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Industry Report
Shipbuilding: All Hands on Deck! Headwinds and Heavy Seas Ahead to Achieve the 355-Ship Navy

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SHIPBUILDING 2017

ABSTRACT: The American shipbuilding industry boasts unmatched technology but has shrunk to a fraction of its former size. American shipyards now depend on defense contracts and protective legislation to survive amid booms, busts, and subsidized foreign competition. For US-based shipbuilders to produce the ships needed to acquire a 355-ship Navy expeditiously and affordably, the US Government must adopt a disciplined approach of long-term planning, building from mature designs, introducing new technologies incrementally, and executing multi-year contracts for blocks of ships. These and other reforms will speed production, reduce cost, stabilize the industry, and help shipyards invest in facilities, technology, and workforce.

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HEADWINDS AND HEAVY SEAS AHEAD TO ACHIEVE THE 355-SHIP NAVY

This paper reviews the current state and future prospects of America's shipbuilding industry and offers recommendations to US national security leaders on how best to preserve, strengthen, and employ that industry in support of the national interests of the United States. More specifically, we investigate how the industry can best contribute to fulfilling the US Navy's goal of creating a 355-ship fleet, and how that effort can in turn stabilize and advance this key industry.

The number of active ships in the US Navy today stands near its lowest point in more than seven decades since the end of World War II. Although today's ships are individually far more capable than those of generations past, they remain bound by the reality that no ship can be in two places at once and every ship and its crew require considerable time in port in order to maintain the ability to operate at peak performance in the most critical circumstances.

At the same time, the United States faces global security challenges of growing scope and sophistication. China and Russia present peer or near-peer capabilities in many areas, and China in particular is developing anti-access and area-denial (A2/AD) weapons systems that threaten the US Navy's ability to operate in the South and East China Seas, regions critical to the national security of the United States and its allies. Meanwhile, threats from terrorism, civil war, organized crime, and natural disasters manifest themselves on the sea or in littoral areas where sea power is an essential element of any solution. Even in more stable and peaceful regions, the regular presence of the US Armed Forces, most often in the form of the Navy, serves to reassure allies, deter potential adversaries, uphold freedom of navigation, promote the ability to cooperate effectively in crises, and improve the situational awareness of the entire US Government. Meeting these threats and harnessing these opportunities will require the United States to deploy a Navy that is powerful, reliable, flexible, tightly networked, technologically advanced, highly trained, politically and culturally astute, and able to deploy a large number of vessels. The technologically advanced features of ships and the training, skills, and dedication of their crews, ultimately cannot substitute for the breadth and depth of capability provided by a fleet of sufficient size.

In this paper, we do not attempt to predict whether the US Congress will in fact provide the level of increased funding that would be required, even in a best-case scenario, to build America's fleet back up to 355 ships, nor do we seek to prescribe a detailed mix of various ship types or specific models. We also do not offer a dollar estimate of the cost of acquiring, much less operating, this fleet, as that would depend on a variety of factors including the types of ships built, the production timeline, and the many decisions made in the course of the acquisition process. Rather, we offer recommendations as to how the effort to recapitalize the US Fleet can make the best use of America's shipbuilding industry while strengthening the industry's ability to contribute to US national security.

Our seminar's methodology in preparing this analysis included the following: extensive reading on the current state of the shipbuilding industry, covering the defense and commercial sectors and the domestic and international markets; presentations and question-and-answer sessions with speakers spanning industry, the Department of Defense, and Congressional and think-tank analysts; visits to 11 shipyards in the United States and two in Italy, as well as commercial and government facilities such as the container port at Norfolk International Terminal and the Naval Surface Warfare Center in Carderock, Maryland; individual and group research, writing, and presentations on select US and international shipbuilding firms and on acquisition programs for warships and other major weapons systems; and most importantly, hours of Socratic classroom discussion and inquiry into the challenges and opportunities facing shipbuilding today.

Our seminar benefitted from the diverse perspectives contributed by uniformed members of all the US Armed Services, civilians from the Departments of the Army and State, and International Fellows representing the Federation of Saint Kitts and Nevis and the Sultanate of Oman. We capped off this semester with individual research into particular topics related to shipbuilding, which fed into the analysis and conclusions presented here.

Overall, we conclude that the US shipbuilding industry is capable of increasing its production of warships to meet the US Navy's goal of 355 ships. In order to have any chance of building such a fleet, however, the US Government will have to make a disciplined commitment to long-term planning, building from mature designs, introducing new technologies incrementally, and executing multi-year contracts for blocks of ships.

These steps will not only speed production and reduce cost, they will also help stabilize the US shipbuilding industry and allow shipyards to invest in facilities, technology, and most importantly, skilled labor. Other steps that would benefit both the industry and the effort to expand the US Fleet are networked operations including smaller ships and autonomous underwater vehicles (AUVs), extending and reactivating some older ships and possibly arming sealift ships, expanding sealift capacity, promoting Foreign Military Sales of US-built warships, considering modest amendments to laws protecting the US shipbuilding industry from foreign competition, and increasing support for vocational and technical education.

Historical Context

Over the course of its history, the United States has learned the importance of maritime power to a nation's economy and security. Shipbuilding was one of the earliest manufacturing industries in British North America, and shipyards were well established in Massachusetts by the mid 17th century.[1] However, despite a century of experience in turning out merchant ships, during the Revolutionary War, the fledgling United States could not produce a fleet to match the might of the British Royal Navy, then the world's greatest sea power. The British captured or destroyed most of the Continental Navy's ships, and the Americans destroyed most of the rest to keep them out of British hands.[2] The War of 1812 told a different story. Though still a small fleet in number, the US Navy boasted world-class ships such as the USS CONSTITUTION whose lethality and survivability gave them an edge in single-ship combat against the Royal Navy.[3]

Government support for the US shipping and shipbuilding industries is almost as old as the Republic. Congress granted tariff preferences to imports carried in US-flagged ships as early as 1789, and in 1817 enacted a cabotage law, a precursor to today's *Jones Act* allowing only US ships to carry cargo between domestic ports.[4] Still, these measures did not suffice to maintain robust US shipbuilding through the end of the 19th century, as global shipping transitioned from wood to iron and from sail to steam, favoring the more industrialized economies of Western Europe, and as American settlement expanded farther and farther from the coasts.[5] Ironically, some of the legal protections meant to nurture American shipping instead contributed to its decline. In the 1860s, American shipbuilders, who were still building wooden sailing ships, prevailed upon Congress to maintain bans on imported ships. Deprived of efficient iron steamships, many US shipping firms shut down.[6] Also, Union ship owners who had reflagged their vessels as neutrals during the Civil War to escape Confederate raiders were later prohibited from moving back to the US flag.[7]

Even as US shipbuilding waned in the latter half of the 19th century, the US economy grew and industrialized, and the Civil War gave way to decades of peace. Shipbuilding and shipping did not appear essential for American security or prosperity, but a far-sighted US Navy officer

warned otherwise. In 1890 Captain (later Rear Admiral) Alfred Thayer Mahan published his now-famous book, *The Influence of Sea Power upon History*, in which he argued that a large merchant fleet not only generated the requirement for a strong navy to protect a nation's commerce, but also formed the backbone of naval strength and the ability of a nation to project power.[8]

Around the turn of the 20th century, world events bolstered his argument. During the brief Spanish-American War in 1898, the US Navy deployed modern warships that easily outmatched the fleet of a declining Spanish empire, but US forces lacked sufficient sealift capacity and were reduced to chartering or purchasing supply ships, delaying military operations.[9] The next year, the Second Boer War began in South Africa. The United States took no part in the war, but the diversion of British commercial shipping to support the war effort left American exports stranded on the docks and seriously disrupted the US economy.[10] Early in the 20th century, the United States began taking its Navy more seriously, resulting in the creation of the Great White Fleet under President Teddy Roosevelt. Commercial shipbuilding, however, still lagged, and when the Great White Fleet set out for a year-long around-the-world voyage, the Navy repeatedly had to charter support vessels from various countries along the route.[11]

On the eve of World War I, the US merchant fleet carried less than eight percent of America's international trade.[12] As soon as the war broke out, it once again interrupted US trade as foreign powers requisitioned their merchant fleets for wartime service. Then in 1917 when America entered the war, the nation once more faced a shortage of sealift capacity.[13] The United States embarked on a crash building program for merchant vessels, but the war ended before many could be completed. By the mid-1930s, the Great Depression again sent American shipbuilding into a deep decline.[14]

With war looming, President Franklin Roosevelt and leaders in Congress saw the need for a strong merchant fleet and passed the *Merchant Marine Act of 1936*, which established construction and operating subsidies for ships and created the US Maritime Administration (MARAD).[15] This effort succeeded, and the United States entered World War II with active shipyards able to ramp up production for the war effort. That surge, coupled with the United States emerging as the only major power with its industrial base intact, meant that "(b)y the end of World War II, the United States controlled 70 percent of the existing merchant shipping tonnage in the world."[16]

In the post-war era, US shipbuilding, like other industries, faced increased foreign competition as other major powers recovered and newly industrialized economies emerged. The health of the industry largely ebbed and flowed in proportion to the level of government support, gradually declining for the first two decades after the war, recovering in the 1970s with an increase in government support, and then falling sharply again with the elimination of most subsidies during the Reagan Administration in the 1980s.[17] As a result, the United States entered the 21st century with a relatively small shipbuilding industry geared almost entirely toward defense production and commercial vessels for the legislatively protected domestic market.

The Current State of US Shipbuilding

Today, the US shipbuilding industry consists of about three dozen firms, producing over a thousand major commercial and defense vessels (over 50 feet in length) each year.[18] Another dozen or so major shipyards perform only repair and conversion work (which many of the building yards also do). The industry generates roughly $26 billion in revenue annually, employs more than 100,000 workers, and has grown by 1.6 percent per year in Fiscal Years (FY) 2011-2016 amidst a sluggish recovery from the 2008 recession.[19] US shipbuilding is an oligopoly with a high

level of concentration, as illustrated by its four-firm concentration ratio of close to 70 percent of all earnings.[20] On the demand side, much of US shipbuilding is a monopsony, because the US Government dominates as a buyer of warships and other vessels. This structure limits competition, inflates prices, and reduces innovation for buyers, while in the defense market producers face greater risks and cyclical swings because of their dependence on a single customer. The international shipbuilding market is also highly concentrated. In 2007, the top four firms, all of them South Korean, held almost 59 percent of market share.[21]

Although the US Government procures only a small number of ships, "these vessels are highly specialized, sophisticated and expensive, which allows them to account for most of the industry's revenue despite relatively low production volumes."[22] In fact, while just seven percent of the vessels completed in 2016 (17 of 227) were delivered to federal agencies, those 17 represented over 60 percent of the 28 large, deep-draft vessels built by US shipyards. Eleven went to the US Navy and six to the US Coast Guard.[23] As of 2016, "five out of the six largest industry players, which account for over 73.6 percent of industry revenue, generate most of their revenue from government and in particular, military contracts."[24] According to the US Navy's *FY2016 Annual Long-Range Plan for the Construction of Naval Vessels*, the Navy will invest $16-20 billion per year in new ship construction, roughly 61 percent to 77 percent of the entire US shipbuilding industry's revenue.[25] This funding is intended to construct between seven and 13 ships annually between FYs 2016 and 2036. Ship construction constitutes approximately four percent of the DoD's $580 billion-plus annual budget request.[26]

The defense side of the industry is especially concentrated. Only 14 firms build US Navy, Coast Guard, and other government vessels, 10 of which also build commercial vessels. The other 20 or so shipyards build only commercial vessels (see Appendix A).[27] In fact, five shipyards belonging to just two firms build the Navy's largest ships: General Dynamics' Electric Boat, Bath Iron Works, and NASSCO; and Huntington Ingalls Industries' Newport News and Ingalls (see Appendix B). A handful of second-tier shipbuilders build most of the remaining military ships (Austal USA, Bollinger Shipbuilding, Eastern Shipbuilding, Marinette Marine, VT Halter, and Philly Shipyard, among others).[28] US commercial shipbuilding is less concentrated than defense, in large part because commercial firms tend to build smaller, simpler vessels and so need less capital investment and technology.

The concentration of firms within shipbuilding has increased significantly over the last few decades as larger firms, including some from overseas, have acquired smaller yards and other builders have simply gone out of business. Consolidation has some positive effects. In US shipbuilding, it has created "large corporations with great technological depth."[29] Building strategic partnerships, pooling research and development resources, leveraging efficiencies and economies of scale, and accessing new technologies can strengthen an individual company and the industry as a whole. Companies with broad product bases and diversified portfolios, if well managed, can spread risk and can weather downturns in one area by performance in another, and vertical integration with suppliers can boost efficiency, production reliability, and standardization.

Still, excessive consolidation and integration carry risk. The loss of competition can weaken firms' drive for lower costs, increased efficiency, and innovation. A shrinking industry of this type threatens supply chains, labor pools, and buyer-builder relationships, and can create a single point of failure that poses "enormous risk" to national shipbuilding capability.[30] History shows the high price of trying to replace lost skills and capital investment. In the 1990s, an effort to revitalize US cruise ship construction after 40 years of dormancy was a $1.1 billion failure. Australia, Canada, and the United Kingdom have all struggled to rebuild lost capability and

capacity. UK efforts to restart its submarine industry after a ten-year hiatus were almost derailed by technical, operational, and cost problems until the United States stepped in to help.[31] For this reason, the US Navy has resisted having only one submarine builder.

US shipbuilding faces boom and bust cycles in both the commercial and defense sectors. Commercial shipbuilding cycles reflect the overall state of the economy as expressed in demand for transportation, or in some cases the health of particular industries, such as the current drastic drop in demand for vessels to serve the offshore oil and gas industries. Defense shipbuilding faces two problems: long-term cycles of build-up followed by years of attrition, as happened after the end of the Cold War, as well as yearly budget cycles that leave shipyards wondering whether the US Government will actually buy the next ship on schedule. Both types of uncertainty discourage long-term planning and investment, which especially hurts an industry like shipbuilding, which is intensive in capital, infrastructure, and skills. The Navy and shipbuilders often have to improvise, as when faced with the prospect of stopping and restarting construction of the aircraft carrier CVN-77 due to budget cuts. Instead, they "stretched" the build to maintain production, for fear that skills would vanish and supply chains would break.[32]

Shipbuilding firms in the United States operate under a wide range of ownership structures and business models. They range from family owned companies (e.g., Eastern and Edison Chouest Offshore) to subsidiaries of large, publicly-traded firms (e.g., General Dynamics' and Huntington Ingalls' yards) to subsidiaries of foreign shipbuilders (e.g., Austal USA, Marinette Marine, Philly Shipyard, and VT Halter). In addition to differentiation by defense versus commercial markets, firms specialize by size and purpose of vessel and by location. For example, some of the dry bulk carriers that Bay Shipbuilding builds in Wisconsin are too large to leave the Great Lakes. Most firms appear to be doing well financially at present, and have order books adequate for the next several years. The exceptions are firms focused on vessels that support offshore oil and gas exploration, as low prices for those resources have slashed demand for new vessels. The precise health of many of the firms is hard to assess, however, because the privately owned or foreign-owned companies are not traded on securities markets and therefore do not publish detailed financial data.

Viewed from the perspective of Porter's Five Forces,[33] shipbuilding firms face the greatest threats from existing competitors and from hard-bargaining buyers. Except for the largest and most complex warships, multiple US firms can produce most types of ships, although some have special expertise in certain niches. Thus, especially when business is moderate or low, firms have to compete on price to some degree. New entrants are not a great threat because of the long learning curve required of both management and workers and the large investment needed to open a shipyard. Shipyards tend to grow gradually, for instance moving over decades from small repairs to major repairs, then to building small and simple vessels, then to building larger and more complex vessels. There are few substitutes for ships; the alternative to most sea transport, i.e., moving cargo by air, would be vastly more expensive. Most suppliers exert little leverage, as there is broad competition to supply commodities and basic equipment, such as steel and pumps. It is ship buyers who have the ability and incentive to seek the best price for such a large purchase, and in the case of defense shipyards, the US Government as the sole buyer holds considerable leverage.

Many shipbuilding firms report a shortage of skilled tradespeople, such as welders, electricians, and pipe fitters, despite attractive wages of over $20 per hour, with medical and leave benefits.[34] The shortages have not yet caused firms to miss production deadlines, but with fewer young people taking up these trades, the workforce is aging, and managers worry about both immediate and long-term labor supply. Several firms have partnered with local high schools,

colleges, and municipalities to offer training and apprenticeship programs, in part to make up for declining high school shop classes and vocational education as more students are steered toward college. The work may be tiring, dirty, and repetitive, and is often done outdoors in harsh weather, but these jobs are the very kind that are supposedly in short supply in the United States today, offering a middle-class income for workers who do not have a college degree. However, the cyclical nature of the industry, and the reality of periodic layoffs, can lead even skilled and experienced workers to leave the industry.

International shipping transports approximately 90 percent of the world's trade.[35] As the global demand grows for goods across the world, ships will remain the primary carriers of freight. Over 50,000 merchant ships, registered in over 150 nations and manned by over a million seafarers of virtually every nationality, carry every kind of cargo.[36] Ships built in the United States, however, carry hardly any of this trade. Indeed, according to the United Nations Conference on Trade and Development, the United States relies on foreign ships to carry 97 percent of its imports and exports.[37] Is the absence of American-built ships outside the protected confines of domestic shipping and defense fleets a real reflection of US comparative advantage? It is true that most cargo is carried on standardized container ships, tankers and bulk carriers whose construction is labor-intensive and not necessarily very high-tech. However, because shipbuilding is such a key industry in both economic and strategic terms, supporting large supply chains and massive labor forces, many governments subsidize and protect their shipbuilders, badly distorting the global market. The United States is no exception, protecting the market of ships for internal shipping, buying all warships domestically, subsidizing some facilities for defense shipbuilders, and, at the state and local level, offering subsidies, tax incentives, and assistance with workforce training. Still, all these forms of assistance and more, including direct government ownership of shipyards, exist in other major shipbuilding countries as well, particularly in Europe, Japan, South Korea, and China, and may be of much greater extent in some of those countries. There are so many forms of government assistance that it is not just a matter of comparing apples and oranges, but a whole produce section of overt and sometimes hidden support that makes direct comparison impossible. Ultimately, each of these measures comes at a price in terms of government spending, tax revenue foregone, inefficiency, and misaligned resources. Therefore, the countries producing the most ships may not in fact be generating the most value for their governments and people.

The mid-term and long-term outlook for the US shipbuilding industry is generally sound, but with limited prospects for significant growth. The market for ships to be sailed in US waters is likely to remain under some form of protection, so American shipyards will continue to fill orders for iron ore carriers for the Great Lakes; container ships to serve Alaska, Hawaii, and Puerto Rico; and the ferries, tugboats and many other vessels needed in the United States. Nevertheless, there seems to be little prospect of US shipyards winning much export business for commercial vessels. Defense shipbuilding too will of course continue, and offers at least a chance for significant growth, either through the export of US warships (discussed later in this paper) or through a sustained effort to increase the size of the US Navy's fleet, to which we now turn.

The 355-Ship Navy Concept

Despite the continued need for power projection by the US Navy, the Fleet has drastically declined from 1,600 ships at the end of WWII, to 400 in 1978, to 274 today.[38] US Combatant Commanders, when surveying the threats and missions they face and calculating the sea power needed to maintain US national security, see the current number of ships as badly inadequate.

Therefore, in its December 2016 Force Structure Assessment, the US Navy announced the goal of building up to a fleet of 355 ships.[39] This plan calls for modest additions in most major combatant types and sharp increases in destroyers and attack submarines.

Other observers have called for similar increases. In January 2017, the Center for Strategic and Budgetary Assessments (CSBA) recommended a fleet of 340 ships, among other initiatives.[40] Meanwhile President Trump entered office with a promise to "build the 350 ship Navy we need."[41]

All of these variant plans to increase the Fleet raise a key question: by when? Neither President Trump's October 21, 2016 campaign speech nor the Force Structure Assessment Executive Summary released by the Navy mentions even a general time frame within which to achieve a fleet of 350-plus ships.[42] The CSBA study merely says that "(t)he shipbuilding industrial base could reach the objective…in the 2030s," in other words over a ten-year window beginning a dozen or more years from now.[43] A far more ambitious proposal by two analysts would aim for early 2025, i.e., the end of a second Trump Administration, but would rely significantly on extending and reactivating older ships, another option discussed later in this paper.[44]

Even in a less ambitious scenario, there would be constraints both in the industrial base and of course in funding. Limitations in the shipbuilding industry center on the physical capacity of shipyards. This is especially true for yards producing submarines, which the Navy has slated for a large increase in numbers. Submarines are arguably the most difficult of all vessels to build, considering their need to operate underwater and withstand great pressure, their extreme space constraints, and the Navy's choice to use nuclear propulsion for all attack and ballistic missile submarines. Money and time, however, can almost certainly find paths around these obstacles. Funding is the ultimate challenge. The Congressional Budget Office estimates that the combined increase in costs to build, crew and operate a 355-ship Navy would be about 13 percent above previously projected levels, or an additional $12 billion every year.[45] As a share of the US Government's budget, or even of the US defense budget, this number is large but not earth-shattering, but in an environment of mounting debt, politically sacrosanct entitlement spending, and an aging population, even maintaining steady defense appropriations will be a monumental challenge. To win the support of Congress for a larger fleet and get the most capability for all funding allocated, the Navy will need to stretch every shipbuilding dollar to its limit. We now explore ways to do that.

Best-Practice Ship Acquisition

Create Stable, Long-Term Shipbuilding Plans

Both industry and government would benefit from a predictable and stable US military shipbuilding program that identifies to industry the number and types of ships to be procured far into the future. This plan would help government do the Planning, Programming, Budgeting and Execution (PPBE) to align the resources required for these major investments. Such demand signaling helps firms develop strategic plans for project bids, workforce, and long-term capital investments in needed equipment. Both of these effects improve efficiency and reduce costs in ship acquisition.

As required by Congress, every year the US Navy publishes a five-year shipbuilding budget request in the Future Years Defense Plan (FYDP) along with a 30-year plan that describes the Fleet makeup year-to-year, including ships to be retired and new ships to be built. "In devising a 30-year shipbuilding plan to move the Navy toward its ship force-structure goal, key assumptions and

planning factors include, but are not limited to, ship construction times and service lives, estimated ship procurement costs, projected shipbuilding funding levels, and industrial-base considerations."[46] Since a ship's service life (typically 25-30 years or more) is usually known when it enters service, and it takes so long to build ships compared to other defense systems, it is prudent for the Navy to maintain a strategic plan for how it will manage its fleet. However, given the recent volatility in this 30-year plan, which increased from a 2016-2045 planned fleet of 308 ships to a 2017-2046 planned fleet of 355 ships, it may not provide much actual value to industry. Complicating planning further, the Navy admits that the 355-ship proposal "assumes that the future plans for our Navy, in ship types and numbers of ships, continues to replace the ships we have today with ships of similar capability and in similar numbers as we transition to the future Navy—it does not address potential options that may come out of the ongoing review of the potential Future Fleet Architecture studies…"[47] Basically, the 30-year plan does not account for future technological advances, new missions, or capabilities that may be required in the design, function, and fleet makeup of future naval ships. While the plan plays an important role in the Navy's fleet planning and management, it does little for industry but provide a general idea of potential future government shipbuilding demand.

The FYDP developed through the PPBE process is not set in stone as a budget plan, but it does provide both government and industry a stable funding profile and corresponding demand for new ships over the coming five years from which to plan. This helps industry in the short term to prepare for potential government work, particularly from the Department of Defense and the Department of Homeland Security. However, considering that building a ship can take four to seven years, a five-year plan does not give industry stability to develop its own strategic plans and become more efficient and effective. Investment decisions that will support and grow their business, such as partnerships with local schools and governments on technical training programs; purchases of large capital equipment, property, and waterfront improvements; and investments in technology, all require many years to plan and execute. Industry needs to know that there is a strong likelihood of continued business well beyond five years that will produce a return on these investments.

Something intermediate in length and certainty between the 30-year shipbuilding plan and the five-year FYDP would serve both the government and industry well by providing more stability and utility than the current process. Such a solution might take the form of a 10 to 15-year plan with enough detail and fidelity to be realistic and stable and to account for current and emerging technologies and mission demands. Additionally, combining the Navy's plan with the plans of some of the other agencies that also procure larger ships, such as the Coast Guard, Army, MARAD, National Oceanographic and Atmospheric Administration, and National Science Foundation, would benefit industry enormously and could help government agencies become more efficient in their long-term strategic planning for maritime capital assets.

Measure Twice, Cut Once – Lock Down Design Requirements Before Construction

The starkest difference between ship procurement by the US Government and commercial buyers is the number of design changes made *after* construction has begun. Typically, the US Government makes hundreds of changes per ship while commercial buyers authorize only a few. The reasons behind this difference are many, but given that design changes almost always raise costs, and often delay delivery schedules, the government ought to learn from commercial ship buyers how to minimize design changes to reduce cost and schedule growth.

To design and build a ship, especially a first-in-class, takes a great deal of time, labor and technical management. Prior to releasing the resources for this process, both buyer and shipbuilder must fully understand, among other things, exactly what capabilities are being procured, how and where the ship will be operated, and what design limitations must be imposed. For a commercial buyer, such as a cruise ship or container ship operator, this can be relatively easy to define because their ships are used for very specific operations within a well-known operating environment. US military ships, on the other hand, are highly specialized, sophisticated, and required to perform myriad missions worldwide in nearly every environment. Additionally, for security reasons, it is not always possible to tell the shipbuilder exactly how the military will operate the ship, adding a level of complexity to the design requirements. Still, the better the shipbuilder understands the requirements at the start, the better able it will be to meet them, minimizing costly change orders.

The Littoral Combat Ship (LCS) is a case study in what can go wrong if the Navy begins to build before it has defined what it is building. For many reasons, the Navy accelerated the LCS program in 2005 before performing a thorough Analysis of Alternatives to evaluate ways, including non-materiel, to address operational capability gaps.[48] Neither the LCS design nor its operating concept was complete when construction began. The LCS became a lightning rod for congressional and DoD concern in part because of hundreds of engineering and design changes at the seaframe level, the apparent infeasibility of the mission payload modularity concept, and changes in the Navy's acquisition strategy, all of which came after construction began.[49] The cost of LCS-1 and LCS-2 more than doubled from the original service estimate, and repeated design changes prevented the builders from gaining significant construction efficiencies from practice in repeatedly building to the same design until much later hulls in the series than normal. The percentage cost growth was the Navy's largest in a decade; the aggregate cost growth of all other ship programs during this period was 40 percent.[50] While the LCS cost growth was extraordinary, even the average cost-overrun figures do not depict well-informed and capable shipbuilding.

The US Government should adopt a stricter change order process, permitting design changes only when absolutely necessary, either to provide an urgently needed capability approved by the Joint Capabilities Integration and Development System (JCIDS), or because lifecycle cost benefits clearly outweigh the cost of the design change. The current US Coast Guard Offshore Patrol Cutter program is mitigating design change risk by awarding contracts incrementally for each phase, including preliminary design studies, initial ship design, detailed ship design, long-lead materials, lead ship construction, and second ship construction. An incremental approach ensures that all requirements are clearly defined and understood before proceeding to the next phase. This should minimize the number of design changes required and limit them to the lead ship since "the lead ship will uncover flaws in the construction process and will be corrected in that ship."[51]

The US Government should also consistently use Cost as an Independent Variable (CAIV), a method to make cost-performance trade-offs throughout a ship's acquisition to reduce cost, defer immature technologies off the program's critical path, while still meeting warfighter needs and expectations.[52] CAIV treats the cost of a weapon system as a constraint rather than a variable dependent on technology and other programmatic risks that emerge after the design is locked and construction has begun.[53] The process requires iterative engagement between the government project manager, warfare user representatives, and industry. CAIV can deliver a ship at or near cost and schedule targets, increase understanding of technical risks, and develop an incremental technology insertion plan throughout the operational lifecycle of the ship.

Adopt Incremental Technology Upgrades and Modularity

The US Government understandably seeks to integrate the latest technology into ships and subsystems to provide greater capability, reduce lifecycle costs, and maintain an advantage over adversaries. In order to stabilize designs, however, planners need to accept that technological advances will have to come in stages, using planned spiral insertions and block upgrades to responsibly manage sub-system acquisition risks separately from construction of the baseline ship. Attempting design leaps that are too drastic, or attempting too many of them at one time, leads to design flaws, production problems, cost overruns, and delivery delays. The DDG-1000 Zumwalt class destroyer offers a good example of how an attempt to meld multiple major new technologies in a first-in-class design can lead to extraordinary cost growth and a reduction in the number of ships to be built. The Navy would have benefitted from an incremental technology maturation and integration strategy. Retired RADM Myron Ricketts proposed an approach to mitigate such risks:

> Changing a ship design while it is under construction is expensive, wasteful of labor, and impacts schedules. However, it is axiomatic that improved components and systems will become available while a combatant is under construction. In order to reduce risk due to unproven developmental equipment, surface combatants should be designed to accept the latest proven components at the time of the design, but with a weather eye as to what could be expected downstream. If a component or system becomes proven during the construction phase of a class of ships, an individual decision can be made as to back fit into delivered ships, forward fit into ships under construction, and include or defer installation into future ships not yet under contract.[54]

In this case, design changes would still be needed if the government decided to upgrade equipment, but leaders could make such choices based on a stable primary design and after they understand the cost and schedule impacts and have made proper risk versus gain decisions.

Modular Open-System Architecture (MOSA) supports such an approach through the functional decomposition of complex weapon systems into defined components and the use of technical standards to define and manage interfaces.[55] Ship design accommodates size, weight, power, and interface specifications that subsystem developers can use to constrain the design of both original mission systems and future system upgrades. While a MOSA approach does not eliminate risk, it mitigates technical risk in integrating immature or developmental mission systems, promotes common technical standards, allows the government to be a better informed and involved ship buyer, and can reduce costs by enabling competition at the component level.

Award Multiyear Procurement Contracts

The US Government often procures multiple ships of the same design. Buying these fleets under one contract offers savings to the taxpayer and helps industry maintain workforce stability, make capital investments, and increase efficiency and profit through continuous production learning. These advantages, however, run up against the annual requirements of the US congressional budget process, as well as government acquisition regulations and procedures that typically procure ships one at a time. Still, the law does grant the Department of Defense authority to award multiyear contracts. Increased use of this authority could benefit both government and industry.

"Multiyear contracting is a special authority for acquiring more than one year's requirements, including weapon systems, under a single contract award without having to exercise an option for each program year after the first."[56] Also known as multiyear procurement (MYP), multiyear contracting is codified under *Section 2306b of Title 10, United States Code*. The law defines a multiyear contract as, "a contract for the purchase of property for more than one, but not more than five, program years. Such a contract may provide that performance…during the second and subsequent years of the contract is contingent upon the appropriation of funds and (if it does so provide) may provide for a cancellation payment to be made to the contractor if such appropriations are not made."[57] The law requires the buyer to meet seven conditions, including stable funding, requirements, and design, as well as realistic cost estimates that show significant savings over annual contracting. Congress must specifically authorize the law's use for each program in both appropriations and authorization bills. A negative aspect to MYP is that by obligating the government to procure many end items (ships), it reduces discretionary funding for other programs in future years and minimizes congressional and agency budgetary flexibility.

However, history has shown that when the US military starts to procure a fleet of ships, Congress and the service generally continue to fund the program without disruptive stops and starts. While the MYP commitment of funding may not appeal to Congress and agency executives, the significant government savings its use can garner should outweigh the risks. The benefit to shipyards is also significant and would go a long way toward stabilizing the US shipbuilding industry, further strengthening US national security.

MAJOR ISSUES IN SHIPBUILDING

Autonomous Underwater Vehicles

Science and technology (S&T) investments necessary to bring about the third offset strategy must anchor on exploitation of the undersea domain through development of full-scale, weaponized, autonomous underwater vehicles (AUVs) immune to global-common anti-access technologies and capable of long duration missions in support of US military operations. This development is necessary to undermine the A2/AD advantages of Russia and China and to serve as a force multiplier to the 355-ship fleet proposed in the US Navy's 2016 Force Structure Assessment.

Former Defense Secretary Chuck Hagel established the Defense Innovation Initiative (DII) to bring such technologies to fruition, and Deputy Defense Secretary Bob Work announced his intent to defeat A2/AD capabilities by capitalizing on research and development (R&D) and procurement of artificial intelligence and autonomous systems.[58] Currently, DoD has heavily invested in systems that focus on the surface, air, and space domains primarily through the LCS, X-47B unmanned combat aerial vehicle, MQ-8C unmanned helicopter, MQ-4C unmanned maritime surveillance and patrol aircraft, F-35 Joint Strike Fighter, Long Range Strike Bomber (LRS-B), and Long Range Standoff Weapon (LRSW) programs.[59]

However, we have yet to see significant S&T and R&D for military employment of AUVs. This failure reflects the technological and economic barriers this nascent capability must overcome. Specifically, five major categories of technology barriers stand in the way of AUVs effective operation in an A2/AD environment: command and control; energy; navigation; communication, sensor, and processing; and cyber.[60] Moreover, only an infant market exists,

composed of the science, ship repair, oil and gas, and defense sectors.[61] Only robust demand in a competitive AUV market will enable firms to overcome the existing high cost and capital entry barriers and develop full-scale versions of these complex systems.

Currently, DoD service priorities laid out in the FY 2016 FYDP align national resources in support of programs other than AUV development to thwart A2/AD. Moreover, R&D requests for AUV development are absent.[62] As a result, there is little incentive for legislative, executive, and industry members of the Iron Triangle to re-align resources to support less mature AUV technology. In the undersea A2/AD domain, the Navy has requested funding of $8.1 billion in 2017 and approximately $40 billion over the next five years to provide a lethal anti-submarine warfare force.[63] This includes incorporation of the Virginia Payload Module into Virginia-class nuclear attack submarines beginning with Block V as well as development of the Universal Launch and Recovery Module.[64] Combined, these systems can launch underwater vehicles and other payloads up to 60 inches in diameter, 23 feet in length, and 30,000 pounds in weight.[65] How much of the FYDP can and will go toward additional AUV development is unclear. Unless additional specific funding for AUV R&D becomes available, DoD will have to make program tradeoffs among all of the services to shift domain focus to underwater systems that support the overall A2/AD penetration strategy.

Therefore, DoD must specifically call for funding of AUV S&T, R&D, and procurement in the next FYDP, be willing to make tradeoffs from programs that don't support A2/AD objectives, bolster its support of DII to bridge a cooperative strategy among relevant government and non-government stakeholders, and better focus on AUV development. This will allow the United States to achieve a third offset strategy that defeats the A2/AD capabilities of Russia and China and will serve as a force multiplier to the 355-ship fleet that the 2016 Force Structure Assessment has proposed for the future.

If It Floats, It Fights: Extension, Reactivation, and Distributed Lethality

Despite the US Navy's new Force Structure Assessment released in December 2016 outlining the necessity for a 355-ship fleet to cover its global mission sets and the new presidential administration's expressed desire to reach a 350-ship Navy, the better part of valor and budget history tell us that the Navy needs to consider options other than new builds to get from the 274-ship fleet of 2017 to a 355-ship fleet in the future.[66] According to the Congressional Budget Office, regardless of whether the model used is 15, 20, 25, or 30 years, the average annual cost to the DoD budget and the American taxpayer "to build and operate a 355-ship fleet would be $102 billion per year (in 2017 dollars) through 2047… or more than one-third greater than the amount appropriated for FY 2016 for today's 274-ship fleet."[67]

Given the ever-burgeoning US debt, annual budgetary impasses glossed over with continuing resolutions and short term spending bills, and the looming specter of Sequestration 2.0 in 2018, it is more important than ever for the Navy to consider strategies to increase its fleet through means other than strictly new builds. Extending existing ships, reactivating recently retired ships, and installing weapons systems on currently unarmed sealift and support vessels (the distributed lethality concept) are a few ways to grow the Navy and its ability to address the complex missions necessary to maintain freedom of the seas across the globe.

Rear Admiral Peter Fanta, now US Navy Director of Warfare Integration, epitomized innovative thinking in his statement: "If it floats, it fights. That's distributed lethality…"[68] In a *Proceedings* article published in January 2015, Admirals Tom Rowden, Peter Gumataotao, and

Fanta further defined distributed lethality as "the condition gained by increasing the offensive power of individual components of the surface force (cruisers, destroyers, LCSs, amphibious ships, and logistics ships) and then employing them in dispersed offensive formations."[69] In other words, distributed lethality is the capability to strike from any ship (even currently unarmed United States Naval Ship (USNS) logistics and Military Sealift Command (MSC) vessels) from any place in the world with the general thinking that offensive weapons mounted on all US Navy and auxiliary ships complicates the enemy's strategy and hinders its ability to mass forces or attack.[70]

Distributed lethality is also a partial antidote to A2/AD challenges. The maritime logic of A2/AD has been "defeat one ship, or a few, and you defeat them all," that is, kill the aircraft carrier and a destroyer and/or cruiser and the entire carrier strike group is virtually impotent.[71] The current US Navy fighting structure is vulnerable to such logic by virtue of how it clusters offensive firepower instead of dispersing it. If every surface ship, not just carriers, cruisers, and destroyers but LCSs, amphibious transports, logistics ships, and cargo carriers possessed offensive firepower in the form of missiles, railguns, or directed energy weapons, any US adversary would be confronted with a dilemma of what to attack and how, since individual ships might be put out of commission, but the Fleet as a larger fighting "organism" with dispersed capabilities would still live to continue the fight.[72]

Therein lies the beauty of distributed lethality. To use a baseball analogy, it gets everyone out on the field.[73] Through more economical refits, shipbuilders could "spread firepower and reconnaissance assets throughout the surface navy rather than concentrating them in a few top-end combatants… to be singled out, targeted, and overwhelmed with anti-ship missiles, torpedoes, etc."[74] Current doctrine revolves around the Surface Fleet defending high-value and mission-essential ships. Distributed lethality, as it is rolled out, would require an adversary to allocate its resources across a larger set of US Navy targets that can "spread the playing field [and] cause complex targeting problems."[75]

Distributed lethality is a simple but powerful concept. It capitalizes on the offensive capabilities that already exist in the Navy's inventory that can be applied (bolted on) to the entire surface force to sustain and extend the Navy's competitive advantage in power projection and control of the seas against a growing set of A2/AD and other challenges. In this way, distributed lethality could also provide the most effective and efficient method of capitalizing on the Naval Fleet (USN, USNS, and MSC) that exists today and is currently funded for the future.

Considering that our nation's current budget-constricted environment may not support the new build option, other options to increase the naval fleet's end strength are to overhaul and repair existing ships, as well as extend the service life of existing ships and reactivate recently retired hulls. Vice Chief of Naval Operations, Admiral Bill Moran, said recently, "The answer is not to buy more ships, the answer is to make sure that the 275 that we have are maintained and modernized first and then give us the money to buy more ships later."[76] Deferral of maintenance due to the extension of missions has caused the existing 274-ship fleet to remain in repair yards longer, resulting in continually rising maintenance costs. A Navy press report released on January 11, 2017 stated that the Navy requires an additional $2 billion just to overhaul and repair its existing fleet.[77] This $2 billion would be used to improve the Fleet's overall readiness levels and increase modernization. Bringing the Navy's current 274-ship fleet to full operational readiness must be the first milestone toward reaching 355 ships.

Reactivating recently retired ships and extending the service life of existing ships are other viable, rapid, and fiscally prudent methods to reach a 355-ship fleet. Rejuvenating recently retired ships is far less expensive and puts the Navy on a faster path to 355 active ships. The extension

of the service life of current ships will require additional maintenance costs but is far cheaper and faster than constructing 75 or more new ships. All of these options not only get the Navy to a 355-ship fleet quicker than building new ships but also support the shipbuilding industry by providing overhaul and repair work, while allowing a more deliberate and flexible new-build strategy that doesn't box the Navy into just building mature ship designs that may not align with the maritime strategies needed to meet future national security needs.

Continued advancements in technology are also causing the Navy to question what the future Fleet architecture should actually look like. New technology will change how different ships will be grouped in future naval formations. Networked operations that rely on the distribution of ship-based sensors and weapon launchers across the Fleet will call for a change in naval architecture that may not be compatible with current ship designs.[78] The development of autonomous naval ships in which technology is now allowing the vessels to be larger and cruise longer distances will also affect the structure of the future Fleet.[79] These autonomous "ghost" ships will eventually perform missions that in the past have only been conducted by manned Navy ships. Before the Navy spends billions of taxpayer dollars building 75-80 new ships that stand the possibility of being obsolete before they get out of dry dock, it needs to consider the requirements of a year 2050 fleet and apportion its budget across those areas that best position the United States to neutralize and defeat our future adversaries, not those of 2017 or 2022.

Strategic Sealift

Strategic sealift is vital to the national security of the United States. The ability of the US military to forward deploy with mass and lethality enables operations to succeed and deters potential adversaries. However, America faces many challenges in strategic sealift today, including the quantity of ships, availability of ships, aging ships, and declining government contracts.

Approximately 90 percent of world trade is carried by the international shipping industry.[80] There are over 50,000 merchant ships trading internationally, transporting every kind of cargo.[81] However, since World War II, the decline in American strategic sealift has been alarming. Sixty-seven years ago, the United States had more than 1,400 civilian seagoing merchant ships.[82] Today, there are 78 US-flagged international sealift ships.[83] Our National Defense Reserve Fleet has declined from 2,277 ships in 1950 to 99 ships as of February 28, 2017.[84] Based on an assessment by MARAD, the availability of US-flagged commercial and government reserve sealift vessels for a sustained period of more than six to eight months is no longer certain.[85] This problem arose as a result of the quantity of US-flagged ships for international trade falling below 90.[86]

Compounding the quantity issue are availability shortfalls. Sealift asset availability times can constrict the ability of the United States to respond to a global contingency, depending on the size of the conflict. These availability times, i.e., times within which to be able to activate a reserve sealift asset, can range anywhere from four to 135 days.[87] Compounding the low quantity and availability of US-flagged international ships, the ships in the National Defense Reserve Fleet and its subset, the Ready Reserve Fleet, are aging and now average over 40 years old. Some are steam-powered and need parts that are no longer made. Finding mariners with experience in steam-powered ships is becoming more difficult as well.

Finally, government contracts for commercial vessel carriers through the MARAD Maritime Security Program (MSP) are declining due to reduced US military operations in the Middle East.

This decreased US Government demand for commercial shipping services will, in turn, continue to weaken US-flagged shipping firms that may rely on government contracts."[88]

America's adversaries will not wait for us to ramp up our shipping if we have to go to war. Depending on our adversary and the location of operations, we may need more time to mobilize sealift to get our forces into theater. The United States needs a responsive sealift force to move the forces and cargo required to defend our national security abroad.

The US Government needs to provide requirements for US sealift ships with reasonable performance standards and reasonable technology that can then be procured within reasonable costs. A common hull "family" of ships or multi-purpose ships would simplify requirements, and the acquisition process would be simpler for a common-hulled ship or a ship that could perform multiple missions. This would also provide more versatility and flexibility to meet Combatant Commander requirements depending on the time, place, and needs while making sealift ships more affordable.

The MSC and MARAD should also request that Congress authorize and appropriate funds for more sealift ships to support the military and the MSP. Sealift ships are critical to our national defense needs, and we can only sustain our forces if we have dependable logistical support to meet those needs. Our sealift fleet is aged and needs updating. Modernizing it would support both our national security and our shipbuilding industrial base.

Foreign Military Sales

The state of the US defense shipbuilding industry today has declined greatly since the "shipbuilding heyday" of the 1980s, when President Reagan oversaw a buildup to a 600-ship Navy.[89] Production, employment, capacity, and stability are all far lower today. One way to reverse this trend is for the US Navy to aggressively use the Foreign Military Sales (FMS) process to increase sales of new naval ships to allies. Doing so would advance US security cooperation efforts with allies, benefit and strengthen the US shipbuilding industry, and reduce costs of new US Navy ships for DoD. This effort requires a new strategy and a cultural shift within the US Government.

America develops and builds warships for the US Navy's own use and mission sets, versus consciously developing and building ships that are also marketable to US allies. While this approach has succeeded in the past, it should change to address the decline in US shipbuilding capacity. The United States should develop a class of ships that are marketable to US allies and should embrace a "whole of government approach" to marketing and selling these ships. The French model of doing this could serve as an example for the United States.

The French have developed a niche international market for small surface combatants that helps maintain their domestic shipbuilding industry. Their Gowind-class corvette 'family of ships' is similar in size and capability to the US Navy LCS and has found buyers overseas.[90] This class of French ships is a very basic, economical and seaworthy platform that supports intelligence, surveillance, and reconnaissance; law enforcement; and special operations missions. The ships do not contain highly technical systems and are marketed as a sea frame with electronics.[91] There is a demand for them because they are affordable and reliable. The United States should pursue a similar approach.

One technique to achieve this would be for the US government to induce private industry to build a smaller prototype ship to ultimately market internationally to compete with the French corvette. This would make more sense than trying to market large, complex, and expensive US

combatants, because most US allies either cannot afford them or do not have a mission set compatible with these types of ships. Rather, the smaller class, multi-purpose ships are where the United States should put its efforts.

Another approach to consider is the United States working with its allies in the Pacific to develop a standardized fleet of ships in a "NATO-like" interoperability arrangement. If we and our allies were to achieve this, it would likely create an opportunity for the US shipbuilding industry to expand its design and construction of naval tugs and rescue and salvage, replenishment, ice-breaking, and patrol craft.[92] It would also facilitate comprehensive allied strategy development and the "1,000 ship Navy" concept of the US and allied navies combining to project power to the most remote parts of the world.[93]

A third consideration to help stimulate more sales of new US Navy ships would be to provide a share of US security assistance to certain countries in the form of credits toward the purchase of new US Navy ships via FMS. For example, if the US packaged some percentage of its military aid to allies such as Israel, Egypt, and Jordan as funding tied to the purchase of new US ships to upgrade their navies, it would inject hundreds of millions of dollars into the US shipbuilding industry. The applicability of such an incentive would depend on the security needs of the country in question, but if the recipient government were considering buying ships elsewhere while using US security assistance to buy other goods or services, this measure could rescue what might otherwise be a lost opportunity for the US shipbuilding industry.

Ultimately, it is imperative that the United States stop the decline of its critical shipbuilding capacity, a capacity that is extremely difficult and expensive to surge. The industry requires long-term stability to remain healthy and vibrant. Regardless of the US Navy's future shipbuilding plans, and what Congress ultimately funds, the United States should aggressively pursue selling more new naval ships to allies. Doing so will help provide required stability to this critical industry, reduce overall shipbuilding design and development costs to the US government, and further security cooperation efforts with US global partners.

The Jones Act

Any study of the US shipbuilding industry inevitably runs into the subject of the *Merchant Marine Act of 1920*, more commonly referred to as the *Jones Act*, a protectionist measure that regulates the domestic US shipping industry.[94] The *Jones Act* mandates that goods transported by water between two points in the United States must be shipped on a US-built, US-owned, US-flagged, US-repaired, and at least 75 percent US-crewed vessel.[95] The original purpose was to sustain the Merchant Marine Fleet after the First World War. Since then, the *Jones Act* has become a support mechanism for domestic and commercial shipbuilding.[96]

Rules of this type, known as cabotage laws, are common in countries that have shipbuilding industries and domestic shipping routes, but the *Jones Act* is particularly strict. "The *Jones Act* is the most restrictive of global cabotage laws and an anomaly in an otherwise free market like the United States," according to a 2013 World Bank report on Global Trade and its Barriers.[97] The *Jones Act* has a negative impact on many businesses, especially those of Hawaii, Alaska, and Puerto Rico.[98] These destinations rely heavily on *Jones Act* vessels for the transportation of goods between the islands and the continental United States. A study by the US General Accounting Office in the early 1990s found that the *Jones Act* costs Hawaii, Alaska, and Puerto Rico between $2.8 billion and $9.8 billion per year.[99]

Puerto Rico is presently facing a financial crisis, and one of the strategies under consideration to alleviate the crisis is an exemption from the *Jones Act*. The New York Federal Reserve Bank reports that the *Jones Act* is a likely cause of high shipping costs to Puerto Rico, resulting in Puerto Rican ports doing less business compared to other regional ports.[100] The report states, "It costs an estimated $3,063 to ship a twenty-foot container of household and commercial goods from the East Coast of the United States to Puerto Rico. The same shipment costs $1,504 to nearby Santo Domingo (Dominican Republic) and $1,687 to Kingston (Jamaica)—destinations that are not subject to *Jones Act* restrictions."[101] Puerto Rico's premier port, San Juan, has seen container volume drop by 20 percent over the last ten years, while the capacity of the Port of Kingston, Jamaica's primary port, has more than doubled over the same period, despite Puerto Rico having a larger economy.[102]

The Hawaiian economy has not escaped the effects of the *Jones Act*. According to Hawaii State Senator Sam Slom, "It costs approximately $790 to ship a 40-foot container from Los Angeles to Shanghai, China compared to $8,700 to ship the same container from Los Angeles to Honolulu."[103] Even Hawaiian cattle ranchers have been affected by the law. They find it more affordable to charter a weekly 747 to fly their cattle to the mainland than to ship them using vessels covered by the *Jones Act*. High shipping costs under the *Jones Act* have also led some firms in the continental United States to source from foreign countries materials available in the United States. Also, oil producers from the Gulf Coast have resorted to selling crude oil in Canada rather than in the northeastern United States because the cost of using *Jones Act* tankers is five to six dollars per barrel, compared to two dollars for shipping a barrel to Canada.[104] This cost means an additional million dollars in shipping cost per tanker for the oil producer.

Shipping and shipbuilding firms cite the economic contribution they are able to make to the US economy and the jobs they are able to create thanks to the *Jones Act*. However, protectionist measures such as this one incur a deadweight loss because resources are diverted from their most efficient uses and the overall costs to various other industries are greater than the benefits to US maritime industry.[105] Also, protection from international competition can lead to stagnation, inefficiency and a lack of innovation in the protected industry. Judged on a purely economic basis, the *Jones Act* is poor policy.

The greatest justification for the law, however, is its impact on national security. Without the *Jones Act,* there would be almost no commercial shipbuilding industry in the United States. Even if the US government continued to buy all of its warships and other vessels domestically, the industrial base would shrink to a fraction of its already small size. Some of the shipyards that now do both defense and commercial production would likely close, leaving an even more concentrated industry with less competition to control costs; supply networks would wither without sufficient business; and there would be even less attraction for workers to learn the necessary shipbuilding trades, with fewer jobs and no commercial business cycle that might offset highs and lows in US Government acquisition.

Still, one could ask whether the *Jones Act* as it exists today is the best method to maintain a healthy maritime industrial base, and indeed if it is working at all, given how sharply the US shipbuilding industry has shrunk over the last several decades. Are there parts of the Act that could be relaxed, either to reduce some of the economic distortions, to bring more competition to the industry, or both? Are there other measures that could support the US maritime industry without as many negative side-effects? Could some combination of these measures help the US Government stretch its ship acquisition budget in support of a 355-ship Navy?

One measure that might bring some degree of relief or at least compensation from Jones Act constraints for Alaska, Hawaii, and Puerto Rico could even come in the form of support for shipyards existing or to be established in those places. Shipbuilding would especially be a boon to economically depressed Puerto Rico.

The National Defense Reserve Fleet needs to upgrade its ships, but it doesn't necessarily need expensive brand-new vessels to sit and wait for a call to service. A *Jones Act* exception could allow for the purchase of used foreign ships. Another exception might allow the use of foreign ships in emergencies, such as after a natural disaster, or at other times when sufficient American ships are unavailable. The United States might also promote tourism by allowing foreign cruise ships to carry passengers between US ports; this would not disrupt a US industry because at present the, *Jones Act* has simply made this market uneconomical. A broader exception, for instance modifying the requirement for building ships in the United States but maintaining the requirements for US ownership, flagging, and crewing, could help push US shipbuilding to be more competitive. Given the highly protected and distorted shipbuilding market worldwide, this would likely be a bridge too far, but targeted exceptions might spur competition in the high-value ships where US builders would be most competitive.

In the meantime, additional measures could help support the industry, making up for revenue that might be lost through any modifications to the *Jones Act*, but without simply handing out subsidies and without skewing competition among American firms. Individual companies would still have to sink or swim.

First, a ramp-up to a 355-ship fleet would give a major boost to US shipbuilding, as would an increase in FMS sales. Not all US shipyards would benefit directly from the additional contracts for warships, but enough yards do both defense and commercial work that demand should cascade throughout the industry. Second, the US Government could also support the maritime industry by promoting increased use of water-borne transportation. America's roads and bridges face decay and congestion, and Washington is rife with multi-billion-dollar infrastructure investment proposals. Directing some investment toward infrastructure for moving more freight by water could ease congestion, especially truck traffic, and reduce the need for costly highway expansions. Such a program could be most effective in some of the most densely populated parts of the country, especially up and down the East and West Coasts.

Workforce Development

America will be challenged to ramp up shipbuilding capacity in the near-term given the severe decline over the last few decades in the number of skilled craftsmen in the labor market. The hollowing out of skilled trade is a direct result of America's education policies, which have focused on steering nearly all young people toward attending (or attempting to attend) college, while greatly reducing, or in many cases abandoning, education in skilled trades. In short, the United States has neglected the technical schools which feed the skilled labor force. This systemic neglect has produced a skilled labor shortage that negatively impacts shipbuilding and therefore national security.

The multi-decade shift from manufacturing toward a more service-based US economy has shuttered many businesses offering middle class jobs. US businesses have outsourced manufacturing overseas to minimize costs in highly competitive markets. As the skilled labor market has declined, many young people, as well as their parents and educators, have given up on the idea of any kind of manual labor and any road to success that does not pass through college.

High schools have reduced or eliminated shop classes; and funding for vocational and technical schools (VOTECs) has declined in favor of community college courses geared toward white-collar jobs. Today, shipbuilders and other employers who seek skilled workers and are willing to offer competitive wages face a shrinking and aging pool of talent. Ultimately, this condition exacerbates the difficulty of any attempt to rapidly increase the size of the US Navy.

As America has built fewer ships, and shipyards have become increasingly automated, demand for skilled labor has contracted. Experienced workers have left the field, and few new entrants have joined the labor force. Despite all the technology and automation used in shipyards today, building ships still requires talented, skilled individuals willing to work six to seven days a week during peak periods to perform physically demanding, skilled labor, such as welding, electrical work, and crane operations. Shipyard work requires training and experience. Because of the investment required of shipbuilding firms to train and build a qualified and experienced workforce, ebbs and flows in ship orders impede those firms' ability to maintain skilled, available labor. This difficulty impacts any government plans to increase the industry's capacity.

Today, shipbuilding firms find themselves facing a delta between their need for skilled labor and the pool of available future shipbuilders. To attract the right talent, many shipbuilders have actively teamed with local government and school officials to get back to the basics. Firms are working with their local VOTECs to design curricula, invest money in scholarships, and promote career opportunities to attract the talent they need. New high school graduates who complete these programs are often guaranteed employment at local shipyards.

Shipbuilders are creating innovative ways to attract talent; the question is whether it will be enough. Other nations, particularly China, are increasing spending to bolster their maritime capability. The ability of the United States to increase ship production toward a 355-ship fleet, let alone be prepared for a war or other emergency where we might have to quickly ramp up the size of the Fleet, will improve if government and industry invest in attracting, developing and retaining skilled labor. For example, the government should consider reallocating a portion of current federal support for college student loans to increase funding for vocational training.

If it becomes apparent that there will be a short surge in US shipbuilding, requiring a corresponding short-term boost in the number of workers and not lasting long enough to warrant extended training of new entrants, the United States could admit temporary workers with special skills to fulfill peak labor demands as required using non-immigrant employment visa programs.

These measures will improve the ability of the US shipbuilding industry to attract sufficient skilled labor to meet the needs of US national security.

Conclusion

The reforms described above, most notably the ideas of long-term planning, building from mature requirements, incremental introduction of new technology, and block-buying, would be beneficial and necessary even in a steady-state warship acquisition environment. If the United States is to strive for a Navy of 355 ships, or any number near that, these recommendations take on even greater importance, both because they could decide the success or failure of that effort, and because they offer a chance to breathe new life into an industrial base that must serve US national security as far into the future as we can see.

A 355-ship goal makes reform not only more vital, but also more achievable. When the Navy is buying relatively few ships, there is greater pressure to squeeze into every ship every capability into each new vessel. With more ships, the United States can afford to design each

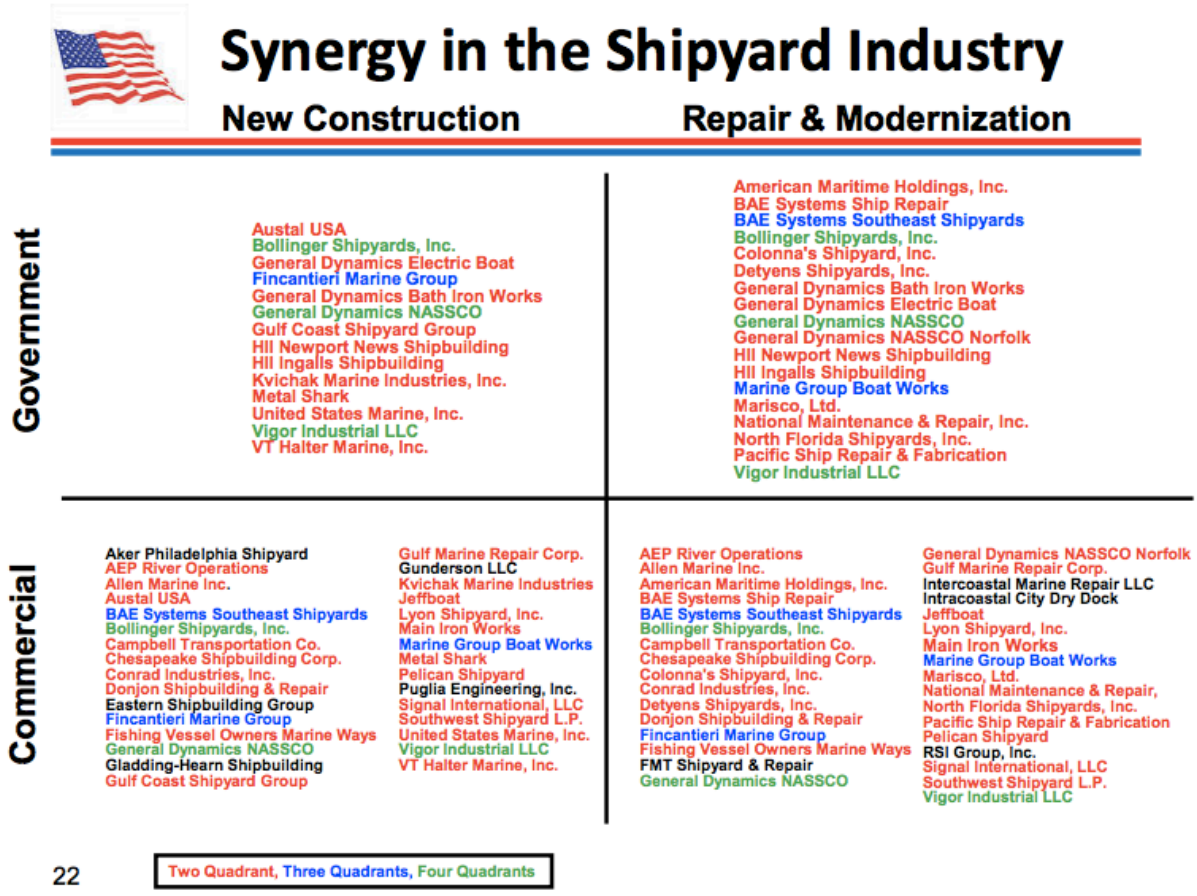
ship for a specific primary mission or, to the extent that it can take on multiple missions, we can add those capabilities gradually and after fully weighing the trade-offs between benefits and costs. By buying more hulls of each design, we would facilitate long-term planning and block buying, design maturity, and incremental introduction of new features and systems.

For industry, the benefits would be cascading, widespread, and available to multiple competitors (which would magnify the benefit to the US Government as the buyer). Mid-term to long-term predictability of future business would give shipyards confidence to invest in facilities, equipment, technology, and workforce training and development. This benefit would pass through multiple layers in the supply chain, to steel mills, engine manufacturers, electronics companies, and others. Predictability and a moderation of business cycles would make shipbuilding a more attractive career, especially for someone trying to decide whether to invest a year in studying a skilled trade such as welding. Larger buys of identical or similar ships then allow the workforce to become more proficient, and those gains can be shared by the US Government, by the shipbuilding firm, and by the shipbuilding workforce.

The overall increase in orders would be concentrated in the defense sector, but given that there are already a number of US shipyards doing both defense and commercial work, and other commercial yards that are capable of taking on certain types of defense shipbuilding, the increase in business would cascade throughout the industry. Sealift expansion would also help the lower-tech end of the industry. Likewise, any new technology introduced, such as AUVs or modularity, would eventually spill over to the industry writ large, creating new products and markets for commercial as well as defense shipbuilders.

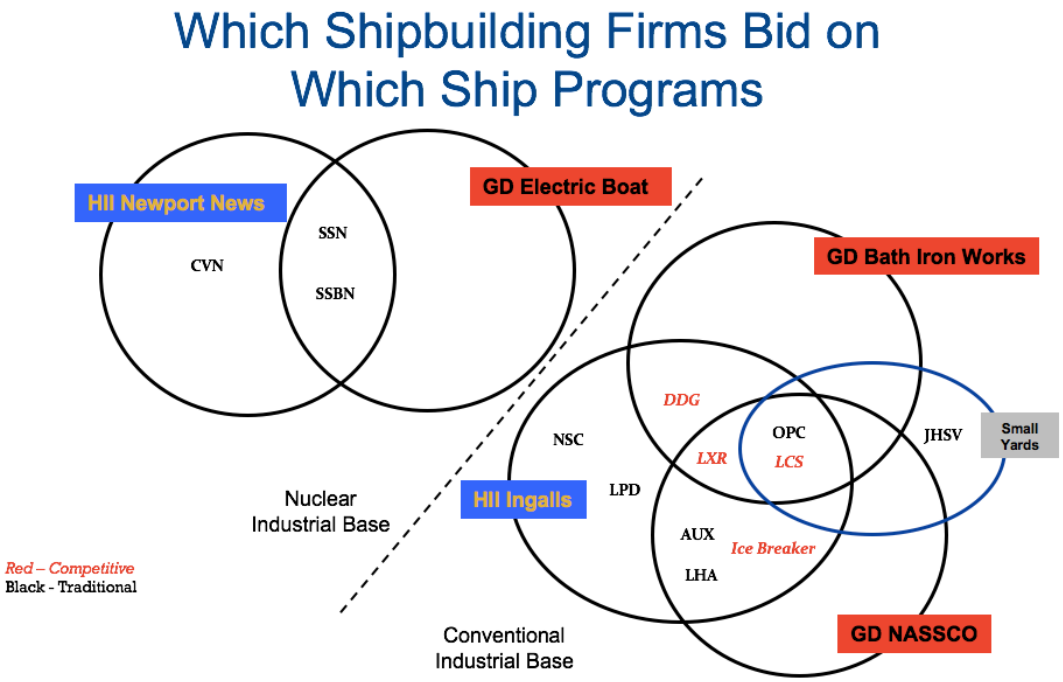
The United States would emerge from the reform effort proposed in this paper not only with a larger, newer, better fleet providing enhanced national security, but also with a better process established to acquire warships, and with a healthier American shipbuilding industry and workforce.

APPENDIX A: MAJOR US SHIPBUILDING FIRMS



Courtesy of RDML Joe Carnavale, USN (ret.), Senior Defense Advisor, Shipbuilders Council of America

APPENDIX B: US SHIPYARDS BUILDING NAVAL VESSELS



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