed in the 1940s. In addition, any modern adversary is unlikely to provide years of advance warning and grant the United States an unmolested period to mobilize its industry.[418] Therefore, it is essential that the United States act now to reduce mobilization timelines for priority items and increase its industrial preparedness. Much like during the interwar period, the first step toward achieving these crucial tasks is industrial mobilization planning.

Third, plans for mobilizing industry to support a protracted war are a vital part of deterring both prolonged conflicts and rapid attempts at a fait accompli. To maintain a viable deterrent, the United States must convince its adversaries that it is willing to engage in a protracted conflict. The credibility of this threat is difficult to assert if the nation does not maintain the industrial capacity, latent capability, and actionable plans to supply its forces over an extended period and rally its national resources in support of a great power conflict.[419] Failure to prepare for industrial mobilization may lead competitors to believe they can achieve their aims through a fait accompli because the United States would not be able to quickly expand production and roll back their military gains. Ignoring the potential need for industrial mobilization may also drive adversaries to engage the United States in

416 For examples of these wargames and vignettes, see Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, *The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan* (Washington, DC: Center for Strategic and International Studies, January 2023), https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf; Stacie L. Pettyjohn, Becca Wasser, and Andrew Metrick, *Bad Blood: The TTX for the House Select Committee on Strategic Competition Between the United States and the Chinese Communist Party (CCP)* (Washington, DC: Center for a New American Security, April 26, 2023), https://s3.us-east-1.amazonaws.com/files.cnas.org/documents/Pettyjohn-Wasser-Metrick-Statement-for-the-Record-for-House-Select-Committee-on-China.pdf; and Hacker, *Beyond Precision*, chaps. 3–4.

417 U.S. Army Center of Military History, *Logistics in World War II*, p. 244.

418 U.S. Army Center of Military History, *Logistics in World War II*, pp. 245–46.

419 This point has been made by numerous DoD officials and analysts in recent years. See Joseph Clark, "Resilient Defense Industrial Base Critical for Deterring Conflict," *DoD News*, October 25, 2023, https://www.defense.gov/News/News-Stories/Article/Article/3569067/resilient-defense-industrial-base-critical-for-deterring-conflict/; Jim Garamone, "Hicks Again Makes Case for Strengthening Industrial Base, Eliminating Continuing Resolutions," *DoD News*, March 20, 2024, https://www.defense.gov/News/News-Stories/Article/Article/3713186/hicks-again-makes-case-for-strengthening-industrial-base-eliminating-continuing/; and Stacie Pettyjohn and Hannah Dennis, *Production Is Deterrence: Investing in Precision-Guided Weapons to Meet Peer Challengers* (Washington, DC: Center for a New American Security, June 2023), https://s3.us-east-1.amazonaws.com/files.cnas.org/documents/Budget2024_Final.pdf.

prolonged conflict in the hope that, much like the Allies in World War II, their war production outmatches the United States in the medium to long run.

A renewed focus on industrial mobilization planning may require revitalization of institutions such as the contemporary descendant of the Army Industrial College, the National Defense University's Eisenhower School. Military education must ensure strategic planning is supported by practicable logistical and industrial planning.[420]

Mobilization Planning Must Be Synchronized With Protracted War Plans

Industrial mobilization planning is essential because it is intimately linked with a nation's grand strategy in a protracted war. Short or limited wars can embrace a strategy based on rapidly achieving decisive objectives and relying on standing inventories of weapons and supplies. As a result, they are less inhibited by industrial limitations. Protracted wars enjoy no such luxury; industrial mobilization planning and capacity (or lack thereof) often become "strategic decisions in disguise" once a conflict commences.[421] Allied strategy in World War II was largely dictated by mobilization requirements and timelines, which dictated a prolonged war centered on leveraging America's latent industrial advantage to eventually overwhelm the Axis powers with men and materiel.

Given the relationship between industrial mobilization planning and protracted war strategy, mobilization planning must be integrated into contemporary warfighting concepts and plans. Meaningful planning for industrial mobilization cannot occur absent some basic strategic planning for protracted war, and vice versa. The development of these plans, even if vague and subject to change, is important because once industrial and logistical wheels begin turning toward preparing for a particular strategy, the range of future options narrows. The industrial decisions and indecisions of 1939–1941 had significant impacts on the direction and outcome of World War II. Unsurprisingly, closing this "operational-industrial planning gap" was a key finding of the recent National Defense Strategy Commission.[422]

Similarly, the United States must today consider the long-term strategic and industrial implications of its responses to various contemporary emergencies, such as the Russia–Ukraine war and the Israel–Gaza conflict, that shape the industrial and strategic options available to the nation in the event of a protracted war in the next decade and beyond. For this reason, plans for fighting a protracted war and mobilizing industry are essential to balancing

420 Analysts have long recognized the vital role the Industrial College plays in these efforts. See John W. Masland and Laurence I. Radway, *Military Education and National Policy* (Princeton, NJ: Princeton University Press, 1957), p. 408.

421 Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 796.

422 A 1988 report by Under Secretary of Defense for Acquisition Robert B. Costello identified this same problem nearly four decades ago. See RAND, *Commission on the National Defense Strategy*, pp. 35-36; and Under Secretary of Defense (Acquisition), *Bolstering Defense Industrial Competitiveness: Preserving Our Heritage, the Industrial Base, Securing Our Future* (Washington, DC: Under Secretary of Defense (Acquisition), July 1988), pp. 42–43, https://apps.dtic.mil/sti/tr/pdf/ADA202840.pdf.

short- and long-term defense priorities. History proves the United States is often wrong in its predictions about where and when it will fight its next war, but the only option worse than planning for the wrong war is not planning for any possibility of protracted conflict.

Determining Requirements Is the Principal Challenge of Mobilization Planning

Protracted war planning is key to mobilization planning because it is a prerequisite for determining military and industrial requirements. As Chapter 2 highlighted, requirements and strategy were related in World War II, with changes to either dictating modifications to the other. Determining industrial requirements prior to the formulation of an overall war strategy proved difficult, and allied strategy could only be finalized once requirements and industrial limitations were clarified.[423] Questions pertaining to exactly what the armed forces needed and in what quantities were paramount to driving the industrial expansion that resulted in the Arsenal of Democracy. As the Army noted in the conflict's aftermath: "War is unpredictable and does not lend itself readily to precise long-range planning; however, a better system must be developed for estimating troop requirements and anticipating the deployment of units—one that will provide the logistician time and a firm basis for producing munitions and equipping the forces needed to implement strategic and operational plans."[424]

Similarly, determining military requirements for protracted great power war remains the vital prerequisite and essential challenge of modern industrial mobilization planning. The military services must think more deeply about what they will require over the duration of a protracted war. For PGMs, these requirements will be determined by the types and quantities of weapons the armed services might expend during varying phases of a prolonged conflict, to include:

1. a war's opening phases and during rapid campaigns intended to achieve decisive results,
2. operational pauses caused by exhaustion or preparation for continuing operations,
3. operational pulses and follow-on campaigns, and
4. sustained requirements for the duration of the war.[425]

In determining these requirements, military planners must think comprehensively about the potential demands of a future conflict, even if current resource levels constrain requirements in the near term.[426] Wedemeyer's prescient Victory Plan requirements departed from

423 Smith, *Army and Economic Mobilization*, p. 211.

424 U.S. Army Center of Military History, *Logistics in World War II*, p. 249.

425 Each of these phases can observed in ongoing protracted conflicts in Ukraine and the Middle East.

426 Thinking big about future requirements proved a challenge for military planners in the years and months prior to World War II. Sweeting, *Building the Arsenal of Democracy*, p. 65.

other assessments of the day because they looked past budgetary constraints to consider national objectives and strategy in a great power conflict that demanded national mobilization.[427] Of course, requirements must maintain a degree of flexibility and adapt to changes in the security environment and ongoing operations. Nevertheless, basic estimates of munition requirements over the full duration of a protracted conflict are a prerequisite for contemporary industrial mobilization planning. These broad, directional requirements serve as a foundation for industrial planning and can be refined as the details of a future conflict become clear.

Allies Must Be Factored Into Mobilization Plans

Another essential facet of determining requirements is the consideration of allies: what they might demand from U.S. industry and what they may be able to provide American forces and industry. Throughout World War II, assessing and coordinating allied requirements was a constant source of frustration and tension for civilian and military mobilization officials. As Chapter 3 noted, the support of allies through Cash and Carry and Lend–Lease both added to and detracted from America's ability to mobilize and equip its own forces for combat. Given the globalized nature of modern industry and defense production, the role of U.S. allies and partners in industrial mobilization may be even more critical today. Just as in World War II, current U.S. allies will likely draw on U.S. industrial capacity and contribute to industrial mobilization efforts.

Based on recent events in Europe and the Middle East, the most significant demand of many U.S. allies and partners will be for finished American weapons. U.S. arms transfers to allies and partners have drawn on limited inventories and created much the same dilemma faced by Roosvelt in 1941: the need to balance U.S. military readiness with the support of allies in need.[428] The U.S. defense industrial base, regardless of its suitability for protracted great power war, remains the world's most robust source of PGMs and supplies many critical systems to U.S. allies and partners throughout the world. Although increased demand over the last several years has led some regions of the world to question their dependence on American arms, it is likely that the United States will remain a major arms exporter for the

427 Kirkpatrick, "Strategic Planning," p. 18.

428 Mark F. Cancian, "Rebuilding U.S. Inventories: Six Critical Systems," Center for Strategic and International Studies, January 9, 2023, https://www.csis.org/analysis/rebuilding-us-inventories-six-critical-systems; Michael Marrow, "U.S., NATO weapons stockpile 'dangerously low': USAF General," *Breaking Defense*, July 12, 2023, https://breakingdefense.com/2023/07/us-nato-weapons-stockpile-dangerously-low-usaf-general/; Natasha Bertrand and Oren Liebermann, "U.S. Military Aid Packages to Ukraine Shrink amid Concerns over Pentagon Stockpiles," *CNN*, September 17, 2024, https://www.cnn.com/2024/09/17/politics/us-reducing-military-aid-packages-ukraine/index.html; and Bryant Harris and Noah Robertson, "Soaring U.S. Munitions Demand Strains Support for Israel, Ukraine, Taiwan," *Defense News*, April 30, 2024, https://www.defensenews.com/pentagon/2024/04/30/soaring-us-munitions-demand-strains-support-for-israel-ukraine-taiwan/.

foreseeable future.[429] Therefore, it is critical that current and potential allied demands for weapons and platforms are built into U.S. requirements and plans. A coordinated demand signal is essential for determining the total American industrial capacity needed to supply U.S. and allied forces. This increased demand signal for U.S. munitions is a positive effect of supplying allies and a critical requirement for sustaining the industrial base and expanding production capacity.

Should U.S. production prove insufficient, the U.S. military could also employ weapons produced by allies and partners during emergencies or before U.S. production can be expanded to meet demands. Precedent exists for U.S. forces to use foreign PGMs, though integration and testing must be conducted during peacetime to enable the employment of these weapons in conflict.[430] Similarly, many opportunities exist for U.S. allies to produce American weapons under license or for the United States and allies to codevelop or coproduce PGMs.[431] Allies and partners are also likely to be essential links in many U.S. defense supply chains and may be dependable sources of components and materials that are not domestically produced in large quantities.

Although the United States should not hesitate to lean on allies and partners when their industrial capacity or exports are needed to accomplish U.S. objectives, planners must also remain mindful of the risks of foreign dependencies in defense production. During crises, allies and partners may choose to limit exports of weapons or materials they deem necessary for their own defense.[432] Other nations may also choose to withhold supplies if political differences arise during a conflict.[433] Consequently, inherent in the extension of U.S. defense supply chains and industrial relationships to allies and partners is a responsibility to maintain healthy diplomatic, economic, and military relations with these nations during competition and crises. Furthermore, international sources of goods and materials remain geographically distant from the United States and require adequate transportation capacity. Depending on the location, nature of the material, and the quantity required, transportation to the United States could lengthen production timelines. In May 1940, industrial planners

429 See, for example, Lorne Cook, "EU Buys Too Much Defense Equipment Abroad, Especially from U.S.: Report," *Defense News*, September 9, 2024, https://www.defensenews.com/global/europe/2024/09/09/eu-buys-too-much-defense-equipment-abroad-especially-from-us-report/.

430 For example, the U.S. Navy and Marine Corps' use of the Norwegian-designed Naval Strike Missile.

431 For additional discussion of codevelopment and coproduction options, see Eric Edelman, Christopher Bassler, Toshi Yoshihara, and Tyler Hacker, *Rings of Fire: A Conventional Missile Strategy for a Post-INF Treaty World* (Washington, DC: Center for Strategic and Budgetary Assessments, August 24, 2022), chap. 4, https://csbaonline.org/research/publications/rings-of-fire-a-conventional-missile-strategy-for-a-post-inf-treaty-world.

432 The challenge of relying on allies and partners for critical supply chains was displayed during the COVID-19 pandemic, when many close U.S. trade partners placed export restrictions on in-demand medical supplies such as surgical masks. See, for example, Min-kyung, "South Korean Government;" and Dahinten and Wabl, "Germany Faces Backlash."

433 For example, the Israel–Gaza conflict has led to numerous nations restricting arms exports and trade with Israel. Riham Alkousaa, "Germany Has Stopped Approving War Weapons Exports to Israel, Source Says," *Reuters*, September 19, 2024, https://www.reuters.com/world/germany-has-stopped-approving-war-weapons-exports-israel-source-says-2024-09-18/.

turned to the development of domestic sources of key materials after it became clear that shipping the material from allied nations would unacceptably extend production timelines and that the United States and allies lacked sufficient shipping capacity.[434] Moreover, these supply lines would be subject to adversary interference and attack and may require protection by the United States. Maintaining these LOCs could increase the defensive burden on U.S. forces and demand the attention of assets that would otherwise be involved in other campaigns.[435] For these reasons, it is essential that planners consider the benefits and risks of these arrangements in peacetime and wartime, which may favor some trade and production arrangements over others.[436]

Including allies in industrial mobilization plans may require combined planning to a degree that is politically challenging in peacetime. Indeed, until the United States entered World War II in December 1941, American and British planners were reluctant to share information related to stockpile contents, military requirements, and war production capacities.[437] Nevertheless, coordination with allies and partners is essential if they are expected to play a vital role in a U.S. industrial coalition or in U.S. defense supply chains. At the very least, the DoD needs to be aware of how military and economic ties with allies and partners may affect the mobilization of American industry.

Mobilization Plans Must Consider Threats to the U.S. Homeland

Contemporary plans for industrial mobilization must consider the full range of threats to the U.S. homeland, its critical infrastructure, and the industrial base. Even during World War II, when the contiguous United States was relatively safe, the armed forces and industry implemented many defensive measures. After the attack on Pearl Harbor and several incidents along the West Coast, military planners worried about the safety of industrial facilities located on the nation's seaboards.[438] These concerns drove mobilization planners to focus new factory construction in the American heartland, which was deemed reasonably safe from adversary attack.[439] Fears of sabotage also led planners to distribute new plants over

434 England, *U.S. Industrial Mobilization 1916–1988*, p. 58.

435 Retrieving critical goods and materials from overseas sources may also require significant maritime shipping capacity—a weakness of the United States in the post-Cold War era. See John D. McCown, "What to Watch 2023: America Must Begin Growing Its Merchant Marine," Center for Maritime Strategy, January 10, 2023, https://centerformaritimestrategy.org/publications/what-to-watch-2023-america-must-begin-growing-its-merchant-marine/.

436 For example, these factors may incentivize arrangements that allow U.S. allies and partners in key theaters to produce and stockpile weapons entirely overseas, negating the requirement for intertheater transport.

437 Lacey, *Keep from All Thoughtful Men*, p. 29.

438 Panic over potential Japanese attacks or an invasion ensued after a Japanese submarine shelled an oil field outside Santa Barbara, CA, in February 1942 and after the Japanese invasion of the Aleutian Islands in June 1942.

439 Herman, *Freedom's Forge*, p. 211; Thomson and Mayo, *Ordnance Department*, p. 108; and Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 212.

a broad geographic area rather than concentrate them, even though that would have been more efficient from an industrial and transportation standpoint.[440]

Today's potential adversaries have numerous capabilities to interfere with U.S. critical infrastructure, degrade American war production, and attack industrial targets located throughout the homeland. Even during peacetime, U.S. adversaries are already utilizing "gray zone" tactics and unconventional warfare to disrupt Western defense production and critical infrastructure, with U.S. allies blaming Russia for acts of sabotage against European defense factories.[441] Although attribution remains uncertain, recent damage to several undersea cables and the destruction of the Nord Stream 2 pipeline foreshadow the infrastructure attacks that may be used to impede war production and civilian economies during a great power conflict.

Modern defenses may take the form of hardened networks and communications infrastructure, additional measures to prevent espionage and sabotage, or air and missile defenses protecting critical nodes. Defending the homeland will draw on limited resources and low-density assets and may be complicated by the need to defend additional facilities as the industrial base expands during mobilization. For this reason, a renewed focus on homeland defense, U.S. Northern Command, and civil defense is a critical element of industrial mobilization planning. Historically, various civil defense organizations have assisted the U.S. government with identifying homeland threats, protecting critical infrastructure, and maintaining domestic transportation and communication networks during national emergencies and times of war.[442] At the same time, the DoD must work with industry to eliminate vulnerable bottlenecks, disperse critical nodes, and harden weak points in defense production facilities. In some cases, mandating security measures through contracting may suffice (such as the Cybersecurity Maturity Model Certification), but other preparedness measures may require the DoD to provide additional funding to avoid creating further barriers to entering the defense market.

440 Thomson and Mayo, *Ordnance Department*, p. 108.

441 Evan Hanson, "If Hephaestus Doesn't Answer: Supply Chains and Modern War," Modern War Institute, December 10, 2024, https://mwi.westpoint.edu/if-hephaestus-doesnt-answer-supply-chains-and-modern-war/; Keir Giles, "Russia Disruption in Europe Points to Patterns of Future Aggression," Chatham House, May 1, 2024, https://www.chathamhouse.org/2024/05/russian-disruption-europe-points-patterns-future-aggression; and Bojan Pancevski, "Russian Saboteurs Behind Arson at German Factory," *Wall Street Journal*, June 23, 2024, https://www.wsj.com/world/europe/russian-saboteurs-behind-arson-attackat-german-factory-c13b4ece.

442 The United States has traditionally relied on a plethora of federal, state, local, and community organizations to bolster national defense and civil preparedness. Although the Federal Emergency Management Agency is currently responsible for coordinating federal efforts, the Department of Defense previously participated in civil defense through the Defense Civil Preparedness Agency and its predecessor organizations. At numerous points in U.S. history, the civil defense mission has been supported by various state defense forces, militias, and volunteer organizations such as the Cold War-era Ground Observer Corps. For more on integrating current civil and military air defense efforts, see Thane C. Clare, "Mending Fences: Strengthening Homeland Defense through Integrated Civil–Military Air Surveillance," *War on the Rocks*, January 10, 2025, https://warontherocks.com/2025/01/mending-fences-strengthening-homeland-defense-through-integrated-civil-military-air-surveillance/.

Mobilization Plans Will Influence U.S. Military Force Design

Preparing for protracted war and industrial mobilization has widespread implications for the U.S. military's current and future force design. The nature of a great power conflict will shape not only what must be built but also what can be built. After all, the U.S. military of 1945 was vastly different than the military of 1940, from different platforms and weapons (e.g., the Sherman tank, P-51 Mustang, B-29 bomber, and the Liberty ship) to new missions (large-scale amphibious invasions and strategic bombing) and novel organizations (the development of the U.S. Air Force, the Office of Strategic Services, and the various mobilization agencies described throughout this monograph). The longer a conflict endures, the more designing and producing new systems becomes essential alongside the production of existing systems.[443]

Most notably, the standing U.S. military must be capable of continuing the conflict until industry is sufficiently mobilized to replace losses and support the campaigns of a protracted war. Should U.S. efforts to achieve a rapid victory fail, then the current force must provide the time and safety required for mobilization. Continued operations will need platforms and expendable provisions such as munitions and fuel.[444] Planners should consider how increased attrition and materiel shortages may affect concepts of operation. These requirements emphasize a force with sufficient modularity and flexibility to be adapted to unforeseen countermeasures and new missions.

Mobilization Plans May Dictate Design Modifications and Requirements

Industrial requirements and limitations may also shape the force produced during mobilization. During World War II, munition designs were often altered to accommodate supply chain and material allocation issues and to increase manufacturing efficiency. Much like many of today's exquisite PGMs, low quantity production during the interwar period led to overengineered weapon designs that failed to leverage the latest mass production techniques.[445] When industrialists sought to expand production, it was often necessary to modify these designs to increase their manufacturability by commercial firms. In many instances, manufacturers redesigned items to simplify production, increase efficiency, and maximize

443 Thomas C. Hone, "Fighting on Our Own Ground: The War of Production, 1920–1942" (presentation at Colloquium on Contemporary History June 25, 1991), https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/g/gearing-up-victory.html.

444 Historian George Lincoln identified this as a key lesson of the World War I mobilization: "Prior provisions of stores are necessary to support combat until new systems can be produced." Similarly, Captain T.J. Brown noted that the mission of the current force in a protracted war "may be to buy time for mobilization." Lincoln quoted in England, *U.S. Industrial Mobilization 1916–1988*, p. 38; T. J. Brown, "Ain't No Way to Mobilize," *Proceedings*, U.S. Naval Institute, September 1998, https://www.usni.org/magazines/proceedings/1998/september/aint-no-way-mobilize.

445 Thomson and Mayo, *Ordnance Department*, p. 35.

output.[446] Other modifications were driven by necessity, with material shortages requiring substitutions.[447] Military officials were often skeptical of altered designs until it became clear that changes were needed to produce items at scale.[448]

The complexity of modern PGMs means any redesigns needed to increase manufacturability or restart old production lines may take years.[449] The DoD should work with munition suppliers to determine how existing weapon designs could be simplified for increased production. For example, the services could reevaluate the minimum requirements of munition programs and producers could assess the potential for material substitutions and process modernizations.

Should the design of modern PGMs make them unsuitable for scaled production, then entirely new classes of weapons must be designed with manufacturability included as a design requirement in conjunction with performance requirements such as speed, range, and survivability.[450] World War II created a need for platform and weapon designs that could be rapidly produced by a variety of manufacturers, such as the Liberty ship and the M3 submachine gun. These systems emphasized producibility, user-friendly designs, and modularity. Although firms completed many redesigns of WWII-era weapons in the months before the United States entered the conflict, today's development and production timelines necessitate the adoption of these weapons far in advance of a conflict. New systems must emphasize modularity, exportability, reduced material demands, and commoditizing components to increase the number of potential manufacturers. Industrial concerns may also encourage the standardization of weapons between U.S. services or between U.S. forces and allies.[451] In some cases, U.S. allies may be able to assist in the development, testing, and production of minimum viable weapons that the U.S. military has no current requirement for but might be needed in a protracted war. In all cases, these initiatives should ease the burden of industrial mobilization planning.

446 For example, manufacturers improved the designs of artillery shells, aircraft-delivered bombs, anti-aircraft guns, and vehicles. Engineers at Chrysler reduced the manufacturing time of the 40-mm Bofors anti-aircraft gun from 3.5 hours to 15 minutes. See Thomson and Mayo, *Ordnance Department*, pp. 77–78, 114; and Herman, *Freedom's Forge*, pp. 98, 201.

447 The most notable example of substitution in munitions production was the use of steel cartridge cases. Thomson and Mayo, *Ordnance Department*, p. 119; and U.S. Army Center of Military History, *Logistics in World War II*, p. 96.

448 The reverse was also true at times. Civilian manufacturers "did not always understand the essential complexity of guns and ammunition." Thomson and Mayo, *Ordnance Department*, p. 35; and Herman, *Freedom's Forge*, pp. 95, 99.

449 For example, recent efforts by the U.S. Navy to "rework the 1990s-era [heavyweight] torpedo design, which was riddled with parts that were no longer available," required three years to complete. Megan Eckstein, "Supplier Bottlenecks Threaten U.S. Navy Effort to Grow Arms Stockpiles," *Defense News*, February 6, 2024, https://www.defensenews.com/naval/2024/02/06/supplier-bottlenecks-threaten-us-navy-effort-to-grow-arms-stockpiles.

450 In many instances, these weapons are already in development. Still, it remains to be seen how quickly these weapons are adopted or procured by the military services. See, for one example, John A. Tirpak, "It's Not Replicator, CCA, or Weapon, Yet: What Is the Enterprise Test Vehicle?," *Air & Space Forces Magazine*, June 11, 2024, https://www.airandspaceforces.com/air-force-diu-enterprise-test-vehicle-weapon/.

451 Standardization of different Army and Navy interwar bomb designs was crucial for speeding mobilization in World War II. Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, p. 335.

Industrial Mobilization Will Take Time, But Can Be Expedited

Transforming America's economy into the Arsenal of Democracy took several years and a massive national effort. Although interwar plans and industrial leaders expected mobilization to require just 18 months, it began in 1939 and did not reach full production for most items until mid-1943.[452] As Chapter 4 revealed, mobilizing today's munitions industry is likely to take far longer than it did in World War II. This trend can be plainly seen in attempts to expand production of several modern weapons in wake of the Russian invasion of Ukraine. Since 2022, the U.S. Army has worked to increase domestic production of 155 mm artillery shells. Between February 2022 and October 2024, the service has successfully grown shell production from 14,400 to 40,000 per month.[453] This near tripling of output is impressive, but has required over 30 months and remains well short of the Army's goal of producing 100,000 shells per month—the quantity required to meet current demand.[454] More complex weapons, many of which are as militarily vital as 155 mm shells, have enjoyed much less impressive production gains over the same period.[455]

The exploration of World War II industrial mobilization revealed several phases of mobilization, some that can be expedited through planning and emergency measures and others that are constrained by physical realities. The major phases of industrial mobilization include:

Planning and requirements determination. Mobilizing industry begins with determining what must be produced and in what quantities. As previous sections have shown, this step is a prerequisite to industrial expansion but can be difficult to accomplish amid an emergency. Fortunately, basic requirements and plans can be prepared well ahead of a crisis, and this phase offers the greatest opportunity for the DoD to shorten mobilization timelines in the near term.

Allocation of funding. Once requirements and a basic scheme for mobilization are determined, the DoD must work with Congress to appropriate funds to execute industrial expansion or implement industrial preparedness measures. During World War II, funding increases began in 1939 but did not significantly increase until summer 1940. Mobilization steps, from contracting to the expansion of facilities, cannot begin absent the appropriation

452 Thomson and Mayo, *Ordnance Department*, p. 33; and Herman, *Freedom's Forge*, p. 146.

453 Jen Judson, "Army Races to Widen the Bottlenecks of Artillery Shell Production," *Defense News*, October 14, 2024, https://www.defensenews.com/land/2024/10/14/army-races-to-widen-the-bottlenecks-of-artillery-shell-production/.

454 Moreover, these gains were reached by opening a new production facility in Texas that was only possible through the purchase of existing machine tooling from Turkey, Germany, and Japan. Doug Cameron, "How a Texas Factory Is Emerging as a Key Ammo Supplier for the U.S., Ukraine," *Wall Street Journal*, June 24, 2024, https://www.wsj.com/politics/national-security/dallas-texas-ammo-ukraine-3ce81762.

455 For example, Patriot missile production has only increased from 350 missiles per year to around 550 per year, despite large expenditures of the weapon in Ukraine and its importance in nearly any great power conflict involving the U.S. military. Jen Judson, "How Companies Plan to Ramp Up Production of Patriot Missiles," *Defense News*, April 9, 2024, https://www.defensenews.com/land/2024/04/09/how-companies-plan-to-ramp-up-production-of-patriot-missiles/.

of funds. Donald Nelson, the chairman of the WPB, called this fact the "hardest lesson" of 1941.[456]

Contracting. With money, procurement officials can begin contracting for additional weapons and production capacity. As Chapter 3 discussed, the Roosevelt administration worked with Congress to expedite wartime contracting procedures, including abandoning competitive bidding in favor of direct negotiations. Throughout the war, the military's procurement divisions strove to simplify contracting processes and reduce bureaucratic requirements. The DoD could pursue similar refinement of the acquisition system or use emergency or wartime authorities to reduce the time required for contracting during mobilization.

Surge production. When demand intensifies during a crisis, the first increases in supply are typically from existing facilities maximizing or surging the output of active production lines. For many munitions, surge production has been the primary industrial response to ongoing conflicts in Europe and the Middle East. Surging production is the first mobilization step that is dependent on industrial factors and subject to the physical limits of existing production lines, subcontractors, material sources, and labor availability. In 1940, Army officials testified to Congress that even if they had sufficient plant capacity, surging production would require a minimum of five months.[457] Today, the DoD can increase surge production capacity and reduce the amount of time necessary to maximize the output of existing facilities by including surge requirements in weapon procurement contracts.[458]

New facilities construction and conversion. Should surge production prove insufficient, manufacturers will need to build additional factories or expand their production base to include new sources. Like surging production, construction requirements, acquiring capital equipment, and training new workers place fundamental limits on the speed at which production can be increased. Even with the industrial advantages enjoyed by the United States in the 1940s and the urgency gained after Pearl Harbor, this step often took more than a year to complete during World War II.[459] Given the trends described in Chapter 4, building and operating new production facilities is likely to require significantly more time today. The U.S. government may be able to cut this time by waiving some regulatory requirements or taking other emergency measures, but military planners must contend with the limitations of the current U.S. industrial base.

Clearly, there are opportunities to reduce the amount of time required for each step of the industrial mobilization process. Nevertheless, increasing production will require time that

456 Gropman, *Mobilizing U.S. Industry*, p. 53.

457 Colonel H.K. Rutherford, quoted in U.S. Senate, *Military Establishment Appropriations Bill for 1941*, p. 192.

458 Because these requirements will necessitate the maintenance of excess capacity, they are likely to require additional funding and will raise the cost of weapons programs.

459 For examples, see Thomson and Mayo, *Ordnance Department*, pp. 2–3, 7–8, 33, 36; and Coakley and Leighton, *Global Logistics and Strategy: 1943–1945*, p. 796.

is likely to be measured in years rather than months. As such, one vital role of industrial mobilization planning is estimating the length of these timelines so they can be built into defense planning. These estimates should help decision makers determine when to begin mobilization, drive military–industrial engagements during strategic competition, and help the government determine the need for other preparedness measures such as stockpiles. Moreover, examining opportunities to shorten each step of industrial mobilization reveals investments that can be made in the near term to better prepare the United States for a protracted great power war. American success in World War II hinged on availability of time for mobilization.[460] Prevailing in a contemporary U.S.–China conflict will require these investments and preparations to be made in peacetime, well ahead of a crisis in the Indo-Pacific.

Mobilization Capacity Is Largely Dependent on the Existing Industrial Base

A key lesson of Chapter 2 was the importance of America's total industrial base during mobilization. The massive expansion of war production was only possible because of America's industrial strength at the time, particularly in raw material processing and manufacturing. U.S. automobile and aviation industries converted to war production, along with their multitude of subcontractors. For the munition-specific capacities the United States lacked, the government leveraged the broad pool of manufacturing expertise to build and staff new plants, with most constructed and operational before America entered the war. Even with this starting point, the conflict's demands still required massive expansion of the wider industrial base, including the production of steel, aluminum, rubber, and energy products. Today's U.S. economy and industrial base present a much different starting point and foundation for mobilization. As Chapter 4 outlined, it remains unclear how deindustrialization, the loss of manufacturing capacity, and the transition to a service-focused economy would affect present-day industrial mobilization.

That said, there are numerous measures the U.S. government could take to bolster the American industrial base with an eye toward national defense and mobilization. These span from broad economic and trade policies, such as trade agreements, tariffs, tax incentives, and industrial subsidies, to more surgical actions by the DoD and other agencies to support specific sectors of the defense industrial base. Over the last decade, various measures encouraging domestic reindustrialization have received bipartisan support within

460 The Army concluded after the war that in future wars, "the slightest delay or inefficiency in harnessing our logistic resources may cost us victory." U.S. Army Center of Military History, *Logistics in World War II*, p. 245.

both the executive and legislative branches, particularly when related to national security.[461] At the same time, the DoD has pursued many (though often limited in scale) efforts to strengthen the defense industrial base and mitigate areas of significant risk.[462] Numerous opportunities remain to increase defense production efficiency and capacity through advanced manufacturing, improve industrial processes with software, or decouple weapon design and manufacture. The United States still has significant commercial manufacturing capacity that could be harnessed to support defense production. The next chapter will explore these opportunities to revitalize U.S. defense manufacturing and leverage American industrial advantages.

Mobilization Will Not Supersede Politics

Finally, America's mobilization for World War II shows that even during a national security emergency resulting from a direct attack on the United States, domestic and international politics will not disappear. Indeed, they will continue to define what is achievable through industrial mobilization and shape mobilization efforts. One of the greatest flaws in interwar planning was the assumption that emergency requirements would overrule politics. Before the war and throughout its execution, Roosevelt remained constrained by domestic and international politics. Politics shaped the series of mobilization bureaucracies that Roosevelt established, affected the willingness of industrial leaders to support war production, and led to numerous labor strikes that impeded the military's output goals.[463] Americans overwhelmingly banded together to create the Arsenal of Democracy, but domestic politics still created obstacles along the way.

Domestic and international politics will similarly affect contemporary industrial mobilization, and plans must be developed around these factors. Planners must not rely on the flawed assumption that a national emergency will sweep away restrictions and allow the DoD to

461 To cite some examples: President Donald Trump pursued protectionist policies and tariffs on steel and aluminum in 2018. President Joe Biden signed the CHIPS and Science Act into law in 2022 to support domestic semiconductor manufacturing and research. Biden also blocked foreign acquisition of U.S. Steel in 2024. Trump appears poised to continue such policies during his second term. Ana Swanson, "Trump Calls Trade Wars 'Good' and 'Easy to Win'," *New York Times*, March 2, 2018, https://www.nytimes.com/2018/03/02/business/trump-calls-trade-wars-good-and-easy-to-win.html; Department of Defense, "Department of Defense Invests Additional $160 Million in CHIPS Act Funds to Propel Microelectronics Leadership," Department of Defense, November 8, 2024, https://www.defense.gov/News/Releases/Release/Article/3961172/department-of-defense-invests-additional-160-million-in-chips-act-funds-to-prop/; Alan Rappeport, "Biden Blocks Takeover Bid of U.S. Steel Japan's Nippon," *New York Times*, January 3, 2025, https://www.nytimes.com/2025/01/03/us/politics/us-steel-nippon-biden.html; and Michael Gold, "Trump Pitches 'New American Industrialism' and Luring Foreign Manufacturing," *New York Times*, September 24, 2024, https://www.nytimes.com/2024/09/24/us/politics/trump-economic-policy.html.

462 For multiple examples, see Assistant Secretary of Defense for Industrial Base Policy, "Industrial Base Policy," Department of Defense, https://www.businessdefense.gov/index.html.

463 For examples of how politics affected the mobilization bureaucracies, see Herman, *Freedom's Forge*, p. 9; Gropman, *Mobilizing U.S. Industry*, p. 22; and Sweeting, *Building the Arsenal of Democracy*, pp. 34-35. For examples of how it affected the willingness of business leaders to support the war effort, see Herman, *Freedom's Forge*, pp. 101–02, 110; Gropman, *Mobilizing U.S. Industry*, pp. 28–29; and Sweeting, *Building the Arsenal of Democracy*, pp. 98, 100, 223. For the impact of strikes on industrial mobilization, see Herman, *Freedom's Forge*, pp. 184, 246–47.

execute a speedy mobilization absent interference from competing political priorities. This fact is readily on display in the Russia–Ukraine conflict, where despite the large resource demands and existential nature of the conflict, both sides are fundamentally limited in the scale of their mobilization by domestic politics.[464]

Although no war effort will ever fully supersede politics, preparing the U.S. industrial base for future war will require some degree of political prioritization. Achieving rapid growth in industrial outputs in the time demanded by modern warfare may require executive policy changes and legislative action. As during World War II, this may involve placing military and industrial concerns over competing political priorities and policies relating to antitrust prosecution, environmental protection, revenue generation, labor regulation, and foreign sourcing of materials. Similar regulations posed serious barriers to mobilizing industry in the 1940s, and today's regulatory and statutory restrictions would pose similar challenges and place a speed governor on contemporary mobilization efforts. In developing contemporary industrial mobilization plans, planners must consider:

1. What factors are likely to interfere with industrial mobilization today?[465]
2. How will domestic attitudes affect the DoD's plans for industrial mobilization?
3. What constraints or restrictions might be politically viable to lift during an emergency? What restrictions are unlikely to be relieved?
4. What additional or emergency authorities might the DoD request to expedite industrial mobilization efforts?

Lessons for Mobilization Execution

Mobilization Will Require Increased Funding and Acceptance of Risk

Although politics will always influence industrial mobilization planning and execution, any successful effort to mobilize American industry will require prioritization of resources and political capital. Present-day references to America's achievements during World War II often tout the impressive production gains without fully articulating the scale of resourcing required. With defense spending growing 15 times from 1941 to 1945, creating the Arsenal of Democracy was tremendously expensive and required the United States to raise taxes and

464 For Russian limitations, see Dara Massicot with Richard Connolly, *Russian Military Reconstitution: 2030 Pathways and Prospects* (Washington, DC: Carnegie Endowment for International Peace, September 2024), p. 2. For Ukrainian limitations, see Oleksandr V. Danylyuk, "The Current State of Ukrainian Mobilization and Ways to Boost Recruitment," Royal United Services Institute, August 8, 2024, https://www.rusi.org/explore-our-research/publications/commentary/current-state-ukrainian-mobilisation-and-ways-boost-recruitment.

465 For example, labor strikes such as those witnessed in Boeing plants in October 2024. David Koenig and Manuel Valdes, "Boeing Machinists Reject Labor Contract, Extending Strike," *Defense News*, October 24, 2024, https://www.defensenews.com/industry/2024/10/24/boeing-machinists-reject-labor-contract-extending-strike.

take on record-breaking debt.[466] The cost of ammunition alone made up almost one third of all Ordnance Department spending during World War II.[467] Even the prewar preparations of 1939 to 1941 saw exponential increases in defense funding, as displayed in Figure 1. Between 1940 and 1944, annual expenditures on national defense grew over 3,000 percent. A similar increase in spending today would see a defense budget north of $27 trillion.[468]

Of course, there are many options short of mobilization that the United States may pursue to increase industrial readiness, but these efforts will compete for dollars with personnel costs, procurement and modernization efforts, research and development, and other aspects of military readiness. Efforts to increase the mobilization potential of the U.S. munitions industrial base and shorten timelines for expanding munitions production will create excess capacity and are unlikely to be pursued by commercial firms absent incentivization from the DoD. In short, the DoD must foot the bill and take on the financial risks associated with investments in excess capacity in order to increase the industrial base's readiness to supply sufficient numbers of weapons for great power conflict. These additional expenses must be factored into future procurement. This reflects the American experience in World War II, when the U.S. government funded nearly all expanded munitions production and several other industries that lacked commercial demand.[469]

Given current limitations on fiscal resources, however, the DoD should consider the optimal balance between procuring and stockpiling weapons and investing in industrial capacity and mobilization preparedness. Balancing these measures is an essential element of preparing for protracted war and may require planners to think differently about munition requirements in various great power conflict scenarios.

Mobilization May Require Novel Approaches to Acquisition

The scale of industrial requirements in World War II led procurement officials to leverage a variety of innovative methods to purchase the equipment they needed and incentivize expanded production. The recruitment of so-called dollar-a-year men was a way to secure

466 The highest U.S. debt-to-GDP ratio, 113 percent, occurred in 1945. See "The History of the Debt," U.S. Department of the Treasury, https://www.treasurydirect.gov/government/historical-debt-outstanding/; and Matt Phillips, "The Long Story of U.S. Debt, from 1790 to 2011, in 1 Little Chart," *The Atlantic*, November 13, 2012, https://www.theatlantic.com/business/archive/2012/11/the-long-story-of-us-debt-from-1790-to-2011-in-1-little-chart/265185/.

467 Thomson and Mayo, *Ordnance Department*, p. 106.

468 National defense expenditures grew from $2.6 billion in 1940 to $89.3 billion in 1944, a percent increase of 3,333%. Defense expenditures for 1940 to 1944 drawn from U.S. Treasury Bulletins from January 1939 to January 1947, available at https://fraser.stlouisfed.org/title/treasury-bulletin-407?browse=1930s. This increase in defense spending can also be analogized using defense spending as a percentage of GDP. In 1944, U.S. defense spending represented 37 percent of GDP. Today, this would mean spending more than $10 trillion on defense. U.S. Office of Management and Budget, "Historical Tables," Table 3.1—Outlays by Superfunction and Function: 1940—2029, https://www.whitehouse.gov/omb/budget/historical-tables/; and Bureau of Economic Analysis, "Table 1.1.5. Gross Domestic Product," Bureau of Economic Analysis, updated April 30, 2025, accessed on May 6, 2025, https://apps.bea.gov/iTable/.

469 These efforts included, for instance, "97 percent of the synthetic rubber industry construction," and 85 percent of military explosives production. Gropman, *Mobilizing U.S. Industry*, p. 105.

for the war effort the industrial know-how and far-reaching networks of America's leading businessmen. These personal relationships were crucial to the success of mobilization efforts prior to Pearl Harbor, when mobilization agencies lacked directive authority and relied on the voluntary participation of commercial firms. The services also brought on many individuals from the commercial sector to staff their procurement organizations and bring "new ideas and enthusiasm to the task of rationalizing the Army's buying methods and organization."[470] With these hires came extensive knowledge of specific industries and commercial practices to incentivize expedited purchasing, such as letters of intent that preceded formal contracts but allowed firms to make the necessary investments in additional tooling, materials, and personnel.[471]

At the time, the establishment of GOCO munition plants was a novel way for the government to shoulder the business risk associated with munitions production while leveraging the manufacturing knowledge contained within America's commercial industrial base.[472] In other cases, the U.S. government purchased the capital equipment needed to expand private manufacturers, leased the equipment to the producer for the duration of the war, and then offered to sell the equipment at a depreciated cost at the end of the war.[473] Finally, Cash and Carry and Lend–Lease represented creative ways of supplying allies despite neutrality restrictions and without relying on unpopular loans.[474] Contemporary industrial mobilization might require similarly innovative approaches to military procurement and industrial policy that rebalance the burden of financial risk among the U.S. government, American allies and partners, and industry.

Mobilization Is a Competitive Activity

The purpose of wartime mobilization, industrial or otherwise, is organizing a nation's resources to support its political and military objectives.[475] In this sense, industrial mobilization is inherently competitive during a protracted war in which both belligerents are attempting to bring their national resources to bear and provide their forces with the overwhelming firepower necessary to outmatch their opponent and accomplish their objectives. Chapter 3's exploration of the strategic implications of industrial mobilization in World War II showed how the Allies' victory was contingent upon their decision to fight a protracted war of production and their ability to marshal their resources toward this aim. In doing

470 Smith, *Army and Economic Mobilization*, p. 224.

471 Smith, *Army and Economic Mobilization*, p. 223.

472 Thomson and Mayo, *Ordnance Department*, p. 129.

473 Sweeting, *Building the Arsenal of Democracy*, p. 160.

474 Herman, *Freedom's Forge*, p. 126.

475 In the words of Joint Publication 4-05, "Mobilization is the process of assembling and organizing national resources to support national objectives in time of war or other emergencies." U.S. Department of Defense, *Joint Publication 4-05: Joint Mobilization Planning*, October 23, 2018, p. I-1, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp4_05.pdf.

so, industrial mobilization at home was paired with diplomatic and military campaigns to degrade the production capacity and supply lines of the Axis powers. Notable efforts included the British and American strategic bombing campaigns and naval operations in the Mediterranean Sea, but operations and campaigns designed to impede the enemy's logistics and dismantle their war economy pervaded the entire war.[476]

A contemporary industrial mobilization effort would be a similarly competitive endeavor, and efforts to expand war production could be accompanied by campaigns to degrade the adversary's ability to maintain their war economy and supply their military forces. These efforts might include:

1. disruption of enemy supply chains via economic sanctions, diplomatic pressure, or maritime interdiction or blockade;
2. degrading enemy transportation networks and LOCs via nonkinetic or kinetic attacks; or
3. kinetic strikes against enemy military–industrial facilities and infrastructure.

In a protracted war, strategic planners must consider the value of industrial and economic targets and the balance between attacking an adversary's military forces and the industrial facilities or supply chains essential to equipping and supplying those forces.[477] Disrupting maritime LOCs or destroying defense production sites may require a different set of capabilities than striking military targets or halting an invasion force. Executing these operations may favor operational concepts and tactics fundamentally different from those employed by the U.S. military in the previous few decades. It may also require detailed analysis of adversary supply chains and economic infrastructure to identify vulnerabilities. In all, military planners should consider various methods of imposing costs and impeding adversary war production over the duration of a protracted conflict.

Industrial Mobilization Typically Occurs Alongside a Broader National Mobilization

Finally, policymakers and planners must remember that the Arsenal of Democracy was the result of not only expanding America's defense production but also mobilizing the nation's entire economy, workforce, and resources toward the war effort. Although Roosevelt's limited mobilization efforts before Pearl Harbor laid the foundation for later growth, the production gains realized during World War II required national mobilization, which was only politically viable after the United States entered the conflict. As Chapter 3 outlined, building the Arsenal of Democracy carried with it very real costs and sacrifices for the American public. Even with the entire country on a war footing, mobilization officials

476 R. Cargill Hall, ed., *Case Studies in Strategic Bombardment* (Washington, DC: U.S. Government Printing Office, 1998).

477 In the wake of World War II, Army historians speculated that in future wars, "The destruction of logistic potentials will be the primary objective of warfare, the defeat of combat forces in the field becoming a secondary consideration." U.S. Army Center of Military History, *Logistics in World War II*, p. 251.

were still constrained by the limits of the nation's total resources and were forced to make numerous tradeoffs and adjustments to their strategic plans.[478]

Industrial mobilization on a similar scale today would require comparable levels of national effort. Even limited initiatives to grow key sectors of the defense industrial base, such as munitions production, may require broader economic measures and expansion of the wider U.S. industrial base.[479] After World War II, the Army noted its failure to engage with the American public in the years prior to conflict:

> In retrospect it is clear that our most tragic handicap in the prewar period was public unawareness of the difference between developed and undeveloped military strength in the face of sudden attack. This unawareness was shared by some of our responsible leaders, but it was the general complacency of our people that limited the over-all extent of our defense preparations and contributed largely to our vulnerability in December 1941. Deluded by the sense of security, we had ignored the time and space factors of logistics.[480]

The recent report of the National Defense Strategy Commission echoed similar sentiments about the American public today. It advocated for increased national conversation and debate about the national security challenges facing the United States.[481] Creating this understanding will require leadership at the national level, including the president and members of Congress. This reflects the fact that preparing the nation's munitions industry and the wider industrial base for great power conflict and bolstering its mobilization potential are key elements of long-term strategic competition, not short-term pursuits confined to the DoD.

478 Arguably, the Vietnam War showed the risk of engaging in a conflict without the public will to sufficiently mobilize industry. President Lyndon Johnson was unwilling to declare a national emergency and therefore had limited authority to mobilize industry for war production. As a result, military orders competed with civilian production, manufacturers were largely unwilling to invest in additional production capacity, and unexpectedly high consumption of munitions degraded war reserve stocks. England, *U.S. Industrial Mobilization 1916–1988*, pp. 135-45.

479 Robert Almelor Delfeld, *Broadening the Base: A Blueprint for Expanding Defense Industrial Capacity* (Washington, DC: The Marathon Initiative, 2024), https://themarathoninitiative.org/wp-content/uploads/2024/04/Broadening-the-Base-Final-2024-04-3.pdf.

480 U.S. Army Center of Military History, *Logistics in World War II*, p. 13.

481 RAND, *Commission on the National Defense Strategy*, p. 20.

CHAPTER 6

Conclusion: Thinking About U.S. Competitive Advantages

> We can build things in America—that is why most of the world is looking toward us, hoping and praying that we will come through.
>
> —William Knudsen, unaired speech for national radio broadcast, January 1942[482]

> Many of the logistical problems faced in World War II may never need to be addressed by a future army, but problems of mobilizing, adjudicating competing demands, and fitting strategic ends to material means will inevitably plague future military leaders. They may have better organizations and tools at their disposal, but they can expect that policy guidance will be vague, expectations of field commanders excessive, and complex logistics systems almost impossible to keep in balance in the midst of war's vagaries.
>
> —BG Harold W. Nelson, *Logistics in World War II*[483]

Mobilization planning is an endeavor the U.S. government and military have not seriously pursued since the end of the Cold War.[484] Renewed strategic competition and the specter of great power conflict make it necessary in the present era. Reviewing the events of World War II's industrial mobilization reveals a striking series of parallels between present conditions and the interwar period: insufficient munition stockpiles, a withered munitions industrial

482 Norman Beasley and William S. Knudsen, *Knudsen: A Biography* (New York: McGraw-Hill Book Company, Inc., 1947), p. 346.

483 U.S. Army Center of Military History, *Logistics in World War II: Final Report of the Army Service Forces* (Washington, DC: U.S. Government Printing Office, 1993), foreword.

484 Captain T. J. Brown noted in a 1998 *Proceedings* article, "Mobilization has little meaning for military professionals today, and therefore is discussed rarely. This was not the case in 1937; mobilization was actively discussed, defined, and had immediate relevance." Brown, "Ain't No Way To Mobilize."

base, and the renewed threat of multitheater war amid technological and political advances that are changing the nature of modern warfare and the geoeconomic landscape.[485]

The DoD must develop plans to mobilize the defense industrial base to support a protracted great power war. To be effective, these efforts must go beyond paper plans or strategy documents and spur meaningful actions such as investments in the U.S. industrial base; increases in surge and reserve production capacity; educational orders with nontraditional producers; and the building of stockpiles of munitions, long lead time components, and critical materials. Unlike those formulated during the interwar period, today's mobilization plans likely will require significant action to be taken during peacetime due to longer supply chains and production timelines, the lack of a homeland sanctuary, and the increased readiness of America's potential adversaries for rapid and protracted military operations. Several authorities and mechanisms are available to accomplish these tasks, including the Defense Production Act, the national defense stockpile, and the Defense Logistics Agency's Warstopper program, to name only a few.[486] Developing these plans will require a new generation of thinkers, planners, and analysts across the U.S. military and industry, as well as the bipartisan support of leaders in all branches of the U.S. government and the American public. Given the far-ranging political, economic, and military implications of industrial planning and preparation, it is the duty of American political and military leaders to convey its importance to the American people.

As they do so, these leaders should be careful about referencing the Arsenal of Democracy and making analogies to World War II mobilization. A fleeting series of political, economic, military, and industrial circumstances made the United States exceptionally ripe for industrial mobilization in the early 1940s. Many of these conditions no longer hold, and the global economy, American industrial base, and U.S. defense requirements of the 21st century are extremely different from previous eras. Moreover, the successes of mobilization, allied victory, and the postwar economic boom have, at times, obscured the true scale of effort and resources required to convert America's latent industrial capacity into war production. This study has shown that the Arsenal of Democracy may be more useful as an aspirational model for large national endeavors than as a model for executing industrial mobilization in the modern era. That said, the United States achieved a significant military–industrial feat

485 See Thomas G. Mahnken, "A Three-Theater Defense Strategy: How America Can Prepare for War in Asia, Europe, and the Middle East," *Foreign Affairs*, June 5, 2024, https://www.foreignaffairs.com/united-states/theater-defense-war-asia-europe-middle-east; and Hal Brands, "The Next Global War: How Today's Regional Conflicts Resemble the Ones That Produced World War II," *Foreign Affairs*, January 26, 2024, https://www.foreignaffairs.com/united-states/next-global-war.

486 See Alexandra G. Neenan and Luke A. Nicastro, *The Defense Production Act of 1950: History, Authorities, and Considerations for Congress* (Washington, DC: Congressional Research Service, October 6, 2023), https://crsreports.congress.gov/product/pdf/R/R43767; Cameron M. Keys, *Emergency Access to Strategic and Critical Materials: The National Defense Stockpile* (Washington, DC: Congressional Research Service, November 14, 2023), https://crsreports.congress.gov/product/pdf/R/R47833; and Dianne Ryder, "Rare But Ready," *DLA News*, December 16, 2016, https://www.dla.mil/About-DLA/News/News-Article-View/Article/1041913/rare-but-ready/.

during World War II, and this should inspire current generations of Americans in addressing the challenges of rebuilding U.S. industrial capacity in the 21st century.

More broadly, contemporary policymakers should also exercise caution when drawing on the history of America's participation in World War II to talk about engaging in strategic competition with present-day adversaries such as China and Russia. In the two years prior to Pearl Harbor, Roosevelt quietly took steps to ready the United States for war while repeatedly assuring the American public that these were purely defensive measures and that the nation would not participate in another European conflict. After the attack on Pearl Harbor and decades of hindsight, Roosevelt's prewar preparations appear not only justified but also wholly inadequate. The 1930s culminated in global war on a never-before-seen scale that cost the lives of over 400,000 Americans despite Roosevelt's pledge that the United States would remain aloof. In the nuclear age, such a war with China or Russia would be the most dangerous outcome of contemporary great power competition. In this light, industrial mobilization planning and a healthy defense industrial base should be viewed as not only important for prevailing in great power war but also as key elements of deterring such an outcome.

Thinking about industrial mobilization for protracted war runs the risk of being discounted as an overwhelming task because of its potential scale and complexity. Bureaucracies like the DoD, after all, often prefer to avoid addressing difficult challenges that might upend the status quo.[487]

The U.S. military cannot lean on the empty hope that an unplanned, spontaneous, or ad hoc mobilization will meet its needs. Instead, the DoD and its interagency partners must begin planning and preparing for this endeavor today.[488] The current state of the U.S. defense industrial base is the result of decades of trends and policies; reinvigorating it for the challenges of great power competition will not be accomplished overnight. Where should the DoD begin this undertaking?

Given the nature of PGMs—their expendability, their reduced cost and complexity relative to platforms, and their criticality in any great power conflict scenario—these weapons and their industrial base are an ideal place to start addressing the larger question of industrial mobilization. Fortunately, many of the DoD's industrial base initiatives center on expanding the

487 Thomas G. Mahnken, Evan B. Montgomery, and Tyler Hacker, *Innovating for Great Power Competition: An Examination of Service and Joint Innovation Efforts* (Washington, DC: Center for Strategic and Budgetary Assessments, 2023), p. 70, https://csbaonline.org/research/publications/innovating-for-great-power-competition-an-examination-of-service-and-joint-innovation-efforts.

488 Actionable mobilization planning will involve numerous U.S. government organizations in addition to the Department of Defense, including the State Department, the Federal Emergency Management Agency, and the Treasury and Commerce departments.

production of critical munitions, albeit at a smaller scale than may be necessary.[489] In line with these efforts, the DoD released a National Defense Industrial Strategy in January 2024 and followed with an implementation plan in October.[490] Both documents make brief reference to mobilization authorities and the need for mobilization planning.[491]

These initiatives are a welcome first step toward preparing the industrial base for great power conflict. Still, they are mostly responses to crises in Europe and the Middle East or focus on narrow, near-term operational challenges such as halting a Chinese invasion of Taiwan rather than thinking more broadly about a protracted U.S.-China war. To prepare for and deter this outcome, the DoD should follow its current efforts with more detailed planning for longer term industrial expansion and, potentially, mobilization. Much like during the interwar period, the DoD should begin by exploring potential munition requirements over the course of a protracted war and, in turn, the industrial base that would be necessary to fulfill these demands.[492]

In thinking about these requirements, planners must consider the enduring competitive advantages of the United States versus those of its great power adversaries. The United States is no longer the world's leading commercial manufacturer, and planners should not build strategies that rely on bygone strengths. Instead, prevailing in a war against the PRC will require a military and industrial strategy that leverages America's present advantages to their full effect.

What are these contemporary military–industrial advantages? This study concludes by highlighting three qualities commonly cited as U.S. advantages: an innovative free market system, advanced defense and manufacturing technologies, and a global network of allies and partners. The following sections examine each of these characteristics in turn and ask:

1. Are these advantages enduring?
2. How can the United States strengthen its position in each area?
3. Finally, how can these attributes be leveraged in strategic competition and, if necessary, conflict with U.S. adversaries?

489 For example, Deputy Secretary of Defense Kathleen Hicks began the Replicator initiative in August 2023 to field large quantities of autonomous systems across multiple domains within 24 months. Joseph Clark, "DOD Innovation Official Discusses Progress on Replicator," *DOD News*, U.S. Department of Defense, December 12, 2024, https://www.defense.gov/News/News-Stories/Article/Article/3999474/dod-innovation-official-discusses-progress-on-replicator/.

490 Department of Defense, *National Defense Industrial Strategy* (Washington, DC: Department of Defense, 2023), https://www.businessdefense.gov/docs/ndis/2023-NDIS.pdf; and Department of Defense, *National Defense Industrial Strategy Implementation Plan for FY2025* (Washington, DC: Department of Defense, 2024), https://www.businessdefense.gov/docs/ndis/NDIS-Implementation-Plan-FY2025.pdf.

491 Department of Defense, *National Defense Industrial Strategy*, pp. 39–40.

492 A follow-on study by CSBA will explore methodologies for assessing munition requirements for protracted great power war and balancing investments in production capacity with weapon stockpiles.

The Free Market System

The free market system and the innovation it encourages were essential factors in creating the Arsenal of Democracy and are often named as enduring advantages the United States holds over its authoritarian competitors. Before and during World War II, Roosevelt and mobilization leaders continually managed the delicate balance between relying on decentralized authority and the free market versus centralized planning and direct government control of industry, materials, and labor. On the one hand, relying on capitalist principles and free market incentives maintained American tradition, encouraged efficiency, and left much of the mobilization effort to experts with decades of experience in various industrial sectors. On the other hand, centralized planning and control were often necessary as the scale of mobilization expanded to prevent wasteful competition between contractors, control the allocation and price of critical materials, and manage competing interests.

The Roosevelt administration deliberately used the free market system to incentivize speed and maximize output using profit incentives—a method that encouraged business and technological innovation on all fronts. As industrial mobilization intensified and consumed the American economy, Roosevelt and Congress incrementally ratcheted up centralized control to manage conflicts that arose between various parties and break through material and production bottlenecks. This approach proved to be a more effective way to leverage American industrial strength than the authoritarian and centrally planned systems of the war's other belligerents.[493]

Today, China has many industrial advantages over the United States, from greater manufacturing capacity to superior access to many raw materials. But prevailing in industrialized warfare requires nations to convert these resources into the weapons, platforms, and supplies necessary to engage in military campaigns. The American free market system has proven to be the superior approach to marshaling a nation's capacity into military strength because it balances centralized coordination and deconfliction with decentralized action that takes advantage of individual mandates and innovation. Many have suggested this advantage endures, and mobilization planners should leverage the strengths of the free market system in contemporary strategic competition.[494]

Such an approach recognizes the reality that the DoD, like the War Department of the late 1930s, does not have the expertise or capacity to direct the nation's vast industrial and commercial enterprise. The traditional American system allows government, military, and

493 For an analysis of the degree of centralization during the belligerents' mobilizations, see Harrison, "Mobilization for World War II."

494 For a current net assessment of U.S. and Chinese techno-security systems and industrial bases, see Tai Ming Cheung and Thomas G. Mahnken, *The Decisive Decade: United States–China Competition in Defense Innovation and Defense Industrial Policy in and beyond the 2020s* (Washington, DC: Center for Strategic and Budgetary Assessments, 2023), https://csbaonline.org/research/publications/the-decisive-decade-united-stateschina-competition-in-defense-innovation-and-defense-industrial-policy-in-and-beyond-the-2020s.

industry to each focus primarily on the tasks for which they are organized and staffed. General Hugh Johnson, a leader of America's mobilization for World War I and a New Deal official, summarized these sentiments in 1939:

> The War Department itself has no business whatever 'directing' industry in war. That is a mammoth and vital task—as great and vital as fighting a war. The Army already has the latter task. It should not jimmy up the works by taking on another just as big the moment the guns begin to roar.... It would be just as absurd and disastrous to use them on this job as it would be to elbow all the generals aside and put industrial leaders in command of armies.[495]

Relying on the free market to drive the expanded production of military goods is also key to maintaining a functioning and growing civilian economy. A continual balance between military and civilian manufacturing was a major strength of the American mobilization effort in World War II.[496] Economic strength—both commercial and military—is essential to long-term strategic competition. Germany and, later, the Soviet Union, neglected to balance these requirements, a failure that had disastrous consequences for both nations.

Finally, World War II and the Cold War show there is an ideological element inherent to strategic competition and great power war. In this regard, the capitalist free market system remains a tenet of the status quo the United States seeks to uphold in the face of challenges from authoritarian nations like China and Russia. Donald Nelson, chairman of the WPB, noted this in his account of industrial mobilization, explaining that the United States "had to prove that...our system of political and economic freedom was in fact more efficient, more productive, more able to respond to the demands of a great emergency than the dictatorial system of our enemies. If we failed to do this, we might win the war in a military sense yet lose everything that we had fought for."[497]

Of course, relying on the free market carries substantial risk as well. The free market alone does not always produce outcomes beneficial to national defense. Many of the industrial trends noted in Chapter 4 can be partially blamed on overreliance on the free market and free trade system amid American deindustrialization and periods of reduced U.S. defense spending. In its natural state, the private sector will always prioritize profit potential and be wary of investing in the boom-and-bust opportunities presented by many military goods, like munitions. Industry has historically preferred free trade and been slower to recognize and adapt to changes in the global threat environment—as can be witnessed in the reluctance of many American business and financial institutions to accept the threat posed by China to U.S. national interests.[498]

495 General Hugh Johnson, quoted in Gropman, *Mobilizing U.S. Industry*, p. 17.

496 Herman, *Freedom's Forge*, pp. 206, 254.

497 Donald M. Nelson, *Arsenal of Democracy: The Story of American War Production* (New York: Harcourt, 1946), p. 206.

498 Although business began taking mobilization more seriously over the course of 1941, only Pearl Harbor definitively changed the attitudes of many American business leaders. Gropman, *Mobilizing U.S. Industry*, p. 23.

The government can, however, mitigate these risks through financial incentives and by shouldering a larger portion of the business risk associated with investments to expand production capacity. Secretary of War Henry Stimson recognized this reality during World War II: "If you are going to try to go to war or to prepare for war in a capitalist country, you've got to let business make money off the process or it won't work."[499] The DoD must create the market incentives vital to building and maintaining a defense industrial base capable of supporting its military strategies. These incentives could take many forms, from updated planning and policy revisions to procurement decisions and targeted investments.

These measures will require time and significant investments but are likely to benefit the U.S. public and economy in ways that transcend national defense. To focus these efforts, the DoD should consider which economic metrics are best suited for assessing the potential military–industrial strength of the U.S. economy. Broad economic indicators such as gross domestic product or stock market indexes are crucial for American government and financial institutions to gauge economic growth, but they may be poor indicators of U.S. industry's ability to produce military goods during a global conflict. Some parts of the U.S. economy, such as technology and manufacturing, may be more valuable in military competition than sectors like healthcare or services. Identifying the best economic and industrial metrics to assess the industrial base will point to the most effective incentives for the DoD to utilize in its procurement and industrial policy. The DoD must recognize that policies favored by the commercial sector and other agencies in the U.S. government may encourage economic growth writ large but might conflict with the sometimes protectionist policies and incentives suited to preparing the U.S. industrial base for great power war.

Both a strong U.S. economy and defense industrial base are essential to American success in long-term competition with China, and it remains the duty of national leaders to balance and prioritize these interests when they conflict so the free market system endures as a U.S. competitive advantage.

Defense Innovation and Advanced Technology

Leveraging the free market is also essential because it fosters the innovation critical to maintaining a second traditional U.S. advantage: decades of leadership in cutting-edge commercial and defense technologies. Since World War II, the U.S. military has at times relied on superior technology to offset the numeric advantage of its adversaries.[500] In the 1950s, President Eisenhower's New Look strategy leveraged America's lead in nuclear weapons to counter the Soviet Union's larger conventional ground forces. In the 1970s, the DoD again utilized American advances in several defense technologies to confront the

499 Henry L. Stimson, quoted in Gropman, *Mobilizing U.S. Industry*, p. 5.

500 For more on previous U.S. offset strategies, see Robert Martinage, *Toward a New Offset Strategy: Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability* (Washington, DC: Center for Strategic and Budgetary Assessment, 2014), chap. 1, https://csbaonline.org/uploads/documents/Offset-Strategy-Web.pdf.

growing Soviet nuclear and conventional threat in Central Europe.[501] Today, many have proposed a similar "third offset" strategy that would address the growing threat posed by China in the Indo-Pacific by emphasizing U.S. leadership in long-range strike, autonomous and low-observable aircraft, and undersea warfare.[502]

At the same time, America's historical technological advantage in many of these sectors is being actively contested by its competitors, and the race to develop ever more advanced commercial and defense technologies remains at the forefront of U.S.–Chinese strategic competition. Xi Jinping's Made in China 2025 initiative identifies ten technology areas in which the PRC seeks to gain advantage over the United States, including aerospace, materials, maritime equipment, robotics, and other sectors critical to defense innovation.[503] Indeed, Chinese officials have promised to mobilize their national resources toward this objective.[504] U.S. strategic documents similarly stress the crucial role of technology in maintaining the U.S. military's strength in the face of growing competition.[505] Competition remains close, with some analyses emphasizing areas in which the United States appears behind and others highlighting continued American leadership.[506] China has long relied on intellectual property theft as a key element of its economic and military growth; at this time, it still appears to lag in areas such as advanced semiconductor production and jet propulsion.[507]

501 Technologies key to the offset strategy included precision-weapons, stealth aircraft, space-based communications and intelligence platforms, and new sensor and networking capabilities. Martinage, *Toward a New Offset Strategy*, pp. 14–16.

502 See, for example, Cheryl Pellerin, "Deputy Secretary: Third Offset Strategy Bolsters America's Military Deterrence," *DOD News*, U.S. Department of Defense, October 31, 2016, https://www.defense.gov/News/News-Stories/Article/Article/991434/deputy-secretary-third-offset-strategy-bolsters-americas-military-deterrence/; and Gian Gentile, Michael Shurkin, Alexandra T. Evans, Michelle Grise, et al., *A History of the Third Offset, 2014–2018* (Santa Monica, CA: RAND, March 31, 2021), https://www.rand.org/pubs/research_reports/RRA454-1.html.

503 Karen M. Sutter, *"Made in China 2025" Industrial Policies: Issues for Congress* (Washington, DC: Congressional Research Service, March 10, 2023), https://sgp.fas.org/crs/row/IF10964.pdf.

504 Sarah Zheng and Gao Yuan, "China Vows to Mobilize Nation as It Fights U.S. for Tech Supremacy," *Japan Times*, March 5, 2024, https://www.japantimes.co.jp/business/2024/03/05/tech/china-us-tech-supremacy/.

505 See, for example, Department of Defense, *2022 National Defense Strategy of the United States of America* (Washington, DC: Department of Defense, October 27, 2022), pp. 19–21, https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-national-defense-strategy-npr-mdr.pdf; RAND, *Commission on the National Defense Strategy*, chap. 5; and Department of Defense, *National Defense Science & Technology Strategy 2023* (Washington, DC: Department of Defense, May 2023), https://media.defense.gov/2023/May/09/2003218877/-1/-1/0/ndsts-final-web-version.pdf.

506 See, for example, Jamie Gaida, Jennifer Wong-Leung, Sethpan Robin, and Danielle Cave, *Critical Technology Tracker: The Global Race for Future Power* (Canberra, Australia: Australian Strategic Policy Institute, 2023), https://ad-aspi.s3.ap-southeast-2.amazonaws.com/2023-03/ASPIs%20Critical%20Technology%20Tracker_0.pdf; and Jon Schmid, "Rethinking Who's Winning the U.S.-China Tech Competition," RAND, August 16, 2023, https://www.rand.org/pubs/commentary/2023/08/rethinking-whos-winning-the-us-china-tech-competition.html.

507 Ana Swanson and Paul Mozur, "U.S. Takes Aim at China's Production of Essential Computer Chips," *New York Times*, December 23, 2024, https://www.nytimes.com/2024/12/23/business/economy/us-china-semiconductor-legacy-chips.html; and China Aerospace Studies Institute, "PLA Aerospace Power: A Primer on Trends in China's Military Air, Space, and Missile Forces, 4th Edition," U.S. Air Force, July 22, 2024, https://www.airuniversity.af.edu/CASI/Display/Article/3840174/pla-aerospace-power-a-primer-on-trends-in-chinas-military-air-space-and-missile/.

Maintaining America's traditional lead in commercial and defense technologies is essential to succeeding in military and economic competition with the PRC. The defense prime contractors, their subcontractors, and new upstarts in the defense market—many of whom emphasize the role of software, autonomy, and advanced manufacturing techniques—are critical players in this struggle. The DoD must foster competition and innovation within the industry to further this technological advantage, which requires not only the development of advanced technologies but also the application of these technologies to defense problems and the integration of technologies within complex military systems. American defense firms have decades of experience as systems integrators—a proficiency many other nations lack in their defense industries. The continued U.S. dominance in areas such as undersea technology and the international success of platforms like the F-35 and Patriot air defense system prove that despite advances by other nations, U.S. defense technology remains the envy of the world.

Moreover, the U.S. military is on track to field a host of new platforms and weapons in the next decade to further this technological advantage, from maneuverable hypersonic weapons to the next generation of stealthy, long-range, and unmanned aircraft. Key to leveraging these advanced systems is their successful fielding and integration through parallel developments in doctrine, training, and operational concepts. To date, work in this arena by the armed services has been encouraging.[508]

But the U.S. defense enterprise must not rest on its laurels. As recent events have shown, today's problem is less about the quality of technology in U.S. weapons and more about the scale at which systems employing these cutting-edge technologies can be produced. Quality is key, but it can never fully replace quantity. U.S. military planners must avoid using "technological fetishism" to replace strategy or avoid hard choices, including the need to expand industrial capacity and increase defense expenditures, if necessary.[509] Instead, the focus must be on maintaining and growing current areas of technological advantage while simultaneously working now to scale the industry to the size necessary for today's challenges. As this monograph has argued, waiting for a crisis to initiate industrial mobilization is a recipe for military disaster. Some degree of expansion and improvement of the industrial base must be completed in peacetime to be useful in a contemporary great power conflict that offers neither time nor sanctuary to mobilize. The mobilization of Ukraine's industrial base

508 For an assessment of joint and service innovation efforts, see Mahnken, Montgomery, and Hacker, *Innovating for Great Power Competition*, pp. 58–59.

509 See Kelly A. Grieco and Robert A. Manning, "Red Cell: The Chimera of Technological Superiority: Why a New Offset Strategy Will Not Succeed," The Henry L. Stimson Center, March 21, 2023, https://www.stimson.org/2023/red-cell-the-chimera-of-technological-superiority/.

to produce one million drones per year offers a current example—albeit for less complicated systems—of the sorts of national policy changes that such expansions might require.[510]

To produce advanced technologies in sufficient quantity, the United States should restore its defense industrial base with advanced manufacturing technologies. After World War II, Japan and Germany rebuilt their shattered steel industries using the latest technologies and continued to invest in more efficient techniques and infrastructure. Over time, this allowed foreign companies to outcompete American steel manufacturers, which possessed large amounts of outdated capital equipment and relied on older production techniques.[511] As the United States prepares its defense industrial base to support great power conflict, it should invest in similarly game-changing production technologies and infrastructure to gain a competitive advantage over the military–industrial complexes of its adversaries.

Such advances in manufacturing technology and mass production were essential to transforming the United States into the Arsenal of Democracy. Over the course of World War II, technological innovation occurred not just in weapons themselves but also in the manufacturing processes vital to building them. Numerous examples abound, most notably advances in manufacturing techniques that increased efficiency in order to reduce production times and costs.[512] In munitions, advances in the manufacturing of bomb bodies cut the amount of time to produce and deliver large quantities of air-delivered bombs in half.[513] One major bottleneck that affected nearly all mobilization efforts was the shortage of machine tools. For many weapons, improved or alternative manufacturing techniques were used to help ease the shortage by reducing the amount of tooling required for each item.[514]

Due to their exquisite nature, low-quantity production, and dated designs, many of today's critical PGMs and their components are assembled by hand and do not fully leverage

510 For example, "Beginning in late 2022, the Ukrainian government slashed taxes, simplified customs clearance and streamlined contracting procedures for armament manufacturers, including for drone firms, and increased profit margins for sales of unmanned weapons to 25 percent from 1 percent." C. J. Chivers, "How Suicide Drones Transformed the Front Lines in Ukraine," *New York Times*, December 31, 2024, https://www.nytimes.com/2024/12/31/magazine/drones-weapons-ukraine-war.html.

511 Chris Isidore, "U.S. Steel, Once a Symbol of America's Economic Might, Is Now for Sale in the Bargain Bin," *CNN*, August 19, 2023, https://www.cnn.com/2023/08/19/business/us-steel-steelmaking-history/index.html; and Lloyd R. Kenward, "The Decline of the U.S. Steel Industry," *Finance & Development* 24, no. 4, International Monetary Fund, December 1987, https://www.elibrary.imf.org/view/journals/022/0024/004/article-A009-en.xml.

512 Gropman, *Mobilizing U.S. Industry*, p. 105.

513 According to General George C. Marshall, the follow-on effect of the reduced manufacturing time was lower war reserve requirements for the Army Air Corps. Quoted in U.S. Senate, *Military Establishment Appropriations Bill for 1941*, pp. 41–42.

514 These developments were especially useful in the production of artillery shells. U.S. Army Center of Military History, *Logistics in World War II*, p. 95; and Rowland and Boyd, *U.S. Navy Bureau of Ordnance*, pp. 433–47.

advanced manufacturing techniques and automation.[515] Along with updated weapon designs that emphasize producibility, building weapons at the scale necessary for great power war will require parallel innovations in manufacturing technologies and the adoption of designs that leverage dual-use components built on production lines shared by military and commercial products. Numerous efforts are already underway, from improved 3D printing techniques to software-defined manufacturing.[516] Going forward, defense programs must incentivize continued innovation in weapons and production technology. The DoD must provide sufficient demand for these items to encourage or otherwise incentivize costly investments in advanced manufacturing and automation. Much like mass production enabled weapons and platforms to be produced at rates previously thought impossible during World War II, improvements in manufacturing technology and processes may hold the key to rapidly expanding the production of modern PGMs and new classes of weapons suited for great power war.

Beyond improved manufacturing, weapon production could be aided by decoupling munition design from production and expanding the portion of the total U.S. industrial base involved in manufacturing munitions and their components. The United States still accounts for 16 percent of global manufacturing output, and the combined output of the United States and its allies rivals that of China. To cite just one sector, the U.S. fabricated metals industry consists of over 50,000 companies with an annual industry revenue of around $340 billion.[517]

To produce weapons and weapon components for World War II, the U.S. government gave arsenal designs to commercial companies that had a proven ability to manufacture products at scale. Today, the private U.S. defense industrial base designs the world's most advanced weapons. By moving toward more modular weapon designs that better leverage commercially produced components, the DoD can foster the separation of munition design and manufacture, expand the number of firms involved in weapons production, and once again

515 For instance, new production of Stinger anti-aircraft missiles requires the missile's nose cone to be installed by hand. Marcus Weisberber, "Raytheon Calls in Retirees to Help Restart Stinger Missile Production," *Defense One*, June 28, 2023, https://www.defenseone.com/business/2023/06/raytheon-calls-retirees-help-restart-stinger-missile-production/388067/.

516 See, for example, David Hambling, "3D Printed Rocket Motors Could Restock Missile Arsenals Fast," *Forbes*, June 14, 2024, https://forbes.com/sites/davidhambling/2024/06/14/3d-printed-rocket-motors-could-restock-missile-arsenals-fast/; Michael Marrow, "Anduril Unveils New 'Arsenal' Factory in Bid to Scale Up Weapons Production," *Breaking Defense*, August 8, 2024, https://breakingdefense.com/2024/08/anduril-unveils-new-arsenal-factory-in-bid-to-scale-up-weapons-production/; and "From Last Supper to First Breakfast: The Defense Tech Ecosystem," Palantir, September 8, 2023, https://blog.palantir.com/from-last-supper-to-first-breakfast-cb971128b0bf.

517 Prairie Capital Markets, "Prairie Industry Perspective: Metal Forming Industry," Prairie Capital Markets, May 2023, p. 1, https://www.prairiecap.com/wp-content/uploads/2023/05/Prairie-Industry-Perspective_Metal-Forming_May-2023.pdf; and Adji Fatou Diagne, "Made in America: Fabricated Metal Products," Department of Commerce Economics and Statistics Administration, 2013, https://www.commerce.gov/sites/default/files/migrated/reports/made-in-america-fabricated-metals.pdf.

draw upon the full might of U.S. manufacturing.[518] As in the 1930s, the DoD could survey the spectrum of domestic firms capable of producing pieces of critical munitions and fund production studies and educational orders to familiarize these firms with the unique aspects of defense production.

Decoupling weapon design and production presents significant challenges related to intellectual property, and the DoD must work with munition designers to avoid impeding the innovation critical to continued American technological superiority.[519] Similar challenges arose when the Army funded educational orders for aircraft components in the 1930s, but these issues fell by the wayside as the threat of war became increasingly imminent.[520] To hearken back to Knudsen's quote in this chapter's epigraph—many in the United States still know how to build things. Just as Knudsen faced the challenge of orienting these builders toward war production, it remains up to the DoD to better harness the full spectrum of contemporary American industrial strength.

Allies and Partners

America's multitude of economic and military partners throughout the world is often touted as one of its most significant competitive advantages vis-à-vis the PRC. Chapter 4 discussed many of the ways China's industrial capacity exceeds that of the United States. But the United States currently enjoys close diplomatic, military, and industrial ties with most of the world's leading economies. Considered together, the economic and productive potential of these nations rivals the PRC across many metrics. Present circumstances might push the United States to rely on an Arsenal of Democracies rather than itself becoming the sole Arsenal of Democracy.

Recognizing this advantage, U.S. adversaries are building military and economic blocs of their own. Increased Chinese military cooperation with Russia has manifested in recent years with numerous bilateral and multilateral military exercises.[521] In Russia's war in

518 For a more thorough exploration of modular weapons, open architectures, and opportunities to involve nondefense firms in weapons production, see Hacker, *Beyond Precision*, chap. 5.

519 Tyler Hacker, "Money Isn't Enough: Getting Serious about Precision Munitions," *War on the Rocks*, April 24, 2023, https://warontherocks.com/2023/04/money-isnt-enough-getting-serious-about-precision-munitions/.

520 Aircraft producers and their supporters in the Army Air Corps objected to the use of educational orders on the grounds that "aircraft manufacturers would not be willing to share their trade secrets with firms engaged in mass producing items such as automobiles" and feared that the orders would create additional competitors in the aviation industry. Knudsen stated in 1946 that "airplane manufacturers spent a lot of time telling me that nobody else could do what they did." These concerns were, at times, well founded. In another example, the Army contracted Willys to produce the jeep over the jeep's designer, Bantam Car, because it believed Willys could produce the jeep at scale and Bantam Car could not. As a result, "Bantam did not reap the benefits of the production sales of an item it had developed, and it suffered economically after the war." These examples display the tradeoffs and potential costs associated with industrial mobilization. Hone, "Fighting on Our Own Ground;" and Lacey, *Keep from All Thoughtful Men*, p. 52.

521 Department of Defense, *Military and Security Developments Involving the People's Republic of China 2024* (Washington, DC: U.S. Department of Defense, December 2024), pp. 14–15, https://media.defense.gov/2024/Dec/18/2003615520/-1/-1/0/military-and-security-developments-involving-the-peoples-republic-of-china-2024.pdf.

Ukraine, China has emerged as a key supplier of inputs for Russian war production, including "microelectronics, precision machine tools, spare parts, titanium and magnesium alloys, and chemical inputs for munitions production."[522] At the same time, China has restricted exports of many inputs for drone manufacturing and other war production to Ukraine while claiming it restricts the export of such goods to both Ukraine and Russia.[523] Iran has also assisted Russia with efforts to expand drone and munition production, and Chinese firms are vital suppliers in Iranian ballistic missile production.[524] As the world moves toward these selective, bloc-aligned defense trading partnerships, it is incumbent on the United States to ensure its allies and partners remain oriented toward the United States, particularly for military goods and their industrial inputs.

Chapter 4 explored the risks posed by foreign dependencies in U.S. defense supply chains, but the international nature of the U.S. industrial base is both a risk and an advantage. The National Defense Industrial Strategy rightly recognizes that U.S. allies and partners are important additional sources of vital raw materials and defense components.[525] In this way, allied sources add resilience and diversity to U.S. supply chains. Should American manufacturers require significantly larger quantities of certain inputs, such as during mobilization, allies and partners may be able to fill crucial gaps in supply chain subtiers, particularly for materials not domestically available or while domestic sources are expanding. Should coalition demand for certain weapons or systems far exceed the capacity of U.S. producers, foreign defense companies may be able to share the production burden through licensed production or other manufacturing arrangements. Finally, the U.S. benefits from the shared innovation and technological developments of its allies. Just as its partnership with the UK led to the sharing of technologies related to jet propulsion and radar during World War II, the U.S. edge in defense technology may today be aided by the investments, advancements, and applications of its numerous allies and partners.

In today's globalized economy, the United States must consider how to utilize these relationships in ways that maximize their benefits and minimize the risks associated with foreign dependencies. Policymakers should consider the relative industrial strengths of close U.S. allies, particularly as recent increases in demand have led to the expansion of many foreign defense firms. In the munitions realm, the Russia–Ukraine conflict has caused

522 Department of Defense, *Military and Security Developments*, p. 14.

523 Aosheng Pusztaszeri, "Why China's UAV Supply Chain Restrictions Weaken Ukraine's Negotiating Power," Center for Strategic and International Studies, December 16, 2024, https://www.csis.org/analysis/why-chinas-uav-supply-chain-restrictions-weaken-ukraines-negotiating-power.

524 Dalton Bennett and Mary Ilyushina, "Inside the Russian Effort to Build 6,000 Attack Drones with Iran's Help," *Washington Post*, August 17, 2023, https://www.washingtonpost.com/investigations/2023/08/17/russia-iran-drone-shahed-alabuga/; and Laurence Norman and Benoit Faucon, "China Is Helping Supply Chemicals for Iran's Ballistic-Missile Program," *Wall Street Journal*, January 23, 2025, https://www.wsj.com/world/middle-east/china-is-helping-supply-chemicals-for-irans-ballistic-missile-program-ab272ad7.

525 Department of Defense, *National Defense Industrial Strategy*, p. 21.

significant growth in Europe's munition production capacity.[526] Similarly, Australia has moved to build its own domestic munitions industry and established a Guided Weapons and Explosive Ordnance Enterprise to support these efforts in coming years.[527] In Asia, South Korean arms exports have grown.[528] These developments in allied nations represent added production capacity, additional suppliers of materials and components, and potentially innovative production techniques and methods.[529] The United States should consider how to best leverage these developments in its own defense supply chains and industrial mobilization plans.

The U.S. military must also work to limit the risks associated with an international defense industry and globalized defense supply chains. This begins with further analysis of where the most significant foreign dependencies exist and how those dependencies might affect defense production in peacetime and during conflict. Producers and program offices must understand which legs of their supply chains rest on foreign sources and how disruption of these sources would affect active production. Realistic industrial mobilization planning should track the capacities of major domestic and foreign sources of critical defense materials. Supply chain analysis and industrial planning are areas where the DoD can expand its use of innovative software solutions and data visualization methods.[530]

In today's threat environment, however, a coalition-based industrial strategy requires the DoD to go beyond tracking foreign dependencies and actively prepare for supply chain disruptions and adversary interference. With foreign suppliers identified, the DoD can begin analyzing LOCs critical to maintaining defense production. An important part of industrial mobilization and protracted war planning is developing the strategy and forces required to protect these LOCs, which may differ in shape and size from the forces required for offensive

526 See, for example, Rudy Ruitenberg, "MBDA Books Record Orders amid European Air-Defense Rush," *Defense News*, March 13, 2024, https://www.defensenews.com/global/europe/2024/03/13/mbda-books-record-orders-amid-european-air-defense-rush/; Joshua Posaner, "EU Doles Out €500M for Artillery Ammunition and Missiles as It Seeks to Match Russia," *Politico*, March 15, 2024, https://www.politico.eu/article/eu-doles-out-e500m-for-artillery-ammo-and-missiles-as-it-seeks-to-match-russia/; and Matthew M. Burke, "First Patriot Missile Facility outside U.S. Starts Up in Germany," *Stars and Stripes*, December 2, 2024, https://www.stripes.com/theaters/europe/2024-12-02/construction-begins-patriot-facility-germany-16032845.html.

527 Australian Ministry of Defence, "Australia Forges Ahead on Missile and Munitions Manufacturing," Australian Ministry of Defence, October 30, 2024, https://www.minister.defence.gov.au/media-releases/2024-10-30/australia-forges-ahead-missile-and-munitions-manufacturing.

528 Gordon Arthur, "How South Korea's Defense Industry Transformed Itself into a Global Player," *Breaking Defense*, November 6, 2023, https://breakingdefense.com/2023/11/how-south-koreas-defense-industry-transformed-itself-into-a-global-player/.

529 U.S. Navy Secretary Carlos Del Toro recently praised the integration of automation, artificial intelligence, and other advanced production technologies in Japanese and South Korean shipyards. Justin Katz, "How SECNAV's Claims about S. Korea, Japanese Shipbuilders Do and Do Not Line Up," *Breaking Defense*, July 15, 2024, https://breakingdefense.com/2024/07/how-secnavs-claims-about-s-korean-japanese-shipbuilders-do-and-do-not-line-up/.

530 Numerous firms offer software for analyzing and visualizing defense supply chains. See, for example, Palantir, "Palantir Supply Chain Solutions," Palantir, https://www.palantir.com/offerings/supply-chain/; and Govini, "Applications: Supply Chain," Govini, https://www.govini.com/products/ark/supply-chain.

operations and other operation plans. The DoD should work with industry to identify alternative sources of critical materials and components, including foreign sources with LOCs that are shorter or easier to defend, such as those in Central or South America. These operations may provide renewed focus to U.S. Northern and Southern Command, which would be key players in defending domestic industrial and logistics sites and maintaining LOCs in the Western Hemisphere. As in World War II, reliance on foreign material sources and industrial cooperation with allies also calls for rebuilding the U.S. Merchant Marine, including both U.S.-flagged commercial vessels and those of Military Sealift Command. Should foreign-flagged commercial vessels or foreign-owned shipping firms refuse to operate or carry military goods during a conflict, the United States must maintain the ability to transport inputs from foreign nations and exchange materials and finished military goods with its allies and partners in overseas theaters.

Final Thoughts

The U.S. munitions industry and the broader defense industrial base have evolved alongside the U.S. military since the beginning of the 20th century. Despite Americans' fond remembrance of the Arsenal of Democracy and the many lessons the era holds for today's planners and policymakers, there is no returning to the defense industrial base of previous eras. America's mobilization for World War II was a unique product of the circumstances and national capacities of the period. Today's military-industrial strategy and mobilization plans must be forward looking. Looking to the future, key questions for the DoD include:

1. What is the ideal munitions industrial base for the United States in strategic competition and, potentially, protracted conflict with the PRC? What capacities are necessary?

2. How can the DoD use the tools at its disposal to shape the industrial base toward these goals? Does the DoD have the tools—namely the authorities and funding—required?

3. What are the critical technology areas, acquisition methods, and production techniques essential to building and maintaining this industrial base?

Preparing the munitions industrial base for protracted war will require the combined effort of the DoD and the defense industry. Just as strategy and production enjoyed a reciprocal relationship during World War II, the DoD must incentivize the industry it desires while working with industry to inform and refine its mobilization plans. The U.S. military and defense industry have evolved significantly over the decades, but the interplay between strategy and production is an enduring feature of American military–industrial relations.

In many regards, the PRC is well ahead of the United States in preparing for mobilization. The National Defense Mobilization Department reports directly to the Central Military Commission, and Xi Jinping's military–civil fusion effort aims to apply Mao's

protracted People's War strategy to modern Chinese military–industrial relations.[531] The effectiveness of these measures during wartime remains a subject of debate, but the centrality of such concepts to People's Liberation Army modernization and Chinese industrial development shows how seriously America's adversaries consider protracted war and industrial mobilization.

The dangers of failing to prepare for industrial mobilization are numerous and serious. Insufficient munitions production capacity could leave U.S. forces with empty magazines in a conflict that persists beyond weeks. An inability to replace platforms lost to attrition might severely limit U.S. global power in the aftermath of a costly engagement and force military planners to choose between the protection of U.S. national interests, including the fulfillment of defense commitments to allies and partners, and the preservation of the force for future contingencies. Perhaps most dangerously, an inability to sustain conventional military power might force U.S. decision makers to rely too much on the threat of nuclear weapons or risky attempts to decisively end a conflict before it becomes protracted. Should defense expenditures fall and the U.S. military decrease in size or capability, then planning for mobilization and the reconstitution of forces takes on an even greater importance—just as in the interwar period.

The DoD and the defense community appear to be coming around to the possibility of protracted war and the need for dedicated planning for industrial mobilization. The numerous studies of defense supply chains, the industrial base, and the recent National Defense Industrial Strategy are steps in the right direction. They champion many of the points made throughout this monograph. These efforts amount to a call for action that now must be followed with continued focus and sustained investments. Rebuilding American defense industrial capacity after decades of neglect will be a national project extending well into the future. The military–industrial feats of 1938–1945 stand as inspirational reminders of what the United States is capable of with sufficient unity and purpose.

531 Department of Defense, *Military and Security Developments*, p. 29; Larry M. Wortzel, *Military Mobilization in Communist China* (Arlington, VA: Association of the United States Army, 2020), p. 1, https://www.ausa.org/sites/default/files/publications/LWP-136-Military-Mobilization-in-Communist-China_0.pdf; and Devin Thorne, "China's National Defense Mobilization System, Testimony before the U.S.-China Economic and Security Review Commission," U.S.-China Economic and Security Review Commission, June 13, 2024, https://www.uscc.gov/sites/default/files/2024-06/Devin_Thorne_Testimony.pdf.

LIST OF ACRONYMS

ANMB	Joint Army and Navy Munitions Board
CSBA	Center for Strategic and Budgetary Assessments
DoD	Department of Defense
GMLRS	Guided Multiple Launch Rocket System
GOCO	government-owned, contractor-operated
IMP	industrial mobilization plan
LOC	line of communication
NDAC	National Defense Advisory Commission
NDIA	National Defense Industrial Association
OASW	Office of the Assistant Secretary of War
OEM	Office for Emergency Management
OPM	Office of Production Management
OWM	Office of War Mobilization
PGM	precision-guided munition
PLA	People's Liberation Army
PRC	People's Republic of China
WIB	War Industries Board
WPB	War Production Board

CSBA
Center for Strategic and Budgetary Assessments

1667 K Street, NW, Suite 900
Washington, DC 20006
Tel. 202.331.7990 • Fax 202.331.8019
www.csbaonline.org