Congressional Research Service
Informing the legislative debate since 1914

TESTIMONY

Statement of

Ronald O'Rourke
Specialist in Naval Affairs

Before

Armed Services Committee
Seapower and Projection Forces Subcommittee
U.S. House of Representatives

Hearing on

"The State of U.S. Shipbuilding"

March 11, 2025

Congressional Research Service
7-5700
www.crs.gov
<Product Code>

Introduction

Chairman Kelly, Ranking Member Courtney, distinguished members of the subcommittee, thank you for the opportunity to appear before you today to testify on behalf of the Congressional Research Service (CRS) on the state of U.S. shipbuilding.

The subcommittee stated in its invitation letter that it "is interested in having Mr. O'Rourke bring to bear the full measure of his experience and expertise in assessing and analyzing the current situation regarding shipbuilding and related Navy matters, and in having him present options for addressing it." This statement aims to do that, using my experience in tracking and analyzing Navy shipbuilding programs and the shipbuilding industrial base for the past 41 years as the CRS specialist in naval affairs.

The subcommittee asked that I discuss, among other things, shipbuilding lessons learned, shipbuilding cost growth, the requirements process in shipbuilding, recent inflation in shipbuilding, shipbuilding delays and industrial base capacity constraints, and options for addressing challenges in Navy shipbuilding and the shipbuilding industrial base. The statement is organized around these topics. The appendices that follow the statement provide additional explanation and details. Portions of this statement are adapted from my CRS reports on Navy shipbuilding programs, particularly my overview report on Navy shipbuilding, CRS Report 32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*. The supporting footnotes and citations for this adapted material, which are numerous and sometimes lengthy, are included in these reports but are largely excluded from this statement so as to reduce the statement's total length.

Shipbuilding Lessons Learned

The success or failure of the Navy's current and future shipbuilding efforts can be strongly impacted by the success or failure of its shipbuilding lessons learned process, meaning its process for identifying lessons from past shipbuilding efforts and transmitting those lessons to current and future Navy shipbuilding program managers, acquisition officials, and leaders.

A Summary of Some Shipbuilding Lessons Learned

A summary of some shipbuilding lessons learned, taken from CRS Report 32665, is reprinted in this testimony as **Appendix A**. As stated in that summary, these lessons reflect comments made by various sources over the years. As also stated in that summary, identifying these lessons is arguably not the hard part—most if not all have been cited for years. The hard part, arguably, is abiding by them without letting circumstances lead program-execution efforts away from these lessons.

Noting Lessons Rather than Learning and Transmitting Them

My experience over the past 41 years is that while the term used is *lessons learned*, the Navy sometimes appears to temporarily note lessons without necessarily "learning" them and transmitting them to future shipbuilding program managers, acquisition officials, and leaders, only to have those successors rediscover them the hard way years later in connection with subsequent shipbuilding programs. I have witnessed what appear to be multiple such instances over my career at CRS.

A recent case in point concerns the Constellation (FFG-62) class shipbuilding program, which has demonstrated the potential challenges and pitfalls of attempting to modify the features of an existing ship design that is being used as a parent design (i.e., a baseline design) for a new Navy shipbuilding program. A Navy official commenting on the FFG-62 program recently reportedly stated that "[it] turns out modifying someone else's design is a lot harder than it seems," and that "sometimes, you're just better off designing a new ship."[1] Another Navy official, also commenting on the FFG-62 program, reportedly stated that "I'll be brutally honest, I don't think people truly understood what it meant to adapt a parent design to Navy requirements."[2]

The potential challenges and pitfalls of attempting to modify a parent design were identified and called out years before the procurement of the first FFG-62 in FY2020. For example, a 2015 article on the potential challenges and pitfalls of using a parent design that was published in a professional journal for naval architects and marine engineers—an article that is block-quoted in my CRS report on the FFG-62 program[3]—states:

> Using an existing design as the "parent" design, also referred to as "modified-repeat" design, is on its face an attractive option. Many acquisition executives, program managers and some ship design engineers believe that a design based on a parent has fewer technical risks than a new "clean sheet of paper" design and therefore the time and cost to design and build it will be reduced. They assume early in the ship acquisition program that "the design is mature" and because of that fewer problems will be encountered in completing the design and savings will thus be accrued. Yet, a number of naval ships based on a parent design have in fact experienced unanticipated cost and schedule growth during construction as well as technical problems during their in-service life. The authors will examine some of these ship designs which were based on an existing design and/or prototypes and highlight the fallacies of such beliefs and assumptions.[4]

Option for a Shipbuilding Lessons Learned Center

One option for helping ensure that shipbuilding lessons are in fact learned and transmitted to future shipbuilding program managers, acquisition officials, and leaders, would be to establish a Navy shipbuilding lessons learned center. In 2013 testimony to this subcommittee, for example, I stated:

> Given the long history of the Navy encountering and addressing challenges in Navy shipbuilding programs, one option for identifying, recording, and transmitting to future generations the lessons learned from past shipbuilding programs, and thereby improving the ability to fully implement the 30-year shipbuilding plan in a situation of finite resources, would be to establish a Navy shipbuilding lessons-learned center roughly analogous to the combat operations lessons-learned centers operated by the military services. Such a center might, for example, help prevent instances similar to the use of design/construction concurrency in the sea frame portion of the LCS [Littoral Combat Ship] program—something that the Navy did even though design/construction concurrency is a well-known source of cost and schedule risk in defense acquisition programs, and that the Navy later acknowledged was a cause of substantial cost growth on LCS sea frames.[5]

---

[1] Former Assistant Secretary of the Navy (Research, Development, and Acquisition), as quoted in John Grady, "Navy's Plan for Frigate Parent Design Caused Delays, Former Acquisition Chief Says," *USNI News*, February 19, 2025.

[2] Captain Andy Gold, program manager for the FFG-62 program within Program Executive Office (PEO) Unmanned and Small Combatants, as quoted in Rich Abott, "Frigate Manager Says Design To Finish This Year, Delays Because Parent Design Mods Not Understood," *Defense Daily*, January 15, 2025.

[3] CRS Report R44972, *Navy Constellation (FFG-62) Class Frigate Program: Background and Issues for Congress*, by Ronald O'Rourke.

[4] Robert G. Keane Jr. and Barry F. Tibbitts, "The Fallacy of Using a Parent Design: 'The Design Is Mature,'" *Transactions (Society of Naval Architects and Marine Engineers [SNAME])*, 2015, No. 1 (January): 91-104, with additional discussion from the authors and other commentators on pages 105-122. The quoted passage appears at the start of the article, on page 91, where it forms part of an abstract or summary for the article.

[5] Statement of Ronald O'Rourke, Specialist in Naval Affairs, Congressional Research Service, before the House Armed Services Committee, Subcommittee on Seapower and Projection Forces on the Navy's FY2014 30-Year Shipbuilding Plan, October 23, 2013, p. 13.

Such a shipbuilding lessons learned center could be as simple as a physical (i.e., shelf) collection and/or electronic collection of documents that summarize lessons from past shipbuilding programs, and that is made available to Navy officials preparing to embark on new shipbuilding programs.[6]

Cost Growth

Overview

Cost growth in Navy shipbuilding—defined here as increases in the estimated procurement costs of lead ships in Navy shipbuilding programs that occur after those lead ships are procured (i.e., authorized and funded)—is significant and chronic, as shown by my Congressional Budget Office (CBO) colleague Dr. Eric Labs' work over many years.[7] Cost growth in the lead ship of a shipbuilding program tends to be followed by commensurate cost growth for subsequent ships in the class, as the costs for the subsequent ships are adjusted upward to bring them into alignment with the cost growth on the lead ship. (An exception is when cost growth on a lead ship is caused by a factor that applies only to the lead ship, such as growth in detailed design costs for the class, which are nonrecurring costs that are incorporated largely or entirely into the procurement cost of the lead ship.)

Unrealistically Low Lead Ship Cost Estimates

After tracking and analyzing the matter for many years, Dr. Labs and I are of the view that a principal cause of cost growth in Navy shipbuilding programs is that the Navy's estimated procurement costs for lead ships at the time those lead ships are procured are simply unrealistically low. The unrealistically low nature of these cost estimates sometimes has been so apparent to Dr. Labs and me that we have been able to quickly conclude that the lead ships in question are at risk of experiencing cost growth.

Reasons for Unrealistically Low Lead Ship Cost Estimates

The question is why the Navy's lead ship cost estimates are unrealistically low. There has been much discussion about this among various observers over the years. My assessment is that the chief explanation resides not so much in disagreement over technical cost estimating factors, but rather in what might be called the political economy or sociology of ship cost estimating. In short, I assess that Navy cost estimates for lead ships tend to be unrealistically low chiefly for the following three reasons:

- **Selling programs.** In estimating the cost of a proposed new shipbuilding program, there is an incentive to select a lower, more optimistic cost estimate rather than a higher, less optimistic estimate, that can come into play for shipbuilding program offices (so as to help sell the program to Navy leadership), for Navy leadership (so as to help sell the program to OSD, and to help the Navy remain within its budget topline), and for the Navy and OSD (so as to help sell the program to Congress, and to help the Navy and

[6] Navy officials preparing to embark on new shipbuilding programs also have the option of consulting past project managers (PMs) and program executive officers (PEOs) to solicit their views regarding lessons learned. A lessons learned center can provide lessons from past PMs and PEOs who are no longer available to consult, or who have moved on to positions (such as those in the private sector) that could raise an issue of conflict of interest concerning the views they might provide.

[7] See, for example, Congressional Budget Office, *An Analysis of the Navy's 2025 Shipbuilding Plan*, January 2025, p. 34 (Figure 11). The figure shows cost growth on Navy lead ships since 1985. It has appeared in numerous CBO reports and presentations over the years, with updates each time to include the most recent return data.

DOD remain within their respective budget toplines). My assessment is that this incentive is pervasive within Navy ship cost estimating, to the point where it has become almost standard operating procedure within the Navy.

- **Unbalanced assumptions about things going right or wrong.** In estimating the cost of a lead ship, shipbuilding program offices are allowed to incorporate the estimated cost-reducing effects of certain shipbuilding innovations or other changes that will differentiate that program from previous Navy shipbuilding programs, but they do not appear to be equally allowed to incorporate the potential cost-increasing effects that can occur if those innovations or changes do not play out as expected, or if other, unanticipated problems (i.e., problems that by definition cannot be specified in advance) occur in the effort to build the ship. A short way of saying this is that Navy lead ship cost estimates tend toward being closer to a best-case view in which things go generally well, as opposed to a less optimistic case in which certain things do not go as well as planned.
- **Near-term vs. longer-term consequences of lower estimates, relative to terms in office.** Shipbuilding program offices, the Navy, and OSD appear to have concluded that the near-term benefit of unrealistically low cost estimates for Navy lead ships—winning approval from the Navy, OSD, and Congress for starting the programs—is more salient than the potential longer-term consequences of unrealistically low estimates, which include increased eventual pressures on Navy and DOD budget toplines, reduced eventual procurement quantities, the possible termination of programs (which is rare), and facing criticism at eventual congressional oversight hearings when the cost growth becomes apparent to Congress. Given the finite terms in office for shipbuilding program officials, senior Navy officials, and OSD leaders, it would not be surprising for the near-term benefit of winning approval for starting the program appear to be viewed by those officials as more salient than the potential longer-term costs, which would become potential problems not for those officials, but instead for their successors. Congress has struggled for years to find a way to hold the Navy and DOD accountable for cost growth in shipbuilding programs, in part because program officials, Navy leaders, and OSD leaders that are in office at the time of the lead ship's procurement have typically moved on by the time, usually years later, when the cost growth becomes fully apparent to Congress.

CBO's Cost Estimates

CBO's cost estimates for shipbuilding programs are not subject to the first two bullet points above—CBO is not in the business of selling proposed shipbuilding programs, and CBO's estimates are based primarily on the actual results of previous Navy shipbuilding programs, which reflect not only what went right with those programs, but what went wrong with them as well. Regarding the third bullet point above, CBO analysts can remain in their position for many years, during which time at least some of their cost estimates will be shown to be correct or incorrect. Dr. Labs, for example, has been in his position for 30 years. I assess that these three differences between CBO and Navy cost estimating are why, in cases where there are differences (sometimes quite significant ones) between a Navy cost estimate for a lead ship and a higher CBO cost estimate for a lead ship, the cost sooner or later turns out to be closer to the CBO estimate.

A case in point concerns cost growth in the Zumwalt (DDG-1000) destroyer program. Early in that program, Dr. Labs' cost estimate for that ship was 55% higher than the Navy's estimate. When asked at a 2008 hearing before this subcommittee about this difference between the Navy's estimate and CBO's estimate, one of the Navy witnesses replied: "I would answer that I believe the Navy's estimate is more accurate. We've certainly had good dialogue with Dr. Labs and CBO. And some of our assumptions are just different. And so that's where you see the disparity. We've done a very hard scrub over the last several years to make sure that our cost estimates are more realistic."[8] Cost growth then began to manifest in the DDG-1000 program, and as of the Navy's FY2025 budget submission, had reached 54.1%,[9] even though the DDG-1000 design was modified after the lead ship was procured to reduce the cost of the ship's radar suite.

A second case in point concerned the lead ship in the Gerald. R. Ford (CVN-78) class aircraft carrier program. As I noted for years in my report on the CVN-78 program,[10] CBO (and also the Government Accountability Office [GAO]) expressed skepticism about the Navy's cost estimate, with Dr. Labs pointing out, among other things, that the Navy asserted that the cost of the lead ship in this program (i.e., a ship that would be at the top of the production learning curve for the class)[11] would be less than the cost of building an 11th Nimitz (CVN-68) class ship (i.e., a ship that would be well down the learning curve for that class). CBO estimated that the ship would likely experience significant cost growth, and the ship eventually experienced 27.0% cost growth.[12] Navy officials in the past have attributed the ship's cost growth to the new technologies that were incorporated into the ship's design. While those technologies contributed to the ship's cost growth by slowing the ship's construction and increasing the amount of rework that was needed to fix earlier construction problems, the primary cause of cost growth on the ship was the Navy's unrealistic cost estimate at the time the ship was procured, which was an estimate the Navy made with a full knowledge of the technologies that were incorporated into the ship's design.

A third and more recent case in point concerns the program to acquire new Polar Security Cutters (or PSCs, i.e., heavy polar icebreakers) for the Coast Guard, a program managed by a joint Coast Guard-Navy program office. As discussed in my CRS report on the PSC program,[13] CBO in May 2024 testimony and an August 2024 report estimated that PSC procurement costs would be about 60% higher than the program office's estimate.[14] A Coast Guard official testified in December 2024 that the Coast Guard is completing negotiations with the PSC builder to modify the existing PSC contract to include a cost increase of about 50%.[15]

A fourth and also recent case in point concerns the Navy's planned Medium Landing Ship (LSM) program. As discussed in my report on the LSM program,[16] an April 2024 CBO report for the program provided a cost estimate that was roughly 127% to 187% higher than the Navy's

---

[8] Spoken testimony of Allison Stiller, Deputy Assistant Secretary of the Navy (Ship Programs), at a March 14, 2008, hearing on the FY2009 budget request for Navy shipbuilding, as shown in the CQ transcript for the hearing.

[9] See Table A-1 in CRS Report RL32109, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*, by Ronald O'Rourke.

[10] CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by Ronald O'Rourke.

[11] For more on production learning curve effects in Navy shipbuilding, see Appendix C (pages 95-110) in CRS Report 96-785, *Navy Major Shipbuilding Programs and Shipbuilders: Issues and Options for Congress*, by Ronald O'Rourke.

[12] See Table 2 in Report RS20643.

[13] CRS Report RL34391, *Coast Guard Polar Security Cutter (Polar Icebreaker) Program: Background and Issues for Congress*, by Ronald O'Rourke.

[14] Eric J. Labs, *The Cost of the Coast Guard's Polar Security Cutter*, Congressional Budget Office, Testimony Before the Subcommittee on Transportation and Maritime Security Committee on Homeland Security, U.S. House of Representatives, April 30, 2024 (for hearing of May 7, 2024), p. 2 (PDF page 3 of 4); Congressional Budget Office, *The Cost of the Coast Guard's Polar Security Cutter*, August 2024, p. 1.

[15] See Cal Biesecker, "Coast Guard Seeks DHS Decision Thursday To Begin Polar Security Cutter Construction," *Defense Daily*, December 18, 2024; Malte Humpert, "U.S. Coast Guard Heavy Icebreaker Production Decision Expected This Week After Multi-Year Delay," *gCaptain*, December 20, 2025.

[16] CRS Report R46374, *Navy Medium Landing Ship (LSM) Program: Background and Issues for Congress*, by Ronald O'Rourke.

estimate.[17] The Navy, in the reported words of one official, believed that its cost estimate was "bulletproof," but in December 2024, the Navy canceled its Request for Proposals (RFP) for the LSM program due to bid costs that were much higher than anticipated.[18]

12 Ships in Navy's FY2025 Budget Submission

In CRS Report 32665, I identify 12 ships in the Navy's FY2025 budget submission whose estimated procurement costs for FY2026-FY2029 appear unrealistically low compared to ships of the same types that are programmed for procurement prior to that period (i.e., in FY2025) or after that period (i.e., after FY2029), apparently due to the dynamic discussed in the second bullet point above (i.e., to help keep the Navy within its budget topline, in this case, during the final four years of the FY2025-FY2029 Future Years Defense Plan [FYDP]).[19] These 12 ships include seven LSMs programmed for procurement in FY2026-FY2029, one AS(X) submarine tender programmed for procurement in FY2027, and four TAGOS[20] ocean surveillance ships programmed for procurement in FY2026-FY2029.

Options for Congress

Options for Congress for addressing cost growth and otherwise improving Navy shipbuilding programs include but are not limited to the following:

- Focus oversight of shipbuilding programs in part on whether the Navy is abiding by the shipbuilding lessons learned that are summarized in **Appendix A**.
- Encourage or direct the Navy, if it has not done so already, to establish a shipbuilding lessons learned center, and require Navy officials that are preparing to embark on new shipbuilding programs to review the center's materials as an initial step in their work.
- Ensure that the Navy's acquisition executive—the Assistant Secretary of the Navy (Research, Development, and Acquisition) (ASN [RDA])—is familiar with Navy shipbuilding, and establish a term in office for the ASN (RDA) similar to the eight-year term of the Director of Naval Reactors—a term long enough so that the ASN (RDA) can see through the implementation of reforms to Navy shipbuilding that might take several years to implement, and be held accountable for the outcomes of decisions made in the earlier years of the eight-year term. Under current practice, ASN RDAs often serve for periods of four years or less. (An exception is Sean Stackley, who served as the ASN (RDA) for about nine years—from July 2008 to August 2017.) A parallel option would be to establish a similarly long term in office for the Commander of the Naval Sea Systems Command (NAVSEA).
- Maintain an awareness of the political economy or sociology of Navy ship cost estimating as described above, and build that awareness into congressional oversight of proposed Navy shipbuilding programs.
- Obtain and track the confidence levels that the Navy assigns to its shipbuilding cost estimates, with a particular eye for confidence levels that are below 50%. In connection

[17] See Congressional Budget Office, *Acquisition Costs of the Navy's Medium Landing Ship*, April 2024, p. 1.

[18] Mallory Shelbourne, "Landing Ship Medium Program Stalled Over Price, Navy Cancels Industry RFP," *USNI News*, December 17 (updated December 18), 2024; Nick Wilson, "Navy Punting LSM Award Due to Pricier-than-Expected Bids," *Inside Defense*, December 11, 2024.

[19] See the section entitled "Procurement Costs of Certain Ships in Five-Year Shipbuilding Plan," in CRS Report 32665.

[20] In the designation TAGOS (also written as T-AGOS), the *T* means the ships are operated by the Military Sealift Command (MSC); the *A* means they are auxiliary (i.e., support) ships; the *G* means they have a general or miscellaneous mission; and the *OS* means the mission is ocean surveillance.

with this, bear in mind—although it might seem paradoxical at first glance—that there can be a difference between avoiding cost growth and minimizing cost, and that confidence levels much above 50% can be associated with this apparent paradox. (For additional discussion see **Appendix B**.)

- Employ fixed price contracts for shipbuilding, while bearing in mind the cautionary notes relating to fixed-price contracts that are discussed in **Appendix C** of this statement.
- Take into account the complexity of the question of whether to employ warranties in shipbuilding contracts as a means of attempting to reduce shipbuilding costs, including the risk that expensive warranties might not reduce eventual procurement costs. (For additional discussion, see **Appendix D**.)
- Continue CBO's role in providing independent cost estimates of Navy shipbuilding programs, and maintain an awareness of CBO's track record relative to the Navy's track record in estimating lead ship procurement costs when evaluating proposed Navy shipbuilding programs.
- Continue GAO's role in evaluating Navy shipbuilding programs and making recommendations for reducing cost growth, and otherwise improving Navy shipbuilding programs.

Requirements Process and Shipbuilding

The requirements process can impact Navy shipbuilding costs in several ways, including but not necessarily limited to the following:

- **The requirements process can make a ship design bigger and more expensive to procure.** The requirements process can lead, as the design for a new ship is developed, to growth in the capabilities that the ship is to have, increasing the ship's size and cost. A case in point is the DDG-1000 program, which was originally called the DD-21 program. As stated in a 2006 CRS report, "when development of the DD-21… began in 1994, the initial unit procurement cost target was $750 million in FY1996 dollars, a target cost that was somewhat lower than the DDG-51's unit procurement cost at the time [implying a design about as large as, or perhaps smaller than, the DDG-51 design]…. By 2001, however, the DD-21 design had grown to between 16,000 tons and 18,000 tons [i.e., a figure more than 50% greater than that of the DDG-51], and its estimated cost had grown considerably."[21] This dynamic can occur in a shipbuilding program when affordability considerations are de-emphasized and mission and threat considerations become predominant.
- **The requirements process can undermine a parent design strategy, leading to increased design time and design cost.** A case in point is the previously mentioned FFG-62 frigate program, in which Navy requirements led to numerous changes to the Italian-French parent design, making the FFG-62 program appear more like what I refer to as a PDINO (parent design in name only) approach.[22] Another example of a program that appears to have moved from a parent design approach toward a PDINO approach is the PSC program, where significant modifications have again been made to the parent design (a German design for a polar research ship that may not have been fully developed

[21] CRS Report RL32109, *Navy DD(X), CG(X), and LCS Ship Acquisition Programs: Oversight Issues and Options for Congress*, by Ronald O'Rourke, updated February 28, 2006, p. 34 (see also p. 12). See also CRS Report RS21059, *Navy DD(X) Future Surface Combatant Program: Background and Issues for Congress*, by Ronald O'Rourke, November 9, 2001, p. 2.

[22] One possible way to pronounce the acronym PDINO would be pa-DEE-no.

as a design at the time the PSC contract was awarded). The three-year delay in the FFG-62 program and the six-year delay in the PSC program are due in large part to limits on the number of ship designers (i.e., naval architects and marine engineers) that have been available to make the significant modifications to the intended parent designs.

- **The requirements process can lead to changes in the ship's design as the ship is being produced, leading to design-construction concurrency.** One of the oldest lessons in shipbuilding is to avoid design-construction concurrency (i.e., designing the ship at same time that the ship is being built). Although the Navy is fully aware of the need to avoid design-construction concurrency, the Navy has allowed it to happen in the past as a result of its requirements process. A case in point is the previously discussed Littoral Combat Ship (LCS) program, in which the Navy made changes to the ship's design for the purpose of increasing the ship's survivability features as the ship was being built.[23]
- **The requirements process is mostly outward oriented, toward missions and threats.** As discussed later in this statement, the Navy's requirements process is mostly outward oriented, toward missions and threats, and not very much inward oriented, toward the U.S. society that will be called on to design, build, crew, and maintain the ship. This can lead to ship designs that look good on paper for performing missions and meeting threats, but which can lead to design, construction, crewing, and maintenance challenges.

Recent Inflation in Shipbuilding Costs[24]

Shipbuilding, like other sectors of defense procurement and the U.S. economy in general, experienced significant inflation following the start of the COVID-19 pandemic due to supply chain disruptions and other impacts. The Department of the Navy states in its FY2025 budget highlights book that "the residual effects of inflationary pressures of the past few years, workforce challenges, plus increased labor and supply costs across the defense enterprise, all drove costs associated with our shipbuilding account up roughly 20% over the past couple of years."

This inflation has increased the estimated procurement costs of multiple Navy shipbuilding programs, reducing the purchasing power of the Navy's shipbuilding budget. For an annual Navy shipbuilding account of about $32 billion, 20% inflation applied across the account could reduce the purchasing power of the account to a pre-inflation equivalent of about $26.7 billion, or about $5.3 billion less. Stated differently, 20% inflation applied across the new-construction portion of the Navy's shipbuilding account could reduce the number of ships that could be procured for a certain amount of funding from 12 ships to 10 ships.

Inflation can also affect shipyards and their associated supplier firms, particularly those operating under fixed-price contracts. Contracts for building Navy ships sometimes include Economic Price Adjustment (EPA) clauses that permit costs within the contract to be adjusted upward to account for inflation. EPA clauses may cover some of the ships being built at a shipyard but not others, might cover changes in costs for labor but not materials (or vice versa), and cover inflation-related increases in costs up to a certain percentage increase, but not beyond.

In addition to EPA clauses, firms have the option of filing Requests for Equitable Adjustment (REAs) to cover inflation-related cost increases not fully covered by EPAs clauses.

---

[23] See also the earlier-quoted passage from my 2013 testimony to this subcommittee, which appears in the section of this statement entitled "Option for a Shipbuilding Lessons Learned Center."

[24] This section is adapted from CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

In addition to EPA clauses and REAs, a third option for responding to inflation-related cost increases is P.L. 85-804 as amended (50 U.S.C. 1431-1432), a law originally enacted in 1958 that authorizes certain federal agencies to provide certain types of extraordinary relief to contractors who are encountering difficulties in the performance of federal contracts or subcontracts relating to national defense. P.L. 85-804 has amended by the FY2023, FY2024, and FY2025 NDAAs to, among other things, include a temporary authority to modify certain contracts and contract options based on the impacts of inflation.[25]

Shipbuilding Delays and Capacity Constraints

Overview Observations

Overview observations that can be made about shipbuilding delays and capacity constraints, taken from CRS Report 32665, include the following:

- On April 2, 2024, the Navy revealed projected delays in a number of its shipbuilding programs. The projected delays were revealed in the form of a one-page a summary of findings from a 45-day review of Navy shipbuilding programs that the Navy conducted in early 2024. The one-page summary is reprinted in CRS Report 32665. The projected delays are quite significant and extend across several shipbuilding programs, amounting to an unusual and arguably extraordinary situation in the post-World War II history of the Navy.
- Some observers, commenting on both these projected delays and the comparative shipbuilding capacities of the United States and China, have characterized the situation as a strategic liability or major cause for concern for the United States in competing militarily with China.
- Industrial base capacity constraints for building Navy ships are present at both shipyards and supplier firms. The most prominent constraints are those for building submarines. Capacity constraints are also affecting construction rates for certain surface combatants.
- Workforce challenges appear to be a central factor in projected delays and capacity constraints. These challenges include difficulties in recruiting and retaining sufficient numbers of production workers at shipyards and supplier firms, lower productivity of newly hired workers compared with that of more experienced workers, and limited numbers of ship designers (i.e., naval architects and marine engineers).
- The Navy's challenges in designing ships and building ships can be viewed as part of a larger situation in which the Navy additionally faces challenges in crewing ships (due to recruiting shortfalls that the Navy is working to overcome) and maintaining ships (particularly nuclear-powered attack submarines, but also certain conventionally powered surface ships). Stated differently, the Navy is currently facing challenges in designing, building, crewing, and maintaining ships. This combination of challenges is the most significant I have seen in my aforementioned 41-year career at CRS. One might need to go back to the post-Vietnam war era of the 1970s to find a time when the Navy faced a combination of challenges as daunting or more daunting than the one it faces today. The

[25] Section 822 of the FY2023 NDAA (H.R. 7776/P.L. 117-263 of December 23, 2022) amended P.L. 85-804 to, among other things, add a temporary authority, ending on December 31, 2023, to modify certain contracts and contract option based on the impacts of inflation. Section 824 of the FY2024 NDAA (H.R. 2670/P.L. 118-31 of December 22, 2023) extended this authority to December 31, 2024, and Section 824 of the FY2025 NDAA (H.R. 5009/P.L. 118-159 of December 23, 2024) extended it further, to December 31, 2025.

Navy today can certainly show its capability and effectiveness in focused operations, such as those the Navy has conducted for countering anti-ship threats in the Red Sea. But the Navy as a whole nevertheless faces the combination of challenges described here.

Navy and Industry Response

As discussed in CRS Report 32665, the Navy and industry have responded to shipbuilding delays and capacity constraints by taking a number of actions, including but not limited to the following:

- In August 2024, the Navy stood up a new Maritime Industrial Base (MIB) office to track and address industrial base challenges for building ships, aircraft, and munitions.
- Carlos Del Toro, who was the Secretary of the Navy during the Biden Administration, encouraged foreign shipbuilders, particularly those in Japan and South Korea, to invest in shipbuilding facilities in the United States, and to share their world-class shipyard management best practices with U.S. shipbuilders.
- The Navy is spending billions of dollars in submarine industrial base (SIB) funding that has been appropriated since FY2018 to increase submarine construction capacity at the country's two submarine-construction shipyards and their supplier firms, as well as smaller amounts of funding that have been appropriated for increasing surface ship industrial base capacity.
- The Navy and industry are employing, to some degree at least, several of the options for expanding shipbuilding capacity that are listed in the next section of this statement, such as nationwide worker advertising (for submarine construction), increased worker pipeline efforts, increased worker wages and benefits, worker quality of work and quality of life projects, and federated shipbuilding (which the submarine community refers to as strategic outsourcing).

Ten Options for Increasing Shipbuilding Capacity

As discussed in CRS Report 32665, in addition to using strategic outsourcing for building submarines and providing industrial base funding for shipyards and supplier firms, other options for addressing industrial base capacity constraints for building Navy ships (i.e., for increasing available shipbuilding capacity) include but are not limited to the ten options that are listed below, which are not mutually exclusive and not listed in any particular order. Eight of these ten options are already being pursued to some degree by the Navy and industry, but could be pursued more intensively and/or at broader scale. Two of the ten options—those relating to worker immigration and foreign shipyards—are not currently being used by the Navy and industry. The ten options are as follows:

- **Worker nationwide advertising** for building all types of ships, not just submarines;
- Increased **worker pipeline efforts**;
- **Worker immigration**;
- Increased worker **wages and benefits**;
- Projects for improving **worker quality of work and quality of life**;
- Increased use of **robotics and automation** at shipyards and supplier firms;
- Increased use of **federated shipbuilding (aka nation as a shipyard)**;
- Building **additional shipyard facilities**—new shipyards and/or additions to existing shipyards;

- Increasing the number of **smaller ships**, including unmanned ships, in the Navy's planned mix of ships; and
- Employing **foreign shipyards** to build U.S. Navy ships or modules of U.S. Navy ships.

The worker immigration option was suggested by Carlos Del Toro, who as I noted earlier was the Secretary of the Navy during the Biden Administration. One issue that might arise in connection with this option would concern the citizenship of such workers, since contracts for building all U.S. Navy ships require that workers building the ships be U.S. citizens.

Substantially increasing worker wages and benefits could begin producing results in recruiting and retaining new workers almost immediately. It could substantially increase ship procurement costs, since shipyard labor can account for roughly 40% of a military ship's total procurement cost.

The aim of federated shipbuilding (aka nation as a shipyard) would be to gain access to production facilities and (perhaps more important) regional labor markets in parts of the country that currently are not significantly involved in Navy shipbuilding. Federated shipbuilding could require altering ship designs to facilitate the production of ship modules in locations other than final assembly yards, and could make shipbuilding programs more complex to manage.

Building a shipyard facility capable of producing large ships for the Navy could require hundreds of millions or billions of dollars of investment and years of construction time.

Changing the Navy's planned mix of ships to include a larger number of smaller ships could expand shipbuilding capacity by bringing into the Navy's shipbuilding effort smaller shipyards that are not large enough to build the Navy's larger ships. This option would produce a fleet mix that might be less optimal for performing missions than the Navy's currently preferred mix. (Smaller shipyards could also form part of a federated shipbuilding effort by building modules of larger Navy ships that are then sent to larger shipyards where ships undergo final assembly.)

One issue that would arise in connection with the option of using foreign shipyards are U.S. laws that prohibit U.S. Navy ships or major components of Navy ships from being built in foreign shipyards. These laws include, among others, 10 U.S.C. 8679, which includes a presidential waiver for national security interest, and a recurring provision in the annual DOD Appropriations Act that has not included such a waiver.

In general, many of the ten options listed above could be very expensive, could take years to produce results, or both. For more on these ten options, see **Appendix E**.

Five Options for Using Shipbuilding Capacity

In addition to the above options for addressing shipbuilding capacity constraints (i.e., for *increasing* available shipbuilding capacity), additional options for *using* available ship-design and shipbuilding capacity include but are not limited to the five discussed briefly below, which are not mutually exclusive and not listed in any particular order. Four of these five options are already being pursued to some degree by the Navy and industry, but could be pursued more intensively and/or at broader scale. The fifth option, relating to up-front fleet design, is not currently being used by the Navy and industry to a significant degree. The five options are as follows:

- Taking actions to ensure that U.S. shipyards use **world-standard shipbuilding practices and methods**;
- Shifting Navy shipbuilding toward a more comprehensive and systematic **kit of parts approach**, in which standard components parts go into standard systems that are installed on ships with standard internal features;

- Adopting the South Korean approach to design for producibility, which includes a focus on developing **ship designs requiring fewer labor hours to build**;
- Employing **continuous production**—a notion that has several elements that are discussed further in **Appendix F**; and
- Employing **up-front fleet design**, as well as a related vetting question in reviewing proposed shipbuilding programs.

When incorporating world-standard shipbuilding practices and methods into Navy shipbuilding, significant differences between commercial and naval ships need to be taken into account. Examples of such differences include ship production quantities; interior density and complexity; commercial vs. military construction standards; specialty steels and welding techniques (particularly for submarines); propulsion systems (including nuclear propulsion); ship design and construction for reduced detectability and high survivability; the installation, integration, and testing of complex combat systems; and intended service lives. For additional discussion of the differences between commercial shipbuilding and naval shipbuilding, see **Appendix H**.

Shifting the Navy more toward a kit-of-parts approach could involve de-optimizing individual ship designs (when those designs are viewed individually) in exchange for better optimizing Navy ship design at the collective (i.e., fleet-wide) level.

Pursuing the continuous production option could involve, among other things, a change in how the future Navy is described and discussed. Instead of describing and discussing the future Navy as a fleet that is to consist of a certain precise number of ships (e.g., 381 ships) by a certain future year, the future Navy might instead be described and discussed as a fleet of a certain general size range that will be produced by building a certain number of attack submarines each year, a certain number of destroyers per year, and so on, with the precise number of ships in the future fleet to be determined in the future, through end-of-life (i.e., end of service life) retirement decisions. This might be described as a rate-centered or production-centered way of describing and discussing the future Navy (as opposed to the current target end point-centered approach).

The five options listed here for using available ship-design and shipbuilding capacity could take years to produce results. They could require significant changes in Navy fleet design practices, ship acquisition practices, and Navy organization. They could also have potentially significant impacts for maintaining congressional oversight of Navy shipbuilding programs and maintaining year-to-year congressional flexibility for determining shipbuilding-related spending. For more on these five options, see **Appendix F**. For additional discussion of capacity for conducting maintenance, repair, and overhaul (MRO) work on Navy ships, and on commercial shipbuilding in relation to Navy shipbuilding, see **Appendix G** and **Appendix H**.

Current American Naval System, and a Potential Alternative

Current American Naval System

The Navy's current overall approach to ship acquisition, which might be referred to as the current American naval system, includes three general elements that I assess are inherently contributing to the Navy's challenges in designing, building, crewing, and maintaining ships. If not addressed, these three general elements could continue creating challenges, possibly putting the Navy in an endless cycle of discovering problems and addressing them in a reactive, ad hoc, and costly manner. That is, the Navy could remain in a situation of seeing a light at the end of the tunnel with regard to resolving challenges, but never getting there as new challenges continue to appear. The three general elements are as follows:

- First, the Navy treats its force-level goals for various ship types as more precise and durable than they really are, and then chases those force-level goals by continually tinkering with ship procurement profiles, leading to production inefficiencies and industrial base challenges that are incurred in the pursuit of something that the Navy is unlikely to ever achieve—a close match between the Navy's ship inventories and most or all of those force levels goals.
- Second, the Navy is suboptimizing ship design efforts at the individual-ship level, instead of optimizing them at the fleet-wide level, producing challenges throughout the ship design, build, crew, and maintain life cycle. In other words, the Navy puts a priority on fine tuning the design of each ship for its intended missions and places less priority on looking for opportunities to coordinate the design of that ship with the designs of its other ships for the purpose of increasing cross-class advantages in design, construction, crewing, and maintenance—a process sometimes called production engineering.
- Third, the Navy is developing shipbuilding programs without adequately taking into account the features of the U.S. society (e.g., numbers of potential workers in the economy, and the education, training, and interests of potential workers) that will be called on to design, build, crew, and maintain those ships, producing further challenges throughout the design, build, crew, and maintain life cycle. The Navy in the past has not had to look inward to the features of U.S. society more than a certain amount, but my assessment is that the complexity of what the Navy is attempting to do with individual ship designs and how its platforms are to work together has now grown to the point where the Navy will need to do this much more than it has in the past (while continuing its practice of also looking outward, to missions and threats).

A Potential New American Naval System

Proceeding on the basis of the previous section, and drawing from the 15 options listed earlier, a potential option for a revised overall approach to ship acquisition, which might be referred to as a potential new American naval system, might look something like the following, with the individual components of the approach constituting severable options in themselves:

- **The goal** of a new approach could be to prevent at least some of the challenges the Navy is experiencing in designing, building, crewing, and maintaining ships from arising in the first place by taking actions to **make the fleet, by design, intrinsically easier to design, build, crew, and maintain**, while still delivering the needed capacity and capability for performing current and projected missions. Among others things, the aim could be to design a fleet that would require fewer people, and place less-complex demands on people, to design, build, crew, and maintain.
- In support of the above goal, the approach could essentially reverse the three general elements discussed in the previous section:
    - **Force-level goals could be treated as not so precise, and more subject to change over time**. Diseconomies from tinkering with procurement plans in an attempt to chase precisely stated force-level goals that will change multiple times between now and the target year would be avoided.
    - **Ship design could be optimized more at the fleet level**, and less at the individual-class level, with the aim of avoiding the diseconomies of having a fleet that is an assemblage of individually developed, bespoke designs. In short, the Navy could

design and build *a fleet*, rather than designing and building a collection of individual ship classes.

- **The Navy could examine, understand, and take better advantage of the features of the U.S. society** that will be called on to design, build, crew, and maintain the fleet, including both the strengths and limitations of U.S. society for meeting the Navy's needs, and areas of U.S. society whose capacity for meeting the Navy's needs might be increased by the Navy's own actions.

- As a consequence of the overall goal and the reversal of the three general elements of the existing approach, the potential new approach could include the following five elements:
  - **Federated shipbuilding/nation as a shipyard**, to gain access to production facilities and (perhaps more important) regional labor markets in parts of the country that currently are not significantly involved in Navy shipbuilding;
  - **Navy as a kit of parts**, to make the eventual fleet easier to design, build, crew, and maintain;
  - **Ship designs that take fewer labor hours to build**, following the South Korean approach to design for producibility;
  - **Continuous production**, including
    - **Multiyear contracting** (i.e., MYP and block buy contracting) where possible and cost effective;
    - Holding production rates steady and managing changes in force size not through changes in procurement rates, but instead through end-of-life decisions, which is **Japan's approach to submarine procurement rates and force levels**;
    - **Condition-based, minimal-loss procurement transitions in classes**, which is discussed further in **Appendix F**; and
    - Characterizing the future fleet more in terms of steady procurement rates than precisely stated force-level targets—**a production-centered or rate-centered approach** (as opposed to the current end point-centered approach) to thinking about and discussing the future fleet; and
  - **Up-front fleet design**—a generalized fleet design framework that incorporates federated shipbuilding, Navy as a kit of parts, the South Korean approach to design for producibility, and continuous production in its various aspects—and **vetting of proposed shipbuilding programs** in relation to this generalized framework.

The above potential alternative approach (with its severable sub-element options) is by no means the only possible approach for addressing the Navy's challenges in designing, building, crewing, and maintaining ships, and it would by no means solve all of the Navy's challenges in these areas. Continuing the Navy's current approach, however, is likely to lead to a continuation of these challenges.

Conclusion

Chairman Kelly, Ranking Member Courtney, thank you again for the opportunity to appear before you today, and I will be pleased to respond to any questions the subcommittee may have.

Appendix A. A Summary of Some Shipbuilding Lessons Learned[26]

This appendix presents a general summary of some shipbuilding lessons learned, reflecting comments made by various sources over the years. These lessons learned include the following:

- **At the outset, get the operational requirements for the program right.** Properly identify the program's operational requirements at the outset. Manage risk by not trying to do too much in terms of the program's operational requirements, and perhaps seek a so-called 70%-to-80% solution (i.e., a design that is intended to provide 70%-80% of desired or ideal capabilities). Achieve a realistic balance up front between operational requirements, risks, and estimated costs.
- **Use mature technologies.** Use land-based prototyping and testing to bring new technologies to a high state of maturity before incorporating them into ship designs, and limit the number of major new technologies to be incorporated into a new ship design.
- **Impose cost discipline up front.** Use realistic price estimates, and consider not only development and procurement costs, but life-cycle operation and support (O&S) costs.
- **Employ competition** where possible in the awarding of design and construction contracts.
- **Use a contract type that is appropriate for the amount of risk involved**, and structure its terms to align incentives with desired outcomes.
- **Minimize design/construction concurrency** by developing the design to a high level of completion before starting construction and by resisting changes in requirements (and consequent design changes) during construction.
- **Properly supervise construction work.** Maintain an adequate number of properly trained Supervisor of Shipbuilding (SUPSHIP) personnel.
- **Provide stability for industry**, in part by using, where possible, multiyear procurement (MYP) or block buy contracting.
- **Maintain a capable government acquisition workforce** that understands what it is buying, as well as the above points.

Identifying these lessons is arguably not the hard part—most if not all have been cited for years. The hard part, arguably, is abiding by them without letting circumstances lead program-execution efforts away from these lessons.

[26] This section is adapted from Appendix D of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Appendix B. Avoiding Procurement Cost Growth vs. Minimizing Procurement Costs[27]

The affordability challenge posed by the Navy's shipbuilding plans can reinforce the strong oversight focus on preventing or minimizing procurement cost growth in Navy shipbuilding programs, which is one expression of a strong oversight focus on preventing or minimizing cost growth in DOD acquisition programs in general. This oversight focus may reflect in part an assumption that avoiding or minimizing procurement cost growth is always synonymous with minimizing procurement cost. It is important to note, however, that as paradoxical as it may seem, avoiding or minimizing procurement cost growth is not always synonymous with minimizing procurement cost, and that a sustained, singular focus on avoiding or minimizing procurement cost growth might sometimes lead to higher procurement costs for the government.

How could this be? Consider the example of a design for the lead ship of a new class of Navy ships. The construction cost of this new design is uncertain, but is estimated to be likely somewhere between Point A (a minimum possible figure) and Point D (a maximum possible figure). (Point D, in other words, would represent a cost estimate with a 100% confidence factor, meaning there is a 100% chance that the cost would come in at or below that level.) If the Navy wanted to avoid cost growth on this ship, it could simply set the ship's procurement cost at Point D. Industry would likely be happy with this arrangement, and there likely would be no cost growth on the ship.

The alternative strategy open to the Navy is to set the ship's target procurement cost at some figure between Points A and D—call it Point B—and then use that more challenging target cost to place pressure on industry to sharpen its pencils so as to find ways to produce the ship at that lower cost. (Navy officials sometimes refer to this as "pressurizing" industry.) In this example, it might turn out that industry efforts to reduce production costs are not successful enough to build the ship at the Point B cost. As a result, the ship experiences one or more rounds of procurement cost growth, and the ship's procurement cost rises over time from Point B to some higher figure—call it Point C.

Here is the rub: Point C, in spite of incorporating one or more rounds of cost growth, might nevertheless turn out to be lower than Point D, because Point C reflected efforts by the shipbuilder to find ways to reduce production costs that the shipbuilder might have put less energy into pursuing if the Navy had simply set the ship's procurement cost initially at Point D.

Setting the ship's cost at Point D, in other words, may eliminate the risk of cost growth on the ship, but does so at the expense of creating a risk of the government paying more for the ship than was actually necessary. DOD could avoid cost growth on new procurement programs starting tomorrow by simply setting costs for those programs at each program's equivalent of Point D. But as a result of this strategy, DOD could well wind up leaving money on the table in some instances—of not, in other words, minimizing procurement costs.

DOD does not have to set a cost precisely at Point D to create a potential risk in this regard. A risk of leaving money on the table, for example, is a possible downside of requiring DOD to budget for its acquisition programs at something like an 80% confidence factor—an approach that some observers have recommended—because a cost at the 80% confidence factor is a cost that is likely fairly close to Point D.

Procurement cost growth is often embarrassing for DOD and industry, and can damage their credibility in connection with future procurement efforts. Procurement cost growth can also disrupt congressional budgeting by requiring additional appropriations to pay for something Congress thought it had fully

[27] This section is adapted from Appendix F of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

funded in a prior year. For this reason, there is a legitimate public policy value to pursuing a goal of having less rather than more procurement cost growth.

Procurement cost growth, however, can sometimes be in part the result of DOD efforts to use lower initial cost targets as a means of pressuring industry to reduce production costs—efforts that, notwithstanding the cost growth, might be partially successful. A sustained, singular focus on avoiding or minimizing cost growth, and of punishing DOD for all instances of cost growth, could discourage DOD from using lower initial cost targets as a means of pressurizing industry, which could deprive DOD of a tool for controlling procurement costs.

The point here is not to excuse away cost growth, because cost growth can occur in a program for reasons other than DOD's attempt to pressurize industry. Nor is the point to abandon the goal of seeking lower rather than higher procurement cost growth, because, as noted above, there is a legitimate public policy value in pursuing this goal. The point, rather, is to recognize that this goal is not always synonymous with minimizing procurement cost, and that a possibility of some amount of cost growth might be expected as part of an optimal government strategy for minimizing procurement cost. Recognizing that the goals of seeking lower rather than higher cost growth and of minimizing procurement cost can sometimes be in tension with one another can lead to an approach that takes both goals into consideration. In contrast, an approach that is instead characterized by a sustained, singular focus on avoiding and minimizing cost growth may appear virtuous, but in the end may wind up costing the government more.

Appendix C. Fixed-Price Contracts[28]

Fixed-price contracts help shift the risk of cost growth from the government to the contractor, and are an important tool for constraining procurement costs. At the same time, there are some cautionary notes regarding fixed-price contracts that are worth bearing in mind:

- In writing the terms of a fixed-price contract, the devil can be in the details, particularly as there are multiple sub-categories of fixed-price contracts. A fixed-price contract can include provisions for adjusting the total price in response to various developments.
- The contractor, in fulfilling the terms of a fixed-price contract, may choose to do the work exactly as described in the contract, and not a single thing more—even if doing that single thing more would have made sense in terms of value delivered to the government. In writing fixed-price contracts, DOD needs to understand its requirements well, so as to avoid instances in which it would have benefited from having the contractor perform work items that were not included in the terms of the contract.
- Depending on the bargaining leverage available to DOD in its negotiation with the contractor, the contractor, in return for agreeing to the use of a fixed-price contract (particularly a Firm Fixed Price contract), might demand a high price for the item to be built (a price close to what I refer to in **Appendix B** as Point D), which would mean that the contract, while avoiding cost growth, could create an increased risk for DOD of paying more for the item than was necessary.
- When the government is to a significant degree in a closed relationship with the contractor—that is, when the contractor is to a significant degree dependent on the government for its business, and the government in turn must rely on that contractor as the source for at least some of what that contractor provides to the government—then it is not clear what fixed-price contracts are accomplishing in the long run in terms of insulating the government from the risk of cost growth. Use of fixed-price contracts can translate cost growth into losses for the contractor. In a relationship between the government and the contractor that is to a significant degree a closed relationship, the contractor could seek to recover those losses by charging higher prices for future work it does for the government. Alternatively, the contractor could simply absorb the losses, which could weaken the contractor financially, reducing its ability invest in its work force and modernize its capital plant, which in turn could increase the cost of work that the contractor performs for the government in the future.[29] Either way, the cost growth on the earlier contract could, in the long run, be effectively shifted back to the government.

The points above are made not to argue against using fixed-price contracts—as mentioned above, fixed-price contracts are an important tool for constraining procurement costs. Even in a situation where the government is in a largely closed relationship with the contractor, fixed-price contracts can, at a minimum, help make cost developments in a program more immediately visible to policymakers, which can be of value in maintaining oversight of the program. The point, rather, is to provide some perspective on what can be accomplished through the use of fixed-price contracts.

[28] This section is adapted from Statement of Ronald O'Rourke, Specialist in Naval Affairs, Congressional Research Service, before the House Armed Services Committee on Case Studies In DOD Acquisition: Finding What Works, June 24, 2014, pp. 14-15.

[29] Another option for the contractor, at least in theory, would be to stop (or threaten to stop) work on the contract unless the government agrees to renegotiate the terms of the contract or agrees to provide a payment to cover the contractor's losses.

Appendix D. Some Considerations Relating to Warranties in Shipbuilding Contracts[30]

In discussions of Navy (and also Coast Guard) shipbuilding, one question that sometimes arises is whether including a warranty in a shipbuilding contract is preferable to not including one. The question can arise, for example, in connection with a past GAO finding that "the Navy structures shipbuilding contracts so that it pays shipbuilders to build ships as part of the construction process and then pays the same shipbuilders a second time to repair the ship when construction defects are discovered."[31]

Including a warranty in a shipbuilding contract (or a contract for building some other kind of defense end item), while potentially valuable, might not always be preferable to not including one—it depends on the circumstances of the acquisition, and it is not necessarily a valid criticism of an acquisition program to state that it is using a contract that does not include a warranty (or a weaker form of a warranty rather than a stronger one).

Including a warranty generally shifts to the contractor the risk of having to pay for fixing problems with earlier work. Although that in itself could be deemed desirable from the government's standpoint, a contractor negotiating a contract that will have a warranty will incorporate that risk into its price, and depending on how much the contractor might charge for doing that, it is possible that the government could wind up paying more in total for acquiring the item (including fixing problems with earlier work on that item) than it would have under a contract without a warranty.

When a warranty is not included in the contract and the government pays later on to fix problems with earlier work, those payments can be very visible, which can invite critical comments from observers. But that does not mean that including a warranty in the contract somehow frees the government from paying to fix problems with earlier work. In a contract that includes a warranty, the government will indeed pay something to fix problems with earlier work—but it will make the payment in the less-visible (but still very real) form of the up-front charge for including the warranty, and that charge might be more than what it would have cost the government, under a contract without a warranty, to pay later on for fixing those problems.

From a cost standpoint, including a warranty in the contract might or might not be preferable, depending on the risk that there will be problems with earlier work that need fixing, the potential cost of fixing such problems, and the cost of including the warranty in the contract. The point is that the goal of avoiding highly visible payments for fixing problems with earlier work and the goal of minimizing the cost to the government of fixing problems with earlier work are separate and different goals, and that pursuing the first goal can sometimes work against achieving the second goal.[32]

---

[30] This section is adapted from Appendix E of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[31] See Government Accountability Office, *Navy Shipbuilding[:] Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP, June 2018, p. 21. A graphic on page 21 shows a GAO finding that the government was financially responsible for shipbuilder deficiencies in 96% of the cases examined by GAO, and that the shipbuilder was financially responsible for shipbuilder deficiencies in 4% of the cases.

[32] It can also be noted that the country's two largest builders of Navy ships—General Dynamics (GD) and Huntington Ingalls Industries (HII)—derive much of their revenues from U.S. government work. These two shipbuilders operate the only U.S. shipyards currently capable of building several major types of Navy ships, including submarines, aircraft carriers, large surface combatants, and amphibious ships. Thus, even if a warranty in a shipbuilding contract with one of these firms were to somehow mean that the government did not have pay under the terms of that contract—either up front or later on—for fixing problems with earlier work done under that contract, there would still be a question as to whether the government would nevertheless wind up eventually paying much of that cost as part of the price of one or more future contracts the government may have that firm.

The Department of Defense's guide on the use of warranties states the following:

> Federal Acquisition Regulation (FAR) 46.703 states that "the use of warranties is not mandatory." However, if the benefits to be derived from the warranty are commensurate with the cost of the warranty, the CO [contracting officer] should consider placing it in the contract. In determining whether a warranty is appropriate for a specific acquisition, FAR Subpart 46.703 requires the CO to consider the nature and use of the supplies and services, the cost, the administration and enforcement, trade practices, and reduced requirements. The rationale for using a warranty should be documented in the contract file….
>
> In determining the value of a warranty, a CBA [cost-benefit analysis] is used to measure the life cycle costs of the system with and without the warranty. A CBA is required to determine if the warranty will be cost beneficial. CBA is an economic analysis, which basically compares the Life Cycle Costs (LCC) of the system with and without the warranty to determine if warranty coverage will improve the LCCs. In general, five key factors will drive the results of the CBA: cost of the warranty + cost of warranty administration + compatibility with total program efforts + cost of overlap with Contractor support + intangible savings. Effective warranties integrate reliability, maintainability, supportability, availability, and life-cycle costs. Decision factors that must be evaluated include the state of the weapon system technology, the size of the warranted population, the likelihood that performance requirements can be achieved, and the warranty period of performance.[33]

[33] Department of Defense, *Warranty Guide*, Version 2.0, October 30, 2020, accessed February 25, 2025, at https://www.dau.edu/sites/default/files/Migrated/CopDocuments/Warranty_Guide_Version_2.0.pdf, pp. 5, 14.

Appendix E. Ten Options for Addressing Shipbuilding Capacity Constraints[34]

In addition to using strategic outsourcing for building submarines and providing industrial base funding for shipyards and supplier firms, other options for addressing industrial base capacity constraints for building Navy ships (i.e., for increasing available shipbuilding capacity) include but are not limited to the ten options discussed briefly below, which are not mutually exclusive and not listed in any particular order. Eight of these ten options are already being pursued to some degree by the Navy and industry, but could be pursued more intensively and/or at broader scale. Two of the ten options—those relating to worker immigration and foreign shipyards—are not currently being used by the Navy and industry.

Worker Nationwide Advertising

As one workforce development effort funded in part with Navy-provided submarine industrial base funding, the submarine construction industry has raised awareness across the country of openings for submarine construction jobs through nationwide advertising efforts such as the Build Submarines advertising campaign and its associated website, buildsubmarines.com. Similar efforts could be used to more widely advertise job openings for building surface ships. This option could raise awareness of shipbuilding jobs in regional U.S. labor markets that are distant from the shipyards that build Navy ships.

Worker Pipeline

Worker pipeline efforts involve shipyards and supplier firms working with state and local governments, state and local school systems, labor unions, and other organizations to not only increase awareness within regional labor markets surrounding shipbuilding firms of shipbuilding as a potential line of work or career option, but also to encourage or provide instruction of students in basic trade skills that could help prepare them for potential future work in shipbuilding. Such efforts have been underway for years and have been expanded in part with Navy-provided industrial base funding. This effort could be expanded further, to other parts of the country not currently involved in Navy shipbuilding.

Worker Immigration

Carlos Del Toro, who, as previously noted, was Secretary of the Navy during the Biden Administration, suggested worker immigration as an option for providing more workers for shipyards building Navy ships. One issue that might arise in connection with this option would concern the citizenship of such workers, as contracts for building all U.S. Navy ships require that workers building the ships be U.S. citizens.

Worker Wages and Benefits

Shipyards and associated supplier firms face challenges in recruiting and retaining new workers in part because wages and benefits in service and retail jobs have grown more in recent years than have wages and benefits at shipbuilders and supplier firms. As a result, the differential in wages and benefits between shipbuilding jobs and service and retail jobs has narrowed, and workers consequently might now more likely to choose service and retail jobs, where the work, while still paying less than shipbuilding work, is more likely to be done in air-conditioned and cleaner indoor settings, involve less heavy lifting or risk of

[34] This section is adapted from the similarly titled section of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

serious injury, take place in locations offering easier daily commutes, and in other respects offer better quality-of-work and/or quality-of-life features. Reestablishing a larger differential in wages and benefits between shipbuilding jobs and service and retail jobs could require substantially increasing total wages and benefits for shipbuilding workers. Such a change could, in turn, substantially increase ship procurement costs, since shipyard labor can account for roughly 40% of a military ship's total procurement cost.

Worker Quality of Work and Quality of Life

Related to the discussion in the previous section, efforts to improve recruiting and retention of shipbuilding workers can also involve various initiatives to improve their quality of work or quality of life, such as providing affordable housing within certain commuting times of shipyards, ensuring sufficient parking at shipyards for workers arriving by car, building recreational or other support facilities for shipyard workers and their families at or close to shipyards, providing child care for workers, or paying retention bonuses to workers.

Robotics and Automation

Increasing where possible the use of robotics and automation for accomplishing manufacturing work at both shipyards and supplier firms could increase production capacity beyond what might otherwise be possible with a production workforce of a given size. Shipyards and supplier firms are already making use of robotics and automation; under this option, use of robotics and automation would be increased to take advantage of new advances in robotics and automation, or to perform work that in theory could be done more cost effectively by people, but that cannot be done by people due to insufficient numbers of production workers.

Federated Shipbuilding/Nation as a Shipyard

Another option—one that might be called *federated shipbuilding* or *nation as a shipyard*—would involve expanding the use of strategic outsourcing, which as discussed earlier is currently used for building submarines, to the construction to surface ships as well, so as to apply strategic outsourcing to Navy shipbuilding programs in a more systematic and comprehensive manner. This option could also involve designing Navy ships and their production strategies with this approach in mind. Under this approach, ship modules would be built at facilities that are some distance from the final assembly shipyard, and the modules would then be transported by truck, train, or barge to that shipyard for incorporation into the ship. The aim of this option would be to gain access to production facilities and (perhaps more important) regional labor markets in parts of the country that currently are not significantly involved in Navy shipbuilding. The manufacturing facilities that are some distance from the final assembly shipyard can be owned and operated by an owner of a final assembly shipyard or by an owner other than the owner of a final assembly shipyard.

Navy ships that have been built with modules produced at locations distant from the final assembly yard include certain submarines built by General Dynamics/Electric Boat (GD/EB) since 1975, every Virginia-class submarine procured since the start of Virginia-class procurement in FY1998, and several LPD-17 Flight I class amphibious ships that were built using this approach as a way of responding to damage to shipyards building San Antonio (LPD-17) Flight I class amphibious ships that was caused by Hurricane Katrina in 2005. Philly Shipyard in Philadelphia, PA, reportedly is considering building ship modules for the Navy as part of its targeted future work. A Navy official reportedly stated in December 2024 that the Navy is looking at using federated shipbuilding as part of its effort to expand production of FFG-62 class frigates.

Implementing federated shipbuilding/nation as a shipyard could require altering ship designs to facilitate the production of ship modules in locations other than final assembly yards, and could make shipbuilding programs more complex to manage.

Additional Shipyard Facilities

Another option would be to construct new shipyard facilities for building Navy ships at waterfront sites other than those currently used for building Navy ships. One version of this option would be to establish such facilities at sites that were once used to build Navy ships, such as—to name only three notional possibilities as examples, one each from the West Coast, Gulf Coast, and East Coast—the former Todd Seattle shipyard (now operated by Vigor Industrial), which once built surface combatants, including Oliver Hazard Perry (FFG-7) class frigates; the East Bank site of Huntington Ingalls Industries/Ingalls Shipbuilding (HII/Ingalls) in Pascagoula, MS, which was once used to build nuclear-powered submarines;[35] and the site of the former Philadelphia Naval Shipyard (a portion of which is currently operated by Philly Shipyard). As stated, these are only three notional possibilities, one each from the West Coast, Gulf Coast, and East Coast. Other waterfront locations around the country offer additional possible sites for building new shipyard facilities.[36] Constructing a shipyard facility capable of building large ships for the Navy could require hundreds of millions or billions of dollars of investment and years to build.

Smaller Ships

Another option would be to change the Navy's planned mix of ships (i.e., the Navy's planned fleet architecture) to include a larger number of smaller ships (such as missile-armed corvettes) that can be built by smaller shipyards that are not able to build larger Navy ships. This could increase the number of shipyards that participate in Navy shipbuilding.[37] Changing the Navy's planned mix of ships to include a larger number of smaller ships would produce a fleet mix that might be less optimal for performing missions than the Navy's currently preferred mix.

Foreign Shipyards

Another option would be to build Navy ships or parts of such ships in foreign shipyards, such as shipyards in Japan, South Korea, or allied countries in Europe. Former Navy Secretary Carlos Del Toro stated that he would be open to having foreign shipyards assemble modules for certain US Navy ships.

One issue that would arise in connection with this option are U.S. laws that prohibit U.S. Navy ships or major components of Navy ships from being built in foreign shipyards. These laws include, among others,

[35] For a press report discussing the East Bank site, see Justin Katz, "At Ingalls, Plenty of Space for Shipbuilding but Ramping Up Workforce Will Be the Challenge," *Breaking Defense*, August 23, 2024.

[36] For press reports about a new facility at the Austal USA shipyard of Mobile, Alabama, see, for example, Rojoef Manuel, "Austal to Build Module Factory for US Navy Submarine Programs," *Defense Post*, October 29, 2024; Sam LaGrone, "Austal USA Awarded $450M to Build a Submarine Construction Facility in Mobile," *USNI News*, September 16, 2024.

[37] See, for example, Congressional Budget Office, *Perspectives on the Navy's 2025 Shipbuilding Plan*, Presentation at the National Defense Industrial Association's 26th Annual Expeditionary Warfare Conference, Eric J. Labs, National Security Division, October 22, 2024, briefing slide 20 (PDF page 21 of 23); Collin Fox, "Distributed Manufacturing for Distributed Lethality," Center for International Maritime Security (CIMSEC), February 26, 2021; Frederick "Andy" Cichon, "Rebooting the High-Low Mix of Ships," *U.S. Naval Institute Proceedings*, February 2024. See also Megan Eckstein, "Small Shipyards Consolidate amid Navy Program Delays," *Defense News*, November 8, 2022; Bryan Clark, Timothy A. Walton, and Seth Cropsey, *American Sea Power at a Crossroads: A Plan to Restore the US Navy's Maritime Advantage*, Hudson Institute, October 2020, p. 50.

10 U.S.C. 8679, which includes a presidential waiver for national security interest,[38] and a recurring provision in the annual DOD Appropriations Act that has not included such a waiver.[39]

Another issue that would arise in connection with this option would concern the ability to safeguard sensitive U.S. naval technology and ship-design know-how in foreign shipyards and supplier firms whose employees would not be U.S. citizens. This issue currently arises in connection with repairing and maintaining certain U.S. Navy ships at shipyards in locations such as Japan; one question would be how this issue might differ for a situation of building (rather than repairing and maintaining) U.S. Navy ships.

Challenges and Limitations of These Options

In addition to challenges and limitations noted for certain individual options discussed above, many of the above options could be very expensive, could take years to produce results, or both.

[38] The text of 10 U.S.C. 8679 as of February 25, 2025, is as follows:

> §8679. Construction of vessels in foreign shipyards: prohibition
>
> (a) Prohibition.-Except as provided in subsection (b), no vessel to be constructed for any of the armed forces, and no major component of the hull or superstructure of any such vessel, may be constructed in a foreign shipyard.
>
> (b) Presidential Waiver for National Security Interest.-(1) The President may authorize exceptions to the prohibition in subsection (a) when the President determines that it is in the national security interest of the United States to do so.
>
> (2) The President shall transmit notice to Congress of any such determination, and no contract may be made pursuant to the exception authorized until the end of the 30-day period beginning on the date on which the notice of the determination is received by Congress.
>
> (c) Exception for Inflatable Boats.-An inflatable boat or a rigid inflatable boat, as defined by the Secretary of the Navy, is not a vessel for the purpose of the restriction in subsection (a).

[39] The provision, which has been included each year in the paragraph of the annual DOD Appropriations Act that makes appropriations for the Navy's shipbuilding account (i.e., the Shipbuilding and Conversion, or SCN, account), states

> … *Provided further*, That none of the funds provided under this heading for the construction or conversion of any naval vessel to be constructed in shipyards in the United States shall be expended in foreign facilities for the construction of major components of such vessel: *Provided further*, That none of the funds provided under this heading shall be used for the construction of any naval vessel in foreign shipyards:…

Appendix F. Five Options for Using Available Shipbuilding Capacity

In addition to the ten options discussed in **Appendix E** for addressing shipbuilding capacity constraints (i.e., for *increasing* available shipbuilding capacity), five additional options for *using* available ship-design and shipbuilding capacity include but are not limited to the five discussed briefly below, which are not mutually exclusive and not listed in any particular order. Four of these five options are already being pursued to some degree by the Navy and industry, but could be pursued more intensively and/or at broader scale. The fifth option, relating to up-front fleet design, is not currently being used by the Navy and industry to a significant degree.

World-Standard Shipbuilding Practices and Methods

One option for maximizing the use of available shipbuilding capacity is to incorporate world-standard shipbuilding practices and methods—including those used by leading shipbuilders in Japan and South Korea—into the operations of U.S. shipyards that build Navy ships. Some of these practices and methods relate to in-house worker training methods; others relate to shipyard operations management and materials management (such as, for example, monitoring and managing the flow of work through the shipyard on a continuous basis); and still others relate to the design and fabrication of ship sections and components.

DOD and Navy interest in this option dates back to at least 2005. GAO has focused on this option in multiple reports since at least 2009. Other observers have also focused on this option. Former Navy Secretary Carlos Del Toro encouraged Japanese and South Korean shipbuilders to consider investing in U.S. shipyards and transferring their shipbuilding practices and methods to U.S. shipyards. Some builders of Navy ships have pursued this option. For example, General Dynamics' National Steel and Shipbuilding Company (GD/NASSCO) of San Diego, a builder of both Navy auxiliary ships and commercial cargo ships, has done so since at least 1990.

In adopting commercial world-standard shipbuilding practices and methods into naval shipbuilding, significant differences between commercial and naval ships need to be taken into account. Examples of such differences include ship production quantities; interior density and complexity; commercial vs. military construction standards; specialty steels and welding techniques (particularly for submarines); propulsion systems (including nuclear propulsion); ship design and construction for reduced detectability and high survivability; the installation, integration, and testing of complex combat systems; and intended service lives. For additional discussion of the differences between commercial shipbuilding and naval shipbuilding, see **Appendix H**.

Navy as a Kit of Parts

Under an option that might be called *Navy as a kit of parts*, the design of the Navy would be modified over time toward one in which, more fully than is now the case, standardized components would go into standardized weapon systems that would be incorporated into a collection of hull designs with standardized features, with the aim of making the Navy easier to design and build (and also easier to crew and maintain). Such an approach has been proposed and considered since the 1970s, and the Navy since the 1970s has taken some steps in this direction, particularly in terms of pursuing commonality in its ship propulsion and ship combat system equipment. This option would expand the effort into one that is more systematic and comprehensive, so as to optimize the Navy more fully for ship design and ship construction (and also ship crewing and ship maintenance) at the fleet-wide level rather than optimizing the design of individual ship classes at the potential cost of reducing or missing opportunities for optimizing at the fleet-wide level. This option could involve de-optimizing individual ship designs (when those designs are viewed individually) in exchange for better optimizing the Navy at the fleet-wide level.

Ship Designs Requiring Fewer Labor Hours to Build

Another option—one used by South Korean warship designers—would be to design ship sections with a strong focus on reducing the labor hours needed to produce them. This option—which can be viewed as an example of the world-standard shipbuilding practices and methods discussed above—can involve enlarging ship sections somewhat so as to improve worker access to spaces in the ship sections and allow the sections to be filled with things like straighter pipe runs that take up more space but require less labor to produce and install, rather than space-saving but more convoluted pipe runs that require more labor to produce and install. In such cases, the aim is for the reduction in labor costs to be greater than the increase in material costs that would result from making the ship section larger. Some observers argue, based on South Korea's experience, that this can result in ship designs that are somewhat larger—but nevertheless easier and less expensive to build, maintain, and modernize over their life cycles.

Continuous Production

Another option, which can be referred to as *continuous production*, would be to construct Navy shipbuilding plans that

- emphasize continuous steady, production rates;
- employ multiyear contracting where cost-effective;[40]
- avoid year-to-year changes in near-term procurement profiles (i.e., programmed annual procurement quantities) that are made in an attempt to precisely match targeted downstream force levels;
- as a part of the previous point, manage the size of the Navy not at "the front end," though changes in near-term procurement profiles, but at "the back end," through end-of-life retirement decisions;
- manage transitions from procuring one class of ship (such as the Navy's DDG-51 destroyer) to procuring the next class of ship of the same general kind (such as the Navy's planned DDG(X) next-generation destroyer) in a manner that avoids or minimizes reductions in the numbers of ships of that general kind that are procured during the transitional period; and
- conceive and talk about the future Navy more in terms of steady production rates and a broadly defined future size than in terms of a precise targeted downstream force-level.

Compared with current practice, this option would place more emphasis on avoiding the potential costs and inefficiencies of irregular or changing procurement profiles, and recognize the likelihood that targeted downstream force levels could change, perhaps multiple times, between now and the year that the targeted downstream force levels are to be achieved.[41]

Managing the size of the Navy not at "the front end," though changes in near-term procurement profiles, but at "the back end," through end-of-life retirement decisions, would be similar to the approach that Japan uses for building its submarines and managing the size of its submarine fleet: to provide stability for its submarine construction industrial base and maximize efficiency in the production of its

---

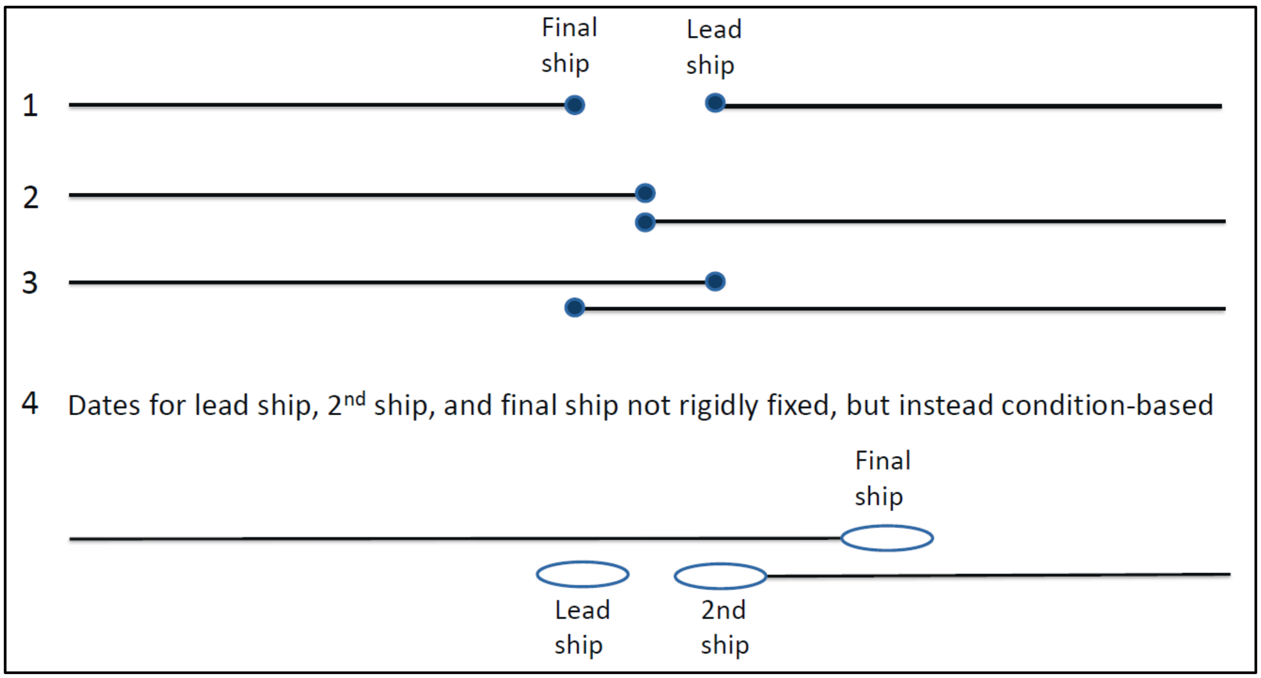
[40] For more on multiyear contracting, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke.

[41] For examples of past changes in U.S. Navy force-level goals, which tend to occur once every few years, see TableA-1 in CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

submarines, Japan aims to maintain a steady submarine production rate of one boat per year. When Japan planned to maintain a force of 18 submarines, it did so with the one-per-year build rate by keeping its submarines in service to about age 18. When Japan increased its submarine force-level goal to 22 boats, it maintained the one-per-year build rate and started keeping its submarines in service to about age 22. If Japan were to decide to further increase its submarine fleet to 30 boats, it could again maintain the one-per-year build rate and start keeping its boats in service to age 30. Under this approach, the one-per-year build rate is held constant even while the planned force size changes, because the size of the force is managed through end-of-life retirement decisions.

Figure F-1 presents a graphic on managing procurement transitions between classes. In the graphic, approach Number 1, in which there is a gap of one or more years between the procurement of the final ship of a class and the procurement of the lead ship of the next class, is widely recognized as one that can lead to significant losses of ship procurement opportunities and also cause damage to the shipbuilding industrial base for that type of ship.

Figure F-1. Condition-based, minimal-loss procurement transition between classes



Source: Graphic prepared by CRS.

Approach Number 2 closes up the gap shown in approach Number 1, but does not account for the risk of problems occurring in the effort to get production of the successor class underway. Approach Number 2 is the one that the Navy used in transitioning from procurement of LCSs to procurement of FFG-62s, and the result, given the delays in the FFG-62 program, is that the Navy is currently losing numerous small surface combatant ship procurement opportunities.

Approach Number 3 provides a cushion against the risk problems occurring in the effort to get production of the successor class underway. The Navy successfully used this approach in transitioning from the procurement of CG-47 class Aegis cruisers to DDG-51 class Aegis destroyers. During that transition, the effort to get DDG-51 production underway encountered a delay, and the Navy was able to use the overlap between CG-47 procurement and DDG-51 procurement to shift some large surface combatant procurement opportunities back to the CG-47 program while the DDG-51 program recovered from its delay.

Given the complexity of today's ships and industry conditions, my assessment is that Approach Number 3 may no longer provide the desired amount of protection against avoiding losses in procurement opportunities in transitioning procurement from one class to the next, and that a new approach—Number 4—may now be required. This approach would treat lead ships more fully like the prototypes that they are. Under this approach, the date for lead ship procurement is kept flexible until the design is truly done, the date for starting the second ship is kept flexible until challenges in building the lead ship are fully worked out, and in the meantime, procurement of the previous class is continued.

Pursuing the option of continuous production for the U.S. Navy could lead to a change in how the future Navy is described and discussed. Instead of describing and discussing the future Navy as a fleet that is to consist of a certain precise number of ships (e.g., 381 ships), the future Navy might instead be described and discussed as a fleet of a certain general size range that will be produced by building a certain number of attack submarines each year, a certain number of destroyers per year, and so on, with the precise number of ships in the future fleet to be determined in the future, through end-of-life retirement decisions.

Up-Front Fleet Design, and a Related Vetting Question

Another option would be for the Navy to engage more substantially in up-front fleet design (aka up-front, broad-scale, end-to-end design), with an eye toward designing a fleet that as a whole would be intrinsically easier to design, build, crew, and maintain, particularly in terms of the numbers of people needed and the complexity of demands placed on people for designing, building, crewing, and maintaining ships. Under this option, instead of designing the Navy incrementally, one ship class at a time, and producing a future Navy through the accretion over time of separately considered, bespoke ship designs, the Navy would place more up-front emphasis on how its ship acquisition programs collectively place demands on U.S. ship design, production, crewing, and maintenance capabilities, and on how up-front Navy decisions regarding its ship acquisition programs could shape those capabilities over time so as to better support future Navy needs.[42]

---

[42] One observer—the Navy's chief analyst of future force structure and capability requirements within the Office of the Chief of Naval Operations from 2002 to 2014—stated

> It is time to rethink how we will design the future Fleet in a way that rebalances affordability, platform capability, and deployment processes. We must build it as a whole instead of continuing to "let it happen" one platform requirements decision at a time….
>
> Today the Navy operates about 50 different types of ships and aircraft with individual design-service lives of 20 to 50 years. On average, about two classes of ship or aircraft annually come up for a decision on replacement at the end of their service lives. Each of these decisions, a multi-year joint bureaucratic process with dozens of participating organizations, is made individually….
>
> The future Fleet is being designed ad hoc, one platform at a time, and we cannot afford this. How can we change the trend toward an ever-smaller Fleet of ever-better platforms while maintaining the capability superiority needed to execute our missions? It will take a top-down design to provide a structure in which individual platform requirements can be shaped and disciplined despite all of the pressures….
>
> Developing an overall fleet design to structure and discipline individual platform requirements is no small task. Simply constraining platform cost without dealing with how capabilities might be delivered differently is not sufficient. This is not a once-and-done process, as changes in threat and in our own technology options will never stop. But neither can it be a process that changes the design in some fundamental way every year or two—it will have to influence platform requirements for a long period of time to affect a significant number of new platform designs.
>
> We cannot afford to retire legacy platforms prematurely simply because they are not optimized within our new Fleet design, which will take time to implement and have to be done incrementally. Real and fundamental change in the roles, missions, and interdependencies among platform types, and in the balance between manned and unmanned and between platform and payload, is an inevitable outcome of a Fleet design process. That is the point. Change is hard, and it will have to be authorized and directed by the Navy's

(continued...)

This option could also involve the use of a new up-front vetting question for proposed shipbuilding programs that would require those proposing a new program to show how the proposed program reflects the results of an up-front fleet design and how the proposed program would make the Navy inherently easier to design, build, crew, and maintain by doing one or more of the things discussed in the previous three sections (i.e., Navy as a kit of parts, ship designs requiring fewer labor hours to build, and continuous production), by doing other things, or both.

Challenges and Limitations of These Options

The above options for using available ship-design and shipbuilding capacity could take years to produce results. They could require significant changes in Navy fleet design practices, ship acquisition practices, and Navy organization. They could also have potentially significant impacts for maintaining congressional oversight of Navy shipbuilding programs and maintaining year-to-year congressional flexibility for determining shipbuilding-related spending.

---

leadership or risk not happening….

The only way to meet these demands within available resources is to develop a design that provides a structure within which the capabilities of future platforms can be shaped to meet the Fleet's missions efficiently as an overall force. Doing this will require a systems-level approach to defining what it must be able to do, and will mean abandoning some cherished traditions of what each type of platform should do. The alternative is a Navy no longer large or capable enough to do the nation's business.

(Arthur H. Barber III, "Rethinking the Future Fleet, The U.S. Navy Has No Overall Requirements Process for Designing a Fleet, and It Needs One—Desperately," *U.S. Naval Institute Proceedings*, May 2014.)

Appendix G. Capacity for Conducting Ship Repair Work

This appendix discusses capacity for conducting maintenance, repair, and overhaul (MRO) work on Navy ships, and commercial shipbuilding in relation to Navy shipbuilding, which is a topic that sometimes arises in connection with discussions of Navy shipbuilding.

Since challenges in building new Navy ships and in conducting MRO work on SSNs are both due in large part to capacity constraints, it can be reasonable for an observer to conclude that challenges in conducting MRO work on the Navy's conventionally powered surface ships are similarly due chiefly to capacity constraints. Some observers may have made this conclusion, because they have suggested that the challenges of conducting MRO work on the Navy's conventionally powered surface ships can be addressed by adding additional capacity for conducting this work in the form of foreign shipyards.

Dr. Labs and I have asked the Navy on more than one occasion whether the Navy's challenges in conducting MRO work on the Navy's conventionally powered surface ships are due to capacity constraints, and the Navy has consistently replied that this is not the case—that the Navy's challenges in conducting this work are chiefly due not to capacity constraints, but to inadequate Navy planning, scheduling, and funding of this work, which the Navy is now focusing on improving.[43] The Navy has explained to Dr. Labs and me that while there was a shortage of drydocks on the West Coast for conducting this work, that shortage has since been reduced.

Based on the Navy's explanations to Dr. Labs and me, it would appear that proposals to address the challenges in performing MRO work on the Navy's conventionally powered surface ships by adding capacity in the form of foreign shipyards would miss the mark, since the problem is not inadequate capacity, but inadequate planning, scheduling, and funding of the work.

[43] See also, for example, Meghann Myers, "Stop Treating Shipyards Like the 'Corner Garage': Former Navy Acquisitions Chief," *Defense One*, February 19, 2025.

Appendix H. Commercial Shipbuilding in Relation to Navy Shipbuilding

This appendix discusses commercial shipbuilding in relation to Navy shipbuilding, which is a topic that sometimes arises in connection with discussions of Navy shipbuilding.

Some observers are interested in expanding commercial ship construction in the United States, which fell to very low levels in the 1980s—in part due to the Reagan Administration's cancellation in the early 1980s of the Construction Differential Subsidy (CDS), which had previously supported commercial ship construction in the United States—and has remained at those very low levels since.

There are various potential reasons for supporting actions to increase commercial ship construction in the United States, including but not limited to a desire to create jobs (which was a major consideration in connection with shipbuilding initiatives in the Depression years of the 1930s, when there were high levels of unemployment), or a sense that major world powers should (or need to) be major maritime powers, and that being a major maritime power includes being a significant builder of commercial ships.

Given the comparative costs of building commercial ships in the United States and other countries, some of which is due to national differences in labor costs, significantly increasing commercial ship construction in the United States on a sustained basis by increasing the U.S. share of the international market for commercial ships could require reinstating the CDS or something like the CDS. Current world market prices for commercial ships vary considerably by ship type, but to keep the notional math fairly simple, a smaller commercial cargo ship might be said to have a current world market price of roughly $50 million, while a larger commercial cargo ship might be said to have a current market price of roughly $100 million.[44] The cost to build such ships in U.S. shipyards might start out at about four times those figures (i.e., $200 million and $400 million, respectively),[45] meaning that the subsidy amount needed under a reinstated CDS or something like the CDS might start out at something like $150 million to $300 million per ship. These figures might come down somewhat over time as the U.S. shipyards building these ships progress down the production learning curve for building the ships and achieve other production economies of scale, but given differences in national labor costs, a significant per-ship subsidy would likely be required indefinitely.

Increasing commercial ship construction activity in the United States would create a new competitor for the same potential shipyard production workers for which the Navy's shipbuilders are already challenged in recruiting. This could lead to upward pressures on shipyard worker wages and benefits as commercial and Navy shipbuilders compete for workers. A similar situation reportedly is occurring among shipyards on the Gulf Coast due to additional Navy work being awarded to those shipyards.[46]

---

[44] Source: BRS Group, *Shipping and Shipbuilding Markets, Annual Review 2024*, table on page 39 showing prices for new-construction commercial cargo ships in 2023.

[45] See, for example, CRS In Focus IF12534, *U.S. Commercial Shipbuilding in a Global Context*, by John Frittelli, which states: "No overseas purchase of large U.S.-built ships has occurred in decades because U.S.-built ships can be four or more times the world price. Differences in wage rates, particularly for welders, and currency exchange rate policy are factors leading to higher prices in the United States. The lack of exports prevents U.S. shipyards from achieving economies of scale."

By way of comparison, in the Coast Guard's proposed FY2025 budget, the estimated procurement cost of a Fast Response Cutter (FRC)—a 154-foot patrol boat built in a U.S. shipyard—is $100 million. This figure includes costs for military systems not present on a commercial cargo ship, as well as government (Coast Guard) program management costs. After subtracting out those costs, the remaining procurement cost of an FRC might be comparable to the above-stated current world market cost (roughly $50 million) of a smaller commercial cargo ship.

[46] See Sam LaGrone, "'It's Never Going to Be Easy,' Gulf Coast Shipyards Have Plenty of Orders, But Workforce Challenges Persist," *USNI News*, October 14, 2024.

An increase in worker wages and benefits would be a welcome development for shipyard workers. It would increase construction costs for commercial ships (and thus the per-ship subsidy amount needed for commercial ships intended for sale in the international market) and Navy ships. Shipyards building commercial ships might have less-stringent security-related standards for vetting potential employees. Other things held equal, this could give shipyards building commercial ships an advantage over those building Navy ships in recruiting workers. Over time, the total number of workers engaged in shipbuilding in the United States would increase, eventually reaching a new equilibrium reflecting the expansion of commercial ship construction work. The additional workers would be engaged in commercial shipbuilding, and the net impact on the number of workers available for Navy shipbuilding could be essentially neutral. In short, increasing commercial shipbuilding in the United States could add to challenges facing Navy shipbuilders in recruiting new workers in the short term, and could produce no significant net gain in the number of workers available for Navy shipbuilding over the longer term.

Some observers who support expanding commercial ship construction in the United States may do so in part due to a belief that shipyards can easily shift from building commercial ships to building Navy ships, or vice versa. This notion is highly problematic, as shipyards that build commercial ships differ from shipyards that build naval ships in several important ways, including but not limited to the following:

- **Workforce ratio of steel trades to outfitting trades.** Building commercial ships in general requires much less interior outfitting than building complex Navy combatant ships, which have significant amounts of interior outfitting for their combat systems and crew-related spaces. Compared to shipyards that build naval ships, shipyards that build commercial ships consequently tend to have workforces with fewer workers in the outfitting trades relative to the number in the steel trades that build the ship's hull. A shipyard attempting to shift from commercial shipbuilding to Navy shipbuilding could thus face a significant shortage of outfitting workers, while a shipyard attempting to shift from Navy shipbuilding to commercial shipbuilding could face a need to lay off a large number of outfitting workers. This issue arose in the early 1990s, when the end of the Cold War led to a reduction in Navy shipbuilding and a consequent interest in exploring the potential for shifting shipyards from building Navy ships to building commercial ships. As a part of that discussion, the CEO of Bath Iron Works (BIW) testified in 1992 to a House Armed Services Committee panel on the defense industrial base that shifting BIW's work from building Navy ships to building commercial ships would reduce the number of people employed at BIW from 10,000 (the size of its workforce at that time) to about 3,500.[47] Workers who are laid off from a shipyard shifting from Navy work to commercial work might find work in other industries, and might be reluctant to return to the shipyard at a later point due to concerns about job stability at a shipyard that has a business model of shifting back and forth between Navy and commercial work.

---

47 Spoken testimony of Duane D. "Buzz" Fitzgerald, President and Chief Executive Officer, Bath Iron Works Corporation, at a February 19, 1992, hearing on shipbuilding and ship repair before the House Armed Services Committee's Structure of U.S. Defense Industrial Base Panel. Fitzgerald stated:

> Now, I think there is one more point I would like to make on the conversion issue [i.e., converting a shipyard from producing Navy ships to producing commercial ships], Mr. Chairman. We have built commercial ships of all types, as I have said, [and] in the early 1980s we built our last merchant ship and it was an oil tanker, the *Falcon Champion*. So we know we could build ships like that starting tomorrow. But if we devoted our three building ways and our entire steel capacity to building ships like that, and if we had a tanker on our building ways all the time, as soon as we launched one, lay another one down, we would employ about 3,500 people rather than the 10,000 we employ today.
>
> (U.S. Congress, House, 102nd Congress, *Defense Industrial Base, Hearings before the Structure of U.S. Industrial Base Panel of the Committee on Armed Services, House of Representatives*, U.S. Government Printing Office, 1992, p. 536.)

- **Worker security and citizenship requirements.** Workers in shipyards that build commercial ships may have been hired under less-stringent security and citizenship requirements than workers in shipyards that build Navy ships. As noted earlier, all Navy shipbuilding contracts require that the shipyard workers building the ships be U.S. citizens. For shipyards that build commercial ships, this can pose a potentially significant impediment to being able to shift to production of Navy ships.
- **Worker techniques and skills.** Construction standards for building commercial ships are in some respects less stringent than those for building Navy ships, which incorporate higher engineering tolerances, features for ship survivability in combat situations, and longer intended service lives. This can lead to differences in techniques and skills between workers who build commercial ships and workers who build Navy ships. These differences in skills and techniques, as well as the differing security requirements noted in the previous bullet point, pose impediments to shifting workers back and forth between commercial ship construction and naval ship construction. At one South Korean shipbuilding firm that builds both commercial ships and naval ships, there is a fence with barb wire on top to keep the commercial shipbuilding workers separate from the naval shipbuilding workers.[48]
- **Equipment (and associated fixed overhead costs) for installing, integrating, and testing combat system equipment.** Shipyards that build complex Navy combatants have equipment (and associated fixed overhead costs) for installing, integrating, and testing ship combat systems. Shipyards that build commercial ships do not have such equipment and associated fixed overhead costs. This can pose an impediment for shipyards attempting to shift from building commercial ships to building complex Navy combatants, and a cost-competitiveness issue for shipyards attempting to shift from building complex Navy combatant ships to building commercial ships.[49]

Satellite photographs of shipyards in China where both commercial and naval ships are being built can raise a question among observers about whether this might be an approach for the United States to emulate. It is not clear, however, that the naval ships in those shipyards in China are being built efficiently. China might decide to build some of its naval ships in yards that also build commercial ships, even if the naval ships are not built very efficiently, as a means of preserving its commercial shipbuilding industry during periodic downturns in the global commercial shipbuilding market, or to top off its naval production at the margin without having to make the large investment that would be needed to establish an additional specialist naval construction yard. An August 2024 RAND report on China's naval and commercial shipbuilding states:

> *Findings*
>
> This paper comes to two conclusions about the relationship between Chinese naval and commercial shipbuilding:

[48] Source: Information provided by a RAND analyst who visited shipyards in South Korea and Japan in support of RAND's research on shipbuilding issues, provided at a meeting with CRS and CBO on October 1, 2024.

[49] For additional discussion of the differences between commercial shipbuilding and naval shipbuilding, see John Birkler *et al.*, *Differences Between Military and Commercial Shipbuilding, Implications for the United Kingdom's Ministry of Defence*, RAND, Report MG-236, 2005, 111 pp. The report's preface states: "This report should be of special interest not only to the [UK's] DPA [Defence Procurement Agency] but also to service and defence agency managers and policymakers involved in shipbuilding on both sides of the Atlantic."

> First, historically, increases in [China's] naval shipbuilding were accompanied by declines in [China's] commercial shipbuilding and vice versa.… The data does not reveal the underlying motivations for these movements but does emphasize two industries with related movements.
>
> Second, commercial and naval shipbuilding [in China] may now be growing more independent. This is supported by the following observations:
>
> Shipyards [in China] have grown more specialized, focusing either on naval or commercial shipbuilding building, but not both. The two yards examined, Dalian and Jiangnan Changxingdao, are the only facilities that produce some of the latest PLAN[50] warship classes and these yards are now primarily dedicated to naval production. As Dalian and Jiangnan Changxingdao began to build modern surface combatants and aircraft carriers, the number of commercial ships under construction in those yards declined precipitously, even though there was not a similar drop in commercial production nationwide.… While naval production surged in the aftermath of the Great Recession and the accompanying dip in commercial demand, it remained elevated and even expanded after the commercial sector recovered. This suggests the PRC developed new capacity for naval shipbuilding rather than merely backfilling unused capacity in times of low commercial demand….
>
> *Implications*
>
> This divergence is likely a reflection of the increasingly modern PLAN. Modern warships are far more complex than commercial vessels and demand more specialized labor and the latest PLAN vessels appear to be increasingly equal to their American counterparts in some respects. US Navy officers who have been on PLAN vessels have described them as "built to commercial standards," yet these testimonials are based off of visits that occurred over a decade ago. The divergence between naval and commercial shipbuilding suggests that the latest PLAN warships may no longer be built to commercial standards….
>
> However, the cost of the divergence is that the PRC will not necessarily be able to convert its enormous commercial shipbuilding capacity into naval production, at least without a significant investment in time and resources. Previous analysis concluded that there was a there was a high degree of military and commercial overlap in PRC shipbuilding facilities and the PRC's most modern shipyards have the infrastructure and expertise to engage in advanced naval production even if their primary purpose is civilian. More recent data suggests this may no longer be the case, at least for certain classes of PLAN warships. As the PLAN becomes more composed of increasingly specialized warships requiring increasingly specialized yards, the significant gap between US and PRC commercial shipbuilding should not be thought of as easily translating into a major advantage for the PLAN.
>
> PLAN shipbuilding over the past decade is formidable and the PRC is able to construct modern warships at a rapid pace. Yet going forward comparisons between US and PRC naval production should be made on a like-for-like basis rather than looking at shipbuilding totals in aggregate. The PLAN may be a much more modern and high-quality force now, but that also means it will likely be less able to draw from the PRC's vast commercial shipbuilding capacity.[51]

Of the seven shipyards that currently build the Navy's larger ships, one of them—GD/NASSCO—also builds commercial ships. GD/NASSCO is able to build both Navy ships and commercial ships without encountering significant difficulties with the issues discussed above because the ships that GD/NASSCO builds for the Navy—auxiliary ships such as oilers—are not very different from commercial ships. In this sense, GD/NASSCO can be viewed as the exception that proves the rule regarding the challenges of building both commercial ships and Navy ships efficiently at a single shipyard. In the 1990s, one of the

[50] China's military is called the People's Liberation Army, or PLA. China's navy is called the PLA Navy, or PLAN.

[51] Joel B. Predd, William Kim, and Jay Carroll, "PRC Shipbuilding: Naval and Commercial, A Working Paper Exploring the Relationship Between China's Naval and Commercial Shipbuilding," RAND, WR-A2852-1, August 2024, pp. 7-8.

other six yards that currently build the Navy's larger ships—Huntington Ingalls Industries Newport News Shipbuilding (HII/NNS) of Newport News, Virginia, which builds submarines and aircraft carriers (i.e., complex Navy combatant ships)—attempted to enter the commercial shipbuilding market through a program to build oil tankers that it called Double Eagle tankers. In March 1998, the shipyard announced that it was ending the Double Eagle shipbuilding effort after losing $300 million, and a shipyard official stated in June 1999 that he would not have the shipyard attempt something like that again.[52]

As noted earlier, there are various potential reasons for supporting actions to increase commercial ship construction in the United States, including but not limited to a desire to create jobs or a sense that major world powers should (or need to) be major maritime powers, and that being a major maritime power includes being a significant builder of commercial ships. If increasing commercial shipbuilding is not cost effective as a means for increasing Navy shipbuilding capacity, policymakers may nevertheless decide to take actions to increase commercial shipbuilding for other reasons. The main part of this statement, along with **Appendix E** and **Appendix F**, present 15 other options for expanding and using Navy shipbuilding capacity.

[52] Dennis O'Brien, "Yard Christens Last Double Eagle," *Daily Press (Newport News, VA)*, June 19, 1999.