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VITAL SIGNS 2022

The Health and Readiness of the Defense Industrial Base

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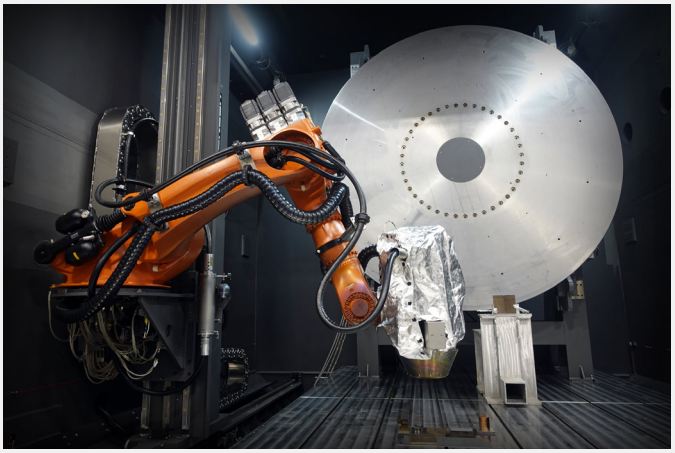

ABOUT THE COVER IMAGE

Pictured on the cover is the largest electron-beam welding system in the Western Hemisphere. Located in Huntsville, AL, the 22-foot-long electron beam is capable of welding additively manufactured scramjet sections with materials as thin as aluminum foil to full-scale ship hulls that are five inches thick. This technology will weld hardware for Virginia- and Columbia-class submarines.

FOREWORDS

NDIA

For the first time, because of the evolving impact of the COVID-19 pandemic and the sustained challenges noted in past reports, our *Vital Signs* study has scored the health of the defense industrial base below a passing grade. As this report reflects the challenging environment in which defense companies operate — rather than the companies themselves — this score serves as a wake-up call to all who care about the state of our national security. While the COVID-19 pandemic continues, so does the critical work of the defense industry. The pandemic reinforces the fact that our defense industrial base is not isolated from the American economy or the global business environment: now, more than ever, we must pay heed to the health of our base as it serves our warfighters.

In 2021, our economy was beset with a host of disruptions related to COVID-19 including workforce shortages, inflation, and supply chain disruptions — conditions that we had yet to observe at such a large scale during the first year of the pandemic. At the same time, cybersecurity and intellectual property threats continued unabated. Aggressive military actions by Russia and the rapid military modernization efforts of China's government continued to alarm policymakers, friends, and allies. These challenges remind us that our industry's work of providing a superior operating environment and products and services to our armed forces, so that they can compete and win in all domains of warfare, can never be taken for granted.

Again, it is important to emphasize *Vital Signs* does not assess the performance of our defense companies. The current health of the defense industrial base renders a sobering challenge to policy makers on Capitol Hill, leaders in the executive branch of government, scholars in academia, and other thought leaders. We hope that *Vital Signs*, and other research efforts by the National Defense Industrial Association, will form part of the remediation process as we discuss and address the impact of COVID-19 and the underlying concerns that remain.

General Herbert "Hawk" Carlisle, USAF (Ret)
NDIA President & CEO

GOVINI

The techno-military confrontation between the U.S. and China will likely not be decided in some contested stretch of the western Pacific, but rather right here at home. If the United States is going to prevail in this confrontation, it must better harness the innovation engine that is the American economy. Successfully doing so, however, is a complex and challenging endeavor.

China is already a more formidable economic competitor than the Soviet Union ever was during the Cold War, and its economic might will likely only continue to grow. The U.S. cannot simply outspend its way to victory this time around. As a result, the U.S. national security enterprise must work more effectively and efficiently with the existing defense industrial base.

But military advantage on future battlefields will not solely stem from who can better churn out a new generation of warships, planes, and tanks. It will also depend on which side can best adapt emerging technologies from the commercial sector for military use. Therefore, the national security enterprise must also broaden the industrial base to incorporate non-traditional partners that are building technologies, such as artificial intelligence, that will define the future.

At the same time, the U.S. must balance efforts to spark and foster innovation with the need to ensure the defense industrial base is sufficiently resilient. And as the COVID-19 pandemic has starkly demonstrated, this resilience must not only protect the industrial base against exploitation or disruption by China, but also enable it to withstand a host of potential economic and environmental shocks.

This is why *Vital Signs 2022* is so, well, vital. Now in its third year, the report's data-driven approach not only provides an empirical assessment of the health and readiness of the defense industrial base over time, but also offers the first real accounting of the damage wrought by the pandemic. Without efforts such as *Vital Signs,* it would be impossible to accurately understand the full extent of the problems facing the defense industrial base or to develop and implement effective solutions. How well the U.S. does so may be the difference between victory or defeat.

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EXECUTIVE SUMMARY

This year's iteration of *Vital Signs: The Health and Readiness of the Defense Industrial Base* marks the third consecutive year that the National Defense Industrial Association offers an unclassified analysis of the state and performance of America's defense industrial base (DIB) as an enterprise.

Accessible to both the American public and defense policy community, *Vital Signs 2022* strives to provide a comprehensive assessment of the resiliency of the defense sector by standardizing and integrating a set of criteria that reviews its performance in the context of the overall business environment.

The report frames the health of the defense industrial base as essential to economic and national security and does not examine individual companies or the Department of Defense (DoD) specifically, but rather the challenging environment in which all stakeholders operate.

When researching *Vital Signs 2022*, NDIA examined data relating to eight "signs" that collectively shape the performance of defense contractors. In a departure from *Vital Signs 2021,* this year's report indicates a final grade of "Unsatisfactory, Failing" for the health and readiness of the defense industrial base (DIB). While technically one point short of a pass mark, specific signs provide cause for real concern.

This year, five of the eight signs received a failing grade. This reflects the tumultuous state of the industry as it grappled with the extraordinary ramifications of the COVID-19 pandemic, which dramatically disrupted the lives of individual Americans as well as global commerce.

This past year has witnessed significant deterioration in the signs including "supply chain" as well as "production capacity and surge readiness," which almost certainly is a result of the impact of the pandemic. Conversely, the only sign that significantly improved was "demand," reflecting recent growth in the defense budget.

Vital Signs 2022 also reflects the story of recent political and regulatory action against adversaries and their influence over the DIB, and the way in which that has shaped and will continue to shape the future of the warfighter.

AREAS OF CONCERN

As a majority of the eight signs received failing grades for the first time this year, *Vital Signs 2022* reveals a DIB that, similar to other industries, suffered sustained losses during the COVID-19 pandemic. Six of the indicators earned composite scores lower than 80 and five of these earned scores below 70, a grade considered failing. These scores point to a DIB struggling to meet the unprecedented and ongoing challenges created by the pandemic in the face of an increasing challenge from competitor nations.

"Industrial security" has gained renewed prominence due to data breaches and brazen acts of economic espionage, perpetrated by both state and non-state actors, that have plagued defense contractors. However, despite the importance of "industrial security", this sign received a score of 50 in 2021, the lowest among the eight signs in 2022. To assess the "industrial security" sign, NDIA analyzed threat indicators to information security and intellectual property (IP) rights. The score incorporates the nonprofit MITRE Corp.'s annual average of the threat severity of new cyber vulnerabilities. This year, the analysis included the new National Institute of Standards and Technology's 3.1 scoring system, superseding last year's usage of the 2.7 system. Threats to IP rights scored well at 80 in 2021, as the number of FBI investigations into intellectual property violations declined to 38. This pattern marks a steady decline since investigations reached an all-time high of 235 in 2011.

Defense industry "production inputs" also scored poorly in 2021, receiving a failing score of 67. These inputs encompass skilled labor, intermediate goods and services, and raw materials used to manufacture or develop end-products and services for defense consumption. In particular, the indicators for security clearance processing contributed to the low score for "production inputs", as on-boarding backlogs persist.

OVERALL SCORES

Condition	2019	2020	2021	Change, 2020 – 2021
Demand	82	88	94	+6
Production inputs	66	66	67	+1
Innovation	69	69	69	0
Supply chain	60	71	63	-8
Competition	92	88	88	0
Industrial security	49	49	50	+1
Political & regulatory	78	76	72	-4
Productive capacity & surge Readiness	80	67	52	-15
Overall health and readiness	***72***	***72***	***69***	***-3***

Figure 0.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

AREAS OF CONFIDENCE

Despite numerous negative scores, areas of confidence give cause for optimism within the defense industrial base. For instance, demand for defense goods and services remained robust in 2021 and received an outstanding score of 94. This increase stems from a rise in contract obligations issued by the DoD. Moving forward, this will be an indicator to closely monitor, as the prospect of flatter defense budgets and rising inflation pose potential headwinds in the near term.

"Competition" was also a strength. An analysis of the top 100 publicly-traded DoD contractors, conducted by decision science company Govini, produced a competition score of 88 for 2021.

This high mark was driven by several high-scoring factors including a low level of market concentration for total contract awards, the low share of total contract awards received by foreign contractors, and a high level of capital expenditure in the DIB.

Conversely, other factors within the "competition" sign experienced decreases, including a significant 11-point decrease for liquidity. These decreases were anticipated, however, due to the impact of the pandemic on the economy.

OTHER TAKEAWAYS

In 2021, the "innovation" sign remained stagnant and received an unsatisfactory score of 69.

Scores also declined for the "political and regulatory" sign. In early 2020, prior to the onset of the pandemic, 50% of participants believed that defense spending is "about right," which marked a 7% increase from 43% in 2019. This 2020 result of 50% is the highest percentage of "about right" responses for this question since Gallup began asking it more than 52 years ago.

"Acquisition reform" and "budget stability," two of NDIA's strategic priorities, once again topped the list of concerns for industry leaders. In the *Vital Signs* survey, participants were asked about the most important thing government could do to help the defense industrial base. Respondents stated that both streamlining the acquisition process, 37.6%, and budget stability, 27.8%, were paramount, which is consistent with last year's findings.

Similarly, a vast majority, 72.3%, cited uncertain business conditions when asked to cite what conditions would limit their willingness to allocate additional capacity to military production. And 62.8% of survey respondents cited the burden of government paperwork as a deterrent. Both findings underscore the continued importance of acquisition reform and budget stability.

HOW HAS THE DEFENSE INDUSTRIAL BASE RESPONDED TO THE PANDEMIC?

The ability of the defense industrial base to expand output and fulfill increased military demand is a key test of its health and readiness. The COVID-19 pandemic, which began in early 2020 in the USA, exemplifies this. In 2021, "productive capacity and surge readiness" earned a critical risk score of 52. This represents a 15-point decrease from 2020 and can largely be attributed to declines in output efficiency. However, it is important to note that this score is not based upon a fully mobilized economy, similar to the context of World War II. Rather, the "production capacity and surge readiness" sign is baselined against the late Cold War defense buildup, a surge of 31% that began during the Carter administration and accelerated throughout the Reagan presidency.

The critical impact of COVID-19 also became evident in the "supply chain" sign, which experienced an 8-point drop that is largely attributed to a worsening in cash conversion cycles for the top 100 defense contractors. Also, as indicated by our survey, workforce challenges and the availability of talent are a critical concern. Interestingly, the pandemic also changed the makeup of the top 100 defense contractors, with pharmaceutical company Moderna, the maker of one of the approved COVID-19 vaccines, making it onto the list.

The health and readiness of the DIB poses a challenge to the national security community. As the DIB evolves to meet new and complex challenges, *Vital Signs 2022* highlights several obstacles the nation must overcome, especially in light of the continuing pandemic.

As always, NDIA intends *Vital Signs 2022* to be a reference document that sets forth conditions for an annual discussion on defense sector issues. It is NDIA's hope that this report contributes to the critical debate surrounding the nation's defense acquisition strategy by offering a common set of fact-based data points on industrial partners that give the men and women in uniform, and their civilian counterparts, an advantage in all domains of warfare. It is the hope of NDIA that *Vital Signs 2022* will help inform policy discussions that lead to improvements in the health and readiness of the industrial base and a higher overall grade in *Vital Signs 2023*, and beyond.

INTRODUCTION

For the first time since NDIA began producing this annual report on the health and readiness of the Defense Industrial Base (DIB), the data shows less than a passing grade. This finding supports the Department of Defense (DoD)'s *FY20 Annual Industrial Capabilities Report* which points out that "our defense industrial base has reached an inflection point in its history regarding the balance between its vulnerabilities and its opportunities for modernization and reform."[1] Facing the challenges of the COVID-19 pandemic, as well as strategic competition from countries like China, this moment is of unique importance to the DIB and ultimately to our nation's long-term security.

Despite the historically vital role of the DIB in supporting America's armed forces during peace and war, U.S. defense policy has not always recognized that vital role. For example, congressional panels on the defense industrial base convened by the House Armed Services Committee in 1980, 1992, and 2011 called attention to U.S. defense policy's persistent neglect of the defense industrial base and the potential tactical and strategic ramifications for the nation in a conflict against a near-peer adversary.[2] In 2017, Executive Order 13806 identified important structural changes to the U.S. manufacturing sector that "raise[d] concerns about the health of the manufacturing and defense industrial base" and called for a "comprehensive evaluation" to help guide future remedial policy actions.[3] As the executive order suggests, a key obstacle to a sound DIB strategy is a common baseline understanding of the overall health and readiness of the DIB.

As in past issues, this annual report is the defense industrial base's yearly health check-up; accordingly, it aims to encourage conversations at all levels about how to adjust policies and make investments that maintain the superior readiness of the American DIB while providing the continued advantages our nation and its warfighters have come to expect. NDIA, in partnership with Govini, a decision science company, has completed our third annual assessment of the health and readiness of the DIB to address the gap in a common baseline understanding of the overall health of the DIB. By analyzing select statistical indicators, NDIA uses a unique composite indicator consisting of a set of eight signs, providing an integrated measure of the health and readiness of the U.S. DIB as an ecosystem. This is a measure more of the challenging environment within which DIB companies operate, rather than a measure of the companies themselves. Given that this synoptic indicator brings together data on multiple sets of factors affecting the defense industry, it facilitates a common, holistic understanding of the state of the defense industrial base and its "vital signs."

WHAT IS THE DEFENSE INDUSTRIAL BASE?

The U.S. defense industrial base partners with the DoD to ensure that the U.S. enjoys decisive advantages to compete, deter, and win. The DIB encompasses manufacturers, systems integrators, service providers, technology innovators, labs and research organizations, and other suppliers linked to one another by contracts into regional, national, and global supply chains to provide America's warfighters with superior tools, capabilities, and resources.[4] In recent years, the U.S. DIB has declined in size, and in the number of new entrants, despite growing demand for its output. DoD is the largest contracting agency in the federal government. Total contract obligations issued by DoD grew from $368 billion in 2018 to $429 billion in 2020 (the last full-year data available).

Defense supply chains touch every state in the Union. According to data from DoD's Office of Local Defense Community Cooperation, defense contract spending in FY20 averaged over $7 billion per state and in the District of Columbia, although spending levels varied widely.[5] For example, Texas received the most of all states with $83 billion in defense contract spending while Wyoming received the least of all states with less than $200 million.[6] The concentration of defense contract spending in major metropolitan areas supports clusters of defense industry production, investment, and employment. The metropolitan areas of Washington D.C.-Baltimore, Dallas-Fort Worth, San Diego, Seattle, St. Louis, Los Angeles, Huntsville, and Boston host the country's largest

1 Department of Defense, "FY20 Annual Industrial Capabilities Report," January 2021. Accessed July 21, 2021. https://media.defense.gov/2021/Jan/14/2002565311/-1/-1/0/FY20-INDUSTRIAL-CAPABILITIES-REPORT.PDF

2 United States House Committee on Armed Services. (1980). The ailing defense industrial base: unready for crisis. Report of the Defense Industrial Base Panel of the Committee on Armed Services, House of Representatives. Ninety-sixth Congress, Second Session. Washington: U.S. G.P.O.; United States House Committee on Armed Services. (1992). "Defense industrial base: hearings before the Structure of U.S. Defense Industrial Base Panel of the Committee on Armed Services," House of Representatives, One Hundred-Second Congress. Washington: U.S. G.P.O.; United States House Committee on Armed Services. (2012). "The defense industrial base: a national security imperative: hearing before the Panel on Business Challenges within the Defense Industry of the Committee on Armed Services," House of Representatives

3 Trump, President Donald J., "Presidential Executive Order on Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," July 21, 2017; Available at: https://www.whitehouse.gov/presidential-actions/ presidential-executive-order-assessing-strengthening-manufacturing-defense-industrial-base-supply-chain-resiliency-united-states/

4 Definitions of the "defense industrial base" vary in their inclusiveness. We adopt a broad definition of the defense industrial base in recognition of the growing size, diversity, and complexity of the supply networks that support America's warfighters.

5 U.S. Department of Defense, Office of Economic Adjustment, "Defense Spending by State - Fiscal Year 2020." October 22, 2021. Accessed December 15, 2021. https://www.defense.gov/News/Releases/Release/Article/2819472/dod-releases-report-on-defense-spending-by-state-in-fiscal-year-2020/

6 Ibid.

New Vendors By Place of Performance, FY20

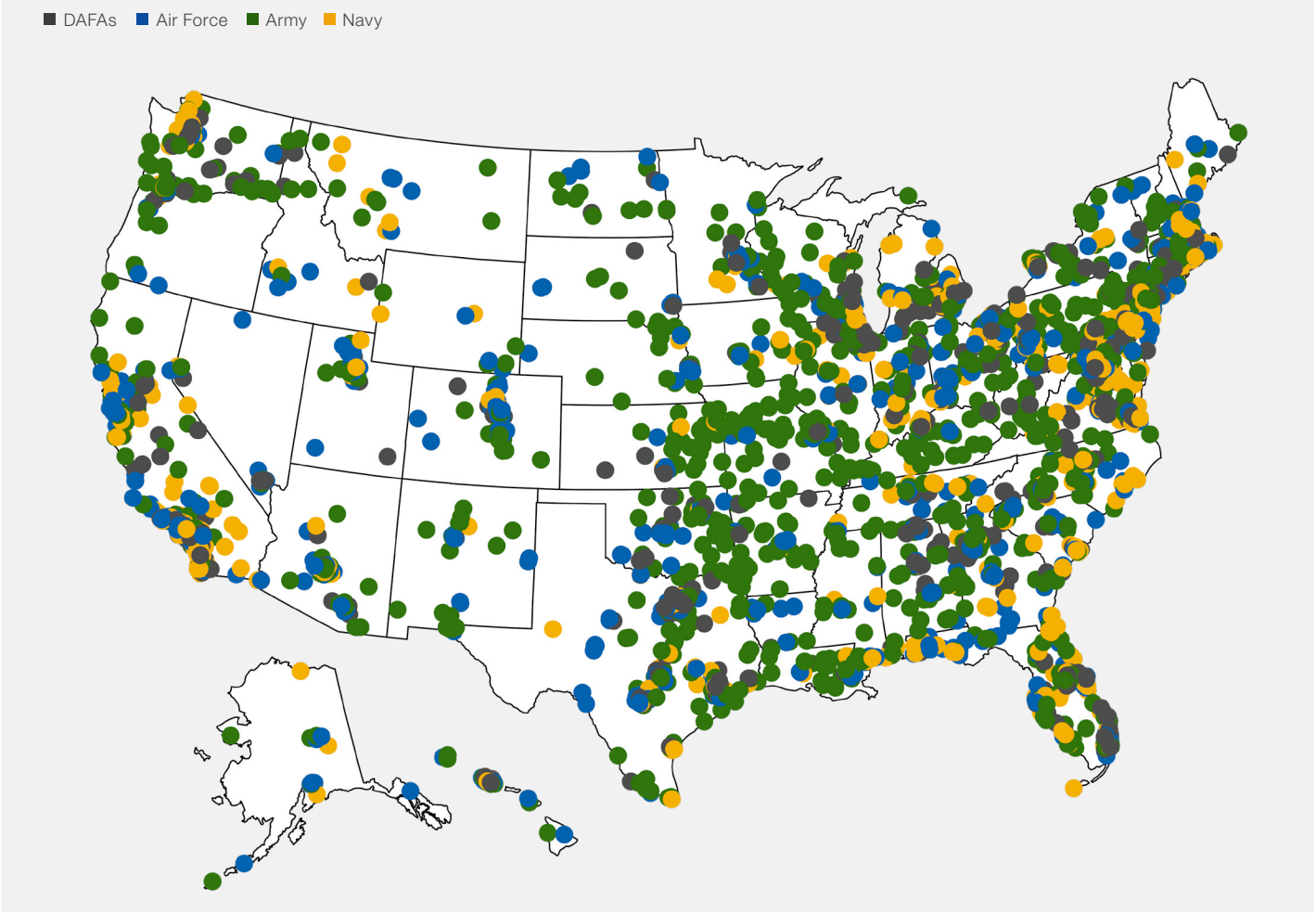


Figure 0.2, Source: Govini

defense contracting clusters.[7] Historically, defense procurement has followed a decadal cyclical pattern, driven by events and policy changes.[8] The breakout of major military conflicts has prompted defense spending peaks with a typical concentration in the high-volume procurement of major defense acquisition programs (MDAPs). Spending troughs have followed such peaks when military conflicts and tensions have deescalated, driving industry consolidation. For the U.S. DIB, these cyclical changes reflect the challenges defense contractors have when maintaining thriving companies while also making critical investments in future capabilities. The globalization of supply chains have only served to exacerbate those challenges.

THE EVOLVING DEFENSE INDUSTRIAL BASE: FROM THE COLD WAR TO TODAY

The 2018 National Defense Strategy (NDS)'s declaration of the re-emergence of an era of great-power competition has held significant implications for the defense industrial base. The NDS called for reforms to defense acquisition systems to ensure the prompt delivery of important capabilities, services, and materials to U.S. warfighters in step with the changing strategic environment. This era of great-power competition presents the challenge of a multi-domain competition with peer and near-peer competitors, specifically China and Russia. Achieving decisive national advantages across emerging technologies — artificial intelligence, hypersonic aviation, quantum computing, autonomy, and human-machine teaming systems, among others — will have significant implications for the future of economic and strategic balances of power. This new era also challenges industry to achieve high levels of readiness to

7 Department of Defense "FY20 Annual Industrial Capabilities Report," January 2021. Accessed July 21, 2021. https://media.defense.gov/2021/Jan/14/2002565311/-1/-1/0/FY20-INDUSTRIAL-CAPABILITIES-REPORT.PDF

8 Watts, Barry D., "The US defense industrial base: Past, present, and future," *Center for Strategic and Budgetary Assessments,* Washington DC, 2008.

rapidly grow the production and deployment of military hardware during a conflict against a near-peer competitor. Nevertheless, trends from previous eras will continue to affect the defense industrial base. Growing dangers to industrial security from cybersecurity threats and traditional economic espionage will require defense contractors to implement new and often costly security procedures and systems. Such dynamic and uncertain business conditions of this emerging era will undoubtedly bring changes to both the organization and behavior of firms within the defense industrial base.

UNDERSTANDING THE HEALTH OF THE DEFENSE INDUSTRIAL BASE

Despite the DIB's importance to America's national security and ability to achieve policy goals, many assessments of national defense capacities, capabilities, and needs lack a broad consideration of the strengths and weaknesses of the defense industrial ecosystem. The *FY2020 Annual Industrial Capabilities Report*, authored by the Office of the Under Secretary of Defense for Acquisition & Sustainment, focused on the current moment and a critical inflection point for the DIB.[9] Several non-governmental analyses tend to address the DIB health question from the perspective of trends in demand-side defense contracting flows.[10] Although such studies provide valuable insights into specific aspects of the health of the DIB, they lack the breadth necessary to develop a holistic understanding of the position of the defense industrial base with respect to peak performance standards. To understand the current business environment of the defense industrial base in empirical terms, NDIA developed a set of eight signs based on an array of statistical indicators. Like the four traditional "vital signs" in a health exam (temperature, pulse, respiratory rate, and blood pressure) NDIA's *Vital Signs* series serves as a health check on the DIB.

VITAL SIGNS SURVEY RESULTS

For *Vital Signs 2021*, NDIA fielded a thirty-two-question survey to our members. This year's survey focused on questions that will be relevant every year (i.e. related to the DIB's capacity to surge) and questions that are relevant to this year (i.e., related to the impacts of COVID-19). The survey results are used throughout *Vital Signs 2022* while key results are presented in a single, dedicated section of the report.

FOR THE FUTURE

Vital Signs 2022: The Health and Readiness of the Defense Industrial Base is the third installment of the *Vital Signs* series. This report makes conclusions on the overall health and readiness of the defense industrial base. We intentionally refrain from offering policy recommendations, supporting any specific legislative or regulatory changes, or advocating for any targeted investments within this report. Our goal is to provide a baseline reference for the defense policy community and Americans concerned with defense policy. We believe an unclassified report, such as this one, will serve as an important annual touchpoint at the beginning of the policy cycle. Our intent is to provide trend analyses that demonstrate the results of changes in the strategic environment, economy, policies, and investments, while equipping stakeholders with the tools to discuss industrial base issues at the national level. In this way, we will be able to identify what actions or decisions were successful and which ones were not. It will then be up to various stakeholders, organizations, and policymakers to interpret and advocate for policies they believe are in the best interest of the defense industrial base and our national security posture.

9 Department of Defense, "FY20 Annual Industrial Capabilities Report," January 2021. Accessed July 21, 2021, https://media.defense.gov/2021/Jan/14/2002565311/-1/-1/0/FY20-INDUSTRIAL-CAPABILITIES-REPORT.PDF

10 Sanders, Gregory, "2021 Defense Acquisition Trends: Topline DoD Trends after a Half Decade of Growth," *CSIS*, December 2, 2021, Accessed December 13, 2021, https://www.csis.org/analysis/2021-defense-acquisition-trends-topline-dod-trends-after-half-decade-growth

HOW WE SCORE *VITAL SIGNS*

SIGNS, FACTORS AND INDICATORS

The complexity and scale of the defense industrial base mean that an array of indicators may be useful for performance analysis and interpretation. In general, statistical indicators provide summary representations of statistical data and typically reveal directional trends or relative positions. Statistical indicators also provide a structured and longitudinal way of understanding the relative performance of the defense industrial base. The criteria for this report is based on eight "vital signs" that collectively shape the performance of defense contractors. These include: "demand", "production inputs," "innovation," "supply chain," "competition," "industrial security," "political and regulatory," and "productive capacity and surge readiness". These signs simplify the challenge of interpreting multiple indicators by combining and integrating various them into "a single index on the basis of an underlying model."[11] As a result, they offer a better value for capturing multi-dimensional concepts, such as the health of the defense industrial base, for which single indicators prove inadequate as means of measurement. By tracking changes over time, our signs make modeling and other forms of advanced statistical values easier to analyze. Beyond their analytical benefits, they facilitate more inclusive and broader communication with the public. *Vital Signs 2022* presents the overall composite index score for each of the eight "vital signs" and the underlying analysis for each condition.

SCORE INDEX

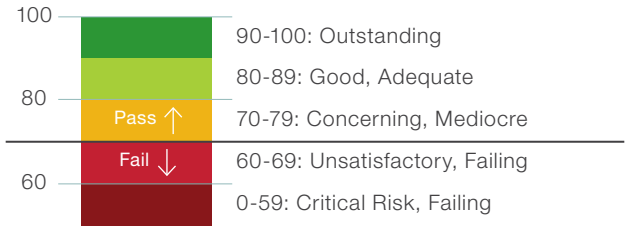


Figure 0.3, Source: NDIA

Signs are made up of one or more factors, which are themselves comprised of one or more indicators. NDIA analyzes over 50 publicly available statistical indicators that serve as empirical proxies, converts them into an index score scaled from 0 to 100,

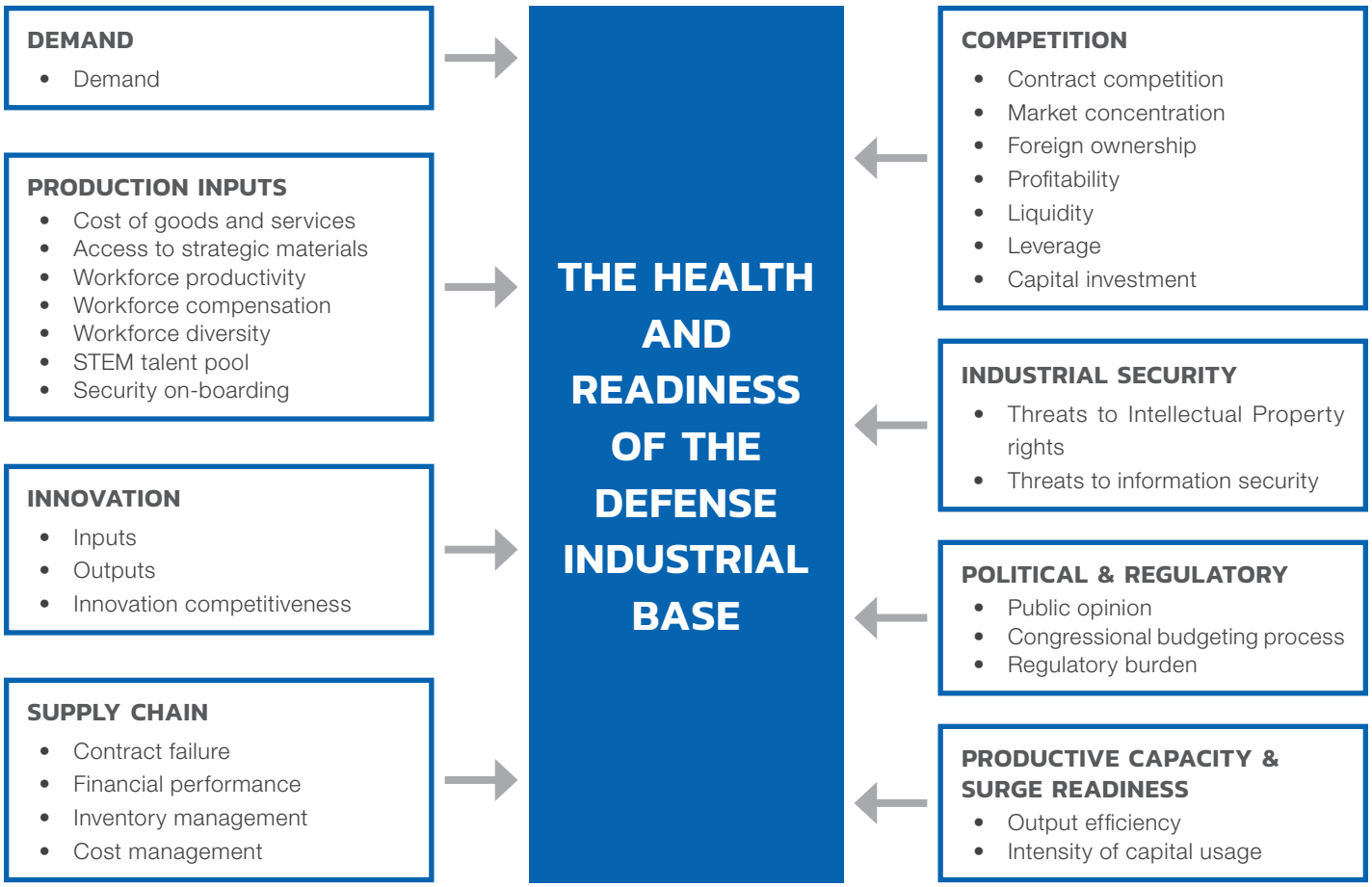


Figure 0.4, Source: NDIA

11 OECD, "The OECD-JRC Handbook on Practices for Developing Composite Indicators," paper presented at the *OECD Committee on Statistics*, 7-8 June 2004, OECD, Paris https://www.oecd.org/els/soc/handbookonconstructingcompositeindicatorsmethodologyanduserguide.htm

and evaluates three years of scores for each indicator. We consider scores above 70 to be a passing grade.

Our scores follow a nested approach, combining quantitative scores for each sign's factors and indicators into an overall health score. Factors are averaged to create the score for the sign. Finally, the eight vital signs are averaged together to make the final score.

SCORING AGAINST BASELINE VALUES

Indicator scores are calculated by the ratio of an indicator's average value to a control baseline value. Baseline values are either historical peak values (a prior value of the indicator that represents the best recent performance given available data) or, when conceptually appropriate, ideal standards. For each indicator, we provide an analysis that incorporates the influence of contemporary contextual events and forces that drive the indicator's performance. Each chapter includes a table detailing the current scores for each indicator in addition to its net change over the previous year. The availability of data in the public domain constrains the selection of baseline values.

DATA SOURCES

The indicators that form the basis of our analysis were constructed from multiple data sources and cited in each chapter. With the exception of the survey of NDIA members fielded in August 2021, our datasets are lagging indicators published before the nationwide vaccination efforts against COVID-19 began. These lagging indicators provide insight into the environment in which the industrial base had to operate during the first year of the pandemic.

Furthermore, we developed many indicators from public data sources. Our financial indicators, for example, are based on publicly available SEC filings obtained through our partner, decision science company, Govini. Some indicators are based on estimates generated by NDIA.

DEMAND

Change, 2020 – 2021

+6

DEMAND SCORES		
Overall factor	**2021**	**Change, 2020 – 2021**
Demand	94	+6
Overall demand score	***94***	***+6***

Figure 1.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

This section reviews developments in both cumulative defense procurement and contract distribution across various classifications of goods and services. It further presents scores for the overall demand for defense goods and services. It also provides an evaluation of major developments in the Department of Defense (DoD)'s contract demand and a corresponding analysis of the impact of these trends on industry as a whole.

KEY TAKEAWAYS

- "Demand" scored a 94 this year, representing a significant improvement from an already strong score last year
- DoD contract obligations for defense goods and services grew about 8% from the previous year.
- Aircraft, ships, and land vehicles were again the preeminent recipients of contract obligation dollars
- Foreign military sales saw a significant increase from 2019 to 2020, enjoying an over 30% increase in sales totaling over $50 billion, which represents a significant departure from the last several years where foreign military sales totaled in the mid-$30 billion
- Facilities and construction continue to make up a significant portion of contract obligations, as do professional services.

OVERVIEW

The scale of opportunities available to defense firms, both domestically and overseas, is a primary driver of the defense industrial base's vigor and health; without a robust market for public contracts and overseas sales, there would be insufficient demand to support a dynamic defense industry. The predictability of demand for defense goods and services directly translates to the capacity of firms to allocate resources towards both defense-related production and research and development of critical technologies.

Of course, the DoD's demand for the goods and services produced by firms is the principal driver of production and investment in the defense industrial base. As such, shifts in the quantity, scope, and composition of DoD purchases and contracts have a direct impact on firms' calculations regarding participation in the defense industrial ecosystem, the production of certain goods and services, resource allocation towards research and development, and their role in broader supply chains.

> **"The demand signals from foreign military sales increased significantly, representing a bright spot for the defense industry.**

The DoD is the single largest buyer of defense goods and services in the world. DoD's yearly contract obligations offer unique and unmatched insight into the larger demand for goods and services. Unsurprisingly, the U.S. defense budget drives a fairly constant "demand" signal. The stability of demand, in turn, allows firms within the defense industrial base to justify investments in the required productive capacity to fulfill contracts as well as funding ventures necessary to remain competitive when vying for future awards. Any decay in these budgetary foundations would undoubtedly raise the relative cost of market entrance for firms not already engaged in the defense industrial ecosystem and similarly raise the cost of continued or increased participation for those firms already engaged in defense markets. Ultimately, a substantial ebb in DoD-propelled demand would drive a corresponding decline in private sector investment and, in turn, modernization and technological dominance.

DEMAND SCORES			
Factor	**Indicator**	**2021**	**Change, 2020 – 2021**
Demand	DoD contract obligations totals	94	+6
Overall demand score		***94***	***+6***

Figure 1.2

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

CONTEXT

The demand for goods and services by the DoD and customers from foreign militaries drive production and investment in the defense industrial base. Similarly, shifts in the volume, disposition, and composition of the Department of Defense's contracting obligations also power corresponding changes in investment choices of individual firms within the defense industrial base. This segment of *Vital Signs 2022* examines major trends in the DoD's purchasing and contracting behavior, as well as the broader impact of these developments on the defense industry as a whole.

METHOD

For this section of the report, the value of annual DoD contract obligations serves as the primary indicator of "demand". This indicator combines the total value of new DoD procurement contract awards; research, development, testing, and evaluation (RDT&E) contracts; and foreign military sales (FMS) contracts. NDIA's decision science partner, Govini, provided this analysis by calculating the total contract obligation values based on their proprietary data science tradecraft.

Demand for defense goods and services

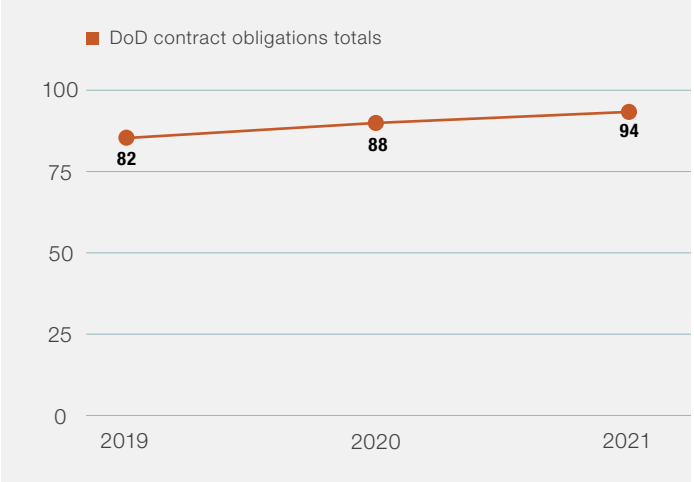


Figure 1.3, Source: NDIA

TRENDS

DoD contract obligations

As the dominant market actor, DoD's total contract obligations are a clear indicator of the demand for defense goods and services. Contract obligations increased again in 2020, building on last year's rise. This year we also adjusted the contract obligations for inflation. 2011 was our benchmark as the highest single year figure and adjusted the following years to 2011 dollars. We then scored the years as normal. This gave us a score of 94, a six point increase on last year when last year was also adjusted for inflation. As the nation's sole buyer of defense goods and services, and as the largest buyer in the world, the DoD and its annual total of contract obligations provide the best indication of the demand for defense goods and services. Contract awards drive production activity throughout industry as the defense industrial base relies on predictable demand from their DoD customer to justify investments in the productive capacity required to fulfill contracts and compete for future awards. Due to a limited amount of data available from the Carter-Reagan Era buildup, annual DoD contract obligations were scored against 2011's baseline value of $373.4 billion[12] — the highest peak in contract obligation volume within our dataset.

At $322.8 billion, contracts for major defense platforms — aircraft, ships, submarines and land vehicles — commanded the plurality of contract dollars, alone representing over 20% of all obligated contract dollars.

Foreign military sales

Figure 1.4, Source: NDIA

12 Based on Annual DoD contract obligations data provided by Govini for this 2022 report.

Facilities and construction ($196.3 billion) and professional services ($186.5 billion) composed nearly a quarter of total awarded contract dollars (24%), continuing to be significant drivers of DoD spending. Over 30% of total obligation dollars were devoted to IT ($136.8 billion), weapons and ammunition ($127 billion), sustainment of supplies and equipment or S&E ($115.2 billion), and research and development ($102.7 billion)[13].

Despite the expectation of flatter budgets in the immediate future (which looms large in the minds of many observers), recent demand signals from the DoD combined with the breadth of challenges that the organization is tasked with handling point to a continuation of strong demand and contract obligation growth.

Foreign military sales (FMS) improved significantly. FMS saw a significant increase from 2019 to 2020, enjoying an over 30% increase in sales totaling over $50 billion[14], which represents a significant departure from the last several years where FMS totaled in the mid-thirty billions. The demand signals from foreign military sales increased significantly, representing a bright spot for the defense industry.

SUMMARY

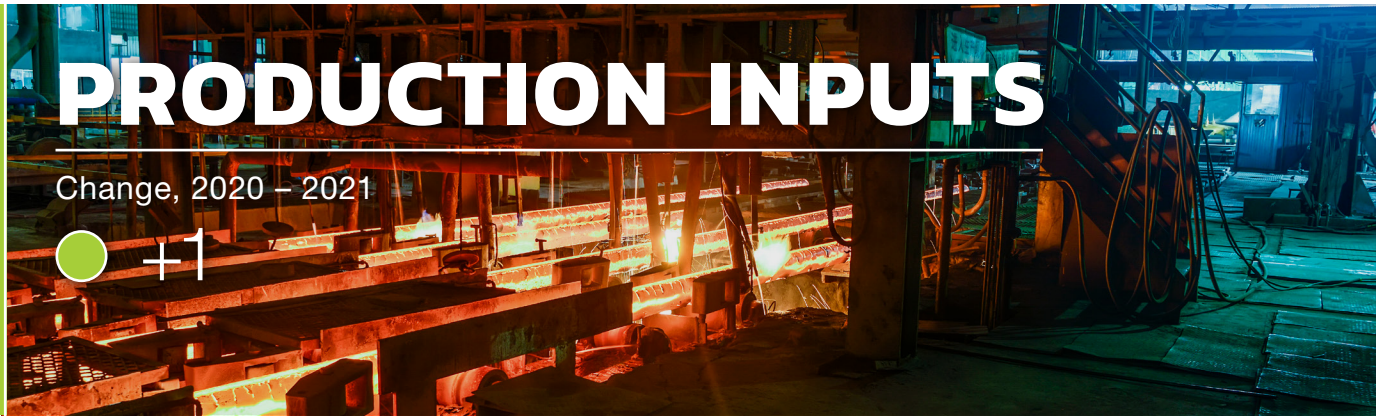
Demand from the DoD customer for defense goods and services has continued its upward trend. In the overall scoring, "demand" scored a 100, improving against last year's score of 93. Defense contract obligations and foreign military sales rose. It will be worthwhile to gauge the future impact of new defense policy documents such as the next National Defense Strategy and the Nuclear Posture Review impact demand.

Future defense demand will face the strain of upcoming budgets that will likely be flatter. Modernization and readiness, as well as recapitalization, are all factors to be decided upon in the future budgets that will have medium-term demand impacts for the defense industrial base.

The combined "demand" signal on the defense industrial base from FMS and direct commercial sales (DCS) remains a bright spot. Foreign sales also provide the DIB with economies of scale and the resources to invest in new capabilities. The U.S. remains the supplier of choice for defense capabilities.

13 Based on Annual DoD contract obligations data provided by Govini for this 2022 report.

14 Based on foreign military sales by fiscal year data provided by Govini for this 2022 report.



PRODUCTION INPUTS

Change, 2020 – 2021

+1

PRODUCTION INPUTS SCORES

Overall factor	2021	Change, 2020 – 2021
Costs of goods and services	58	-14
Access to strategic materials	43	+8
Workforce productivity	63	-1
Workforce compensation	97	+2
Workforce diversity	76	0
STEM talent pool	95	+3
Security on-boarding	36	+8
Overall Production Inputs Scores	***67***	***+1***

Figure 2.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

The cost and availability of the inputs used in the production of goods and services shapes the health and readiness of the defense industrial base in ways that have become more readily apparent since the start of the COVID-19 pandemic. Defense industry production relies heavily on intermediate goods and services, highly skilled labor, and raw materials. Trends in the cost and availability of these resources shed light on the ability of defense contractors to acquire the inputs necessary for production at a price and on a scale to perform on contracts.

KEY TAKEAWAYS

- Federal security clearance processes earned a critical risk score of 36 for 2021, eight points higher than last year's report
- The cost of goods and services indicator was negatively impacted by continuing supply chain constraints
- Workforce compensation remains the best performing indicator within "production inputs".

OVERVIEW

The "production inputs" sign has remained constant over the past two years. Within "production inputs", there is significant improvement among security onboarding, access to strategic materials, and workforce compensation. The largest decline within this sector is the cost of goods and services due to rising prices as seen around the U.S. economy, with productivity also showing a small drop.

Another area of concern is strategic materials, an indicator that represents America's ability to procure and produce rare earth metals critical to the manufacturing of magnets, microelectronics, LEDs and batteries that drive nearly every product that operates using electricity. Although this indicator was not included as a stand-alone factor in *Vital Signs 2020*, the importance of rare earths called for the inclusion of new data as well as the treatment of strategic materials as a separate factor in *Vital Signs 2021* and for this year. This factor continues to score poorly given the low levels of U.S. rare earth production.

> **"The industry's increasing workforce diversity reflects both demographic trends and a growing recognition of diversity and inclusion within the workforce.**

This section also illustrates why *Vital Signs 2022* uses a three-year trailing average for all the indicators. This year, the underlying data for diversity indicated a slight decrease though it highlights improvement from prior to COVID-19. Nevertheless, there were increases across the board for diversity indicators because previous years' increases pushed up the three-year average. Conversely, the underlying data for cost of goods saw a year-over-year decrease, and that declined because inflation drove the price up. However, their score has decreased due to the three-year average being driven down by recent performances.

CONTEXT

The "production inputs" scores are comprised of lagging indicators and reflect their state during the first part of the COVID-19 pandemic. Defense contractors use a variety of goods, services,

PRODUCTION INPUTS SCORES

Factor	Indicator	2021	Change, 2020 – 2021
Costs of goods and services	Producer Price Index of services for intermediate demand	98	+24
	Producer Price Index of processed goods for intermediate demand	18	-52
Overall costs of goods and services		***58***	***-14***
Access to strategic materials	Average Rare Earths Minerals (REMX) ETF prices	83	+8
	U.S. share of world rare earths mine production	39	+16
	Net import reliance as a percentage of domestic consumption	6	0
Overall access to strategic materials		***43***	***+8***
Workforce productivity	Adjusted productivity	63	-1
Overall workforce productivity		***63***	***-1***
Workforce compensation	Estimated average annual per-worker pay for defense-related employment	97	+2
Overall workforce compensation		***97***	***+2***
Workforce diversity	Gender diversity in employment in defense supplier industries	85	0
	Racial diversity in employment in defense supplier industries	79	0
	Latino ethnicity diversity in employment in defense supplier industries	41	0
	Age diversity in employment in defense supplier industries	100	0
Overall workforce diversity		***76***	***0***
STEM talent pool	STEM percentage of total U.S. occupational employment	95	+3
Overall STEM talent pool		***95***	***+3***
Security on-boarding	Annual inventory of security clearance investigation cases	39	+11
	Duration of initial top secret reviews (days)*	29	+6
	Duration of top secret periodic reinvestigations (days)*	39	+6
Overall security on-boarding		***36***	***+8***
Overall production inputs score		***67***	***+1***

Figure 2.2

**DSCA only released data for fasted 90% of cases*

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

materials, and security-cleared skilled labor to fulfill the requirements of defense contracts. The cost and availability of these "production inputs" are subject to institutional forces and changes in the market. Fluctuations in these production inputs affect delivery schedules, the quality of goods and services, as well as the final cost for the government customer. By presenting indicator scores for common defense production inputs, this section analyzes statistical factors that drive the supply side of defense production.

METHOD

This section describes key attributes of defense production inputs that include the costs of goods, services, and strategic materials; the size of the defense workforce; compensation; workforce diversity; workforce STEM talent pool availability; and the security on-boarding process. The indicators for the costs of goods, services, and strategic materials rely on Producer Price Index (PPI) data from the U.S. Federal Reserve Bank of St. Louis. This year, instead of looking at the PPI baselined to a year, we reviewed the rate of change from year to year. This is essentially the rate of inflation for goods and services, which can be benchmarked against a Federal Reserve Ideal of 2%. Data for the rare earth price indicator is based on VanEck Vectors® Rare Earths/Strategic Metals Exchange Traded Fund (REMX ETF) and production data from the U.S. Geological Service. Total employment, average compensation, diversity, and STEM talent data is derived from the U.S. Bureau of Labor Statistics and the National Science Foundation. Data for the security on-boarding process is sourced from the National Industrial Security Program Advisory Council.

Workforce size and productivity were also combined this year to make a new workforce productivity indicator. This is done by taking the workforce size, calculated the same as last year, and multiplying that by the annual labor productivity, which was also retrieved from the Federal Reserve Bank of St. Louis.

TRENDS

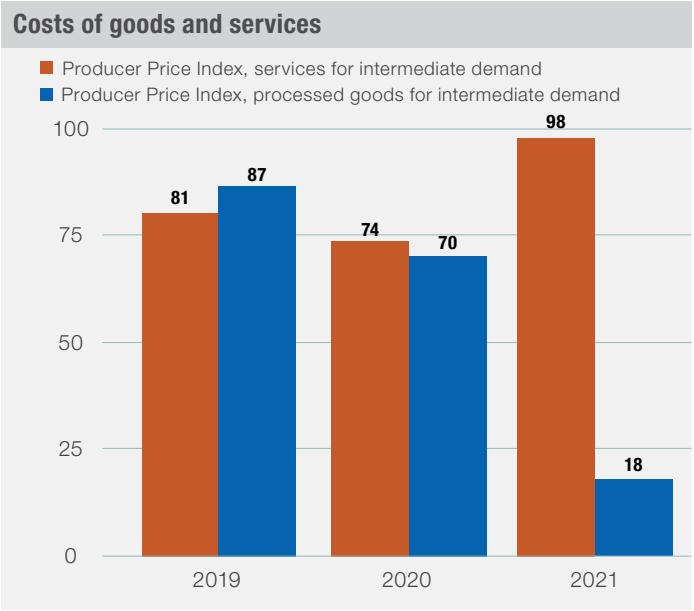


Figure 2.3, Source: NDIA

Costs of goods and services

The factor measuring the costs of goods and services saw the largest drop this year, down to 54, a 14 point drop from last year. The trend is based on the Bureau of Labor Statistics' PPI rate of change for intermediate goods and services, which were -2.8%[15] and 0.4%[16], due to disruptions from COVID-19 .

Defense contractors consume intermediate goods and intermediate services when performing their defense contracts, and rising costs can negatively affect productive capacity. Changes in production input costs can force producers to adapt their production plans by changing their per-unit cost structure of final products, altering production volumes, or passing along additional costs to the government customer. The Bureau of Labor Statistics' PPI measures average prices experienced by end-producers of goods and services across a single sector. The PPI of services for intermediate demand captures average prices for services consumed by end-producers that generate final products. The PPI of services for intermediate demand scored an 87 this year, which is actually a twenty-four point increase from last year, when recalculated with the new indicator method. The increase is not because 0.4% is a good change for 2020, but because the two previous years are strong enough to raise the score in the trailing average. The PPI of processed goods for intermediate demand shows a drop that wipes out any gains from services. In fact, the PPI of processed goods for intermediate demand scored a 18, which is a fifty-two point decrease from last year. This is because the PPI for processed goods has shown a negative value for the past two years, which take the three year average to almost 0%, well short of the federal target of 2%.[17] This drop is one of the largest effects that we can see from COVID-19, and will be an indicator to watch for in *Vital Signs 2023*, when the full impact of the COVID-19 pandemic and rising inflation is fully reflected in our report.

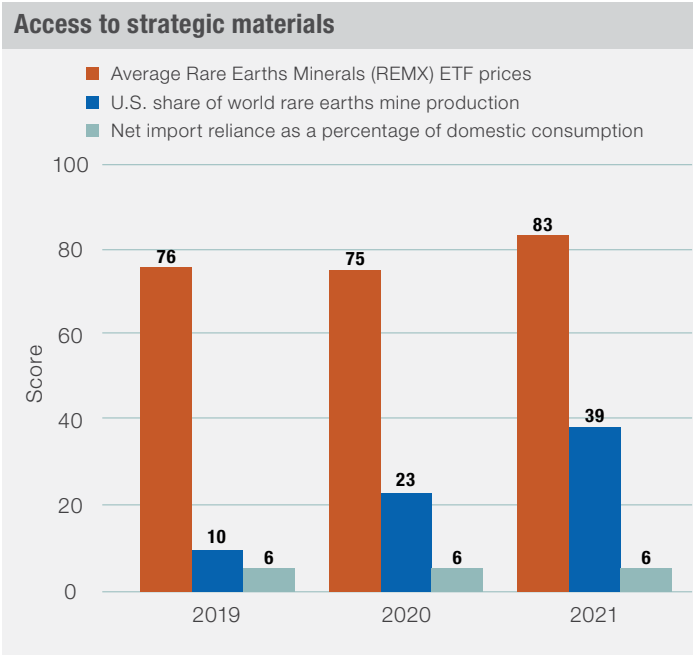


Figure 2.4, Source: NDIA

Access to strategic materials

Many defense companies use rare earth minerals and metals to manufacture defense items. Rare earths are a group of 17 elements critical to the manufacture of magnets, microelectronics, LEDs, and batteries. Rare earth minerals are also used in consumer products such as the Apple iPhone, which use rare earths to run its taptic engine.[18] China has restricted the export of rare earths, prompting concerns for their availability to the DIB.[19] Section 851 of the FY21

15 U.S. Bureau of Labor Statistics,"Producer Price Index by Commodity: Intermediate Demand by Commodity Type: Services for Intermediate Demand [WPUID63]," retrieved from FRED, *Federal Reserve Bank of St. Louis.* Accessed November 14, 2021, https://fred.stlouisfed.org/series/WPUID63.

16 U.S. Bureau of Labor Statistics, "Producer Price Index by Commodity: Intermediate Demand by Commodity Type: Processed Goods for Intermediate Demand [WPUID61]," retrieved from FRED, *Federal Reserve Bank of St. Louis*. Accessed November 14, 2021. https://fred.stlouisfed.org/series/WPUID61.

17 Board of governors of the Federal Reserve System, "Why Does the Federal Reserve Aim for Inflation of 2% over the Longer Run?" *Federal Reserve.* Accessed October 8, 2021. https://www.federalreserve.gov/faqs/economy_14400.htm.

18 Nellis, Stephen, "Apple Taps Recycled Rare Earth Elements for Iphone Parts." *Reuters*, September 18, 2019. Accessed September 29, 2021. https://www.reuters.com/article/us-apple-rareearths/apple-taps-recycled-rare-earth-elements-for-iphone-parts-idUSKBN1W31JG.

19 Yu, Sun, "China Targets Rare Earth Export Curbs to Hobble US Defence Industry." *Financial Times,* February 16, 2021. Accessed October 21, 2021. https://www.ft.com/content/d3ed83f4-19bc-4d16-b510-415749c032c1.

National Defense Authorization Act (NDAA) contains a provision that will require a report on strategic and critical materials that will include the gaps and vulnerabilities in rare earth supply chain.[20]

We consulted the REMX ETF measurement of average price activity across all rare earth metals to calculate our strategic materials score. The cost of rare earths was scored against a baseline annualized REMX ETF price for 2016 of $39.50. Meanwhile, the U.S. share of global production and the U.S. reliance on foreign production were scored against baselines of 32% in 1994, and 6% in 1995, respectively. These years represent peaks within our dataset. Within this metric, the score for the U.S. share of worldwide rare earths mine production increased from a score of ten points in 2018 to a score of 39 in 2021. Moreover, net import reliance as a percentage of domestic production remained unchanged from the 2019 and 2020 score of 6. These scores are representative of the low levels of production of rare earth metals within the United States as well as our continued reliance on imports. In fact, the United States exports nearly all the rare earths that it mines while continuing to rely on imports — all despite its increased domestic production.

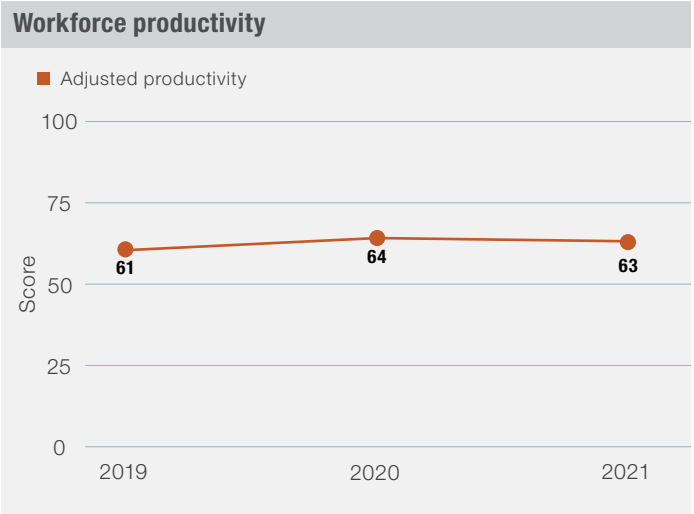


Figure 2.5, Source: NDIA

Workforce productivity

Workforce productivity is newly-included this year and was calculated by taking the top DoD North American Industry Classification System (NAICS) codes by Contract Obligations and pulling the data on the same NAICS codes from the Bureau of Labor and Statistics Quarterly Census of Employment and Wages.[21] The employment numbers for the different sectors were weighted by their portion of the contract obligations and added up to find an estimate for employment in the DIB. From there, we took each annual value and multiplied it by the annual Total Factor Productivity for the corresponding year.[22] This gives an adjusted workforce productivity, which we can baseline to the Carter-Regan buildup era, in this case 1985. The results show a more accurate score than workforce alone. While the number of people who work in the DIB has shrunk greatly, this drop is somewhat accounted for by rising U.S. labor productivity. This year scores a 63, a one-point drop from last year. The underlying cause is a smaller workforce than we saw last year.

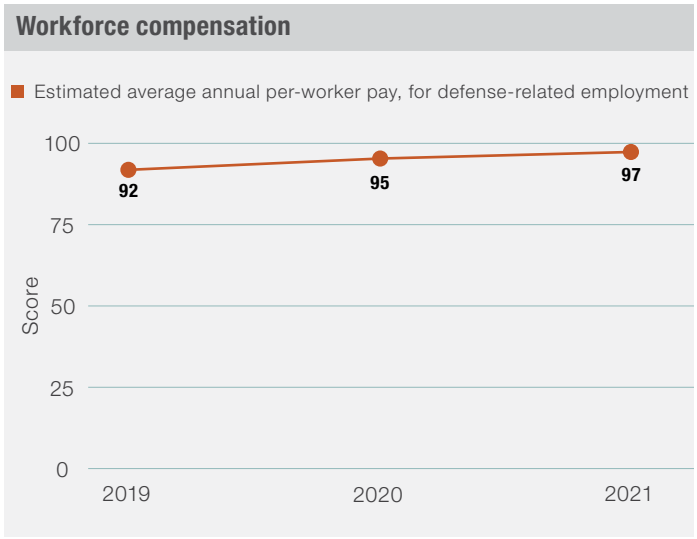


Figure 2.6, Source: NDIA

Workforce compensation

Workforce compensation scored a 97 for 2021, which increased by five points from a score of 92 in 2019, and two points from a score of 95 in 2020. These scores are based on an NDIA estimate of the average annual per-worker pay in defense-related industries of approximately $96,994. The workforce compensation number was arrived at using the same process and for workforce size as above, but with the wage data.

Workforce compensation strongly influences the defense industry's ability to recruit talented people. While skilled workers make essential contributions to the production of goods and services for defense contracts, trends in the average level of pay provided to individual industry workers indicates the value of their labor. Increasing wages, which is generally a very positive development for workers, can indicate tight labor markets that result in increased wages. Using wage data from the Bureau of Labor and Statistics, NDIA estimated a weighted average of annual pay per-worker in defense-related industries to demonstrate the trend in the valuation of talent within the DIB. Average annual per-worker pay was scored against a baseline value of $100,500, which is the inflation-adjusted level of annual per-worker pay from during the defense buildup peak of 1985.[23]

20 U.S. Congress, House, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, HR 6395 116th Cong., https://www.congress.gov/bill/116thcongress/house-bill/6395/text.

21 Bureau of Labor Statistics, "Quarterly Census of Employment and Wages 2020 Average Annual". Accessed September 18, 2021. https://www.bls.gov/cew/publications/employment-and-wages-annual-averages/2020/home.htm.

22 U.S. Bureau of Labor Statistics, "Nonfarm Business Sector: Labor Productivity (Output per Hour) for All Employed Persons [OPHNFB]," retrieved from FRED, *Federal Reserve Bank of St. Louis*. Accessed November 14, 2021. https://fred.stlouisfed.org/series/OPHNFB

23 David K. Henry and Richard P. Oliver, "The defense buildup, 1977- 85: effects on production and employment," *Monthly Labor Review*, 1987. Accessed December 8, 2021. https://www.bls.gov/opub/mlr/1987/08/art1full.pdf

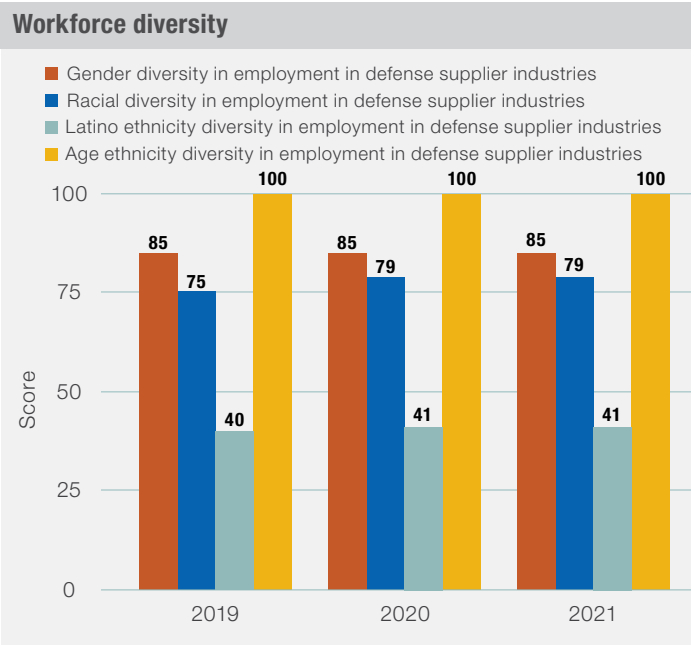


Figure 2.7, Source: NDIA

Workforce diversity

Workforce diversity scored a 76 for 2021, which marks a one-point increase from 2019. This score is based on NDIA's estimate of the value of Simpson's Diversity Index (SDI) for employment in defense-related industries according to age, gender, race, and ethnicity. Notably, this measurement includes the total population of employees and is not segmented by level of employee (e.g., individual contributor, management, executive).

The DIB derives its capabilities from the skills of its workforce and through its ability to attract talent from all parts of American society. Diversity includes differences in age, ethnicity, gender, and race. A diverse workforce enhances the breadth of knowledge, skills, and abilities present in the workforce. Several studies have found that diverse groups make better decisions.

To assess diversity within key supplier industries, an estimate of SDI serves as an indicator of the level of diversity present in the DIB.[24] SDI values measure the probability that any two members of a system, selected randomly, will be the same.[25] Each dimension of diversity was scored against an SDI value of 0.5 — the threshold value for a diverse population.

The industry's increasing workforce diversity reflects both demographic trends and a growing recognition of diversity and inclusion within the workforce. A 2016 Ernst and Young survey found that 54% of human resource professionals at leading global aerospace and defense companies identified the "lack of diversity at different levels of the organization" as the top talent management challenge for the sector.[26] A 2017 *Aviation Week* survey of top U.S. aerospace and defense companies identified a surge in the percentage of minorities in the workforce, increasing from 15% to 21%.[27] In 2020, *Aviation Week* reported a sizable increase in the percentage of women and minority executives.[28] Additionally, in 2019, 37.3% of new hires identified themselves as members of a minority group.[29]

In 2020, there were small dips in the SDI score for all categories, which highlights the importance of the way in which *Vital Signs* uses three-year running averages. That one-year small dip could be either anomalous or a leading indicator; however, this small, one-year shift was not enough to change the data. There were increases across the board for diversity indicators.

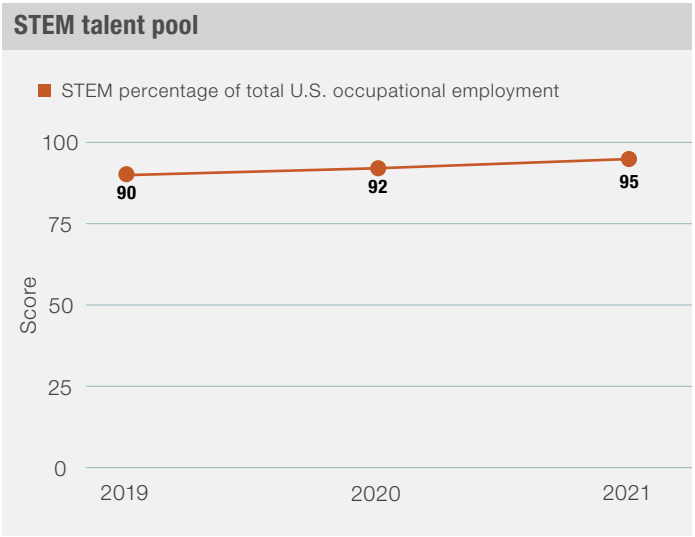


Figure 2.8, Source: NDIA

STEM talent pool

The size of the industry's technical talent pool scored a 95 for 2021, three points higher than in 2020. This score is derived from the science, technology, engineering, and mathematics (STEM) percentage of total U.S. occupational employment. The 2021 score for the technical talent pool uses NDIA's estimate of the average annual STEM share of total U.S. occupational employment — 12.8%. This was also based on data from the Bureau of Labor Statistics (BLS).[30]

24 Knudsen, Eric, "Simpson's Diversity Index: The Diversity Metric You Aren't Tracking Yet," *The Namely Blog*, December 8, 2020. Accessed December 8, 2021. Https://blog.namely.com/blog/the-diversity-metric-you-arent-tracking-yet

25 Royal Geographical Society, "A Guide to Simpson's Diversity Index." Accessed December 8, 2021. https://www.rgs.org/CMSPages/GetFile.aspx?nodeguid=018f17c3-a1af-4c72-abf2-4cb0614da9f8&lang=en-GB

26 Ernst and Young, "Top 10 risks in aerospace and defense." Accessed December 8, 2021. https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/manufacturing/ey-top-10-risks-in-a-d.pdf?download

27 AIA, "2017 Aviation Week Workforce Report," *Aviation Week*, November 30, 2017. Accessed October 12, 2021. https://www.aia-aerospace.org/report/2017-aviation-week-workforce-report/

28 AIA,"The Face of Aerospace & Defense," *Aviation Week*, September 25, 2020. Accessed October 12, 2021. https://aviationweek.com/aerospace/face-aerospace-defense

29 Ibid.

30 Bureau of Labor Statistics, "2020 Current Population Survey (CPS) Table 11b." Accessed September 2, 2021. https://www.bls.gov/cps/tables.htm

The availability of STEM workers impacts the productive capabilities of the DIB because such workers offer highly valuable technical skills that are essential for the design, development, and production of complex goods and services. Data from the BLS on the share of STEM workers that comprise total U.S. occupational employment indicates the amount of STEM-trained talent active within the workforce. This year's average percentage of 12.8% was scored against 13.5%, the single-year peak value that the STEM share of employment reached in 2020.

The growing size of industry's STEM talent pool reflects the influence of several factors. First, more undergraduate students choose STEM majors today than a decade ago.[31] STEM workers benefit from a wage premium when compared to workers in other industries or groups.[32]

In recent years, a debate has emerged among industry and government leaders about a deficit of STEM skills throughout the U.S. workforce. Depending on the field, both shortages and surpluses exist within the STEM workforce.[33] Thus, STEM employment faces a paradox in which an expanding pool of STEM graduates fails to keep up with the growing demand for skilled labor while the STEM workforce is aging.[34]

Within the DIB, concerns about the skills gap have focused on the availability of STEM workers for both manufacturing and engineering roles.[35] A 2018 study of the skills gap by Deloitte and the Manufacturing Institute estimated that 2.4 million open manufacturing positions would go unfilled between 2018 and 2028 due to a lack of available skilled labor.[36] Many defense leaders have issued calls to action to address this sort of STEM-based skills gap, citing growing shortages of engineers and technicians at a time of technological competition.[37] Many leading defense firms have responded to this trend by helping to grow the pipeline of STEM graduates entering defense engineering and manufacturing fields.

Another way to view this issue is our *Vital Signs* Survey. While there is not enough data to score yet, there are some worrying signs, with only 17% of respondents saying that finding STEM workers is "Not difficult." This points towards the demand for STEM workers also growing, because even after a record number of new graduates have entered the market, companies in the DIB continue to report challenges in finding qualified talent.

Rate the difficulty of finding workers

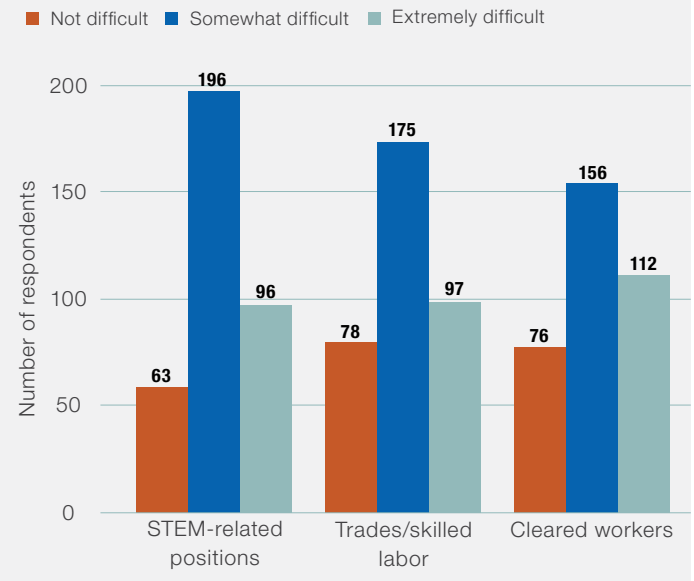


Figure 2.9, Source: NDIA

Security on-boarding

Federal security clearance processes earned a score of 36 for 2021, eight points higher than 2020. The security on-boarding factor is comprised of indicators from 2019 to 2020 that include the average annual inventory of security clearance investigation cases (218,900 cases), the duration of initial top secret clearance reviews (183 days); and the duration of periodic top secret clearance reinvestigations (240 days). The average annual inventory of security clearance investigation cases was scored against a baseline from FY10 (~162,000 cases); the duration of initial top secret clearance reviews (100 days); and the duration of periodic top secret clearance reinvestigations (180 days).[38]

On-boarding new personnel in the defense industry often requires navigating the security clearance process. Access to security clearances affects the availability of skilled workers for the DIB because some contracts require employees to possess security clearances to begin work. Achieving a permanent security clearance requires an extensive background check. The capacity and

31 Yadoo, Jordan, "American College Students Are Swapping Shakespeare for STEM," *Bloomberg News*, September 14, 2018. Accessed December 8, 2021. https://www.industryweek.com/talent/article/22026345/american-college-students-areswapping-shakespeare-for-stem

32 Pew Research Center, "7 facts about the STEM workforce," FACTANK, *Pew Research Center*, January 9, 2018. Accessed December 8, 2021. https://medium.com/@pewresearch/7-facts-about-the-stem-workforce-fe2a9fb87cad

33 Xue, Yi and Richard C. Larson, "STEM crisis or STEM surplus? Yes and yes," *Monthly Labor Review, U.S. Bureau of Labor Statistics*, May 2015. Accessed December 8, 2021. https://www.bls.gov/opub/mlr/2015/article/stem-crisis-or-stem-surplus-yes-and-yes.htm

34 Kramer, Mark et al. "The Global STEM Paradox," *FSG and the New York Academy of Sciences*, 2015. Accessed December 8, 2021. https://www.nyas.org/media/15805/global_stem_paradox.pdf

35 Aerospace Industries Association and the American Institute of Aeronautics and Astronautics, "2016 National Aerospace & Defense Workforce Summit: Proceedings Report & Recommendations," 2016, Accesed December 8, 2021. http://static.politico.com/88/1f/4bdfa7e04063a94044eecf1c7f21/2016-national-aerospace-defense-workforce-summitproceedings-report-recommendations.pdf

36 Giffi, Craig et al, "2018 Deloitte and the Manufacturing Institute skills gap and the future of work study," *Deloitte Insights*, 2018. https://www.themanufacturinginstitute.org/research/2018-deloitte-and-the-manufacturing-institute-skills-gap-and-future-of-work-study/

37 Hewson, Marillyn, "We must close the skills gap to secure our future," *FoxNews.com*, July 19, 2018. Accessed December 8, 2020. https://www.foxnews.com/opinion/we-must-close-the-skillsgap-to-secure-our-future

38 Ogrysko, Nicole, "Agencies on Deadline to Enroll Security Clearance Holders in Continuous Vetting," *Federal News Network*, April 21, 2021. https://federalnewsnetwork.com/defense-industry/2021/04/agencies-on-deadline-to-enroll-security-clearance-holders-in-continuous-vetting/.

efficiency of the security clearance investigation process and the issuance process may act as a constraint on the ability of defense contractors to fill defense contracting jobs. The backlog of security clearances has seen a significant decrease since the release of *Vital Signs 2020*. Though the three-year trailing average is still largely dominated by the massive increase from 2018, the inventory was down from a high of over 700,000 cases to just over 300,000 cases in 2019. The drop in cases has coincided with investigations being handed over from the National Background Investigations Bureau to the Defense Counterintelligence and Security Agency (DCSA). Both new investigation times and reinvestigation times are down on a year-by-year basis. However, it is worth mentioning that DCSA only released the average time for the fastest 90% of investigations in 2019. As mentioned previously, it is unclear if this trend will continue long enough to have a significant bearing upon future averages.

SUMMARY

While "production inputs" demonstrated increasingly poor performance with an overall unsatisfactory and failing score of 67 for 2021, that score is a one increase from 2019. The failing performance of the federal clearance system led to a low score of 36 for security on-boarding, a key limiting component in the defense industry's access to skilled labor. The costs of goods and services scored a good 58 for 2021. This is a 14 point drop from last year and a 26 point drop from 2019; meanwhile, access to strategic materials increased by twelve points from 31 in 2019 to 43 in 2021. Workforce diversity improved by one point — to a mediocre 76 in 2021 from 75 in 2019 — driven primarily by a four-point improvement in racial diversity from two years ago. The skilled workforce pool scored a 95, rising as a result of an expansion of STEM-trained graduates and workers drawn to the compensation premium associated with STEM jobs and educational backgrounds.

INNOVATION

Change, 2020 – 2021

0

INNOVATION SCORES

Overall factor	2021	Change, 2020 – 2021
Innovation inputs	75	-2
Innovation competitiveness	73	0
Innovation/intellectual property production	59	+3
Overall innovation score	***69***	***0***

Figure 3.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

The U.S. has long relied on private industry to spearhead research and development into innovation and new technologies to ensure our nation's capabilities superiority across all domains of warfare. This chapter examines trends in our innovation ecosystem's inputs, outputs, and competitiveness and highlights the defense industrial base's ability to yield innovations that help our warfighters maintain or expand upon their technological advantage. Trends in industrial R&D investment and patent activity help form a picture of the state of private sector defense innovation.

KEY TAKEAWAYS

- Overall, "innovation" scored a 69 for 2021, which meant no change from 2020
- The continued decline in basic science R&D expenditures and overall productivity has placed significant downward pressure on innovation
- Between 2011 and 2016, U.S. government funding for R&D projects fell by 12% in absolute terms. Over the same time frame, Russia and China grew public investment in R&D by 13% and 56%, respectively.

OVERVIEW

For decades, the U.S. National Defense Strategy has looked to the DIB as an essential source of technological innovation. The manufacturing and services industries associated with the most technology-intensive goods and services acquired by DoD are the source of significant amounts of capital for research and development. Trends in industrial R&D investment and patent activity help to form a picture of the state of private sector defense innovation. Many DoD programs require, or are the result of, large investments in research and development. Both the technical research of applied science and foundational basic research are key to this effort.

For *Vital Signs 2022*, "innovation" remained stagnant with a failing grade just below passing when adjusted for changes in scoring. The decline in innovation investments stems from scientific R&D services industries—typically those focused on basic research.

> **"The growing intensity of competition with both China and Russia requires the maintenance and expansion of U.S. technological dominance.**

This sector also continues to be a poor performer in innovation outputs, which accounts for the lack of change in the status of scientific R&D services, a key force in the decline of innovation.

R&D investment in technology and manufacturing continues to be strong. Manufacturing innovation outputs saw a slight rebound from last year but overall, this factor is still down from 2019. Direct DoD innovation spending patterns provide another way of looking at the innovation landscape. Research, development, test, and evaluation continue to dominate DoD innovation spending, but OTA's continue to increase at a rapid rate.

METHOD

This section presents scores for industrial innovation drawn from the U.S.-based innovation inputs, innovation outputs, and the international competitiveness of industrial innovation. The overall scores for "innovation" inputs and outputs are derived from the total dollar value of corporate R&D expenditures and annual patent applications

INNOVATION SCORES

Factor	Indicator	2021	Change, 2020 – 2021
Innovation inputs	Average annual value of worldwide R&D paid for by United States-based companies, selected durable industrial goods manufacturing industries	100	0
	Average annual value of worldwide R&D paid for by United States-based companies, information and communications technologies	100	0
	Average Annual Value of Worldwide R&D paid for by United States-based companies, scientific R&D services	25	-6
Overall innovation inputs		***75***	***-2***
Innovation competitiveness	Share of international patent applications, U.S.-origin	68	-1
	Share of global R&D investment, U.S.-origin	77	+1
Overall Innovation competitiveness		***73***	0
Innovation/intellectual property production	Average annual patent applications, durable industrial goods manufacturing	50	+4
	Average annual patent applications, information and communication technologies goods and services	90	+6
	Average annual patent applications, scientific R&D services	36	-2
Overall innovation/intellectual property production		***59***	***+3***
Overall innovation score		***69***	0

Figure 3.2

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

obtained from the National Science Foundation, respectively. The final score for "innovation" competitiveness is based on patent data from the World Intellectual Property Office, and comparative international expenditures data from the Organization for Economic Cooperation and Development.

TRENDS

Innovation inputs

In 2021, innovation inputs scored 75, a slight decrease of 2 points from the previous year, 2020. NDIA calculates this overall score for innovation outputs based on the value of worldwide research and development (R&D) paid for by U.S.-based companies.[39] More specifically, NDIA accounts for U.S. based R&D spending in three categories: 1) selected durable industrial goods, 2) information and communications technology, and 3) scientific R&D services.[40]

Defense industrial base investment in innovation plays a key role in advancing and enhancing defense-related technologies. By engaging in R&D projects, firms can develop proprietary capabilities that can be scaled-up and incorporated into the larger defense industrial ecosystem, once their value is proven. Private sector investment in R&D still dominates overall R&D funding, accounting for nearly 70%

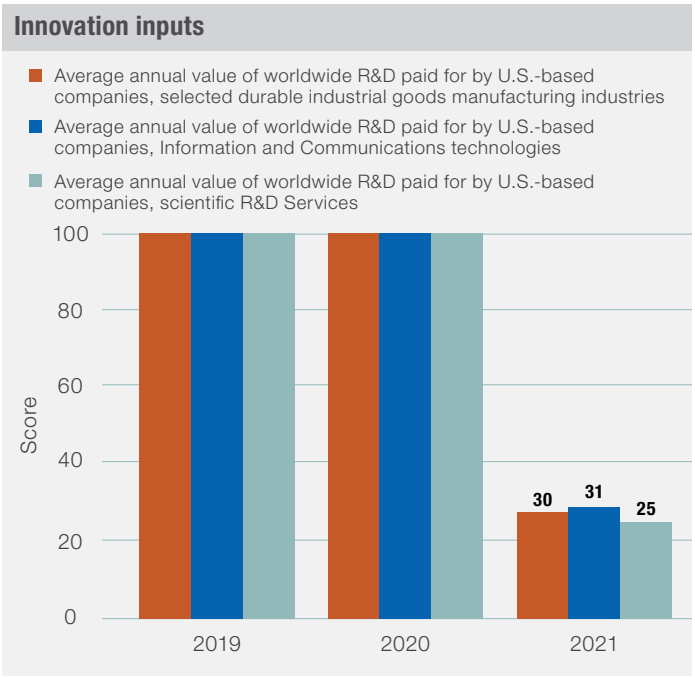


Figure 3.3, Source: NDIA

39 National Science Foundation, "Business Enterprise Research and Development Survey (BERD)." December 16 2020. Accessed September 5, 2021. https://ncses.nsf.gov/pubs/nsf21312.

40 Selected durable industrial goods manufacturing (NAICS codes: 3251, 3252, 3255, 3259, 326, 327, 331, 332, 3336, other 333, 335, 336), Information and Communication Technologies goods and services (NAICS 333242, 334, 5112, 517, 518, 5415), Scientific R&D Services (5417)

of all U.S. R&D expenditures.[41] Nevertheless, the trends outlined in this report indicate a decline in defense-related private sector R&D.

The defense sector does not enjoy the same R&D incentives that the broader organic industrial base does resulting in relatively low levels of R&D. Additionally, the U.S. defense market is a monopsony, which can sometimes result in unclear demand signals by the DoD, the sole customer, creating a larger risk to such investments. As a result, new innovative technologies are often fielded through mergers and acquisition activity by larger companies. We intend to study this effect in future editions of *Vital Signs*.

From 2022, companies will be required to amortize their R&D expenses over five years as part of the Tax Cuts and Jobs Act of 2017 (TCJA). Since 1954, and prior to the introduction of the TCJA, companies were allowed to deduct qualifying R&D expenses under Section 174 of the Internal Revenue Code. The requirement for companies to capitalize and amortize R&D expenses amounts to a significant tax increase, which will negatively impact innovation.[42]

The Congressional Research Service categorizes R&D funding by the nature of the work it supports: basic research, applied research, and development[43]. Basic research is experimental and theoretical, applied research is primarily undertaken with a specific practical aim or objective in mind, and development is directed towards producing new, or improving existing, products and processes. Private industry dominates funding of both development and applied research projects, accounting for 85.2% and 54.3% expenditures, respectively. The Federal Government, however, accounts for the majority of basic research funding.[44] As the Federal Government continues to allocate fewer funds to R&D projects—and without private investment to supplement this decline—the DIB faces the decay of the most basic scientific and technological R&D capabilities.

Innovation outputs

In 2021, innovation outputs scored 59 which was a modest increase from the previous year's 56. NDIA scores innovation outputs based on three indicators tied to annual patent application filings for inventions associated with 1) durable goods manufacturing, 2) information and communications technologies, and 3) scientific R&D services.[45] This year, information and communications technology uses a new baseline because the most recent data represented a new peak value for this indicator.

We define innovation outputs as "how well the U.S. innovation system generates new inventions." Inventions are new solutions to problems that generate goods and services. Patent applications are an effective proxy to measure inventions and innovation productivity. They also help identify new technical creations with beneficial commercial uses. However, patent issuances include only those innovations that qualify for a patent and have been filed, which means they do not effectively represent all productive innovation outputs.

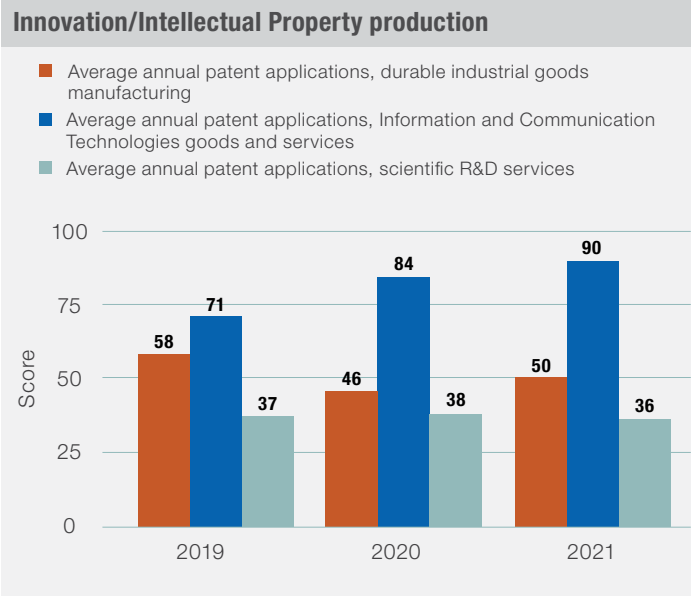


Figure 3.4, Source: NDIA

As with our previous reports, the average annual patent application totals were scored against a series of baseline figures: in 2013 there were 71,202 total patent applications for durable goods manufacturing; 64,665 in 2008, for information and communications technologies; and 7,072 for 2008, for scientific R&D services. These years represent standout levels of patent applications.

And as with innovation inputs, the trends for average patent applications submitted for inventions in durable goods manufacturing and information and communication technologies are related to trends in scientific R&D services.

Innovation competitiveness

Innovation competitiveness scored 73 in 2021, a two-point decline from the 2019 score of 75. NDIA calculated the score for innovation competitiveness using the U.S. share of global R&D investment, which currently stands at a three-year average of 29%.[46]

41 Congressional Research Service, "U.S. Research and Development Funding and Performance: Fact Sheet". October 4, 2021. Accessed November 1, 2021 https://sgp.fas.org/crs/misc/R44307.pdf.

42 Atkinson, Robert D, "The Case for Repealing the R&D Amortization Provision in the 2017 Tax Cuts and Jobs Act," *Information Technology and Innovation Foundation,* September 7, 2021. Accessed December 8, 2021. https://itif.org/publications/2021/09/07/case-repealing-rd-amortization-provision-2017-tax-cuts-and-jobs-act.

43 Congressional Research Service, "U.S. Research and Development Funding and Performance: Fact Sheet". October 4, 2021, Accessed October 5, 2021. https://sgp.fas.org/crs/misc/R44307.pdf.

44 Ibid.

45 National Science Foundation, "Business Enterprise Research and Development Survey (BERD)." December 16 2020. Accessed September 5, 2021. https://ncses.nsf.gov/pubs/nsf21312.

46 Organization for Economic Cooperation and Development (OECD), "Main Science and Technology Indicators." Accessed November 9, 2021. https://www.oecd.org/sti/msti.htm.

Innovation competitiveness

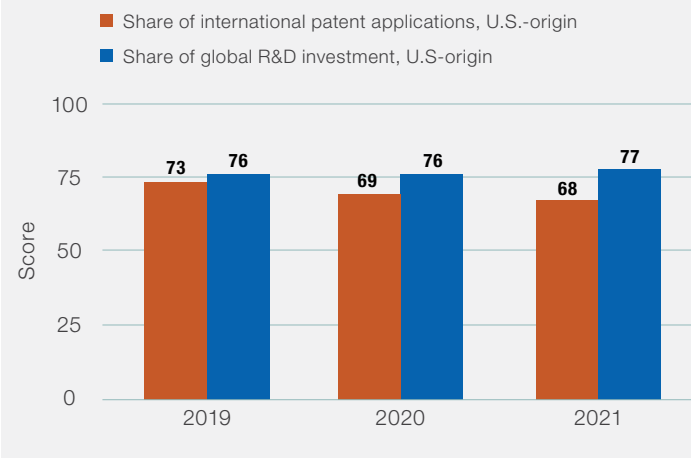


Figure 3.5, Source: NDIA

This indicator also looks at U.S. patents as a share of the global total.[47] This indicator was used in *Vital Signs 2020* but was absent last year given a lack of updated data. This year, the U.S. patents indicator shows a slight improvement from two years ago. The measurement of innovation inputs and outputs are important metrics which frame the state of the current environment, yet such activities also occur within the broader international ecosystem.

The growing intensity of competition with both China and Russia requires the maintenance and expansion of U.S. technological dominance. However, in recent years, U.S. investment in R&D has declined precipitously as a percentage of global expenditures. In 1995, the U.S. accounted for nearly 40% of global R&D; yet by 2019 that number had dropped to just 29%.[48] Similarly, while international research intensity among developed nations has continued to rise, the U.S. has remained behind. As of 1995, the U.S. ranked fourth in terms of total R&D expenditures as a percentage of GDP; by 2019, it had tumbled to tenth.[49]

Outside of the private sector, public sector investment in innovation also continued to deteriorate. This is especially significant considering that public sector funding dominates the area of basic, experimental, and theoretical research in the U.S. Between 2011 and 2016, U.S. government funding for R&D projects fell by 12% in absolute terms. Over the same timeframe, Russia and China grew public investment in R&D by 13% and 56%, respectively.[50]

DoD innovation spending

DoD's innovation spending patterns provide another lens for understanding innovation trends. Since FY 2016, DoD's RDT&E budget requests have grown, with the FY 2022 request being the highest ever made at $112 billion, a 5% increase over FY 2021. The FY 2020 request was DoD's overall largest budget request in 70 years, with a marginal increase of 0.1% coming the year after.[51] The FY 2022 request is the largest ever made at $715 billion.[52] This is up from $705.4 billion in FY 2021, representing a 1.6% increase this year.

In addition to competition with China and Russia, the FY 2022 budget request emphasizes broader challenges to global security such as climate change and the global threat it poses to military installations. This request includes $617 million to accelerate DoD's response to climate change in addition to a further $500 million for pandemic preparedness and COVID-19 mitigation. The budget also focuses on modernization and future technologies, including $14.7 billion for science and technology broadly in addition to investments in artificial intelligence, 5G, and microelectronics.

The DoD has also turned to its National Security Innovation Network to create alternative funding pathways in this area, particularly outside of traditional defense contractor networks. This has included several pitch competitions open to the public and attempts to incorporate non-traditional contractors into defense circles. Finally, this year's budget request also includes a Defense Production Act request "to partner with U.S. companies to boost the defense industrial base and bring critical supply chains back to the U.S., including rare earth elements and microelectronics," totaling $341 million.

SUMMARY

In terms of contributing factors, corporate investment into industrial research and development in defense-related industries scored a 75, marking a two-point decline since 2019. The declining level of inputs coming from scientific R&D services, industries that are typically focused on basic research, is a critical component in the overall decline in "innovation". Innovation outputs regarding patent applications from defense-related industries scored a 59, four points higher than 2019 when previous years were rescored with a new baseline. For 2021, innovation competitiveness scored 73, which is a decrease of two points from 2019.

Overall, "innovation" scored 69 for 2021 in the United States and has failed this year, although this sign is stable across the last two years when new indicators are integrated into previous scores.

47 World Intellectual Property Organization, "WIPO IP Statistics Data Center." Accessed October 29, 2021. https://www3.wipo.int/ipstats/.

48 The Task Force on American Innovation, "Second Place America? Increasing Challenges to U.S. Scientific Leadership," *The Task Force on American Innovation,* May 2019. http://www.innovationtaskforce.org/wp-content/uploads/2019/05/Benchmarks-2019-SPA-Final4.pdf.

49 Ibid.

50 Caleb Foote, Robert D. Atkinson, "Dwindling Federal Support for R&D Is a Recipe for Economic and Strategic Decline," *Information Technology and Innovation Foundation*, December 14, 2018. Accessed November 1, 2021. https://itif.org/publications/2018/12/14/dwindling-federal-support-rd-recipe-economic-and-strategic-decline.

51 Department of Defense, "DoD Releases Fiscal Year 2021 Budget Proposal," February 10, 2020. Accessed November 3, 2021. https://www.defense.gov/Newsroom/Releases/Release/Article/2079489/dod-releases-fiscal-year-2021-budget-proposal/.

52 Department of Defense, "The Department of Defense Releases the President's Fiscal Year 2022 Defense Budget," May 28, 2021. Accessed November 3, 2021. https://www.defense.gov/News/Releases/Release/Article/2638711/the-department-of-defense-releases-the-presidents-fiscal-year-2022-defense-budg/

SUPPLY CHAIN

Change, 2020 – 2021

● -8

SUPPLY CHAIN SCORES

Overall factor	2021	Change, 2020 – 2021
Contract failure	37	● +10
Financial performance	38	● -36
Inventory performance	75	● -8
Cost management	100	● 0
Overall supply chain score	***63***	● ***-8***

Figure 4.1

Factor score key				
● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

The performance of supply chains factors into assessments of the health of the defense industrial base. Defense supplier networks rely on well-functioning relationships among companies to deliver products and services to fulfill their government contracts. This section of the report studies trends in contract failures, supply chain financial performance, inventory performance, and cost management.

KEY TAKEAWAYS

- "Supply chain" scored a 63, erasing the significant improvements measured in last year's report
- Contract failure scored a 37 for 2021, marking a substantial increase of 10 points from the 2020 score of 27
- The defense industry scored a 38 for financial performance in 2021. This represents a very sharp decline, down 36 points from last year.

OVERVIEW

Reliable supply networks are vital to the health and readiness of the defense industrial base and our national security as evidenced by the semiconductor shortage that has hit all industrial sectors during the pandemic. As such, the performance and efficiency of these supply chains directly drive industry's capacity to provide affordable, timely, and high-quality goods and services to defense customers. These broader conditions are the product of other trends across defense-related and commercial supplier networks that include rates of contract failure, financial performance, inventory management, schedule management, and cost management.

> **"We expect that next year's report will reflect even greater supply chain challenges wrought by the pandemic.**

METHOD

There is one major change from last year's report. We are no longer able to track Schedule Management. We based this score on Selected Acquisition Reports (SAR). These reports were based on Major Defense Acquisition Program (MDAP) data that was previously reported to Congress, however, in the FY 2020 NDAA[53], Congress chose to stop requiring these reports. Without them there is no other publicly available source of data that tracks the costs of schedule changes to major DoD programs.

The "supply chain" section offers scores for indicators that reflect the overall performance of defense supply chains. The indicators in this section depict trends in contract failure, supply chain financial performance, inventory management, and cost management. The indicator for contract failure rates was drawn from data on contract terminations for cause, which was obtained from the Federal Awardee Performance and Integrity Information System. For financial performance and inventory management, NDIA calculated industry's cash conversion cycle and inventory turnover ratio, respectively. These calculations relied on data obtained from our partner, decision science company Govini, as well as annual reports, required by the Securities and Exchange Commission, of the annual filings of the top 100 recipients of defense contracts. Lastly, the indicator for cost management was drawn from the number of Nunn-McCurdy cost breaches reported by the DoD's Director of Cost Assessment and Program Evaluation.

53 U.S. Congress, House, National Defense Authorization Act for Fiscal Year 2020 S.1790, 116th Cong., https://www.congress.gov/bill/116th-congress/senate-bill/1790/text.

SUPPLY CHAIN SCORES

Factor	Indicator	2021	Change, 2020 – 2021
Contract failure	Average annual DoD contracts terminated for cause	37	+10
Overall contract failure		***37***	+10
Financial performance	Weighted average cash conversion cycle for top defense contractors	38	-36
Overall financial performance		***38***	-36
Inventory performance	Weighted average inventory turnover ratio for top defense contractors	75	***-8***
Overall inventory performance		***75***	***-8***
Cost management	Average Nunn-McCurdy unit cost breaches	100	0
Overall cost management		***100***	0
Overall supply chain score		***63***	***-8***

Figure 4.2

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

TRENDS

Contract Failure

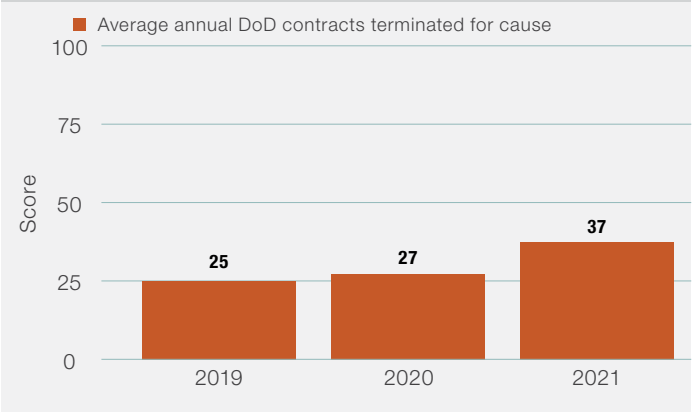


Figure 4.3, Source: NDIA

Contract failure

The defense industry's contract failure indicator scored a 37 for 2021, marking a substantial increase of 10 points from the 2020 score of 27. The considerable surge in scoring is due to an equally sizable decrease in the average number of contract terminations for cause. In 2019, there were 394 contract terminations for cause; in 2020 there were just 164.[54]

All federal agencies, including the DoD, maintain the ability for complete or partial termination of contracts for the convenience of the Government or for default. Contracting officers are often only able to exercise this mechanism after a lengthy process consisting of official complaints and contractor responses. Trends in contract terminations reveal broader patterns of contract performance and award management. As such, contract terminations serve as a very useful gauge to understand systemic challenges across the DoD contract management ecosystem. Contract terminations were scored against a baseline of 135 for 2014, which is the first year for which a longitudinal dataset for this statistic is available.

Financial performance

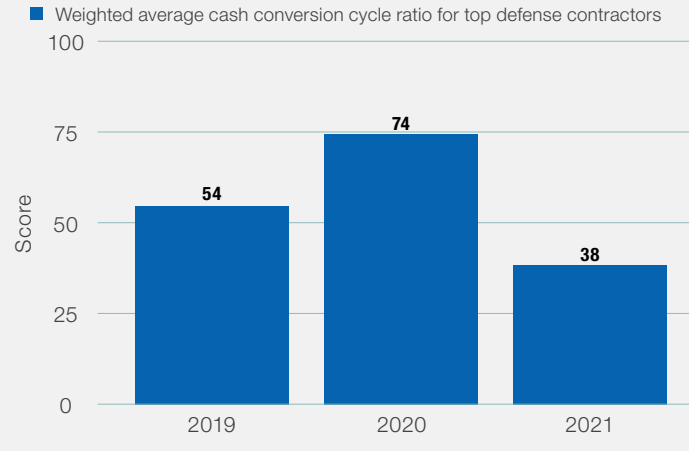


Figure 4.4, Source: NDIA

Financial performance

The defense industry scored a 38 for the financial performance indicator in 2021. This represents a very sharp decline, down 36 points from last year, and reflects the challenges the COVID-19 pandemic has posed to defense supply chains. The score is based on the average cash conversion cycle for companies.[55]

The cash conversion cycle illustrates how well supply chains function by indicating the time needed for a company to regain a dollar invested in product inventory as cash receipts. Converting product investment into cash receipts involves all stages of the supply chain process — providing a valuable indicator to the health

54 General Services Administration, "The Federal Awardee Performance and Integrity Information System (FAPIIS)." Accessed October 25, 2021. https://www.fapiis.gov/fapiis/#/reports.

55 Based on financial data of the top 100 provided by Govini

of defense industrial base supply chains. Trends in the length of the cash conversion cycle suggest a pattern of either improvement or deterioration in supply chain performance.

The cash conversion cycle helps to illuminate supply chain liquidity conditions. Companies rely on cash generated from sales to finance the production of additional goods for sale. While a shorter cash conversion cycle helps companies to fund operations without having to access capital markets, a longer cash conversion cycle indicates that companies face greater difficulty in relying on sales for the liquidity necessary to fund critical operations.

Inventory performance

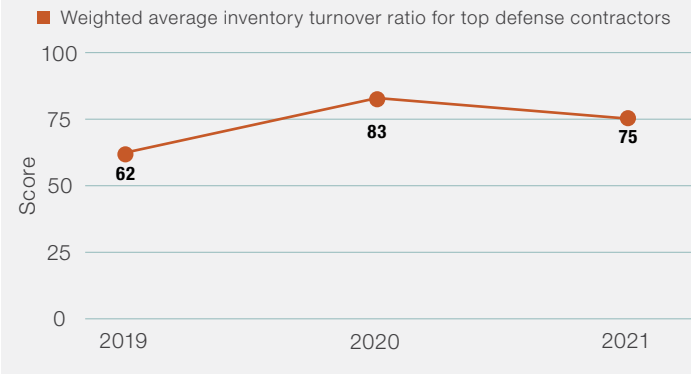


Figure 4.5, Source: NDIA

Inventory performance

Inventory management scored a 75 for 2021, an eight-point decline from last year.[56] The inventory turnover ratio was scored against the highest performing year in our dataset.[57]

Given current conditions, do you think your company's supplier network will be more: reliable, less reliable, or about the same at delivering goods, materials, and services necessary for DoD contracts?

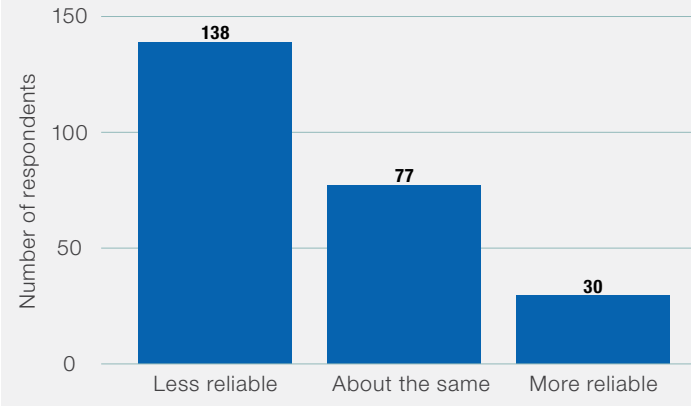


Figure 4.6, Source: NDIA

Historically, defense manufacturing firms maintain extra inventory because of the complexity of their supply chains and long production lead times.[58] While increased inventory can protect against potential sole-source chokepoints among lower-tier suppliers, industry risks a loss of both supply chain flexibility and working capital.[59]

Supply chain issues are also demonstrated in the results of our *Vital Signs Survey 2022*. In it we asked, "given current conditions, do you think your company's supplier network will be more reliable, less reliable, or about the same at delivering goods, materials, and services?"[60] Only 12% thought their supplier networks would be more reliable.

Cost management

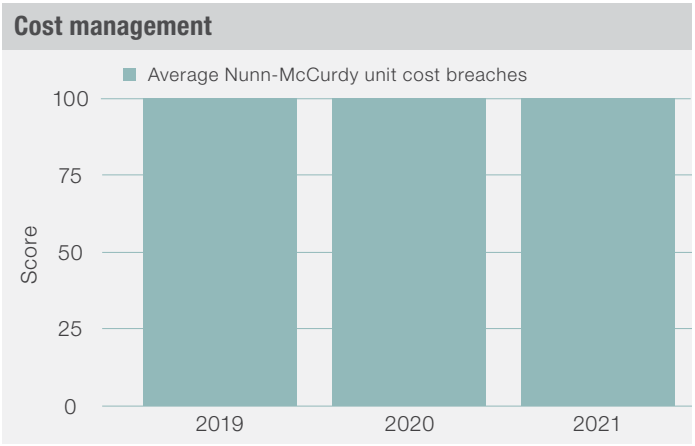


Figure 4.7, Source: NDIA

Cost management

The defense industry's cost management indicator scored a 100 for this year. Over the past decade, there were no more than a handful of Nunn-McCurdy cost breaches each year. Supply chain cost management is a critical sign as to the health and readiness of the DIB. Supply chain costs can come from a wide variety of places. The cost management for Major Defense Acquisition Programs (MDAPs) has been a concern of lawmakers and policymakers for decades. The Nunn-McCurdy Act of 1983 created mechanisms for alerting Congress when an MDAP surpasses its cost threshold. Tracking Nunn-McCurdy breaches provides a valuable proxy for industry's supply chain cost management trends.

SUMMARY

An overall "supply chain" score of 63 reflects an eight-point decline over last year, placing the sign at an "Unsatisfactory, and Failing level." This decline reflects the significant turbulence introduced into the economy during the first year of the COVID-19 pandemic. We expect that next year's report will reflect even greater supply chain challenges wrought by the pandemic.

56 Based on financial data of the top 100 provided by Govini

57 Based on financial data of the top 100 provided by Govini

58 Mayer, Abby, "Supply Chain Metrics That Matter: A Focus on Aerospace & Defense," *Supply Chain Insights LLC*, March 18, 2014. Accessed December 8, 2021. https://www.kinaxis.com/sites/default/files/2017-12/metrics-that-matter-aerospace-and-defense-supply-chain-insights-research.pdf

59 EY, "A&D Edge: Supply chain management in aerospace and defense," *EY*, February 2018, Accessed September 12, 2021. https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/manufacturing/ey-AD-Edge-Supply-chain-management-in-aerospace-and-defense.pdf?download

60 NDIA, "*Vital Signs 22 Survey,*" data collected in August 2021.

COMPETITION

Change, 2020 – 2021

● 0

COMPETITION SCORES		
Overall factor	**2021**	**Change, 2020 – 2021**
Profitability	75	● +2
Liquidity	82	● -11
Leverage	87	● -4
Capital investment	77	● -5
Market concentration	100	● 0
Foreign ownership	100	● 0
Contract competition	92	● 0
Overall Competition Score	***88***	● ***0***

Figure 5.1

Factor score key				
● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

The defense industrial base consists of many thousands of companies competing for and performing on contracts with the Department of Defense. This section looks at conditions that characterize and shape "competition", which can help determine the composition of the industry and its performance outcomes. A competitive defense sector can be both beneficial and indicative — beneficial in that competition can drive innovation and efficiencies to deliver better capabilities at reduced cost to the warfighter, and indicative in that the market incentives and perceived opportunities keep producers in the sector while also potentially pulling in new firms. This section of the report informs our understanding of the health of competitive dynamics within the defense industrial base.

KEY TAKEAWAYS

- "Competition" scored 88 for 2021, the same as in 2020
- In the three years prior to the COVID-19 pandemic, the level of competition had proved relatively stable
- Profitablity is the only factor that has experienced an increase since 2020
- Almost 30% of survey respondents said that they were the sole eligible provider of a product for DoD. However, survey results do not contribute to final scores.

> **"There is a decrease in both the total number of DoD vendors, and new entrants to the DIB.**

OVERVIEW

The state of competition between firms exerts a powerful influence on the productive performance of firms within industry. Many firms of varying sizes, product and service specializations, and even national origins compete for contracts within the defense industrial base. While such competition occurs, trends in financial performance indicate the financial health of the involved firms. The competition between firms for contracts results in patterns of market concentration that illustrate the extent to which relatively few firms dominate defense contracting dollars. The entry of firms into defense contracting provides insight into the openness and attractiveness of the defense contracting market to new sources of competition.

Overall, competitiveness within the defense industrial base has decreased slightly when compared with 2019. Profitability increased by two points compared to last year, and was flat compared to 2019. The liquidity indicator dropped sharply from 2020 while all other indicators slightly decreased. We relied on publicly available Securities and Exchange Commission filings from the top 100 publicly traded recipients of defense contracts to complete our analysis.[61]

61 DoD issues an annual list of the top 100 defense contractors that includes both public companies and privately held companies. We do not attempt to measure the financial performance of the private companies due to the lack of reliable publicly held data. Department of Defense, "CY 2021&22 Top 100 Defense Contractors by Global Vendor Name (FY 20)," https://dodsoco.ogc.osd.mil/Portals/102/Documents/Conflicts/CY%202021-22%20Top100%20Contractor%20List%20-Alpha%20(FY20).pdf?ver=laieJKldvd2EEW_jl59gFQ%3d%3d

COMPETITION SCORES

Factor	Indicator	2021	Change, 2020 – 2021
Profitability	Weighted average core operating margin (return on sales)	76	-17
	Weighted average earnings per share	89	+5
	Weighted average return on assets	97	+31
	Weighted average return on equity	39	-12
Overall profitability		***75***	***+2***
Liquidity	Weighted average free cash flow	67	-19
	Quick ratio (acid test)	82	-12
	Working capital ratio (current ratio)	96	-2
Overall liquidity		***82***	***-11***
Leverage	Debt to equity ratio	84	+1
	Solvency ratio	90	-8
Overall leverage		***87***	***-4***
Capital investment	Capital expenditure ratio	77	-5
Overall capital investment		***77***	***-5***
Market concentration	Level of market concentration (Herfindahl-Hirschman index)	100	0
Overall market concentration		***100***	***0***
Foreign ownership	Contracting market share of foreign-owned firms	100	0
Overall foreign ownership		***100***	***0***
Contract competition	Average number of competitive offers received per contract actions	92	***0***
Overall contract competition		***92***	***0***
Overall competition score		***88***	***0***

Figure 5.2

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

CONTEXT

Market concentration, contract competitiveness, profitability, cash availability, capital investment, and foreign ownership of the defense industrial base are used as assessments in this section of *Vital Signs*. By understanding the trends across these measures, we can determine the current state of competitiveness and whether the dynamics of the defense contracting marketplace are evolving in a healthy direction.

The competitive environment for the DIB remained stable over the three-year period preceding the novel coronavirus pandemic. For all factors, there have been no significant increases since 2019, other than a marginal increase in profitability.

METHOD

NDIA calculated indicator scores for profitability, cash availability, capital expenditures, market concentration, and foreign ownership using financial data for the top 100 publicly traded Department of Defense contractors. We also relied on annual financial data obtained through our partner, decision science company, Govini. NDIA calculated the scores for competitive bidding from federal procurement data analyzed by Govini.

TRENDS

Contract competition

Contract competition earned a score of 92 for 2021, the same as in 2020. Contract competition refers to the number of firms bidding on contracts offered by the DoD. Contracts can be awarded through either a competitive or non-competitive bidding process.

When broken out by the type of competition, Full and Open Competition and Special Acquisition Procedures (SAP) saw a slight decrease from FY 2019. Full and Open Competition dropped from 5.6 average offers per award to 5.38 while the latter dropped from 3.71 to

Contract competition

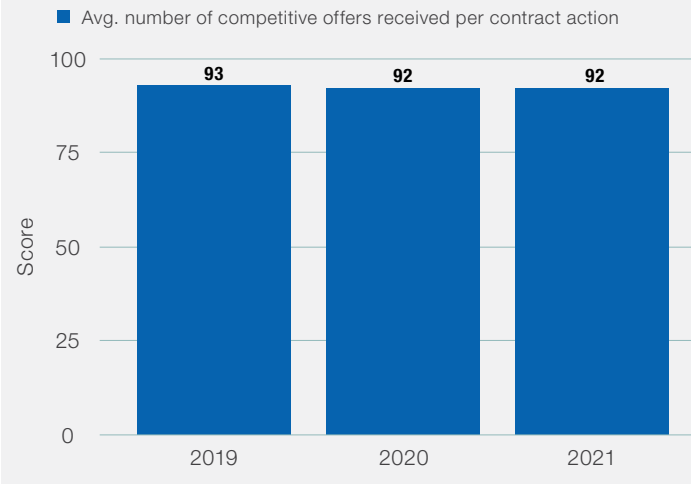


Figure 5.3, Source: NDIA

3.7. The increase came from Full and Open Competition After Exclusion of Sources, which increased from 5.55 average offers to 6.15.[62]

When broken down by category management groups, Transportation and Logistics Services continues to have the most competition with 12.16 average offers in FY2020. The Equipment Related Services category was last this year with only 2.42 average offers, with Aircraft, Ships/Submarines & Land Vehicles just ahead with 2.55 average offers per award.[63]

Market concentration

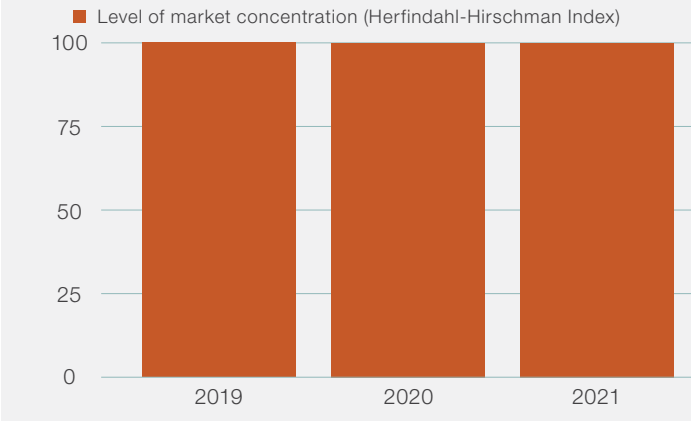


Figure 5.4, Source: NDIA

Market concentration

The overall score for market concentration remains unchanged from last year, a 100. The score is derived from a calculation of the Herfindahl-Hirschman Index (HHI), with a baseline index score of 1,500. The Herfindahl-Hirschman Index is used to measure market concentration within an industry. A high HHI score is illustrative of an industry that is dominated by a few firms. For the health of the defense industrial base, low market concentration is generally preferable to high market concentration. Low-concentration markets feature more competition, competitive prices, and more innovation. HHI is the standard statistical measure of market concentration and is widely used among federal policymakers.[64]

In 2021, the defense industrial base's HHI was 400, below the Department of Justice's threshold of 1,500 for a moderately concentrated industry. Comparatively, the DIB's HHI score that was calculated for *Vital Signs 2022* is nearly 110 points lower than in *Vital Signs 2021*, trending towards a lower degree of market concentration. The defense industrial base's low HHI indicates that total contract obligation dollars remain widely allocated among contractors and suggests a high degree of competition within the defense industrial base. The overall defense industrial base market concentration indicates a competitive market for the time being.

Does your company produce any defense-related products, regardless of industrial line of business, for which it is the sole eligible provider in the United States?

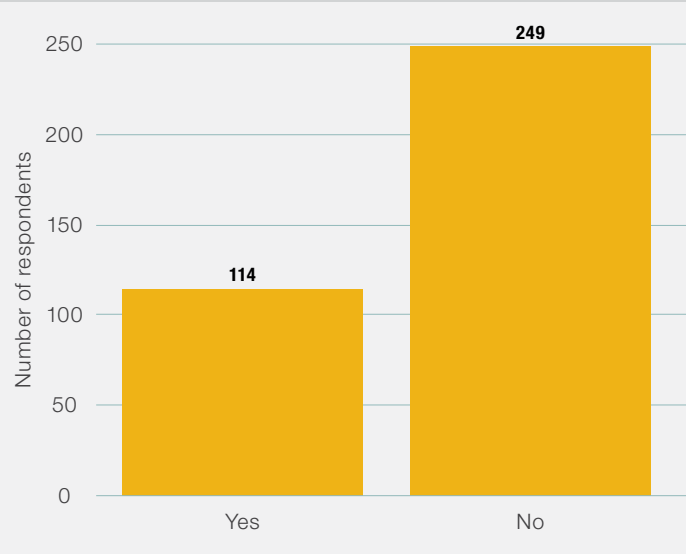


Figure 5.5, Source: NDIA

Due to definitional and unclassified data availability challenges, we did not attempt to calculate the HHI for different defense market segments. As noted in the 13806 Report, certain defense market segments may be highly and increasingly concentrated — such as fuzes—or extremely fragmented — such as transportation services. This factor is also demonstrated by our *Vital Signs* Survey in which almost 30% of respondents (Figure 5.5) said that they were the sole eligible provider of a product for DoD.[65] This matches results from last year, and while it cannot be scored yet, the consistency between years is notable.

62 Based on DoD innovation spending data provided by Govini

63 Based on DoD contract obligation data provided by Govini

64 Rhoades, Stephen A., "The Herfindahl-Hirschman Index," 79 *Fed. Res. Bull.* 188, (1993). Accessed August 23, 2021 https://fraser.stlouisfed.org/files/ docs/ publications/FRB/pages/1990-1994/33101_1990-1994.pdf

65 Interagency Task Force in Fulfillment of Executive Order 13806, "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," September 2018. Accessed June 21, 2021. https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20DEFENSEINDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF

While there are some decreases in concentration at the top level, there are still some worrying signs. There is a decrease in both the total number of DoD vendors, and new entrants to the DIB. Govini numbers show that the DIB has dropped from about 58,000 vendors last year to about 55,000 this year. This is also a significant drop from the 69,000 vendors of 2016.

There is also a drop in new vendors from 2021. While not as extreme as last year's drop, the number of entrants in the DIB did drop from about 6,500 new entrants in FY 2019, to 6,300 in FY2020.[66] That the drop persists is worrying. An overreliance on a smaller pool of entrants may create production or innovation shortages in the future; new entrants may be discouraged from competing which could constrain the capacity of the DIB to respond to threats.

Despite the relative lack of overall industry concentration by Department of Justice standards, some parts of the industrial base are at risk of having only one supplier. For example, the industrial base for fuzes has shrunk from 30 businesses in 1995 to only three today. Despite this rapid consolidation, DoD's acquisition plans are still on track to leave the United States with potentially only one domestic supplier for aerial bomb fuzing by 2023. The presence of only one aerial bomb fuze supplier may introduce unacceptable risks to the supply chain. Foreign-based fuze makers will likely fill the void.

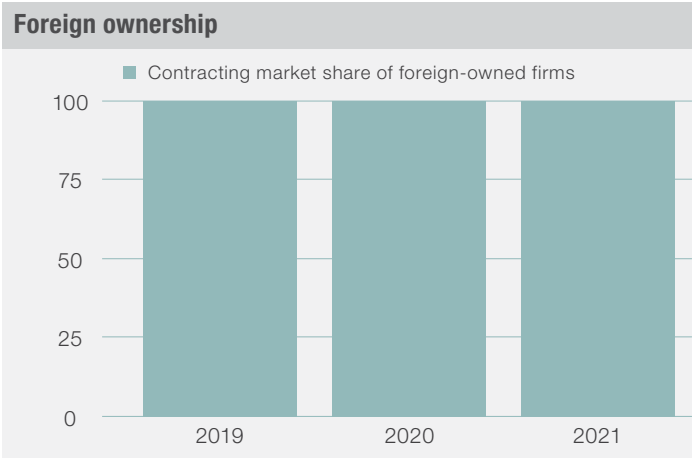


Figure 5.6, Source: NDIA

Foreign ownership

Foreign ownership in the defense industrial base was 5.4% for 2020, demonstrating a decrease over 2019's share of 8.7%.[67] Additionally, foreign ownership scored a 100 for 2021, like in 2019 and 2020. Foreign ownership is the percentage of the 100 largest public companies in the DIB that are not based in the United States. It is baselined against the Carter-Reagan Era buildup of the late 1970s through the mid-1980s. In 1981, the Government Accountability Office reported foreign ownership at 9.4%, which represents the highest level of foreign ownership within the data available to NDIA. Possible reasons for this drop include complications with foreign supply chains due to the COVID-19 Pandemic.

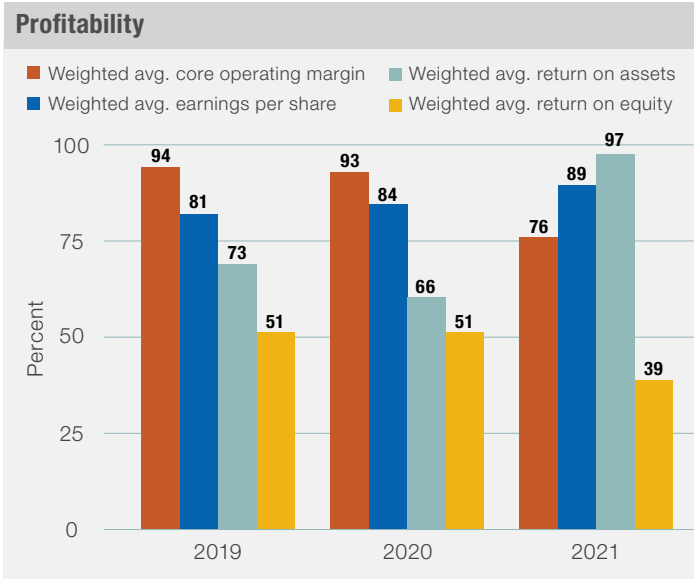


Figure 5.7, Source: NDIA

Profitability

The defense industrial base remained profitable and its performance remained consistent with overall U.S. corporate profits for 2020. Profitability slightly increased from last year; it saw a total increase of two points from 73 in 2020 to 75 in 2021. The increase is despite the change to Return on Sales (ROS) and Return on Equity (ROE), which decreased by 17 and 12 points, respectively.

Return on Assets (ROA) and Earnings Per Share (EPS) remain indicators in this year's profitability factor. These four indicators show a more detailed, albeit somewhat conflicting, picture of profitability in this year's version of *Vital Signs* compared to last year.

These four indicators are weighted averages. The individual company values have been weighted by the defense-related market share of their respective companies. Weighting in this manner ensures that large companies with large non-defense businesses do not skew the scores. ROA is baselined to the Defense Financial and Investment Review study from 1985. Core Operating Margin and ROE are baselined to 2019 while EPS is baselined to 2020. Both years represented high watermarks within our dataset.

Liquidity

Liquidity's overall score is 82 for 2021, plummeting eleven points from 2020. This year's report includes the Quick Ratio, Current Ratio, and Free Cash Flow.[68] The Current Ratio is a measure of a company's current assets to current debt while the Quick Ratio is a measure of liquidity to current debt. Free Cash Flow represents cash available to creditors or investors. Taken together, these indicators show that—since the COVID-19 pandemic began—some in the defense industrial base have found it challenging to meet their outstanding financial obligations, especially those with significant exposure to commercial markets.

66 Based on DoD contract obligation data provided by Govini

67 Based on financial data of the top 100 provided by Govini

68 Based on financial data of the top 100 provided by Govini

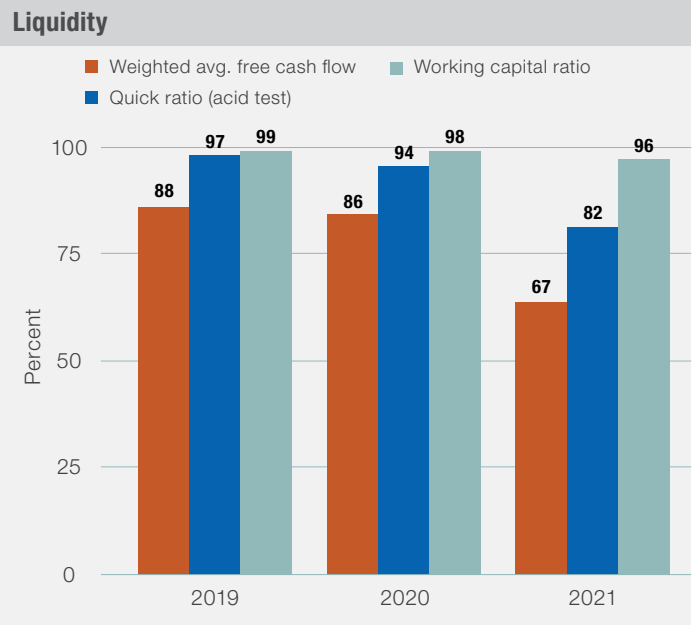


Figure 5.8, Source: NDIA

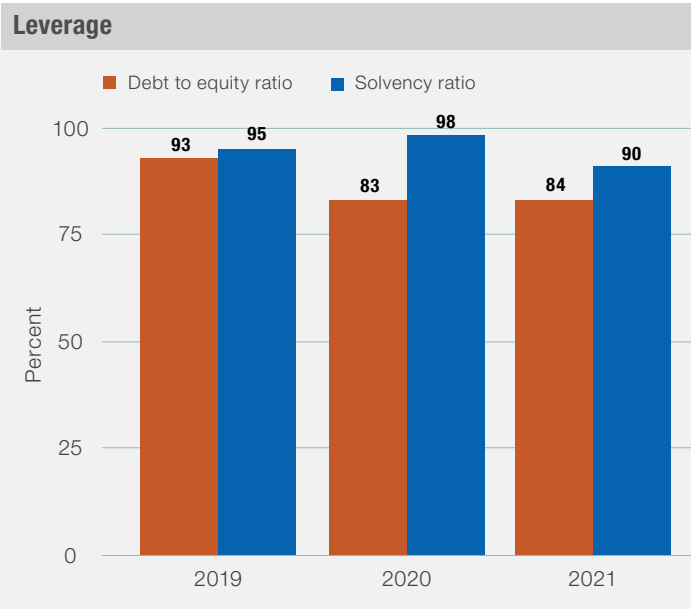


Figure 5.8, Source: NDIA

Leverage

Leverage received a score of 87 for 2021, marking a three-point decline from 2020. Baseline years of 2017 and 2018 were used for the Solvency Ratio and Debt to Equity, respectively.[69] These two years represent the best performing years within our limited data-set. Before the COVID-19 pandemic, the increase in the score for leverage was driven by the Debt-to-Equity ratio increasing from 1.07 to 1.09 and by the Solvency Ratio rising from 0.125 to 0.13.

Leverage is comprised of the Solvency Ratio and the Debt-to-Equity Ratio. The Solvency Ratio measures income to liabilities, while the Debt-to-Equity Ratio measures liabilities to equity. Together, the two variables measure companies' ability to cover both long and short term debts and are suitable measures of how leveraged companies in the defense industrial base are.

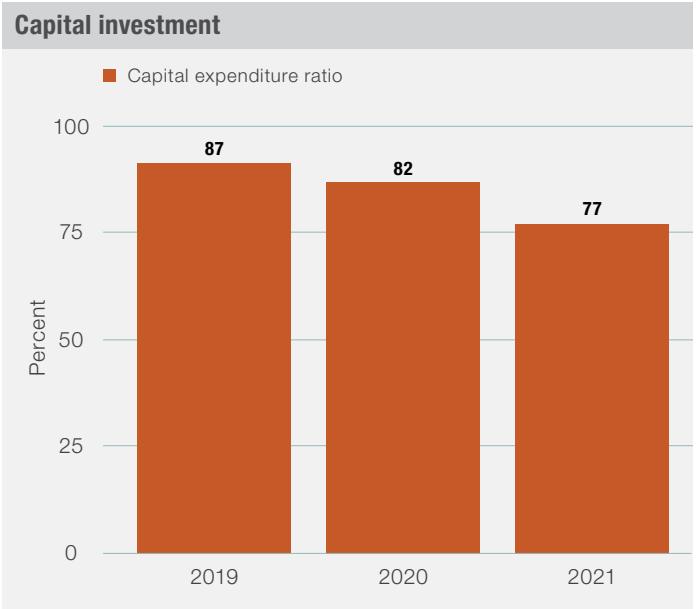


Figure 5.9, Source: NDIA

Capital investment

Capital investment scored a 77 this year, which is a four-point drop from 2020; this drop is after reassessing past years using the same measure. Our baseline year for this factor is 2016, which had a 3.94% ratio. In this year's *Vital Signs*, we used a ratio of capital expenditure to total revenue, which better controls for differences in size between companies in our list of the top 100 DoD contractors and is a more accurate representation of the DIB's capital investment. This year's score of 77 is representative of a landscape in which there is a year-on-year decrease in capital investment relative to revenues.

SUMMARY

An overall score of 88 for "competition" reflects a modest, four-point decline from two years ago in the level of competition present in the U.S. defense sector, which is representative of the overall instability introduced into the economy since the COVID-19 pandemic began. Although most scoring categories have reflected this modest decline, concentration, and foreign ownership are still 100. We expect scores to be further impacted next year as supply chain disruptions and inflation rise as concerns with the continued follow-on effects of the pandemic.

69 Based on financial data of the top 100 provided by Govini

INDUSTRIAL SECURITY

Change, 2020 – 2021

+1

INDUSTRIAL SECURITY SCORES		
Overall factor	**2021**	**Change, 2020 – 2021**
Threats to intellectual property rights	80	+3
Threats to information security	20	-1
Overall Industrial Security Score	***50***	***+1***

Figure 6.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

The Defense Industrial Base (DIB) faces sustained and increasing threats of intellectual property theft, economic espionage, and ransomware hacks among other security breaches. This section examines new Federal Bureau of Investigation (FBI) intellectual property rights violation investigations, the average annual newly-reported common IT cyber vulnerabilities, and the severity of newly reported common IT vulnerabilities.

KEY TAKEAWAYS

- "Industrial security" earned an overall failing score of 50, with the intellectual property rights violation indicator as the only improvement since 2018
- The number of newly-reported common IT cybersecurity vulnerabilities continues to increase
- The severity of each known IT cybersecurity vulnerability has slightly decreased on average since 2016
- *The Vital Signs 2022* scores for industrial security indicate an environment that presents an escalating risk to the DIB.

OVERVIEW

Since our previous report, "industrial security" has slightly improved, although it is still one of the lowest-performing signs. But this merits further context: the improvement in score between 2020 and 2021 is due entirely to a reduction in the number of new FBI intellectual property rights violation investigations, which is the only "industrial security" indicator to improve since 2018. The FBI investigation factor masks the overall trend which is the continued deterioration of the cybersecurity indicator. The overall impact of FBI investigations results in a higher overall score for industrial security in 2021.

Over the past year, "industrial security" has also been an area of active federal rulemaking. In 2020, the release of an Interim Rule for the Cybersecurity Maturity Model Certification (CMMC; 85 FR 61505), and an Interim Rule for Section 889(a)(1)(B) of the FY19 NDAA (Section 889 Part B; 85 FR 42665) highlighted DoD's heightened focus on industrial security issues, indicative of its substantive impact on the DIB.

> **"Over the past year, "industrial security" has been an area of active federal rulemaking.**

CONTEXT

Since the release of the 2018 National Defense Strategy and its focus on renewed great-power competition, the concern with industrial security in the defense sector has steadily increased. Data breaches, intellectual property theft, and state-sponsored industrial espionage in both private companies and university labs are on an unrelenting rise while the dynamic nature of attacks makes it a constantly moving target to address. A 2017 report by the National Bureau of Asian Research estimates cyberthreats cost the U.S. economy as much as $600 billion on an annual basis.[70]

Industrial security issues continue to be a priority for the defense industrial base and DoD. 2020 saw the release of an Interim Rule for the Cybersecurity Maturity Model Certification (CMMC; 85 FR 61505) and an Interim Rule for Section 889(a)(1)(B) of the FY19 NDAA (Section 889 Part B; 85 FR 42665). In 2020, the Interim Rule implementing Section 889 Part B was published, prohibiting executive agencies from entering into contracts with any entity that incorporates any equipment or service that uses telecommunication

70 The Commission on the Theft of American Intellectual Property, "Update to the IP Commission Report," *The National Bureau of Asian Research*, February 2017. Accessed September 15, 2021. https://www.nbr.org/wp-content/uploads/pdfs/publications/IP_Commission_052213_Transcript.pdf.

INDUSTRIAL SECURITY SCORES

Factor	Indicator	2021	Change, 2020 – 2021
Threats to intellectual property rights	New FBI intellectual property rights violation investigations	80	+3
Overall threats to intellectual property rights		***80***	+3
Threats to information security	Average annual newly reported common IT cyber vulnerabilities	26	-1
	Severity of newly reported common IT vulnerabilities	14	0
Overall threats to information security		***20***	***-1***
Overall industrial security score		***50***	***+1***

Figure 6.2

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

equipment made by Huawei, ZTE, and several other Chinese-made telecommunications equipment manufacturers. Section 889 is intended to prevent the exfiltration of sensitive data from the U.S. DIB. CMMC is a DoD effort to improve the handling of sensitive information by and within the defense industrial base. The certification is intended to provide a "unifying standard for the implementation of cybersecurity" across the DIB.[71] These programs are still in interim stages and their impact on cybersecurity is yet to be determined.

METHOD

NDIA's "industrial security" sign threats to our nation's intellectual rights and cybersecurity vulnerabilities. NDIA's "industrial security" indicators are derived from FBI intellectual property rights investigation statistics. We use two sources to obtain averages of IT security flaws for our cybersecurity data: The MITRE Corporation maintains the Common Vulnerabilities and Exposures (CVE) List, a "dictionary of publicly disclosed cybersecurity vulnerabilities" that serves as the most authoritative list of known security holes in IT hardware and software products. In addition, the National Institute of Standards and Technology (NIST) publishes an annual version of that CVE list that includes severity scores for each vulnerability.

A change worth noting is that this year *Vital Signs* went from tracking the Common Vulnerability Scoring System (CVSS) 2.0 to CVSS 3.0, a system which more accurately reflects the types of vulnerabilities encountered.

TRENDS

Intellectual Property rights

Intellectual Property (IP) rights are essential to the health of the DIB. The perception of risks to IP rights shapes investor's willingness to invest in research and development and commercialization activities. The protection of IP rights also compels investments in costly information security measures. New IP rights investigations

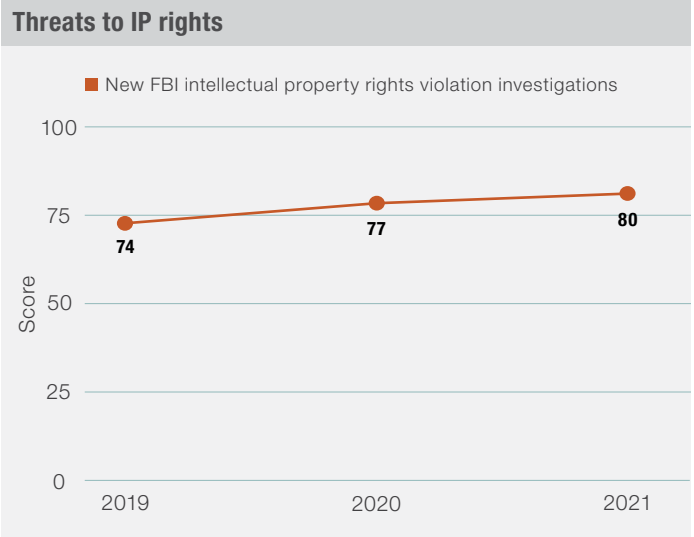


Figure 6.3, Source: NDIA

by the FBI scored an 80 for 2021, which is up six points from 2019. This score is based on an annual average of 48 new FBI IP rights investigations between 2018 and 2020.[72] The frequency of new investigations has steadily decreased since 2011 and was scored against the 2020 single-year value of 38 investigations — the smallest in our dataset. Since 2008, the FBI has published statistics on its intellectual property-based investigative activities. The new IP rights investigations statistic includes intellectual property rights violations, trade secret theft, counterfeiting, copyright infringement, and trademark infringement cases with an impact on national security or a link to organized crime. The FBI shares IP rights enforcement responsibilities with more than 20 other federal agencies and collaborates on investigative activities through the National Intellectual Property Rights Coordination Center, which is hosted by the Department of Homeland Security and deconflicts thousands of investigations each year. This coordination may have led to fewer FBI intellectual property rights cases that are not reflected in the FBI's reporting.

71 In November 2021, DoD announced the rollout of CMMC 2.0 and the start of a new rulemaking process that will revamp CMMC.

72 Intellectual Property Enforcement Coordinator (IPEC), "Annual Intellectual Property Report to Congress," January 2021. Accessed August 23, 2021. https://trumpwhitehouse.archives.gov/wpcontent/uploads/2021/01/IPEC-Annual-Intellectual-Property-Report-January-2021.pdf.

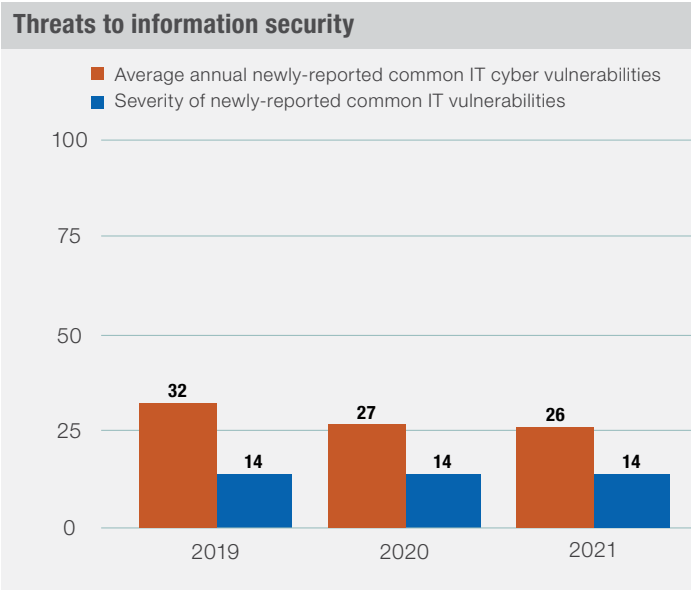


Figure 6.4, Source: NDIA

Threats to information security

Threats to information security scored a 20 for *Vital Signs 2022.* The number of newly reported common IT cyber vulnerabilities rose to 16,971 in 2021 from 15,255 in 2020.[73] The number of average annual documented IT cyber vulnerabilities was scored against a "peak low" value of 4,150 from 2011. In addition to the increase over the 2011 baseline, the average severity of newly reported vulnerabilities decreased from 7.27 in 2020 to 7.12 in 2021.[74] The vulnerability severity scores are different from last year's *Vital Signs* report due to the aforementioned change from CVSS 2.0 to CVSS 3.0. The past five years were all assessed under the CVSS 3.0 system so that changes between years could still be assessed. The results were still scored against an ideal severity score of 1.

Defense manufacturing and services rely on secure information to produce the defense products and services that our service-members need. Vulnerabilities in information systems that facilitate the flow of industrial information can threaten production capabilities, service deliveries, and the integrity of IP rights. Information security threats are also an enduring source of overhead costs as firms implement measures to protect and recover from cyber threats.

Known cybersecurity vulnerabilities continue to rise at a very high rate. New cybersecurity vulnerabilities have seen a 263% increase since 2016. Last year, vulnerabilities affecting business applications as well as internet and mobile software accounted for over 45% of new CVE entries. A 2021 analysis by Skybox Security indicated that there was also a growth in new types of attacks.[75]

The surge in data breaches underscores the risk industry faces from cybersecurity vulnerabilities and ransomware attacks that continue to proliferate, providing a compelling indication of the focus that adversaries, competitors, and bad actors have placed on attacking U.S. systems to garner sensitive information. The ID Theft Center reported that the total number of breaches reported in 2020 (1,854) increased 25% from the total number of breaches reported in 2019 (1,473) and that the business sector exposed the highest number of non-sensitive records with a total of 705,106,352 exposed.[76]

The *Vital Signs 2022* scores for "industrial security" indicate an environment that presents an escalating risk to the DIB.

SUMMARY

Overall, "industrial security" received a score of 50 for 2021. This failing score reflects larger trends in the dramatic shortcomings of industrial cybersecurity despite increasing attention and resources dedicated to combating the threat. Threats to IP rights scored an 80 for 2021, increasing six points since 2019 because of a steadily declining number of new FBI IP rights investigations that came after years of enhanced law enforcement. This increase is enough to offset the decreases to Information Security, giving an overall score of 50, one point higher than two years ago when adjusted for changes in scoring. Federal rule changes CMMC 2.0, Section 889 Part B, and other measures to address threats to "industrial security" will be tracked in coming years.

73 MITRE, "Common Vulnerabilities and Exposures." Accessed June 15, 2021 https://cve.mitre.org/cve/index.html

74 Ibid.

75 Skybox Security, "Vulnerability and Threat Trends Report 2021." Accessed December 9, 2021. https://www.skyboxsecurity.com/resources/report/vulnerabilitythreat-trends-report-2021/.

76 Based on NDIA calculations. See the most recent report from the ID Theft Resource Center: https://notified.idtheftcenter.org/s/

POLITICAL & REGULATORY

Change, 2020 – 2021

-4

POLITICAL & REGULATORY SCORES

Overall factor	2021	Change, 2020 – 2021
Public opinion	44	-5
Congressional budgeting process	83	-6
Regulatory burden	90	+1
Overall political & regulatory score	***72***	***-4***

Figure 7.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

More than most industries, legislative and regulatory processes have a direct impact on defense industry productivity. The public's attitudes toward defense spending shape congressional interest in defense acquisition, affecting congressional budgets. The time that Congress takes to authorize a budget for national defense programs affects capital availability and the product delivery schedule of defense supply chains. Similarly, changes to defense acquisition regulations affect defense contractors' eligibility and administrative costs. In this way, policymakers can have a significant impact on the demand for defense goods and services, the availability of inputs, the conditions in related and supporting industries, and the structure of industry competition. This section of the report assesses political and regulatory trends that shape defense industrial productivity.

KEY TAKEAWAYS

- The "political and regulatory" sign scored a 72 for 2020, which is down 6 points from 2018
- Public opinion saw a major decline in its score since 2018
- Regulatory burden saw minor improvements to offset the slight decline from congressional budgeting.

OVERVIEW

While public opinion and the congressional budgeting process have decreased scores, regulatory burden slightly improved. We are still seeing a score decrease from 2019 to 2021, with public opinion scoring poorly.

The congressional budgeting process also saw a minor drop from last year. Despite the improvement in appropriations passage, the congressional interest in acquisitions and increasing focus on supply chains has led to a slightly lower score than 2021. The highest-performing factor is regulatory burden because we see a slight increase in most metrics ensuring that the score remains steady.

> **"The pandemic may have increased some of the public's anxiety about the need for more investment in defense.**

CONTEXT

The "political and regulatory" sign scored a 72 for 2020, which is down 6 points from 2018. The decrease in score was driven by a deterioration in public opinion, which scored a 44, which is 18 points lower than last year's report.

METHOD

This section presents scores for indicators of the "political and regulatory" sign shaping defense production. These indicators describe 1) public opinion, 2) congressional budgeting and interest, and 3) rulemaking trends. First, public opinion indicators are based on long-standing and publicly available survey data from the Gallup Organization. Second, congressional budgeting indicators are derived from data published by the Congressional Research Service. Third, the congressional interest indicator is provided by Govini through their proprietary data science tradecraft. Finally, regulatory burden was a major change this year. Forward pricing audits is unchanged, and incurred cost audit had been re-baselined to 2020 since that is now the highest scoring single year. Last year's "Red Tape" ratio has been replaced by the number of annual representations and certifications required to be made in the System for Award Management (SAM).

POLITICAL & REGULATORY SCORES

Factor	Indicator	2021	Change, 2020 – 2021
Public opinion	Public opinion polling on defense spending: responses indicating "Too little"	44	-5
Overall public opinion		***44***	-5
Congressional budgeting process	Average number of days NDAA passed after Oct. 1	86	-3
	Average number of days appropriations passed After Oct. 1	85	+8
	Congressional interest in: procurement: MDAPs	80	-19
	Supply chains: manufacturing/supply chain/reshoring/Buy American	81	-10
Overall congressional budgeting process		***83***	***-6***
Regulatory burden	Number of SAM representations and certifications	77	0
	Incurred costs audit average elapsed days	95	+3
	Forward pricing audit average elapsed days	99	+1
Overall regulatory burden		***90***	***+1***
Overall political & regulatory score		***72***	***-4***

Figure 7.2

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

TRENDS

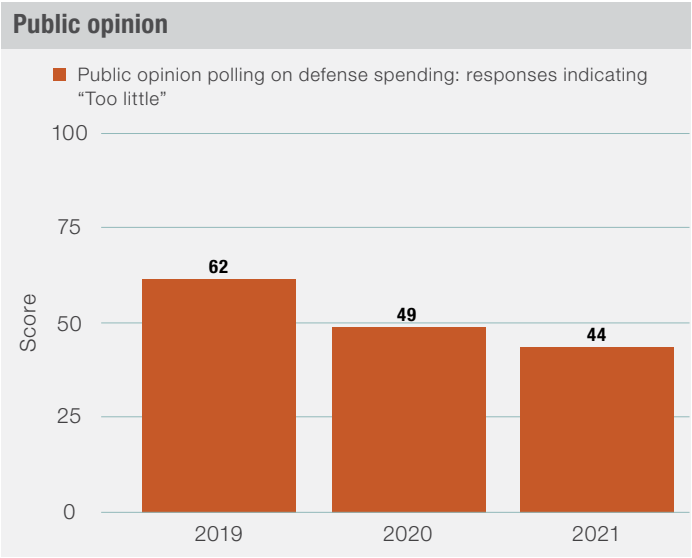


Figure 7.3, Source: NDIA

Public opinion

In general, public opinion about defense policy reflects broad attitudes about both the state of national security and the perceived trade-offs between preferred defense policies and other national priorities. Since 1969, the Gallup Organization has conducted a poll of U.S. adults in which it asked, "There is much discussion as to the amount of money the government in Washington should spend for national defense and military purposes. How do you feel about this? Do you think we are spending too little, about the right amount, or too much?"[77]

In 2021, public opinion scored a 44, which is 18 points lower than the 62 scored for 2019 and 26 points lower than the 70 scored in 2018, continuing a downward trend for this indicator. In February 2021, 26% of respondents said that the U.S. is spending too little on national defense and military purposes, compared to 25% in 2019 and 17% in 2020.[78] The decline has partially reversed this year but the score still declined when taken as part of a three-year average.

The pandemic may have increased some of the public's anxiety about the need for more investment in defense. In Gallup's February 2021 poll, 42% of participants believed that defense spending is "about right," which marked an 8 point decline from 50% in their 2020 poll.[79] Gallup's February 2020 poll result of 50% is the highest percentage of "about right" responses for this question since Gallup began asking it more than 52 years ago.

Conversely, according to Gallup, when asked "Do you, yourself, feel that our national defense is stronger now than it needs to be, not strong enough or about right at the present time?" the percentage of Americans that believed the U.S. military was "not strong enough" rose to 35% in February 2021, from 25% in February 2020.[80] The strongest indicator of this trend is the fact that 50% of respondents believe the strength of U.S. national defense is "about right" which is down from 62% last year.[81]

77 Gallup, "Military and National Defense." Accessed November 3, 2021. https://news.gallup.com/poll/1666/Military-National-Defense.aspx.

78 Ibid.

79 Ibid.

80 Ibid.

81 Ibid.

The same Gallup poll noted that most Americans feel it is important for the U.S. to be the leading military in the world.[82] While most Americans support continuing America's role in global security, they demonstrate a growing concern about the trade-offs involved.

Congressional budgeting process

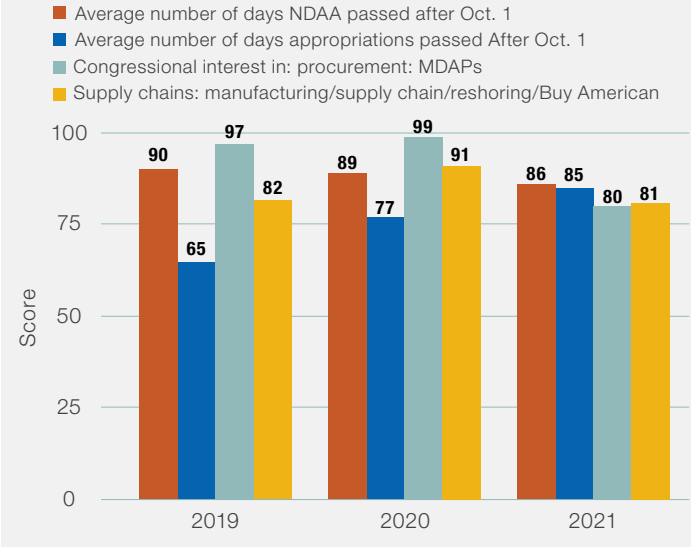


Figure 7.4, Source: NDIA

Congressional budgeting process

The congressional budgeting process for national defense programs scored an 81 for 2021. This factor's score reflects a combination of indicators with contrasting trend lines: the average number of days past 1 October taken to pass the National Defense Authorization Act (NDAA) and defense appropriations, the number of hearings with five or more mentions of MDAPs, and congressional interest in supply chains. The congressional interest indicator score is calculated by our data science partner, Govini. Since FY18, the running average number of days past 1 October taken to pass the NDAA and defense appropriations has remained between 70 to 90 days. For the NDAA, this is far longer than its historical norm of passage by 1 October, though delay in passage is now consistent with that of defense appropriations.

The duration of the congressional budgeting process reveals the level of priority that Congress devotes to defense acquisition issues. Congress faces a statutory expectation to complete the defense budgeting process between the first week of February and 1 October for the next fiscal year. When Congress breaches that schedule, the Executive Branch cannot advance, start, or sustain defense acquisition plans. Similarly, the NDAA sets defense policies, reporting requirements, and outlines programmatics. Without its passage, the department and contractors operate under the previous year's NDAA. Therefore, the amount of time that Congress takes to deliberate on passing the NDAA and Defense Appropriations reflects the performance of the legislative budgeting process.

In recent years, the irregularity of the congressional budgeting processes and the long durations required for NDAA and appropriations passage have subjected the DoD to disruptive budget uncertainty. Frequently forced to operate under continuing resolutions, DoD has had to delay urgent contract awards and future acquisition planning.

The score for the three-year average of congressional interest in MDAPs dropped from 81 in 2020, to 71 in 2021. This score is based on the number of hearings with at least five mentions of any MDAPs, which decreased from 160 in FY17 to just 110 in FY20. Mention of supply chains has also decreased over that same period from 82 hearings with five or more mentions down to 57. Annual congressional interest totals were scored against a baseline value of 160 for MDAPs and 82 for supply chains, both of which are from 2017 — the earliest year for which data was available.

While Congress plays a central role in deciding, enabling, and supervising defense acquisition policy, congressional attention devoted to acquisition-related topics fuels policymaking activity. Therefore, the level of congressional interest in defense acquisitions gives a good sense of the extent of related activity within the legislative environment. Rising levels of interest in defense programs and systems suggest a correlation with increasing policy activity. That activity may take the form of critical oversight of high-visibility MDAPs or forward-looking hearings on the status of future requirements. For this report, Govini measured congressional interest as the number of mentions of MDAPs in congressional hearings, applying a significance threshold of five mentions.

Regulatory burden

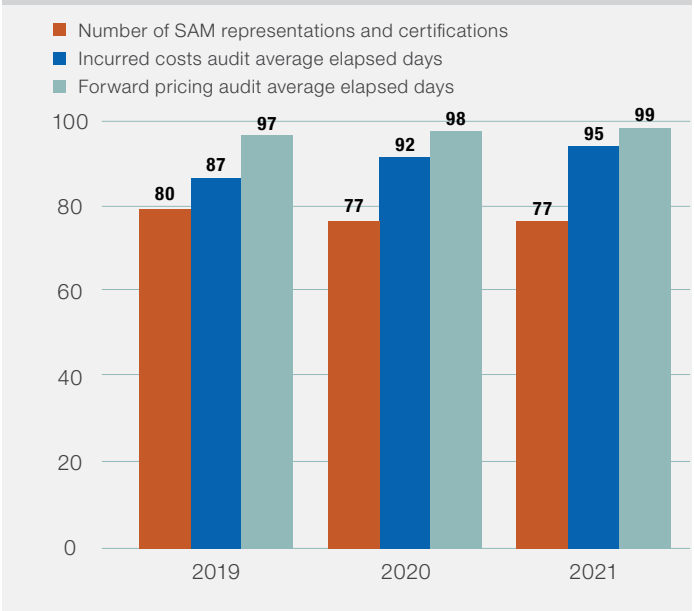


Figure 7.5, Source: NDIA

Regulatory burden

The "regulatory" sign continue to trend upward with the score for regulatory trends increasing two points from 2019. In addition to the industry's number of SAM representations and certifications, the *Vital Signs 2021* score for regulatory burden accounts for the average time taken for incurred cost audits and the average elapsed

82 Gallup, "Military and National Defense." Accessed November 3, 2021. https://news.gallup.com/poll/1666/Military-National-Defense.aspx.

time during the forward price auditing process.[83] Accounting for these indicators, the regulatory burden factor scored a 90 for 2021.

For this edition of the report, the methodology changed slightly. In last year's report, NDIA calculated the ratio of new final rules in FY20 that decrease restrictions to rules that increase restrictions. This year, to get a more objective assessment of the regulatory environment, we instead counted the number of SAM representations or certifications required for contractors and adjusted the previous years' scores accordingly.[84]

The level of regulatory burden that industry faces in contracting within the DoD affects industry's productivity and produces barriers to entry for new companies interested in joining the defense industry. DoD regularly issues new rules that modify the Defense Federal Acquisition Regulation Supplement (DFARS), defining the rights and obligations of the parties involved in defense contracting in accordance with the preferences of Congress, the President, and the Secretary of Defense. Often, new rules add or subtract restrictions or requirements for parties involved in the contracting process. These rules ultimately add up to an overall regulatory burden that imposes costs on companies seeking to do business with the government.

Under the direction of Executive Orders 13771 and 13777, DoD prioritized the exploration of ways to reduce the regulatory burden and, thereby, improve the performance of the defense acquisition system. That effort involves various benefit-cost assessments of existing and proposed regulations in addition to the elimination of unnecessary ones, including some that impact defense acquisitions. This year, both EO's were revoked.

Both audit indicators showed improvement. While the time taken to complete incurred cost audits was down to 110 days from 112 the previous year, the time taken to complete forward pricing audits stayed steady from last year at 82 days. The three-year average for incurred costs is down to 116 days, which contributes to the lower score from last year. Meanwhile, forward pricing audits had a three-year average of 83 days, which produced a score of 99.

According to the Defense Contract Audit Agency (DCAA), as a result of DCAA audits, contract officials saved $3.5 billion in defense spending last year—significant savings that can be reinvested or returned to the Treasury. DCAA was able to reduce the time taken to complete incurred cost audits to 84 days from 88 days.[85] In FY19, DCAA was able to complete 719 forward pricing audits, up from 710 last year, and kept the average time to complete the audits at 82 days.[86] Even with a majority of the workforce teleworking 100% of the time, in 2020, DCAA capitalized on the elimination of the incurred cost audit backlog in 2019 by enhancing customer service in other areas such as proposal reviews and business systems audits, achieving an all- time high 93% customer satisfaction rating. DCAA also met customer agreed-to deadlines for requested work 93% of the time, up from 64% a few years ago.[87]

SUMMARY

The "political and regulatory" sign received an overall score of 72 for 2021, a decline from 78 in 2019. Public opinion towards defense spending fell from 62 points in 2019, to a score of 44. The overall rating of the congressional budgeting process fell by three points from 2019, to an overall score of 84 as the result of a broad loss of congressional interest in major defense acquisition programs. The regulatory burden increased by one point to 90 in 2021. With these scores in mind, the trend for this Sign is downward and marks a considerable decline over the last several years.

83 Department of Defense, "Report to Congress on FY 2020 Activities," *Defense Contract Audit Agency.* March 31, 2021, Accessed September 2, 2021. https://www.dcaa.mil/Portals/88/Documents/About%20DCAA/508%20compliant%20docs/DCAA%20FY2020%20Report%20to%20Congress%20final%20wo%20cost.pdf?ver=oQmfWK424yqKn7RK3mPFuQ%3d%3d.

84 "Annual Representations and Certifications," Code of Federal Regulations, 52.204.-8 https://www.acquisition.gov/far/52.204-8

85 Department of Defense, "Report to Congress on FY 2020 Activities," *Defense Contract Audit Agency.* March 31, 2021, Accessed September 2, 2021. https://www.dcaa.mil/Portals/88/Documents/About%20DCAA/508%20compliant%20docs/DCAA%20FY2020%20Report%20to%20Congress%20final%20wo%20cost.pdf?ver=oQmfWK424yqKn7RK3mPFuQ%3d%3d.

86 Ibid.

87 Ibid.

PRODUCTIVE CAPACITY & SURGE READINESS

Change, 2020 – 2021

-15

PRODUCTIVE CAPACITY & SURGE READINESS SCORES

Overall factor	2021	Change, 2020 – 2021
Intensity of capital usage	84	-2
Output efficiency	20	-28
Overall productive capacity & surge readiness score	***52***	***-15***

Figure 8.1

Factor score key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

The U.S. defense industrial base, more than any other, must be ready to respond to a demand surge for a variety of goods, services, materials, and systems. This section will assess the output efficiency and capacity utilization of the broader U.S. defense sector. The need for an increase in defense production often appears suddenly, leaving little time for defense suppliers to ramp up production to fulfill a surge in demand for their goods, services, or materials. This section analyzes the output efficiency and the capacity utilization of the economy.

KEY TAKEAWAYS

- The 2021 score of 51 represents a 15-point drop from last year
- 78% of VS 22 survey respondents said the availability of skilled labor was a moderate or significant problem
- The U.S. output gap, a proxy indicator for the ability to surge defense production, scored a 20 in 2021, down from 48 in 2020.

OVERVIEW

Demand surges for defense related goods, services, and materials are unpredictable. Often defense suppliers have little warning to scale up production to fulfill a need. To meet surge demand, organizations within industry must leverage any dormant excess productive capacity. For manufacturing, this translates into activating unused capital to hit a surge demand marker. Unfortunately, industrial production is no simple enterprise, and the complex nature of current supply chains hamper the ability of organizations to meet sudden increases of demand, adding lag time between end-product and the initial surge.

The ongoing impact of COVID-19 pandemic on the national, regional, and local economies continues to reinforce the importance of surge capacity. Surge readiness and production capacity are a weakness in the defense industrial base. The 2021 score of 52 represents a 15-point drop from last year, which was already a failing grade. This drop was primarily driven by the decline in output efficiency, while capacity utilization has remained somewhat steady. The national industrial output gap continued its sharp downward trajectory.

> **"Productive capacity and surge readiness" has seen one of the largest drops in this year's Vital Signs.**

CONTEXT

Strong productive capacity and surge readiness are critical to national security and for maintaining a healthy and robust defense industrial base. Both areas are important in understanding and gauging the vitality of the defense ecosystem. Assessing "productive capacity" reveals the extent to which the national economy can expand to accommodate growth in demand for certain goods and services. More specifically, it indicates the DIB's ability to adapt to shifts in supply chain requirements. Similarly, evaluating surge readiness of industries that provide critical resources, supplies, and equipment to the defense ecosystem offers insight into the defense industrial base's capacity to perform successfully in circumstances of heightened DoD Procurement. It is also worth noting that the data from this section is from 2020, so it fully demonstrates the effects of the COVID-19 pandemic on industrial capacity.

PRODUCTIVE CAPACITY & SURGE READINESS SCORES			
Factor	**Indicator**	**2021**	**Change, 2020 – 2021**
Intensity of capital usage	Durable goods manufacturing sector capacity utilization	84	-2
Overall intensity of capital usage		***84***	***-2***
Output efficiency	National industrial output gap	20	-28
Overall output efficiency		***20***	-28
Overall productive capacity & surge readiness score		***52***	***-15***

Figure 8.2

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

METHOD

This section assesses "productive capacity and surge readiness" by examining the intensity of capital usage and output efficiency. The overall score for intensity of capital usage comes from the capacity utilization for durable goods manufacturing, and the score for output efficiency is calculated using the national industrial output gap. The former is drawn from the Federal Reserve's monthly G.17 release; the latter is an annual figure provided by the Congressional Budget Office.

TRENDS

Output efficiency

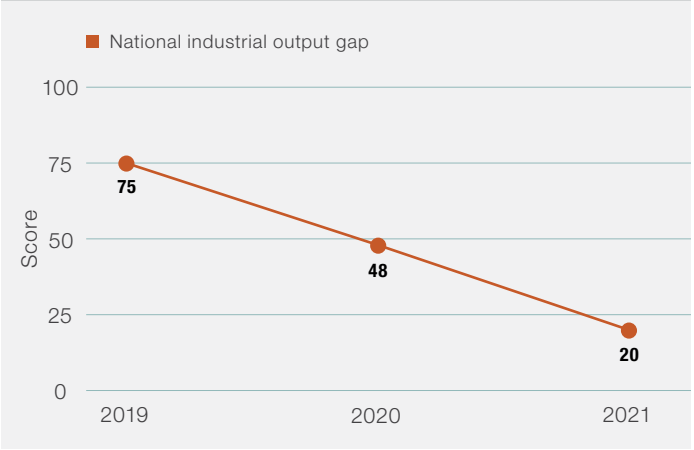


Figure 8.3, Source: NDIA

Output efficiency

The productive efficiency of the U.S. economy shapes the productive capacity of the defense industrial base. The output gap measures the economy's productive efficiency by estimating the difference between its actual output and its potential output. When this difference holds a positive value, the output gap indicates an economy that is over-performing its long-run potential.

The U.S. output gap, a measure of productive efficiency, continued its decline this year, scoring 20 in 2021 down from 48 in 2020. This is a total decline of 55 points since 2019. This year's score is based on an output gap of -1.12%, and average of FY2018, FY2019, and FY2020, bringing this average back below zero after it broke into the positive range between FY2017 and FY2019.[88]

When this situation occurs, high aggregate demand for goods and services throughout the economy forces production facilities to operate in an unsustainable manner and at peak efficiency levels to provide enough supply, leading to tight labor markets and possible price inflation. When the output gap is negative, the economy's production capabilities experience inferior efficiency, indicating that some productive capacity is underutilized. Under ideal conditions, no output gap would exist with actual economic output matching potential output. We use the national output gap as a proxy indicator for the ability to surge defense production.

Essentially, the output gap illustrates how the economy would react to a surge in defense-related demand. A surge of new demand when there is a positive output gap would likely result in production shortages, price inflation, and a lack of investment in new productive capacity. Conversely, a surge of new demand when there is a negative output gap would likely activate dormant capacity; however, production could suffer from low productivity and other inefficiencies. This period, 2018-2020, is the first to have both the pre-COVID-19 pandemic positive output gap (from 2019, when unemployment was low and the labor market was tight) and the early impacts of the pandemic in its averages. 2020 brought a variety of challenges, including real GDP growth of -3.5% (down from 2.3% in 2019) amid sharp increases in unemployment, which is reflected in this calculation.[89]

Intensity of capital usage

For 2021, intensity of capital usage scored an 84 out of 100, which marks a one-point increase over 2020's score of 83. This score is derived from a capacity utilization rate of 74.4% for the period of 2018-2020 — an increase of 0.5% from the running average of 73.9% for the years 2017-2019.[90] Durable goods manufacturing

88 Congressional Budget Office, "An Update to the Economic Outlook: 2021 to 2031," Accessed on December 8, 2021. https://www.cbo.gov/publication/57218

89 Ibid.

90 Federal Reserve Bank of St. Louis, "The 2021 Annual Revision," Accessed on December 8, 2021. https://www.federalreserve.gov/releases/g17/

Intensity of capital usage

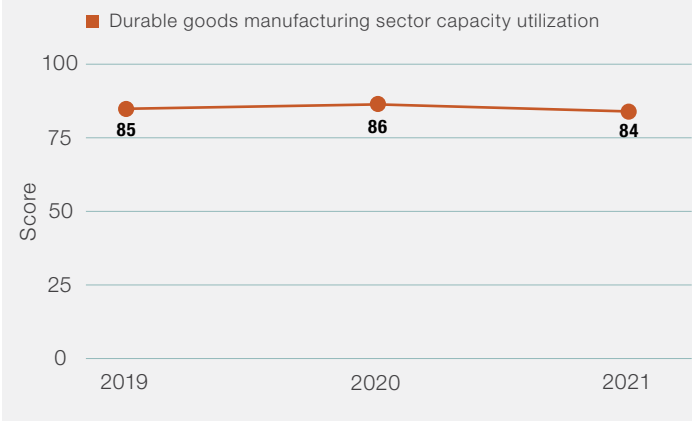


Figure 8.4, Source: NDIA

sector capacity utilization continues to be scored against a 1973 baseline value of 88.6%.

The strength and wellbeing of an industrial base's productive capacity is directly related to the degree manufacturers use and employ their productive capabilities. Productive capabilities are, in turn, derived primarily from physical capital assets including equipment, machinery, and facilities employed throughout the course of the production of goods. For manufacturing industries, capital assets constrain capabilities and are key limiting factors in overall "productive capacity". Capacity utilization rates measure the share of industrial productive capacity employed, on average, over of a defined period. As such, industrial capacity utilization rates are a useful indicator of the intensity of physical capital usage. This year marked a slight shift away from the downward trend in capacity utilization rate that has defined many previous years. This upward-trending rate indicates an increasing dedication of productive capital assets to the industrial base ecosystem, likely due to sustained additional market demand.

SURVEY RESULTS

In August 2021, NDIA conducted a survey of its membership. With nearly four hundred respondents the survey covered several subjects, including the ability to respond to demand surges and the impacts of the ongoing COVID-19 pandemic. Amassing skilled labor appears to be central to limiting surge capacity. When asked what would affect their firm's ability to increase defense production in response to military surge demand, 78% of respondents said the availability of skilled labor was a moderate or significant problem, and 63% said the same for the availability of cleared labor. This becomes a more significant issue because when asked what would be necessary to reach the maximum production increase, only 20% of respondents said, "Hire additional labor and/or add shifts" would not be required. The following figures in this chapter show the amount that production can surge, and the associated price increases necessary.

SUMMARY

"Productive capacity and surge readiness" has seen one of the largest drops in this year's *Vital Signs*. The drop is in large part due to the disruptions caused by the COVID-19 pandemic. This disruption is most clearly seen in the significant drop in the output gap. This year also saw a more substantial introduction of the *Vital Signs* survey into this section. While the survey is still too new to score, in the future, it will hopefully provide another valuable datapoint for this section.

How much could your company increase production within the following timeframes?

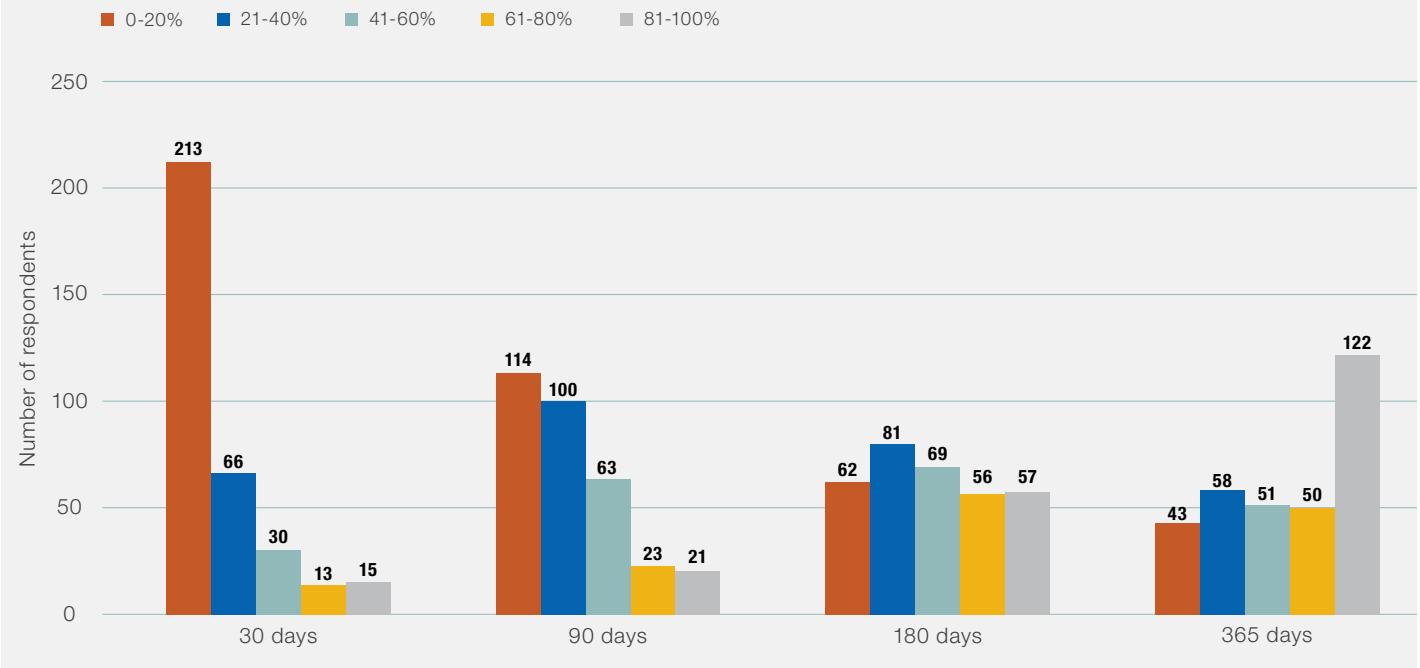


Figure 8.5, Source: NDIA

Approximately what percent increase in the price of your defense-related products would be necessary to cover the cost of the output completed?

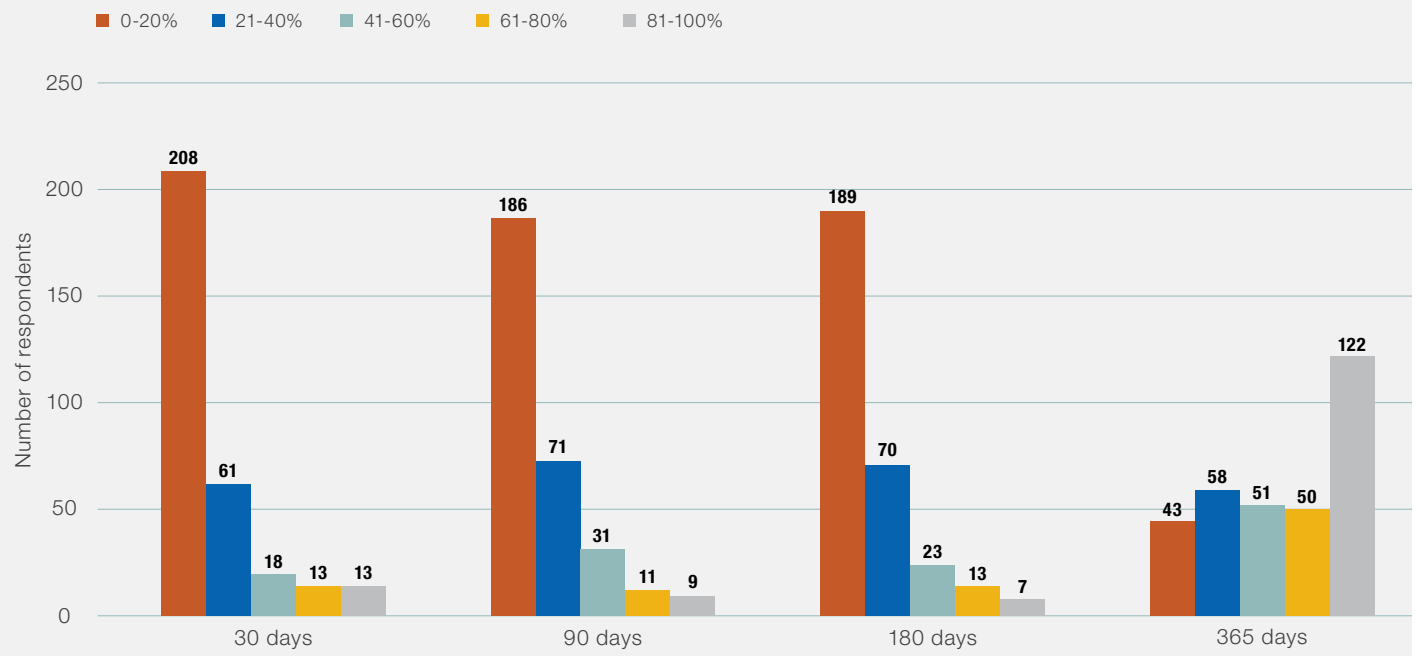


Figure 8.6, Source: NDIA

How would each of the following affect your firm's ability to increase defense production in response to a surge in military demand?

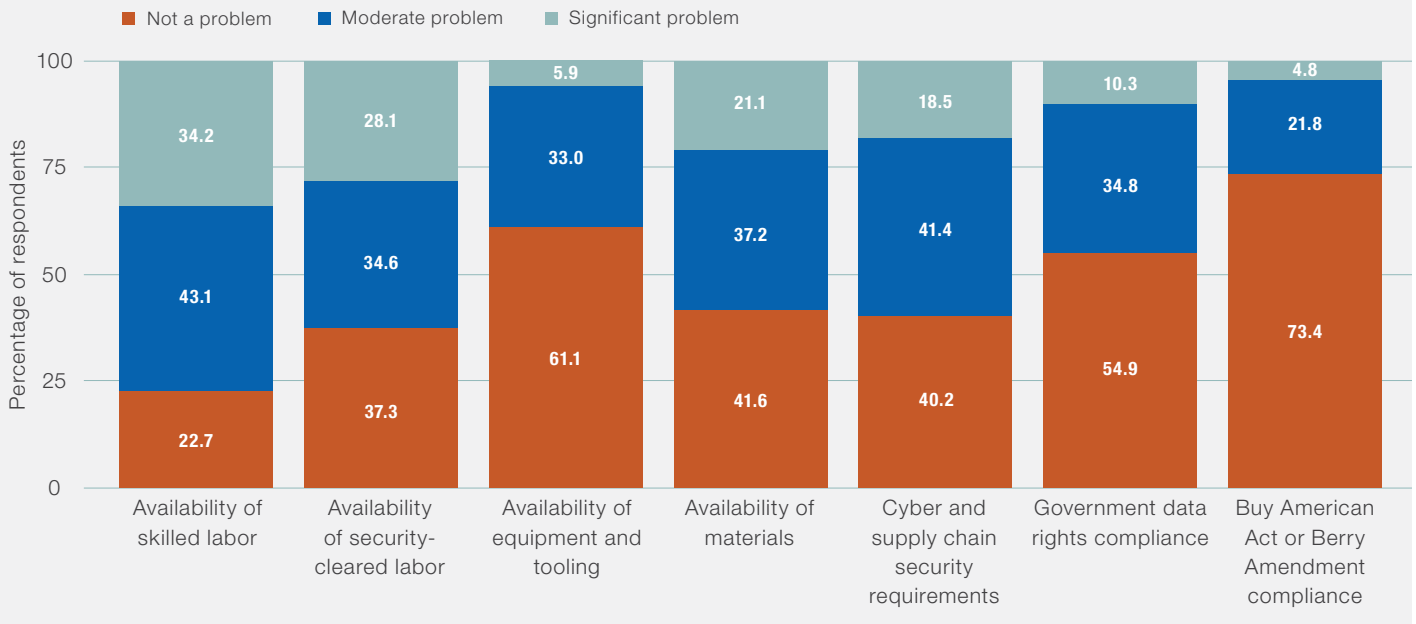


Figure 8.7, Source: NDIA

When would the following actions be necessary in order to achieve the maximum potential production increases?

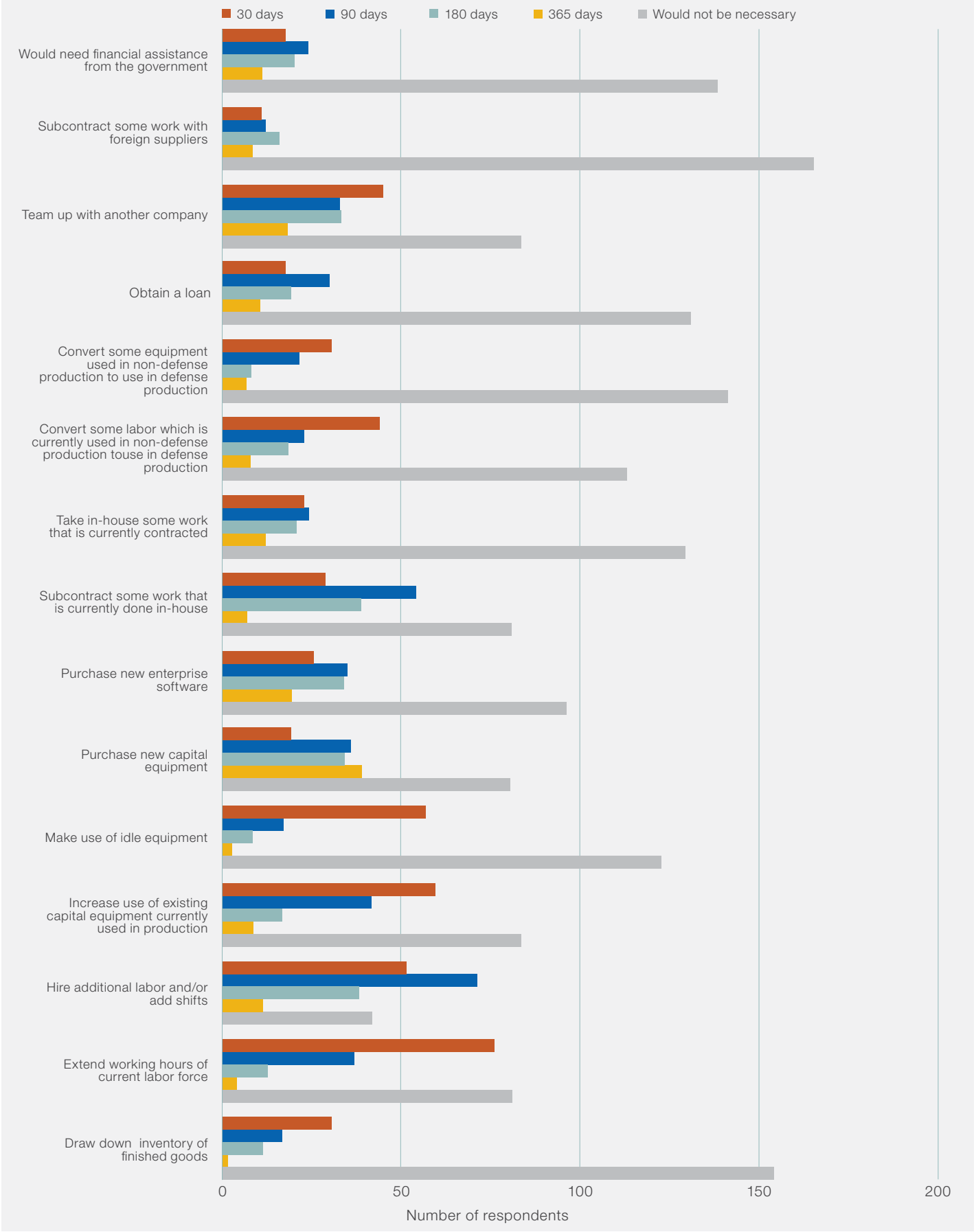


Figure 8.8, Source: NDIA

EMERGING TECHNOLOGY

This newly-incorporated section, while not yet included as one of eight of the signs, merits inclusion given its relevance as to the future health of the industrial base. It is primarily derived from findings by the NDIA's Emerging Technologies Institute (ETI), which was formed in 2021. This unit has offered a new chapter in this report to begin looking at how the emerging tech landscape is fairing, and to monitor it going forward.

OVERVIEW

The Department of Defense (DoD) has long endured the tension between maintaining aging systems and the need for major defense modernization. Today the U.S. faces rapid technological innovation by strategic competitors — China and Russia — who have poured investments into their industrial sectors to become more lethal and resilient than ever before. Aware of the growing threat to our national interests, the DoD has laid out 11 modernization priorities in key emerging technology areas that will deliver the technical capabilities needed by our warfighters to cope with the new security environment.[91] These technologies include: Artificial Intelligence (AI), Biotechnology, Autonomy, Cyber, Directed Energy, Fully Networked Command, Control, and Communications (FNC3), Microelectronics, Quantum Science, Hypersonics, Space, and 5G — all of which will play a vital role in how the DoD will shape its next national defense strategy.

> **"With the outbreak of the COVID-19 pandemic in 2020, the DoD had to collaborate with the DIB to ensure a robust industrial base for combating the spread of the virus.**

CONTEXT

Congressional attention

Members of Congress have grown increasingly focused on developing emerging technologies to enhance U.S. national security and keep pace with top competitors.[92] A metric for Congressional interest in each technology was developed by measuring the number of Congressional hearings per year where a related term was mentioned at least five times [see Figure 9.1]. Of course, that is just one measure of interest; others include legislative language, individual engagements, inquiries, report assignments, and others that are harder to quantify. It is important to note that in FY 2020, there was a substantial drop in the total number of public hearings, likely due to the COVID-19 pandemic, so relative change was measured to draw a comparison between years. For FY 2020, Congressional focus in key technologies such as microelectronics and biotechnology increased from the previous year, while hearings that mentioned hypersonics and space — among others — dropped from FY 2019.

Emerging Technology	FY 2018		FY 2019		FY 2020		Relative Change in Interest
	Hearings	% Total	Hearings	% Total	Hearings	% Total	
Artificial Intelligence	40	10.30%	39	8.99%	24	10.30%	Increase
Space	38	9.79%	38	8.76%	18	7.73%	Decrease
Hypersonics	24	6.19%	30	6.91%	14	6.01%	Decrease
Cyber	30	7.73%	39	8.99%	14	6.01%	Decrease
Quantum Science	21	5.41%	29	6.68%	12	5.15%	Decrease
Fully Networked C3	12	3.09%	10	2.30%	11	4.72%	Increase
5G and Next G	3	0.77%	21	4.84%	9	3.86%	Decrease
Biotechnology	8	2.06%	5	1.15%	7	3.00%	Increase
Microelectronics	7	1.80%	6	1.38%	6	2.58%	Increase
Autonomy	13	3.35%	11	2.53%	5	2.15%	Decrease
Directed Energy	11	2.84%	8	1.84%	3	1.29%	Decrease
Total Hearings	**388**		**434**		**233**		***From 2019 to 2020**

*Figure 9.1, Source: Govini. Congressional Interest in Emerging Technologies (FY18 - FY20) *Note: A hearing was counted if a term related to the emerging technology was mentioned at least five times*

91 Office of the Under Secretary of Defense for Research and Engineering,"Modernization Priorities – DOD Research & Engineering." Accessed January 10, 2022. https://www.cto.mil/modernization-priorities.

92 Congressional Research Service, and Kelley M. Sayler, R46458 "Emerging military technologies: Background and issues for Congress" (2021). Accessed January 10, 2022. https://crsreports.congress.gov/product/pdf/R/R46458/8.

This result might be surprising given the DoD's recent push to modernize hypersonics defensive and offensive capabilities, and expand capabilities within the space domain, which could in fact reflect a view that these issues are already being worked effectively.

The emerging technology discussed most during the 2020 Congressional hearings was artificial intelligence (AI). With the introduction of six AI bills, including the National AI Initiative Act of 2020 and the Advancing AI Research Act of 2020, it is clear that the future adoption and regulation of AI technology was a high priority on Capitol Hill. This was further reflected in the FY 2021 NDAA passed by both houses of Congress in December of 2020, which allocated more funds to AI research and pushed for stronger coordination with the new National AI Initiative Office.[93]

While these findings prove interesting, it is also important to note that the use of strictly unclassified data may have impacted the results given the nature of these technologies. Despite this possibility, evidence points toward a significant drive for technological innovation by members of Congress. For example, the creation of a Congressional Hypersonics Caucus is a strong indication of continuing interest in that area despite the drop in hearings.

Defense innovation spending

In FY 2020, the Defense Department obligated a considerable amount to defense innovation at $73.5 billion, an increase of nearly $14.5 billion from the year prior. While a large majority of these obligations were awarded to Research, Development, Test & Evaluation (RDT&E) contracts at $48.2 billion with about 20% going toward the development of emerging technologies defense-wide, most notable was a shift toward the use of Other Transaction Authority (OTA) contracts. Unlike alternative contracting authorities, OTAs are not subject to the same federal procurement laws and regulations, making the acquisition process more streamlined for contractors. During FY 2020 alone, the DoD awarded over $16 billion in OTAs, almost the same amount as the previous four years combined and up more than $8 billion from 2019.

With the outbreak of the COVID-19 pandemic in 2020, the DoD had to collaborate with the DIB to ensure a robust industrial base for combating the spread of the virus. According to a FY 2020 annual report, the Office of Defense Pricing and Contracting (DPC) noted that the DoD used $7.7 billion of OTA spending on necessary COVID-19 response efforts[94], such as vaccine development and improvements to telework infrastructure, with the rest being allocated to defense modernization programs.

Of the more than $8 billion in OTAs not allocated to pandemic response, nearly half were obligated to research & development efforts in key technologies, including microelectronics[95] and cyber[96] programs administered by the Navy, as well as the Space Enterprise Consortium (SpEC) agreement.[97] The SpEC program gives the Space Force the ability to grow the space industrial base through a more rapid acquisition process and provides flexibility between government and industry while prototyping new technology. With the space domain growing increasingly competitive amongst peer competitors, OTAs provide a new approach for increased resiliency and reduced cost to get technology in the hands of the warfighter at a faster rate.

There has been some controversy surrounding the usage of OTAs despite their efficiencies. Smaller companies could face a barrier to entry as one requirement to joining an OT consortium involves paying an annual fee and does not guarantee a company will win a bid. There is also the question of how much funding is allocated to the consortium's management organization that oversees administrative operations, essentially taxing the work of the performing members. Perhaps the largest concern with OTAs is whether they are just an attempt to mend a broken acquisition process with a Band-Aid solution rather than repairing the process itself to enable more rapid acquisition.

The future of emerging technology

There is universal agreement that, if the U.S. wants to ensure its competitive edge over peer competitors such as China and Russia, it is crucial to maintain technological superiority. To ensure this, the Defense Department will need to work with industry partners to support the development and integration of these critical technologies into our defense systems with the necessary funding levels, and in a timely manner. Organizations such as the Defense Innovation Unit (DIU) can play a role in fielding and scaling these technologies at a much quicker pace,[98] while constructs such as the Technology and Manufacturing Industrial Base (TMIB) directorate within OUSD(R&E) can lead the effort in assessing threats, gaps, and fragility of the DIB to create strategies that support modernization priorities with respect to emerging technologies.[99]

93 Lyon, H. Mark, and Frances Waldmann. Issue brief. "Gibson Dunn: Fourth Quarter and 2020 Annual Review of Artificial Intelligence and Automated Systems," Los Angeles, CA: Gibson, Dunn & Crutcher LLP, 2021.

94 Defense Pricing and Contracting, Office of the Under Secretary of Defense, Acquisition and Sustainment, "Defense Pricing and Contracting Year In Review 2020" (2021). Accessed January 10, 2022. https://www.acq.osd.mil/dpap/ops/docs/2020_DPC_Year_in_Review_Report.pdf.

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SUMMARY

The 2018 National Defense Strategy placed a heavy emphasis on investing in high-end technologies to improve overall capability. The question now is whether the 2022 NDS will do the same. Though we are still in a transitional period, indications are that the Biden administration will make relatively few changes in modernization priorities. DoD leaders have stated that integrated deterrence will play a large part in the new defense strategy, which will require technological improvement across all agencies and services[100]. The FY 2022 defense budget request also appears to stay the course on future force modernization with record R&D investment in cutting edge technologies[101]. However, the DoD[102] is still charged with maintaining current capacity while simultaneously improving U.S. deterrence capabilities — the modernization quandary.

Some uncertainty lies ahead for the future of emerging technologies, but if the U.S. wants to uphold its technological advantage in the great power competition, it needs to prioritize defense modernization above all else.

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VITAL SIGNS SURVEY RESULTS

KEY TAKEAWAYS

- 14% of respondents do not believe their business will return to its normal level of operations relative to one year ago
- Streamlining the acquisition process and the need for budget stability continue to be the top two actions that NDIA members believe that the government can do to help the defense industrial base.
- 63% of respondents did not receive pandemic-related financial assistance from any source since December 27, 2020.

ABOUT THE SURVEY

In August 2021, nearly seventeen months after the COVID-19 pandemic lockdowns began, NDIA conducted a member survey that garnered responses from nearly 400 corporate member respondents. *Vital Signs 2022* is a data-driven look at the state of America's defense industrial base (DIB) that uses accessible datasets and enables both snapshot views and the ability to see trends over time. Survey results can be found throughout the report, with additional questions included in this chapter. Building upon the survey from our previous report, we made it a priority to continue include industry members' sense of how they saw the state of the industry and the environment in which they operate.

As with last year's report, we developed a set of questions that we will ask every year, which includes questions related to the demographics of the industry, business confidence, surge capacity, and other factors. We intend to build a compelling dataset over time, which we will factor into our scores in the future. A second set of questions will change year to year depending on the topical issues of the day. And like last year's report, we included questions focused on the impacts of the COVID-19 pandemic on the defense industry. This second set of questions will allow for a rapid "taking of the pulse" of the defense industry on topical issues immediately affecting the base.

METHOD

As this is the second year of conducting this survey, we do not have the historical data set required to incorporate any of the results into our scoring. Furthermore, this section is not graded.

Is your firm currently responsible for any government property or equipment?

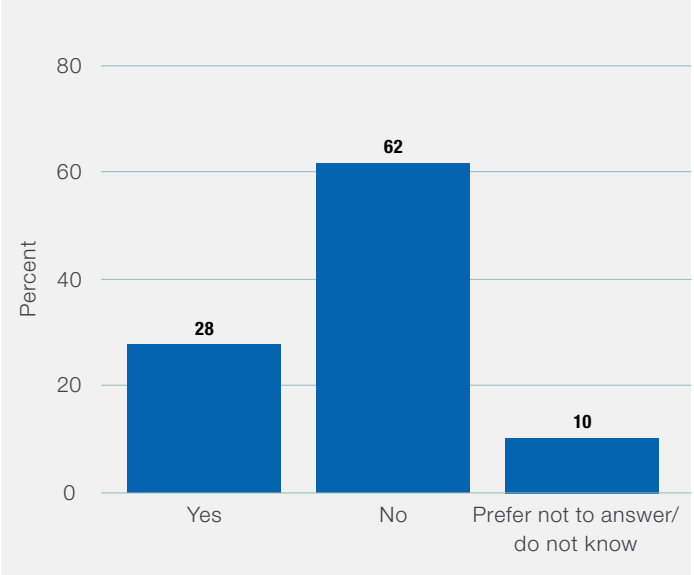

Figure 10.1, Source: NDIA

What percent (by value) of your total equipment is government property or equipment?

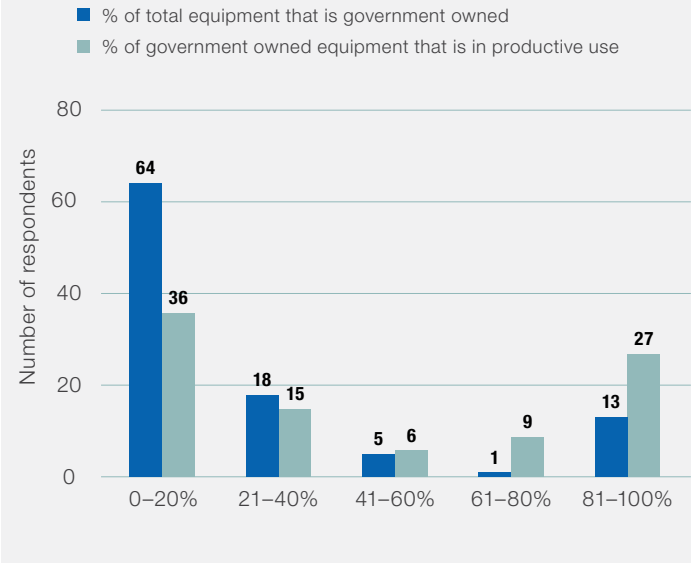

Figure 10.2, Source: NDIA

Approximately indicate the approximate percentage of the dollar value of your firm's sales in your primary NAICS code which went to DoD end-use in 2020

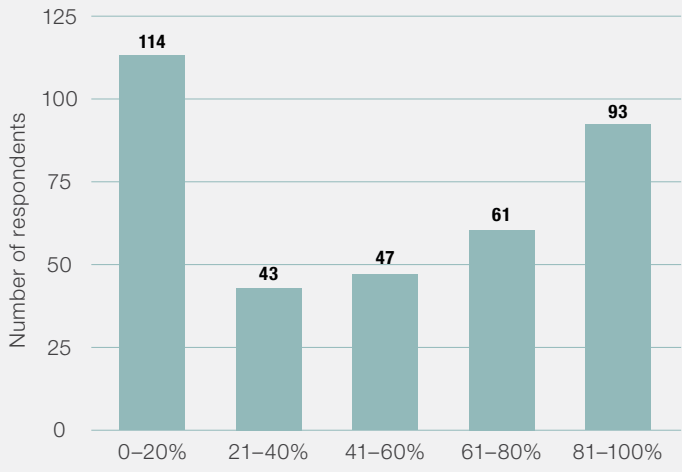

Figure 10.3, Source: NDIA

What impact will federal restrictions on using Chinese communication technologies have on your company's supply chain?

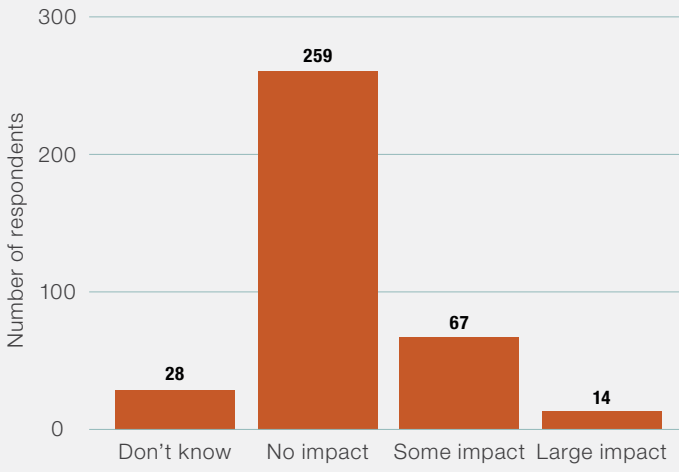

Figure 10.4, Source: NDIA

Would any of these conditions be a deterrent to your firm's willingness or ability to devote larger amounts of productive capacity to military production?

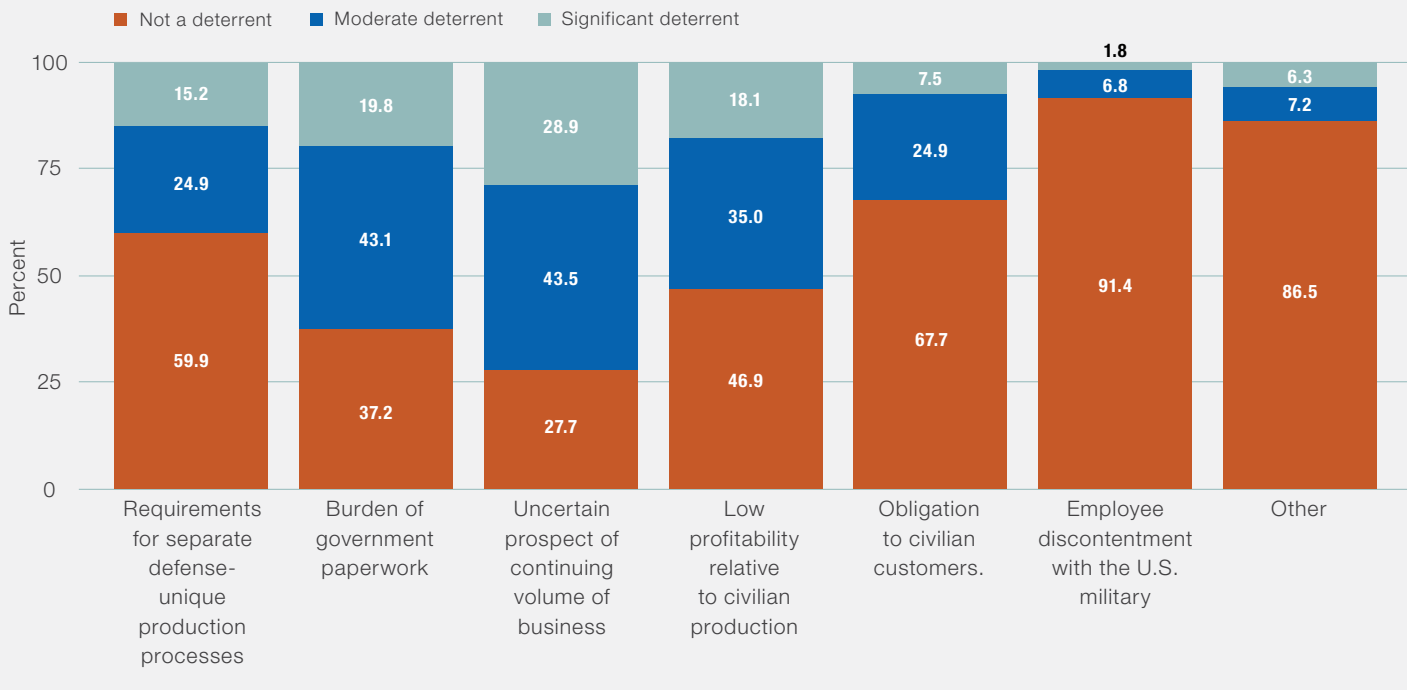

Figure 10.5, Source: NDIA

In a situation short of a declared national emergency, would any of the conditions listed below deter your firm from devoting significant amounts of productive capacity to military production?

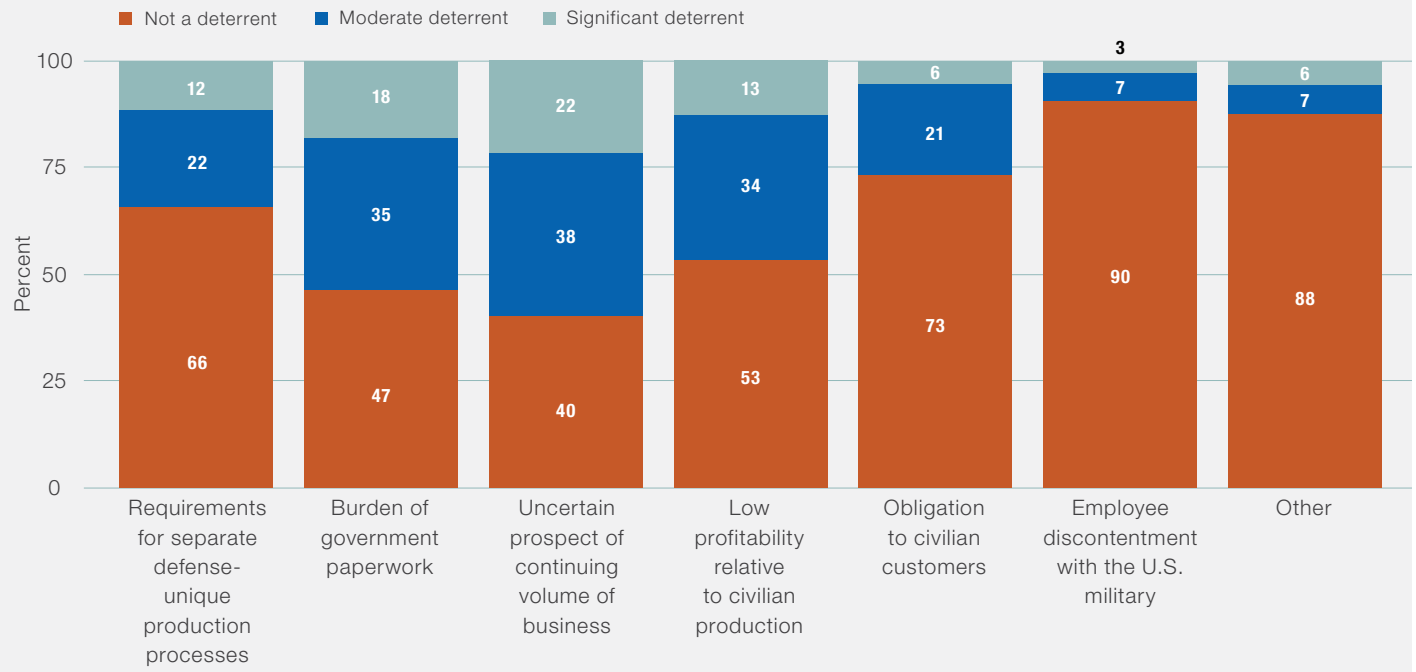

Figure 10.6, Source: NDIA

Given current conditions, do you think your company's defense contracting business will be more profitable, less profitable, or about the same next fiscal year compared to this year?

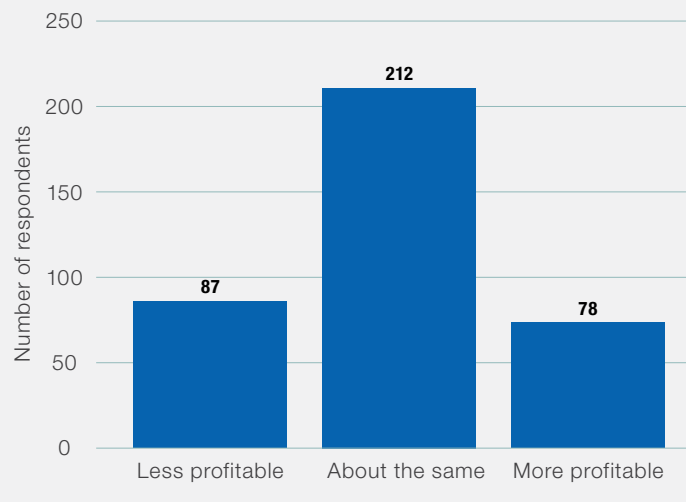

Figure 10.7, Source: NDIA

Given current conditions, do you think your company will bid on more, fewer, or about the same amount of defense contracts next fiscal year compared to this year?

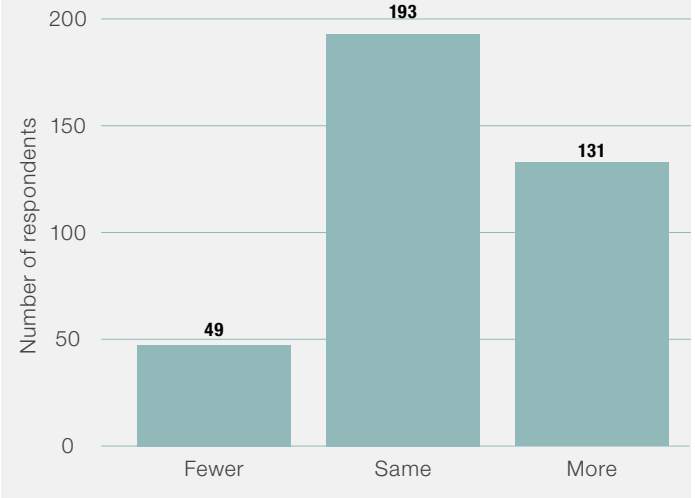

Figure 10.8, Source: NDIA

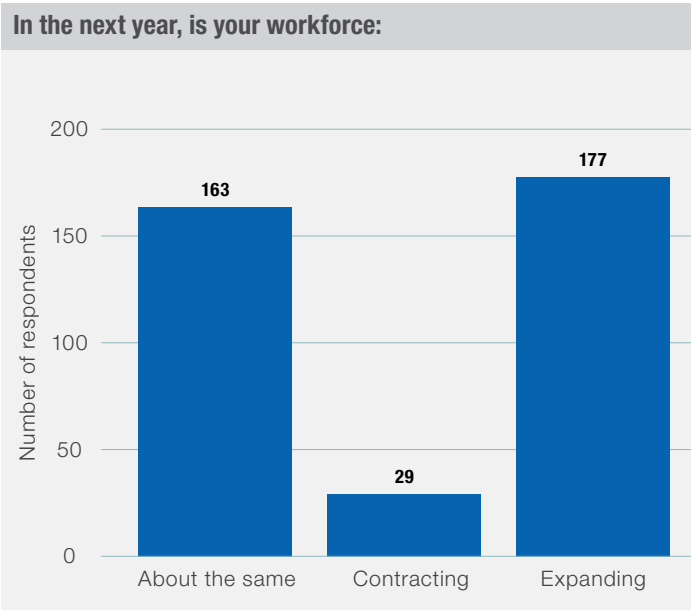

Figure 10.9, Source: NDIA

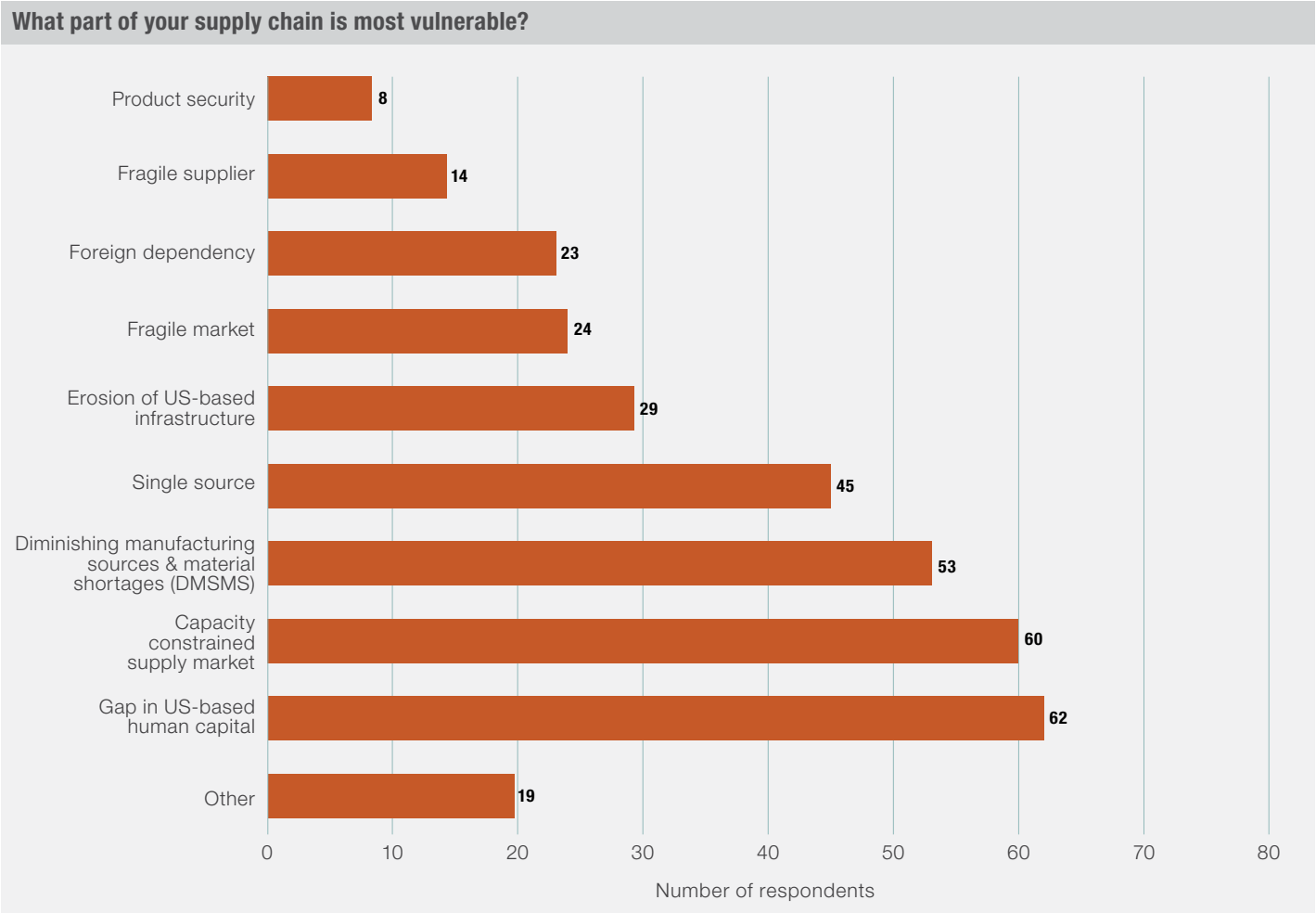

Figure 10.10, Source: NDIA

Since December 27, 2020, has this business received financial assistance from any of the following sources?

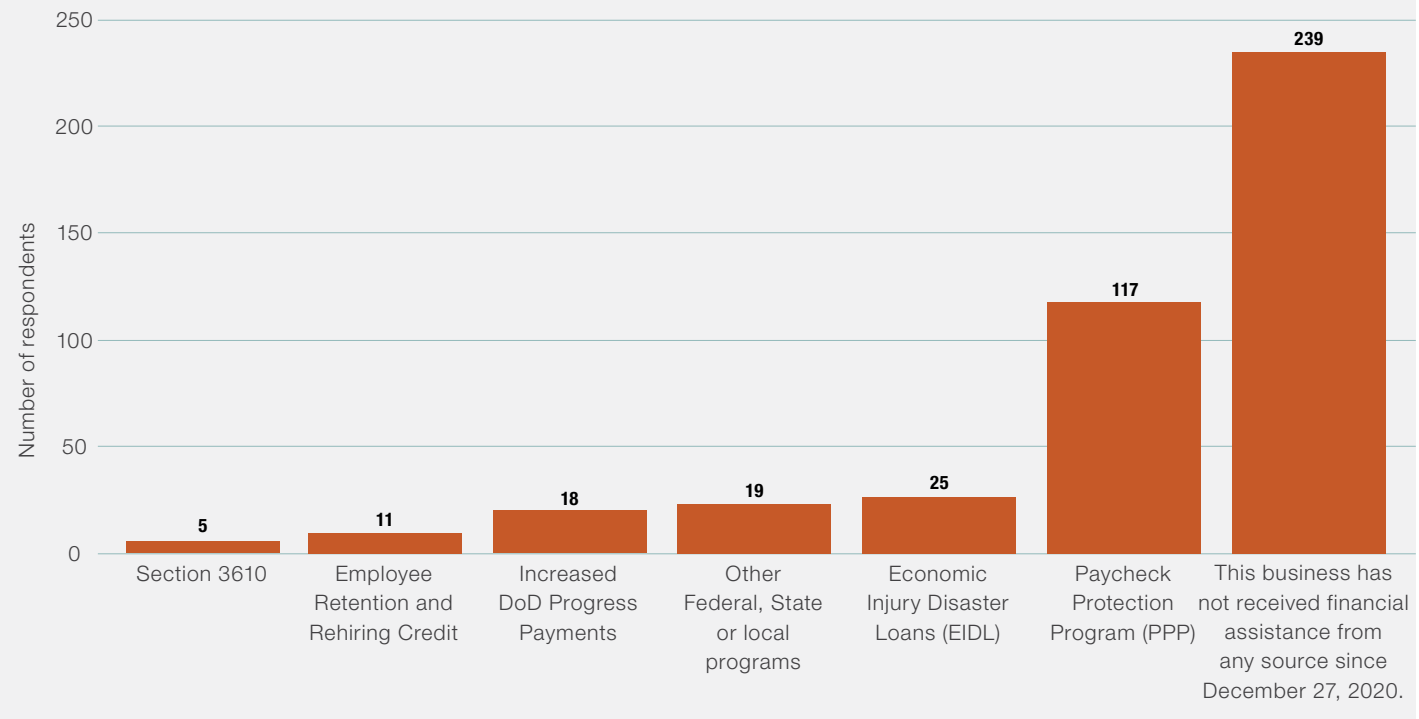

Figure 10.11, Source: NDIA

What is the most important thing the federal government can do to help the Defense Industrial Base?

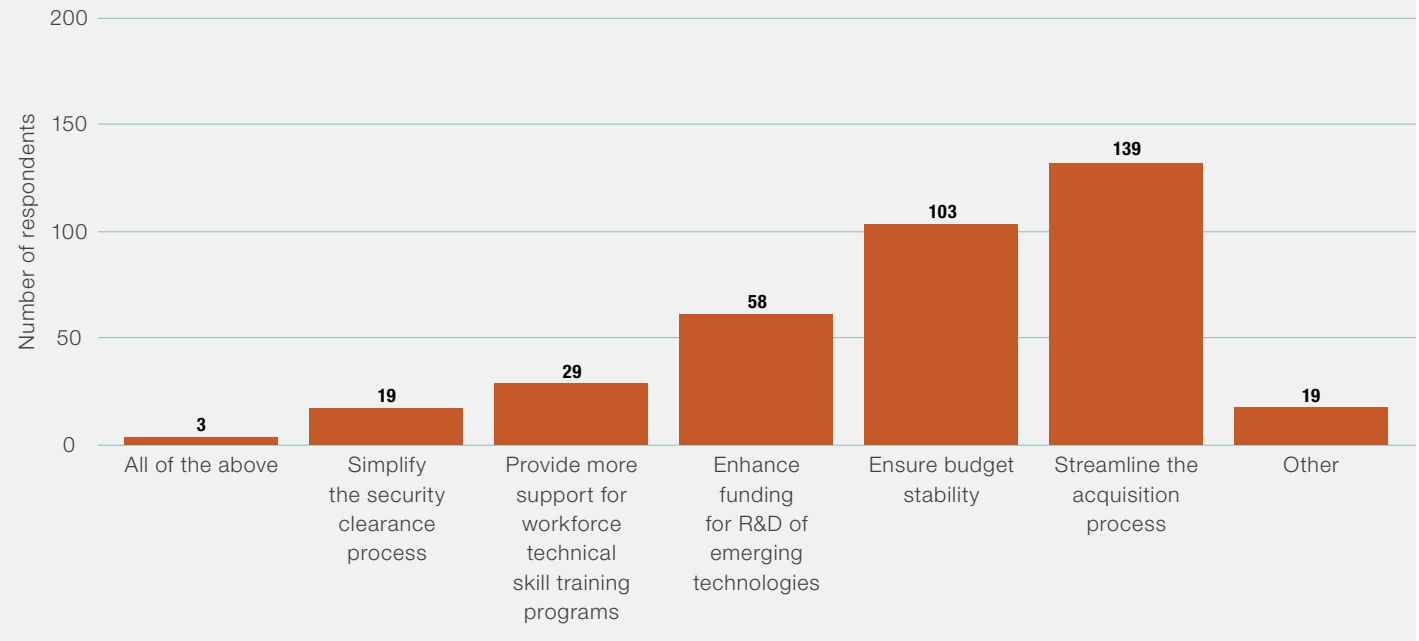

Figure 10.12, Source: NDIA

Overall, how has this business been affected by the COVID-19 pandemic?

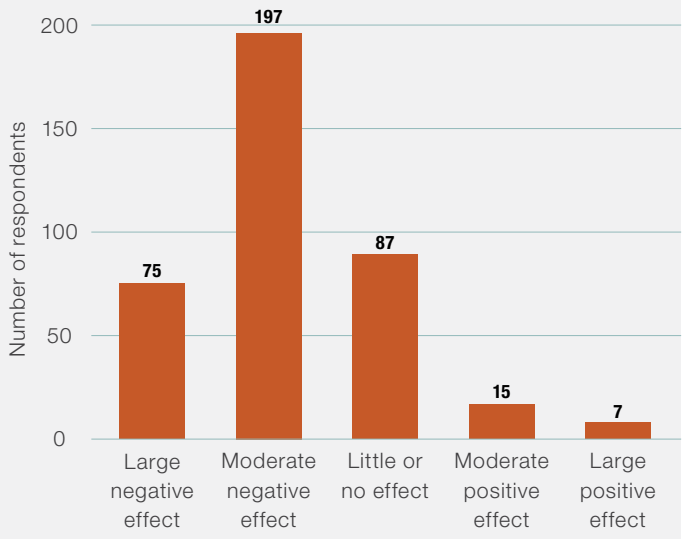

Figure 10.13, Source: NDIA

One year from now, do you think general business conditions will be better, worse, or about the same next fiscal year compared to this year?

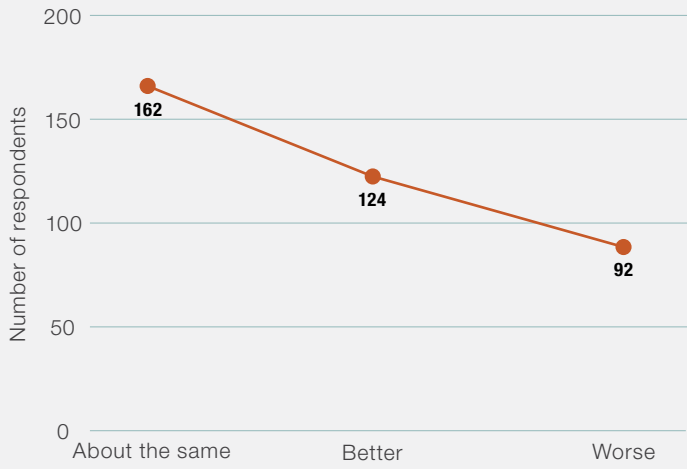

Figure 10.14, Source: NDIA

In your opinion, how much time do you think will pass before this business returns to its normal level of operations?

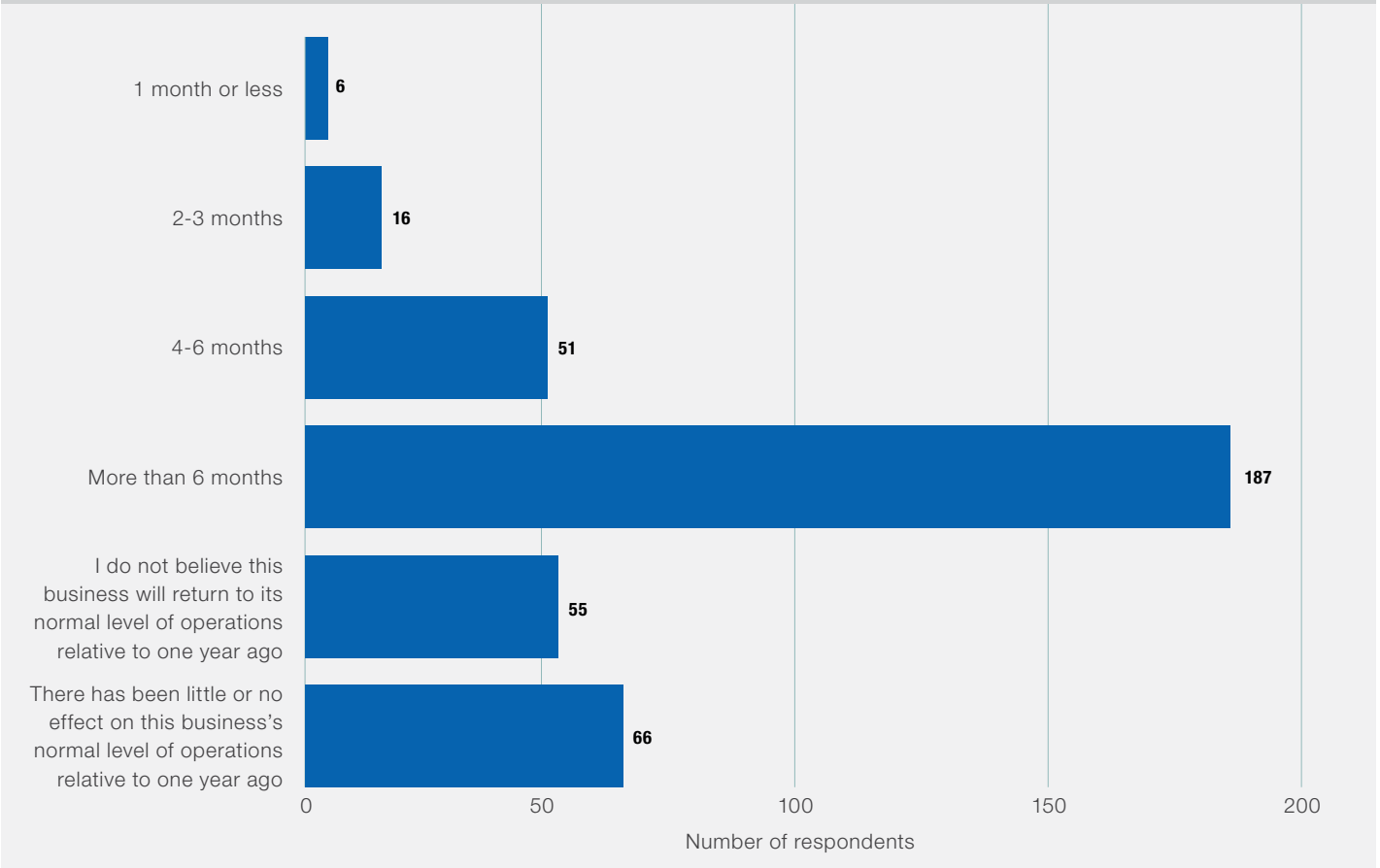

Figure 10.15, Source: NDIA

CONCLUSION

The U.S. defense industrial base's overall health and readiness received a final score of 69 out of 100, reflecting the first overall failing grade in the *Vital Signs* series. This departure reflects sustained challenges to the DIB as well as the unprecedented disruption caused by the pandemic. The report reinforces the notion that the DIB is not insulated from the rest of the economy; it paints a picture of a DIB that has struggled through the first year of the pandemic alongside the rest of the economy. Moving forward, the goal of maintaining or improving the health and readiness of the defense industrial base continues to be a pressing challenge for national security and defense policy communities.

Vital Signs 2022 highlights the hurdles that exist as demands on the defense industrial base rise in the age of renewed strategic competition. The largest drops from last year were in "supply chain", and "production capacity and surge readiness". This will come as no surprise as these issues featured very prominently across the world, due to covid-19 disruptions. They are also critical to U.S. national security interests as they feed into the ability to respond to a crisis.

Continuing a trend over the past two years, "industrial security"with its contributing factor, cybersecurity risks are among the most significant challenges for the industrial base. While the rate of growth has slowed down, the base continues to experience a year-on-year increase in the number of cybersecurity vulnerabilities. Modern defense supply chains rely on the sharing of sensitive information across networks to meet the needs of DoD and our servicemembers. The importance of these issues to policymakers can be seen though the implementation of CMMC and Section 889 Part B, which were created to improve the industry's cybersecurity posture in response to these increased risks.

The escalating costs and constraints on the availability of defense production inputs also threaten the DIB. One significant risk is the acquisition of rare earth metals: The United States is almost entirely reliant on foreign rare earth metal production, with the vast majority coming from our long-term strategic competitor, China. When a sector is dependent upon a single producer, supplies from global competitors or politically unstable regions, risks increase for the DIB's supply chain.

Finally, we continue to look at ways to improve the usefulness of this report. We welcome your constructive comments and suggestions on how we can improve the usefulness and range of *Vital Signs.*

APPENDIX 1

FULL INDICATOR SCORES LIST

#	Factor	Indicator	2019	2020	2021	Change, 2020 – 2021
Demand						
1	Demand	DoD contract obligations totals	82	88	94	● +6
Overall demand			***82***	***88***	***94***	● ***+6***
Production inputs						
2	Costs of goods and services	Producer Price Index, services for intermediate demand	81	74	98	● +24
3		Producer Price Index, processed goods for intermediate demand	87	70	18	● -52
4	Access to strategic materials	Average Rare Earths Minerals (REMX) ETF prices	76	75	83	● +8
5		U.S. share of world rare earths mine production	10	23	39	● +16
6		Net import reliance as a percentage of domestic consumption	6	6	6	● 0
7	Workforce productivity	Adjusted productivity	61	64	63	● -1
8	Workforce compensation	Estimated average annual per-worker pay, for defense-related employment	92	95	97	● +2
9	Workforce diversity	Gender diversity in employment in defense supplier industries	85	85	85	● 0
10		Racial diversity in employment in defense supplier industries	75	79	79	● 0
11		Latino ethnicity diversity in employment in defense supplier industries	40	41	41	● 0
12		Age ethnicity diversity in employment in defense supplier industries	100	100	100	● 0
13	STEM talent pool	STEM percentage of total U.S. occupational employment	90	92	95	● +3
14	Security on-boarding	Annual inventory of security clearance investigation cases	24	28	39	● +11
15		Duration of initial top secret reviews (days)*	24	23	29	● +6
16		Duration of top secret periodic reinvestigations (days)*	36	33	39	● +6
Overall production inputs			***66***	***66***	***67***	● ***+1***
Innovation						
17	Innovation inputs	Average annual value of worldwide R&D paid for by U.S.-based companies, selected durable industrial goods manufacturing industries	100	100	100	● 0
18		Average annual value of worldwide R&D paid for by U.S.-based companies, information and communications technologies	100	100	100	● 0
19		Average annual value of worldwide R&D paid for by U.S.-based companies, scientific R&D services	30	31	25	● -6
20	Innovation competitiveness	Share of international patent applications, U.S.-origin	73	69	68	● -1
21		Share of global R&D investment, U.S.-origin	76	76	77	● +1
22	Innovation/intellectual property production	Average annual patent applications, durable industrial goods manufacturing	58	46	50	● +4
23		Average annual patent applications, information and communication technologies goods and services	71	84	90	● +6
24		Average annual patent applications, scientific R&D services	37	38	36	● -2
Overall innovation			***69***	***69***	***69***	● ***0***

*DSCA only released data for fasted 90% of cases

Factor score key	● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

#	Factor	Indicator	2019	2020	2021	Change, 2020 – 2021
Supply chain						
25	Contract failure	Average annual DoD contracts terminated for cause	25	27	37	+10
26	Financial performance	Weighted average cash conversion cycle for top defense contractors	54	74	38	-36
27	Inventory performance	Weighted average inventory turnover ratio for top defense contractors	62	83	75	-8
28	Cost management	Average Nunn-McCurdy unit cost breaches	100	100	100	0
Overall supply chain			***60***	***71***	***63***	***-8***
Competition						
33	Profitability	Weighted average core operating margin (return on sales)	94	93	76	-17
34		Weighted average earnings per share	81	84	89	+5
35		Weighted average return on assets	73	66	97	+31
36		Weighted average return on equity	51	51	39	-12
37	Liquidity	Weighted average free cash flow	88	86	67	-19
38		Quick ratio (acid test)	97	94	82	-12
39		Working capital ratio (or current ratio)	99	98	96	-2
40	Leverage	Debt-equity ratio	93	83	84	+1
41		Solvency ratio	95	98	90	-8
42	Capital investment	Capital expenditure ratio	87	82	77	-5
31	Market concentration	Level of market concentration (Herfindahl-Hirschman Index)	100	100	100	0
32	Foreign ownership	Contracting market share of foreign-owned firms	100	100	100	0
30	Contract competition	Average number of competitive offers received per contract actions	93	92	92	0
Overall competition			***92***	***88***	***88***	0
Industrial security						
43	Threats to Intellectual Property rights	New FBI Intellectual Property rights violation investigations	74	77	80	+3
44	Threats to information security	Average annual newly-reported common IT cyber vulnerabilities	32	27	26	-1
45		Severity of newly-reported common IT vulnerabilities	14	14	14	0
Overall industrial security			***49***	***49***	***50***	***+1***
Political & regulatory						
46	Public opinion	Public opinion polling on defense spending: responses indicating "Too little"	62	49	44	-5
47	Congressional budgeting process	Average number of days NDAA passed after Oct. 1	90	89	86	-3
48		Average number of days appropriations passed After Oct. 1	65	77	85	+8
49		Congressional interest in: procurement: MDAPs	97	99	80	-19
50		Supply chains: manufacturing/supply chain/reshoring/Buy American	82	91	81	-10
51	Regulatory burden	Number of SAM representations and certifications	80	77	77	0
52		Incurred costs audit average elapsed days	87	92	95	+3
53		Forward pricing audit average elapsed days	97	98	99	+1
Overall political & regulatory			***78***	***76***	***72***	***-4***
Productive capacity & surge readiness						
55	Intensity of capital usage	Durable goods manufacturing sector capacity utilization	85	86	84	-2
54	Output efficiency	National industrial output gap	75	48	20	-28
Overall productive capacity & surge readiness			***80***	***67***	***52***	***-15***

Figure 10.1

Factor score key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

APPENDIX 2

TOP 100 PUBLICLY TRADED DEFENSE CONTRACTORS

Rank	Parent Vendor	FY21 Total
1	Lockheed Martin Corp.	$74.9 B
2	Raytheon Technologies Corp.	$26.9 B
3	General Dynamics Corp.	$22.2 B
4	The Boeing Co.	$21.7 B
5	Northrop Grumman Corp.	$12.3 B
6	Huntington Ingalls Industries, Inc.	$8.0 B
7	Humana Inc.	$6.9 B
8	BAE Systems PLC	$6.6 B
9	L3Harris Technologies, Inc.	$6.1 B
10	General Electric Co.	$4.4 B
11	Booz Allen Hamilton Holding Corp.	$3.7 B
12	Leidos Holdings, Inc.	$3.6 B
13	Centene Corp.	$3.1 B
14	Science Applications International Corp.	$3.0 B
15	McKesson Corp.	$2.8 B
16	CACI International, Inc.	$2.5 B
17	Oshkosh Corp.	$2.5 B
18	Fluor Corp.	$2.5 B
19	Amerisourcebergen Corp.	$2.1 B
20	KBR, Inc.	$2.0 B
21	Perspecta Inc.	$1.8 B
22	Textron Inc.	$1.8 B
23	Vectrus, Inc.	$1.6 B
24	Leonardo S.p.A.	$1.5 B
25	Jacobs Engineering Group Inc.	$1.3 B
26	Moderna, Inc.	$1.2 B
27	Rolls-Royce Holdings PLC	$1.1 B
28	Dell Technologies Inc.	$1.1 B
29	Honeywell International Inc.	$1,013,663,348
30	The Parsons Corporation	$938,800,027
31	Aecom	$820,652,908
32	Fedex Corporation	$812,549,206
33	SERCO GROUP PLC	$809,460,252
34	Verizon Communications Inc.	$772,508,945
35	BP P.L.C.	$659,148,438
36	Viasat, Inc.	$647,542,300
37	Mantech International Corporation	$646,007,001
38	Cardinal Health, Inc.	$544,355,206
39	Great Lakes Dredge & Dock Corporation	$532,226,187
40	International Business Machines Corporation	$471,543,471
41	Omnicom Group Inc.	$470,876,502
42	Phillips 66	$458,124,291
43	Hewlett Packard Enterprise Company	$456,264,421
44	Microsoft Corporation	$421,587,826
45	AIRBUS SE	$415,688,399
46	Pae Incorporated	$414,668,301
47	ACCENTURE PUBLIC LIMITED COMPANY	$403,150,610
48	AT&T Inc.	$398,306,069
49	Teledyne Technologies Inc	$396,060,345
50	Cisco Systems, Inc.	$373,094,226
51	Cdw Corporation	$365,548,549
52	Centurylink, Inc.	$364,048,565
53	Asgn Incorporated	$356,432,093
54	GLAXOSMITHKLINE PLC	$342,454,804
55	CHEMRING GROUP PLC	$325,878,061
56	CAE Inc	$311,382,773
57	Tetra Tech, Inc.	$307,948,031
58	ELBIT SYSTEMS LTD	$305,280,381
59	AAR Corp.	$299,791,271
60	THALES	$295,370,575
61	Insight Enterprises, Inc.	$285,047,941
62	US Foods Holding Corp.	$278,847,219
63	ROYAL DUTCH SHELL PLC	$278,774,939
64	Caterpillar Inc.	$268,246,601
65	Kratos Defense & Security Solutions, Inc.	$260,754,641
66	Owens & Minor, Inc.	$260,398,254
67	Tiger Midco, LLC	$251,262,633
68	SODEXO	$249,971,309
69	Johnson Controls International Public Limited Company	$238,780,265
70	Par Pacific Holdings, Inc.	$235,536,810
71	Aerojet Rocketdyne Holdings, Inc.	$232,503,943
72	Ball Corporation	$229,621,268
73	Cummins Inc.	$226,712,185
74	American Water Works Company, Inc.	$222,576,214
75	Parker-Hannifin Corporation	$213,013,357
76	Atlas CC Acquisition Corp. (Cubic Corp)	$211,833,121
77	Transdigm Group Incorporated	$210,720,999
78	Berkshire Hathaway Inc.	$209,297,560
79	Allison Transmission Holdings, Inc.	$206,329,195
80	Siemens AG	$205,274,052
81	WPP PLC	$200,454,053
82	Duke Energy Corporation	$198,539,770
83	3M Company	$198,067,169
84	Unitedhealth Group Incorporated	$194,149,997
85	Veritas Capital Fund Management, L.L.C.	$186,475,267
86	Tutor Perini Corporation	$182,418,427
87	Austal Limited	$177,669,580
88	Sysco Corporation	$166,607,463
89	Becton, Dickinson and Company	$149,520,877
90	ENEOS Holdings, Inc.	$149,223,925
91	Aerovironment, Inc.	$145,859,900
92	VSE Corporation	$145,424,671
93	Moog Inc.	$144,474,282
94	Arrow Electronics, Inc.	$140,425,760
95	MEGGITT PLC	$138,224,166
96	Gulf Island Fabrication, Inc.	$131,140,350
97	Danaher Corporation	$128,874,429
98	MOTOR OIL (HELLAS) CORINTH REFINERIES S.A.	$128,058,480
99	Unisys Corporation	$117,834,828
100	Matson, Inc.	$114,552,141

Figure 10.2

The National Defense Industrial Association is the trusted leader in defense and national security associations. As a 501(c)(3) corporate and individual membership association, NDIA engages thoughtful and innovative leaders to exchange ideas, information, and capabilities that lead to the development of the best policies, practices, products, and technologies to ensure the safety and security of our nation. NDIA's membership embodies the full spectrum of corporate, government, academic, and individual stakeholders who form a vigorous, responsive, and collaborative community in support of defense and national security. For more than 100 years, NDIA and its predecessor organizations have been at the heart of the mission by dedicating their time, expertise, and energy to ensuring our warfighters have the best training, equipment, and support. For more information, visit **NDIA.org**

NDIA

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