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Shipbuilding Industry



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SHIPBUILDING 2010

ABSTRACT: This paper provides recommendations to ensure that the shipbuilding industry can meet national security objectives in the face of industrial inertia and increased economic, budgetary, and security uncertainties. First, align naval force structure with requirements set forth in recent guidance, strategies, and reviews to field large and sophisticated warships with the distributed and networked capabilities of smaller, less sophisticated vessels. Second, create government and industrial partnerships focused on efficiency and recapitalization through industry rationalization, novel ownership and operational models, and modification of protective legislation. Third, pursue new technologies and processes to reduce life-cycle and disposal costs while minimizing environmental impact.

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PLACES VISITED

Domestic:

US Coast Guard Yard, Curtis Bay, Baltimore, MD
Carnival Cruise Lines, Fort Lauderdale, FL
Portsmouth Naval Shipyard, Portsmouth, NH
General Dynamics-Electric Boat Division, Quonset Point, RI
Austal-USA, Mobile, AL
International Shipholding Corporation-Waterman Steamship Corporation, Mobile, AL
Northrop Grumman Ship Systems-Ingalls Operations, Pascagoula, MS
Northrop Grumman Ship Systems-Avondale Operations, Avondale, LA
Bollinger Shipyard, Lockport, LA
Edison Chouest Offshore-North American Shipbuilding, LaRose, LA
General Dynamics-Bath Iron Works, Bath, ME

International:

Meyer Werft-Papenburg Shipyard, Paperburg, Germany
US Embassy, Rome, Italy
Italian Navy Headquarters, Rome, Italy
Fincantieri-Monfalcone Shipyard, Trieste, Italy
Fincantieri-Marghera Shipyard, Venice, Italy

TROCKS & SHOALS FOR THE AMERICAN SHIPBUILDING INDUSTRY

A storm is brewing for the American shipbuilding industry. Shipbuilding in the United States has been in steady decline for decades now and commercial shipbuilding capacity has been dwindling, except for a limited number of smaller shipbuilders protected by legislation. With only six major shipyards remaining, our military shipbuilding capability and capacity is less than Cold War levels, but still superior compared to any other nation. Recent trends indicate that this may not be the case within the next few decades.

A convergence of the latest external and internal environmental factors requires innovative solutions to ensure we will continue to meet our national security objectives now and in the future. Our storm has four primary aspects: (1) an ever-evolving national security environment, including the need for effectiveness in multi-spectral engagement, hybrid warfare, and military operations other than war (MOOTW), (2) an even more cost constrained future, given the current economic downturn in the US, (3) a non-competitive environment in the US military shipbuilding market and limited competition in the commercial sector, and (4) potential overcapacity beyond what is required for surge production and sustainment.

As it stands now, the shipbuilding industrial base is a relic of the Cold War strategy characterized by producing fewer yet technically complex ships for blue water strike groups. Since the end of the Cold War, the naval shipbuilding industry has kept the same six yards. As Michael Petters, President of Northrop Grumman Shipbuilding, Inc. has noted, “we have the same industry footprint today as we did when the plan called for a 600-ship Navy.”¹ With fewer ships being produced, the shipyards suffer considerable overcapacity and industrial consolidation. As a result, there are only two major companies and a handful of smaller ones which create a market environment that lacks the competition necessary to drive efficiency.

The challenge is to find a means to match national security and defense strategies, based on current and foreseeable threat environments, with a national shipbuilding industrial policy and strategy, such that we can find cost effective solutions to finance capacity at public and private shipyards. This paper analyzes the strategic environment shaping the shipbuilding needs of the US military, examines the market context of the industry, and provides recommendations to achieve congruence between the capacity and capability of the US shipbuilding industry and the needs of national security.

We find congruence will involve a rebalancing of strategy and capacity to a point where we maximize efficiency. In effect, the American shipbuilding industry must align public and private industrial capacity and capability with the Navy’s strategy and naval force structure objectives to sustain a cost effective and fiscally responsible national strategy. It must innovate and create government and industrial partnering models. And it must explore technologies and processes to reduce lifecycle costs.

While this paper will not specifically address the national security implications of the small and ever-diminishing commercial shipbuilding sector, we note that this is a key part of the solution and the relationship is considered in our recommendations. We will also address the need to provide a path for effective adaptation to the pressures and pace of globalization.

NAVIGATING THROUGH THE ROCKS & SHOALS

The Shipbuilding Industry must align its industrial base with a realistic force structure required for national security. It must innovate and create government and industrial partnering models. And it must explore technologies and processes to reduce lifecycle costs.

Determine “What” & “How Many” Ships to Support Today’s National Security Strategy

Alignment of the shipbuilding industry must begin with a review of Naval Force Structure required by the latest Maritime Strategy, Quadrennial Defense Review (QDR), and informed by today’s security and fiscal environments. The United States’ defense, diplomacy, and development must meld into a pragmatic, comprehensive, properly-resourced national security strategy that engages all appropriate instruments of national power. However, as an element of national power, the Navy’s ship portfolio does not appear to take the environment described in its Maritime Strategy or QDR into account.

There will always be a requirement for sophisticated platforms designed to wage war and maintain peace. In sheer combat power, the capabilities of a carrier Strike Group are unmatched, however, these technological marvels, although necessary to wage war, are expensive to produce and maintain for peace-time operations and engagement. Further, procurement of limited numbers of these technologically-complex platforms makes sustaining an industrial base difficult.

Analysis of Force Structure to Sustain a “Global Force for Good”

The Navy’s desire for “high-end” capability has come at a high cost to the taxpayer and the shipbuilding industry. The appetite for more exquisite and expensive platforms has resulted in fewer procured; those procured are built at the few shipyards capable of building them. “Mainly high-end ships are being purchased... they [shipbuilders] are optimizing for long term, low rate production.”² This variable throughput, complicated by erratic funding and requirements, cannot effectively sustain a domestic shipbuilding industrial base, nor can it foster the innovation needed to compete in commercial and military markets. The nation will eventually have to sustain a non-competitive industry, given the lack of market forces, through continued subsidies and protectionist legislation.

The naval shipbuilding industrial base certainly has the capacity to build more ships, but it cannot continue to build ships that are prohibitively expensive. Current naval strategy is to order ships that overmatch an enemy in a low-probability of conflict; while failing to build ships that might better meet today’s and tomorrow’s most-likely challenges. In today’s world, effectively covering the global commons requires more ships with distributed capability, not fewer with capability concentrated around a Carrier Strike Group.

“Quantity has a quality all its own.” This is particularly true in an environment that demands that you be in many places simultaneously with as small a footprint as possible. A distributed force of several smaller and capable ships can better fulfill the task of ensuring national security and sovereignty at sea, and support foreign policy and overseas trade in more places and in a better fashion than a small number of exquisitely capable large ships.

For example, we may no longer be able to afford the carrier-based naval strategy. A Carrier Strike Group consists of approximately eleven ships requiring nearly 8,500 sailors, airmen, marines and civilians to be effective. The Navy’s projected 50-year cost of ownership for a carrier alone is approximately \$26.8 billion³, not including support ships required to service and defend the carrier. The Navy’s projection of influence and power is focused on the Carrier Strike Group, but the time has come to reassess not just what, but how our shipbuilding plan is generated.

Chasing the Navy’s 30-year Shipbuilding Plan

The Navy’s 30-year shipbuilding plan changes every year, creating year-to-year inconsistency and instability. By law, the Navy publishes a 30-year shipbuilding plan every year. Critics note the plan is highly unstable due to: (1) changing budget priorities when the Comptroller harvests procurement funding, and (2) an ever-changing and uncertain threat environment. The Navy is constructing its 30-year shipbuilding plan on a foundation that shifts every fiscal year, if not every quarter.

Changing Budget Priorities

The first argument states that the Navy is much too large and the requirement is for a leaner force tailored to the current threat environment. This is consistent with the nation’s peacetime sentiment and the view held by some military experts and theorists, like Rupert Smith, who conclude that the very nature of war has shifted away from “industrial war” to “war amongst the people.”⁴ In apparent support of this theory, the DoD is shifting the focus from a large contingent of Cold War era surface and subsurface combatants, i.e. a “blue water” Navy, to one that can operate in the littorals, counter piracy, terrorism and insurgency, enable humanitarian efforts, and conduct military operations other than war. The latest QDR supports the shift in thinking, but the 30 year shipbuilding plan has not yet been reset.

The Navy’s fleet currently measures out at 286 deployable battle force ships⁵ after having spent an average of approximately \$11 billion (FY 2009 dollars) per year over the previous decade on new-ship construction.⁶ The current battle force ship level is less than half the size of its Cold War peak; it is unrivaled in global reach, capability, and combat power. Nevertheless, the Navy’s FY 2011 long-range plan for construction of naval vessels calls for procurement of an additional 276 ships across a 30-year time horizon to achieve a total baseline ship force level of 313 vessels.⁷

The 276 new ship starts represents a reduction from the Navy’s FY 2009 30-year shipbuilding plan which called for 296 new ship starts. The Congressional Budget Office (CBO) projected that meeting the Navy’s 2009 long-range plan would require an average annual cost of about \$25 billion (FY 2009 dollars) for new ship construction, including

new ballistic missile submarines.⁸ The Navy's annual estimate for new construction in the 2009 plan averaged out to about \$23 billion (FY 2009 dollars).⁹

The Navy's average annual estimate for the FY 2011 30-year shipbuilding plan is \$15.9 billion (FY 2010 dollars).¹⁰ CBO has yet to complete an official review of the Navy's 2011 long-range plan but in a preliminary review CBO offered that "it would cost considerably more than \$15 billion per year to implement."¹¹ CBO further noted that on the basis of the limited information available on the draft 2011 plan it "would cost an average of \$23 billion per year."¹²

With numbers like these it remains to be seen whether Congress can provide the resources the Navy needs to deliver the 276 ships required to achieve a baseline 313-ship fleet.

Byzantine Acquisition Process

Navigating the waters of the Department of Defense (DoD) acquisition system can be as much an art as a science. According to Secretary of Defense Robert Gates, although the DoD acquisition system has been in place for many years, it is flawed. Secretary Gates points to strategic guidance process flaws, external oversight, and external pressures as instrumental to an inefficient and exceedingly slow budget system and thus a slow acquisition process.¹³

In terms of US Navy acquisition, Admiral Gary Roughead, Chief of Naval Operations (CNO), has defined a 313-ship US Navy requirement to meet its portion of US national security. But Admiral Roughead is competing with the other service chiefs for funding at the same time the US Navy strives to recapitalize and grow the fleet for the future. The Navy understands the reality that it is unlikely to receive additional shipbuilding funds, so whether the service decides to remain based on nuclear aircraft carriers, for example, or change its focus to alternative vessels; it will need to build ships...and shipbuilding costs continue to rise. Therefore, its approach to build and grow the fleet has to involve "nested" strategies to contain shipbuilding costs, generate business efficiencies, and free up funds from other areas. Admiral Roughead's challenge is to convey his naval vision to the DoD and Congress.

Balancing Force Structure between High End/Hard Power and Low End/Soft Power

"When I signed our Maritime Strategy with General Conway and Admiral Allen more than two years ago, I was confident that the strategy would prepare us well for the current and future security environments... The 2010 Quadrennial Defense Review (QDR) validated the underlying principle articulated in the Maritime Strategy that 'preventing wars is as important as winning wars.' The QDR also declared that US security and prosperity are connected to that of the international system, that deterrence is a fundamental military function, and that partnerships are key to US strategy and essential to the stability of global systems. These themes reinforce the tenets of our Maritime Strategy and the six core capabilities it identified for our maritime Services: forward presence, deterrence, sea control, power projection, maritime security, and humanitarian assistance and disaster response."¹⁴

On 11 March 2010, the CNO testified before the House Subcommittee of the Defense Committee on Appropriations and reiterated the importance of the six core capabilities. While each priority seems logical and certainly seems to follow the strategy the United States has maintained since the end of World War II, they no longer serve the nation well considering the fact that the Cold War has been over for twenty years and the country is facing a budget crisis that is sure to impact DoD funding. The Navy must rethink its force structure and portfolio to address the current strategic environment to include globalization, diffused national power, and significant financial pressure on the US Government using a combination of soft and hard power elements, platforms, and capabilities.

A peace-time view of naval missions reflects the sentiment of some military experts and theorists, like Rupert Smith, who conclude that the very nature of war has shifted away from “industrial war” to “war amongst the people.”¹⁵ In apparent support of this theory, the DoD is shifting the focus from a large contingent of Cold War era surface and subsurface combatants, i.e. a “blue water” Navy, to one that can operate in the littorals, counter terrorism and insurgency, enable humanitarian efforts, and conduct military operations other than war. The latest QDR supports the shift in thinking.

There is still a realization that the Navy must maintain its capabilities throughout the spectrum of engagement. Maintaining a capable force of large surface and subsurface combatants hedges against China’s military expansion and a resurgent Russia and drives a bulk of the 30-year plan.¹⁶ These nations, as well as other emerging powers like India, have critical economic interests abroad that require force projection. Proponents of this approach maintain that if we do not accurately conduct a strategic scan and instead focus on today’s reality in planning for tomorrow’s war, then we may fail to resource a sustainable force structure.

Countering Near-Peer and Technologically Enabled Competitors

“Preventing war is preferable to fighting wars. Deterring aggression must be viewed in global, regional, and transnational terms via conventional, unconventional, and nuclear means.”¹⁷ Although the Cold War is over, the US must continue to counter threats posed by near-peer and technologically-enabled competitors. Deterrence in regards to the maritime strategy basically refers to ballistic missile defense and forward offensive missile capability. The requirement for maritime security to secure freedom of movement and secured access remains unchanged, but a different solution may be required to affect it.

Ballistic missile defense is an important piece of the nation’s strategy to protect forward deployed forces, allied nations, and the homeland, and Navy ships play a crucial role in this task. It is a capability important for today and will continue to grow in importance as missiles continue to proliferate in the world both in the hands of nation states and possibly in the hands of nontraditional and non-state actors.

The ability to deliver missiles forward from the sea is also an important piece of the nation’s strategic deterrence. The ability to launch conventional or nuclear missiles from anywhere in the ocean gives pause to any nation that would attempt to do us harm. The submarine is the most effective delivery system of choice since they are virtually

undetectable in location. Power projection should also focus on strategic sealift while ceding some power projection missions from carrier battle groups to other services.

Resurgent Russia and China do not challenge US dominance at sea; however, they do pose a threat to access and freedom of action at sea. Russia understands the current deterrence calculus associated with the strategic stockpile of nuclear weapons that the US possesses. Chinese Anti-Ship Ballistic Missiles (ASBM) places Strike Groups at risk should China decide to engage militarily.¹⁸ A carrier can be defended organically, but at a very high operational cost. Defense of the Strike Group would likely expend prohibitively large portions of the strike capability thereby limiting accomplishment of the carrier's primary power projection mission. If that mission is sacrificed, it changes the cost-benefit analysis that currently favors the Strike Group.

The Nation needs "high-end" solutions that the Navy requests for its national security, but these solutions are not the only ones nor are they even desired for non-kinetic engagements; fostering relationships and cooperation-through-overmatch is not necessarily conducive to engaging with the countries in regions where we wish to avoid conflict.

Low End Solutions and Platforms to Today's Challenges

The demand for "low-end" solutions and capabilities will continue to increase and they cannot be met with high end platforms. Persistent engagement with more and more affordable ships will keep us from waging war with our few high-end ships; both "types" of these ships should be interoperable and compliment each other's capabilities in conflict.

Projection of Public Diplomacy and Humanitarian Relief. The US Government faces the critical issue of determining public diplomacy roles, responsibilities and coordination procedures among military and civilian entities. Since the 9/11 attacks the DoD and the US military have significantly increased their roles in communicating with foreign publics. Within the past few years, the perception of DoD officials has centered on a post-9/11 strategy calling for the use of US military in preventative, deterrent, and preemptive activities involving creation of extensive international and interagency partnerships as well as an expanded DoD role in foreign assistance activities.¹⁹

DoD disaster and humanitarian relief now encompasses a broader range of potential assistance than the basic humanitarian relief of food and emergency supplies provided by nongovernmental organizations (NGOs). Since both DoD and large charitable groups face declining resources, partnerships are attractive and can create synergies when DoD and charitable groups' goals are compatible. NGO involvement provides "corporate knowledge" in specific regions and in the intricacies of worldwide medical volunteerism that may not be readily available in the military, while the armed forces provide logistical and personnel support that NGOs do not normally have.²⁰

The unique power of maritime diplomacy encompasses a continuum ranging from power projection (hard power) to extensive people-to people contact (soft power) inherent in humanitarian assistance and disaster relief efforts. Navy missions serve to develop relationships, strengthen existing friendships, and should focus on strategic

capacity building that fosters sustainable development and partnerships that contribute to global security. By virtue of its mission, organization, and materiel, the Navy bolsters Department of State's public diplomacy efforts, and contributes significantly to a whole-of-government approach in promoting security, mutual understanding and respect across the globe. The importance of military-civilian collaboration was underscored by the enormous successes of humanitarian assistance to Indonesia after the December 26, 2004 tsunami. The USNS *Mercy* provided critical medical support working with multiple NGOs, generating a tremendous amount of goodwill. The challenge now is in sustaining that goodwill after having attained it.

The Navy has branched out into other vital humanitarian assistance areas focusing on building strategic capacity that will affect host nation positive change in 10-20 years and facilitate the nation's security goals. Its newly-formed Maritime Civil Affairs Group (MCAG) deployed one person and two-person teams on several simultaneous multi-month deployments. The group, comprising over 300 persons (including reservists and civilians), assists in numerous missions ranging from providing medical aid and building schools to assisting fisheries.

Much of the world understands the desire, requirement, and impact of US humanitarian missions and their proven ability to ameliorate conditions resulting from strife and natural disasters. Proponents note that for less than one day's cost of the wars in both Iraq and Afghanistan, a tanker could be built and equipped to be a state-of-the-art floating medical facility.²¹ In addition to providing much-needed work for the shipbuilding industry, augmenting the hospital fleet will provide combatant commands with permanently assigned ships within their respective areas of responsibility to support emergent humanitarian requirements. The new ships could sail with a hybrid crew of civilian mariners, joint forces & coalition military personnel, NGOs and civilian volunteers including retired military personnel.

These continuous humanitarian missions, not just under emergency conditions, will facilitate open communications with global leaders and encourage the use of soft-power (diplomatic discussions, economical partnerships, and information sharing), instead of the always looming and ominous presence of military might. The US must lead this effort, then its role should gradually fade into a larger multinational effort.

Regional Engagement, Theater Security Cooperation, and Piracy. Theater Security Cooperation intends to develop long term relationships with emerging security partners in these regions – or theaters. The requirements and capabilities of a carrier Strike Group overmatch those of the smaller navies the US seeks to engage with. Even the embarked air wings are larger than some countries' air forces. The capability gradient of a 91,000 ton aircraft carrier gets in the way of establishing co-operative and inter-operative relationships, resulting in the US shouldering a bulk of the regional security responsibilities. The Navy must foster long-term relationships with emerging security partners through Theater Security Cooperation.²² Developing these relationships will require persistent regional presence and interoperability with friendly nations to develop "partner capacity" to counter threats to stability, especially in areas where the rule-of-law is not upheld.

Weak rule-of-law, Islamic extremism, environmental destruction, and bleak economic prospects have made conditions within the Horn of Africa ripe for entry into

the pirate business. Piracy has grown in the region by 196% over 2008 and by 454% in the last five years.²³ The rise of piracy in Somalia is due to an abundant supply of ships transiting nearby waters, and freedom to act in ungoverned regions.

To counter the spread of piracy and foster theater security cooperation, the Navy – specifically the US Naval Forces, Africa Command – introduced the African Partnership Station (APS) program. The concept, first presented at a maritime conference in 2006, was quickly pursued with the intent to build stronger maritime governance and a stable maritime environment.²⁴ Today, APS operators have trained thousands of African sailors, community leaders, facility managers, and countless civilians, in such subjects as navigation, leadership, security, and have provided infrastructural construction support. The US having the most capacity, served as the lead sponsor on initial missions since 2007, but passed the baton in the fall of 2009, the latest mission, when the Royal Dutch Navy took the lead. The successful hand-off to another lead nation marks a major milestone in the Navy’s Maritime Strategy – to seek international cooperation and responsibility sharing.

To effectively conduct Theater Security Cooperation, the Navy tasked RAND to determine appropriate ship characteristics for the various missions and environments they would encounter. RAND identified three general classes of vessels suitable for use: Nearshore Patrol Vessels, displacing fewer than 100 tons and dependent upon a mothership for logistic support; Coastal Patrol Vessels, displacing between 300 and 700 tons and requiring some logistic support from a mothership; and Offshore Patrol Vessels, displacing 1,500 tons and capable of independent operations.²⁵ The study concluded that Offshore Patrol Vessels offer the greatest independence of operation and versatility for these mission sets while being interoperable with “high-end” ships.²⁶ These characteristics also make these vessels attractive to foreign navies, providing an opportunity for both the Navy and for the shipbuilding industry.

Government and Industrial Partnering Models to Sustain a Competitive Market

There is no debate regarding whether or not America’s shipbuilding industrial base is a critical part of our National Security Strategy (NSS). Unfortunately, there is no coherent and comprehensive defense shipbuilding industrial base strategy tied to the current NSS and other related strategies. That fact aside, the military shipbuilding industry is a key part of the defense industrial base and must be maintained. Where private shipbuilders are functioning in a competitive market, there are great opportunities for lower prices and there is potential for greater innovation and continuous improvement. A competitive, open market also creates opportunities for more efficient management and technical processes, as well as the potential for application of commercial best practices. Finally, maintaining the private sector shipbuilding industry allows a mechanism for potential surge capacity in times of national emergency. All of these benefits have a single underpinning element – a competitive marketplace.

Unfortunately, five of the six large, private military shipyards do not function as a component of a truly competitive marketplace. Following defense industrial base consolidation at the end of the Cold War, the private sector military shipbuilding oligopoly evolved into a duopoly, comprised of Northrop-Grumman Corporation (NGC) and General Dynamics (GD). These companies often “competi-mates,” sharing the

workload from naval ship contracts rather than true competitors. Several mid-tier shipbuilders still function in the market as well, such as Bollinger and now Austal and Fincantieri, building smaller vessels for the Coast Guard and Navy. These companies maintain a commercial market share and are shaped by market forces that drive their strategies for such decisions as capital investment and process improvement. NGC and GD on the other hand have no commercial business with the exception of GD's National Steel & Shipbuilding Company (NASSCO) yard, which only builds limited numbers of cargo and support ships for the US Navy and Military Sealift Command, as well as similar large vessels for commercial customers. Surface combatants and submarines are built at three NGC yards and two GD yards. Despite the fact that there are two companies and six yards, commonly referred to as "The Big Six," there is essentially no competition in this market. Furthermore, the demand is so low that there is most often only enough work for one company, or a partnership arrangement between the two.

The Navy's current 30-year plan includes 66 LCS's and 41 JHSV's. Extracting the LCS and JHSV vessels leaves 169 of the plan's new construction requirements to be supplied by the "Big Six" shipyards, which represents an average of roughly 6 ships per year across the 30-year shipbuilding plan. Put differently, that is an annual average of one ship, per year, per yard, for the next 30 years. The six ships per year average, is essentially equal to the annual average that occurred over the 12 year period that began in 1993. By almost any standard it seems to be a very small number for six very large yards. Perhaps more disturbing is that it seems highly improbable that the Navy will be allocated the resources required to build all of the ships in its long-range plan for construction of naval vessels.

For national security reasons, as well as political reasons associated with Congressional support in the affected districts, the US maintains overcapacity by choice. It represents security against the worst case scenario. So the market has become a functioning bilateral monopoly, in which warship workload is shared between the two companies' yards. Corporate perpetuity in this market actually compels them to seek longer production efforts and higher costs, which in turn drives higher overhead.²⁷ The lack of true competition creates several factors that make private sector military shipbuilding undesirable from an efficiency and cost perspective including: (1) higher prices associated with corporate overhead and general & administrative (G&A) costs, (2) inherent complexity and cost associated with contract management, (3) the need for government subsidization, directly or indirectly, (4) growth in quality issues associated with the sense of entitlement within this highly concentrated and non-competitive market, and ultimately (5) the continuation of government ownership of risk for development and production.

The five private shipyards noted are functioning in a failed market, and both bilateral monopoly participants continuously evaluate the mutual benefit. Meanwhile, uncertainties in Navy budgets and contracts impact the bilateral monopoly participants, and sub-contractors on Wall Street. Despite the uncertainty in the shipbuilding market, average profits over the past decade have been nearly 10%, larger than comparable corporations outside the defense sector.²⁸ These conditions necessitate evaluation of alternative options to obtain a more optimal model for ownership and operation of the military shipyards.

Cost-based revenue is a quirk of defense contracting that creates a perverse incentive and helps to provide resistance to reductions in fixed assets. Government contracts are typically priced out on a cost basis with a fee or profit calculated as a percentage of the agreed upon cost. The government seeks to negotiate a fair and reasonable cost for constructing a ship based on the current and forecasted cost structure, methods of construction, and practices and processes employed by the shipyard. It attempts to negotiate a best price based on best practices and processes, but typically this comes down to nibbling at the margins. There may be more efficient methods and processes for constructing a ship than are used by a given shipyard, but the negotiated price is more likely to represent the actual practices, methods and processes used by the shipyard vice more efficient and economical practices that might be employed by the shipbuilder if it were operating in a perfectly competitive environment. Obviously, the higher the agreed upon cost for a contract the higher the revenue and profits to the company. This is a fundamental outcome of the oligopoly that is military shipbuilding, where the market is essentially a closed, bi-lateral monopoly between the government and two companies that have a given workshare of the 30-year plan. With this in mind it is hard to understand why the government ever expected shipbuilders to rationalize on their own. Even if the government reimbursed shipbuilders for expenses associated with rationalizing assets it is unclear why shareholders would think this would be the best use of their resources when the savings associated with restructuring flow to the government.²⁹

Balance Capacity and Efficiency to Meet Naval Force Structure Demand

Rationalize Large-Tier Shipyards

Rationalization involves the reduction of redundant infrastructure. DoD failed to fully appreciate the outcome it was driving when it jumped on the industry consolidation bandwagon by failing to encourage rationalization early. Ownership has changed since 1993 but the same six yards that were delivering the Reagan-era goal for fleet size are now building and delivering ships for a Navy that is half of what was proposed at that time. Prior to industry consolidation, defense companies were significantly less diversified and without any corporate shipbuilding history. The change in DoD policy drove mergers and acquisitions transforming what had previously been a robust industry populated by many firms into half a dozen defense giants that more closely resemble conglomerates. Where the government expected the consolidated industry to purge itself of excess capacity it turns out that the diversified firms had no incentive to trim assets. With hundreds or even thousands of contracts on their books, inter-contract risk was greatly reduced, earnings were stabilized and assets became more valuable.³⁰ Underutilized assets now provided valuable options for more future business. And, companies like Northrop Grumman and General Dynamics had no incentive to rid themselves of excess capacity in their shipyards.³¹

Politics may be the biggest single barrier to rationalizing the shipyards. “Closing shipyards is the defense equivalent of reforming social security.”³² Shipyards are large employers in fairly concentrated geographic regions and consequently have considerable economic impact, not to mention votes.³³ Shipyards, both private and public, and the politicians that represent them have little reason to push for rationalization. The political

and economic reasons given for not closing the yards most often boil down to the necessity to preserve the industrial base and sustain competition.

Preserving an industrial base may be important for the United States and its national security but preserving an industrial base with a capacity that could build the next 30 years' requirements, five times over, appears excessive. The argument for competition is equally difficult to support. Navy aircraft carriers have been supplied by a monopoly for decades and, although there are two submarine yards the low production rate for these ships and the desires of Congress have led to a teaming arrangement where the two yards essentially operate as a single builder.³⁴

Could Congress carry out the rationalization that private companies have not? It would appear that the American legislative body has been unwilling to make such difficult choices. The Navy has made clear signals in the past that it does not need the capacity that is currently available from the "Big Six." However, when the Navy has made decisions to move away from the current pretense of competition and select one shipyard to build its submarines or the DDG-1000, Congress has played the industrial preservation card by stepping in and directing the Navy to split work between shipyards. The evidence suggests that there is little reason to have confidence that Congress will help rationalize shipyard infrastructure.

When the experts discuss how to address problems in defense-related shipbuilding, they typically focus on overcapacity and rationalization or reduction in the number of shipyards. However, overcapacity itself may not necessarily be the only problem. In fact, an additional question we need to ask is how large is the premium should be paid to maintain total capacity, which could be defined as the capacity required to meet the Navy's 30-year shipbuilding plan plus surge capacity, i.e. overcapacity to respond to national emergencies. In effect, the US currently funds an insurance policy to maintain a domestic military shipbuilding capability and capacity, which is comprised of private and public shipyards that design, build and maintain naval vessels. The share of work between private and public yards seems to move along a continuum, shifting throughout our history based upon many factors, but primarily related to requirements during war (hot or cold), when demand is high, and times of peace, when demand is low. Given the lack of competition in the shipbuilding industry as a whole, limited new construction and more fiscal constraints in the near future, the military shipbuilding industry appears to be at a tipping point thereby justifying serious consideration of a move toward a limited form of nationalization, where public entities own, operate, or capitalize shipyards in an attempt to maintain a nominal capability and capacity at the lowest possible cost to the taxpayer.

Explore Alternative Models for the Military Shipbuilding Industry

There appear to be three primary models of ownership for the shipbuilding industry: (1) private, (2) public utility, and (3) fully nationalized. There is a fourth model, which involves direct government subsidies to the shipbuilding industry, akin to what "private" European and Asian shipyards have enjoyed for many years. Direct subsidies for the construction of ocean-going vessels were actually in practice in the US up until 1981, when the Reagan administration abolished it, effectively ending the commercial shipbuilding industry in this country with the exception of smaller

construction efforts protected under the Jones Act.³⁵ We will not consider direct subsidies to private shipyards primarily because it is essentially the same as the indirect subsidies bestowed on private defense firms now in the form of capital investments and higher prices on government contracts. There is also a separate element that could be introduced into any of the three primary models that could improve the future of our national security – targeted capitalization.

Considering the three primary approaches, it seems clear that a pure application of any one model is not appropriate. Without true competition, the private model is ineffective as there is no incentive for the members of the current duopoly to improve processes and workflow through aggressive capital investment. The shareholder simply finds it difficult to act as a stakeholder. The public utility model does not seem to fit well for this industry either. Although military shipyards, like public utilities, are an integral part of our economic and physical infrastructure, and in some respects already function as public utilities because they behave as a surrogate or pseudo government entity, they could not sustain operations like a phone or an electric utility. For instance, yards run like public utilities would have no control over the market due to the monopsony buyer, who would then serve as regulator, customer, investor, and guarantor. Furthermore, there is no predictable long-term demand for output. Without very high rates of production, technological manufacturing improvements will not be enough to achieve the desired efficiencies. The current market simply will not allow for a financial and operating structure that is profitable and independent of government subsidy, which is a public utility requirement.³⁶

The advantages and drawbacks associated with the current private ownership and operation model, and resulting lack of competition would seem to indicate that application of a public yard model may be appropriate. Notwithstanding, nationalization is problematic as well. There is a significant transition cost and the government is likely to be just as inefficient as the current duopoly given the lack of competitive forces. Clearly, the first hurdle in moving toward nationalization would be the upfront cost of buying the private yards and organizing for operating those yards, including the acquisition of skilled managers, production personnel, engineers, and other technical and administrative personnel. The exact number of yards and government personnel depend on the approach, such as a total government workforce or a mix of contractor and government. Many of the required skills are in short supply in the government due to the move away from government led efforts in the acquisition reform of the mid-1990s. There are other significant concerns to manage including: (1) historical lack of capital investment at public yards, which may be due to the very presence of private yards for the same type of efforts, (2) perceived lack of innovation and efficiency due to absence of competition and profit motive, and (3) politically charged environment filled with impediments, constraints, and non-optimal decision making. However, the current private-public relationship in the military shipbuilding market does not excel in these areas either. Clearly, more effective management controls are required, and direct influence and management could be the key in this sector of the industry to solve some historic problems. Accordingly, some combination of government and private ownership and operation appears to be worth considering

In the current volatile, uncertain, complex and ambiguous environment, there is no black and white solution. We require innovative, hybrid approaches that can take

advantage of government and industry strengths and employ new methods, or resurrect some past practices where they make sense. This seems to be a logical approach to ensure we have the right naval force structure for the right price at the right time. We must continue to modulate the exact share of work between private and public yards along the historical continuum, driven by internal and external factors that alter demand. We have reached an inflection point where intelligent reshaping of the public to private mix seems necessary to maintain a nominal capability and capacity at a price suitable to the government's economic situation. In addition to a coherent, suitable Navy strategy that will drive new construction, repair and modification/overhaul requirements, we need a joint government and industry partnership with well-defined roles and responsibilities and a robust, well-qualified workforce. Increasing efficiency could also involve rationalizing the "Big Six" shipyards and seeking partnerships with mid-tier shipbuilders and other countries.

An alternative – and politically sensitive – attempt to recast the public model might be employment of a "capitalization" element. Under most circumstances the lack of competition would drive a prudent nation to consider nationalizing the larger yards that are dedicated to naval ship construction of complex vessels. A hybridized form of nationalization focused on capitalization, does not imply a full government workforce to operate the yards. In this hybridized model, the public shipyards, namely existing naval shipyards would be capitalized by the government and managed by competing firms. These capitalized shipyards can focus on construction of large surface and subsurface combatants. Savings would accrue from eliminating corporate overhead on capital equipment and facilities that would be augmented by forced rationalization. We limit the yards, determine the work for each, and then allow the companies to compete for the workload to be placed in a particular yard. Some type of efficiency standards may help in evaluating the effectiveness of contractor operations at the publicly supplied yards to ensure that this hybrid model remains more advantageous.³⁷ This point is contentious and deserves consideration for balancing capacity.

Rely Upon Capacity and Capability of Mid-Tier Private Shipyards

The more numerous and competitive mid-tier private shipyards could benefit from building smaller naval vessels, which could very well make up a larger percentage of the portfolio in the next decade plus. Like NASSCO, these yards could produce vessels that would largely be considered dual use. Also, mid-tier shipyards and their workforces could also serve as surge capacity during times of national emergency. The government can facilitate this surge capacity by incentivizing upgrades to accommodate distributed and modular ship construction. This surge capacity would be above what the public yards produce and in addition to other commercial shipyards that could be tapped for military products if needed.

This approach tends to support the view that more, smaller surface combatants will be required in the near term to achieve greater presence, while also keeping demand high for mid-tier shipyards. The result is more competition in conjunction with the commercial business that these companies also have, which in turn allows them more flexibility to operate in a competitive environment and take advantage of capital investments. Some give and take may be required to balance between commercial and

military standards. However, companies such as Bollinger have already proven that this is achievable. We could also resume the practice of indirect subsidies to the commercial sector through incentives to make those companies, including mid-tier military shipbuilders, more globally competitive, similar to the aerospace industry. Finally, suppliers to all yards, public or private, will remain intact to support the industry commensurate with demand.

Sustain an Experienced Workforce

The shipbuilding industry is one of America's "crown jewels,"³⁸ requiring a dedicated, educated, and experienced workforce to sustain the industry. Today's shipbuilding industry's workers are challenged not only by job performance, but even more by government's goals, requirements, and restrictions. These include the policies and practices of various entities of the US Government, including past Presidents, the DoD, the US Navy and Coast Guard, and the Congress.

However, the high cost, complexity, and limited production of high-end ships cannot sustain a dwindling experience base. Shipbuilding is a craft industry and its output, especially vessels built for the military, is largely directed by detailed buyer specifications and highly customized requirements. It is not surprising then that competition for a skilled labor force is intense among the limited number of companies that dominate production. This only accentuates the degree to which competition will continue to be highly concentrated. "The need for highly skilled staff and industry knowledge will also prove to be a barrier for new participants."³⁹ In more recent years, the common challenge for the companies and the labor organizations has been to find alternative ways to achieve profitability and maintain reasonable wage increases. They have done so in part by increasing efficiency and productivity. This has been achieved through research and technological development, improved work practices, and greater economies of scale resulting from industry concentration.

Just as the industry adjusts to leaner and more flexible manufacturing processes, the workforce organizations will need to demonstrate that same flexibility. This will require management and professional organizations to change their policies. Otherwise, maintaining quality construction with inexperienced "green labor" will challenge the efficiency of naval shipyards. Lengthy training and dangerous jobs are not the only challenges workers face. The procurement practices of federal agencies, particularly the defense agencies, have had serious and sometimes adverse effects on the industry, and on labor as a factor of production. Problems cited in a 2001 Department of Commerce National Security Assessment of the industry regrettably continue. Nine years ago, the report stated, "...Narrowly defined job classifications (or titles) can cause idle time and reduce a shipyard's flexibility to utilize its workforce effectively."²³ The National Security Assessment report urged the US Navy, the Maritime Administration and the industry to pay attention to this issue and commended the progress of Kvaerner Philadelphia Shipyard for its "...utilization of the workforce in light of the great reduction in job titles."²⁴ Yet as recently as February 2010, the IBIS World Industry Report for Shipbuilding indicates the problem persists: "Industry sources show that military procurement contracting practices have led to over-specialization of workers, with narrowly defined job classifications creating shipyard inefficiencies."²⁵

To maintain productivity with an ever shrinking workforce, unions must allow for less narrow job classifications and allow for a greater skill base. Overspecialization and narrowly defined job classifications – due to union activity and tradesmen certification requirements – reduces a shipyard’s flexibility to utilize its workforce effectively while the skill base of the industry is eroding for welders, pipe fitters, and ship fitters.⁴⁰ Observers noted at General Dynamics-Quonset Point that a lack of unions and ability to cross-train increased labor flexibility and ultimately increased production. Cross training will become more crucial as experienced labor pools decrease.

However, this will be for naught if the industry cannot attract employees. Labor’s role has been significant in achieving today’s higher productivity levels in the industry. That said, labor has not always shared proportionately in increased revenues.⁴¹ “In the five years from 2005 to 2010, wages are estimated to have increased by an estimated annualized rate of 3.2% per annum. However, wages as a proportion of revenue have steadily declined since 1997, falling 40.7% to 26.8% today.”⁴² Other challenges to employee retention are harsh working environments and dangerous conditions. The Occupational Health and Safety Administration describe shipyard work as “...traditionally hazardous, with an injury-accident rate more than twice that of construction and general industry.”⁴³

It is against this backdrop that workers have been gradually exiting the US shipbuilding industry, and “...the rate of employment within the industry is expected to reduce slightly at a rate of 0.6% per annum...”⁴⁴ Wages, however, are not the only reason for the slow exodus. Another reason is that shipbuilding occupations are among the most specialized of any industry and require extended periods of training. “Shipbuilding attracts and retains people who must be developed and nurtured at a particular specialty. It takes two to three years for a submarine shipyard mechanic to become minimally capable and as many as ten years for some craftsmen in specialty areas to reach full proficiency.”⁴⁵ “For surface combatants, it can take five years for a mechanic to reach full proficiency, at a training cost of \$50,000.”⁴⁶ The situation is further exacerbated by the skill required in working with highly specialized military equipment and components.

Remove Global Barriers and Embrace Foreign Collaboration

The global environment is in the midst of fascinating technological, economic, and political changes...all of which are influenced in this era of globalization. The proliferation of international corporations coupled with the impact of government policies both at home and abroad demand that we understand the secondary and tertiary effects of globalization before we can determine an optimum course to steer. This new environment is already having a dramatic effect on domestic and international businesses, as well as on military operations, especially the employment of naval forces and shipbuilding industry as a whole.

Supporters claim that globalization will eventually force all governments to pursue peaceful, democratic, rules-based, and market-oriented policies, resulting in a richer, healthier, safer, more educated, and more stable world population. However, critics believe that globalization feeds corporate profits at the expense of workers, undermines democracy, accelerates environmental destruction, lowers health and labor

standards, imposes cultural homogeneity, feeds crime, and escalates armed conflict. Before we more fully analyze the impact globalization has had on the US shipbuilding industry, we must first look at an important piece of US legislation influencing the industry.

Legislation

Legislation restricts any US naval war ship from being built outside the US. The relative weakness of the US commercial shipbuilding industry matters insofar as the private sector provides a foundation for naval construction. In theory, a healthy commercial shipbuilding sector would be a source of innovation (in new technologies as well as in manufacturing processes), trained labor, and perhaps, investment capital. The relationship between naval and commercial shipbuilding is almost reversed as the US Government (through the resources of the Navy and the Defense Advanced Research Projects Agency as well as other departments) provides the impetus for innovation, seeks to ensure a supply of skilled professionals, and underwrites much of the industries' capital investment.

The single greatest legislative impact to the US commercial shipbuilding industry was and continues to be the Jones Act. The Jones Act is officially titled the Merchant Marine Act of 1920, although it came to be known as the Jones Act after Senator Wesley Jones, who sponsored it.⁴⁷ While there are two parts of the Jones Act that are of particular historical importance, the first part which heavily promoted American built, owned, and staffed ships is the part that is important to the industrial base. Specifically, the act restricts shipping and passenger trade within the United States to American owned or American flagged ships, and stipulated that 75% of a ship's crew must consist of American citizens. In addition, the use of foreign parts and labor in ship construction and repair were also heavily restricted.⁴⁸

Competition for Naval Shipbuilding in Global Markets

“The military export market is largely a market for modestly priced frigates and small conventionally power attack submarines.”⁴⁹ The US does not export any of its newly constructed front-line warships, although it does export selected combat systems installed on its warships.⁵⁰ However, US shipyards do manufacture ships for foreign navies: Northrop-Grumman Ship Systems (Litton-Ingalls Shipbuilding Corporation of Pascagoula, Mississippi) builds the Israeli *Sa'ar 5* class corvette based on Israeli designs.⁵¹ Building a consortium-based design for sale-or-lease to countries without ship production capability should not be any different.

Although the DoD has leased foreign-built cargo ships (for as long as 10 years),⁵² leasing these ships from other countries is neither feasible nor desired. Despite “thousands of jobs for US citizen merchant mariners and millions of dollars of US shipyard work” done to re-flag foreign built vessels,⁵³ the American Shipbuilding Association (ASA) and domestic shipyards would much rather build these ships domestically. However, leasing American-built ships to other countries, to include follow-on support for maintenance and equipment, may be a viable option. For example, the United Kingdom procured their *River* class patrol vessel (displacement 1,600 tons) by

lease agreement with the shipbuilder, Vosper Thornycroft.⁵⁴ This lease agreement offers an option to purchase after the contract period. This class was built to commercial standards and priced at \$50 million apiece, compared to \$40 million for the 325 ton-displacement US Coast Guard *Deepwater* fast-response cutter.⁵⁵

Start Globalizing within the North American Shipbuilding Industry

Capability and capacity can be created through a consortium of American and foreign shipbuilders. Facilitating the creation of such a consortium would require careful recasting of the existing legislation. Designing and building smaller ships would give domestic shipyards the opportunity to acquire best-practices for ship design and production, sustaining an experienced industrial base by providing relatively steady throughput from domestic and international customers. A multi-national effort for a major weapon system has precedent. The Joint Strike Fighter (JSF) is an “international cooperation warplane,” with the United Kingdom, Denmark, Norway, The Netherlands, Canada and Italy as partners, and Singapore, Turkey and Israel as foreign military sales participants.⁵⁶

If politically viable and barriers are addressed, Canadian shipbuilding industry should consider partnering with US companies to leverage Canadian firms competitive strength in “systems integration and component, sub-system development” as a supplement to whole ship construction to better utilize existing yard and personnel capacity.⁵⁷ Existing corporate relationships in the aviation and ground defense industry are excellent models to follow.

Waiver of maritime legislative barriers for Canadian defense related shipbuilding would open doors to increased competition. This ensures that shipyard capabilities are maximized to support the North American Defense Industrial Base. But this initiative should not be limited to Canada and should, instead, include North American Free Trade Agreement partners to fulfill its intent. Countries could benefit from greater innovation, coordination, and elimination of duplicative or excess capability. In turn, a byproduct of this partnership would be increased competition resulting in a freer market (i.e. lower prices and increased efficiencies).

Explore Technologies and Processes to Reduce Lifecycle Costs

The total lifecycle cost of a ship goes beyond design and construction and impacts the ability to resource shipbuilding in support of national strategy. Emerging technologies are at the heart of the opportunities to reduce total lifecycle costs.

The cost savings enabled by emerging technologies and processes begin in the design and fabrication stage. Innovative ship design and cutting edge warfighting technologies combine to make new ships more affordable and efficient. These new technologies offer new opportunities for shipyards to diversify and sustain critical labor skills and experience base during inevitable periods of downtime.

Technological enhancements affect the operation of the ship and reflect a large cost do not end with the design and fabrication stage. Rather, those that impact the operation and sustainment of naval ships have the potential for even more significant cost savings over the long term. Breakthroughs in energy technology offer potential

efficiencies in energy consumption, environmental impact, and manpower requirements. Ultimately, these improvements work together to ensure the health and viability of the U.S. shipbuilding industry.

The industry should continue to seek innovative and alternative solutions for life-cycle cost reduction, including environmental control measures. Although it is hard not to focus on immediate ship “building” issues, the dividends will reap long-term gains for the industry if these technologies and processes are pursued.

Reduced Cost through Design & Production

The domestic shipbuilding industry designs-and-builds the most sophisticated ships put to sea. Carriers, submarines, and “high-end” surface combatants (Aegis cruisers and destroyers) make innovative use of the latest warfighting technologies and designs. But the slowing pace of procurement has slowed shipbuilding innovation, impacting its ability to build the latest hull designs, especially when compared to commercial shipbuilding. Designing this vessel will require commercial innovation and classification rules that will allow their use in US and foreign navies.

“Both governments and naval builders can undoubtedly continue to make improvements by studying the most successful commercial models.”⁵⁸ Those “most successful commercial models” have come from successful commercial shipbuilders – mid-tier and foreign shipbuilders. Both LCS hulls were derived from commercial variants of foreign designs.⁵⁹ And the Joint High Speed Vessel (JHSV) procured from Austal-USA by both the Army and the Navy is also derived from a commercial variant of foreign design.⁶⁰ Construction and warship design modifications accomplished in the US provided experience – and employment – to the domestic industrial base; however, these programs could not be possible without modifying foreign commercial designs.

The latest naval designs are also built using proven commercial processes. “Integration can bring the benefits of military technological advances to commercial construction, and the benefits of efficient commercial processes can feed back to the military side.”⁶¹ State of the art computing tools have made it possible to converge many of the techniques and processes for naval structural design with those for commercial vessels.⁶² Processes and practices developed to improve commercial competitiveness, provided they are acceptable to the Navy, will also reduce the cost of shipbuilding.⁶³

Classification rules for ship structural design vary between naval and commercial construction. “Since 1998, ABS has worked with the US Navy to develop the Naval Vessel Rules, the first guidelines of which were available in mid-2004.”⁶⁴ “Sections [of classification rules] have been developed which facilitate the drive for higher speed naval hull forms with the capability to rapidly change mission focus through modularity.”⁶⁵ Understanding this, Naval Sea Systems Command (NAVSEA) teamed with American Bureau of Shipping (ABS) to develop a matrix of certification standards for different naval vessels; the resulting matrix established mostly ABS standards for JHSV, a combination of ABS and NAVSEA standards for LCS, and NAVSEA standards for DDG 1000 *Zumwalt* class destroyers.⁶⁶ Common designs and classification standards will facilitate interoperability.

Shipyard Industry Diversification

Maintaining the efficiency of shipyards during idle periods erodes their capability and experience base. A possible solution would be to diversify and produce products not related to shipbuilding. For example, faced with expanded shipyard capacity and reduced global demand, Asian shipyards are transitioning under-utilized commercial shipyard capacity to pursue alternative complimentary business such as renewable energy technology. If supported by business case analysis, both the United States and Canada should also explore utilization of excess shipyard capacity in pursuit of alternative energy technology development and production. Here production of large wind turbine generators and motors, towers and specialized offshore construction vessels would seem to be a natural fit for underemployed shipyards with large physical plants, overhead crane capability and resident expertise in large-scale fabrication, large propulsion systems and motors. Among many possible benefits would be productive use of excess facilities, retention of skilled technical employees and leveraging alternative sources of government funding streams versus reliance on traditional defense funding sources. The benefit to military shipbuilding is the continued viability of the greater national shipbuilding industry and potential availability to support military requirements as part of the defense industrial base.

Reduced Energy Costs

New advancements in energy technology will have implications for 21st century US Navy shipbuilding. These new advancements have the potential to revolutionize energy usage in many shipboard functions. As a result of the rapid and exponential leaps in the development of new electrical storage devices, new applications may be designed and old, discarded technologies which were previously deemed ineffective should be re-examined. Ultimately, senior decision makers must integrate innovations in energy storage and usage into the design and specifications of new ship platforms to realize cost savings and efficiencies which benefit the national shipbuilding industry and support the National Security Strategy.

“The Navy is going to electric drive. But for the ships already built, the hybrid electrical-mechanical system is a modification that will allow ships to shut down one of the main engines for low speeds and save a lot of gas.” Hybrid gas turbine-electric drive propulsion systems, similar in concept to automobile hybrid drive systems, are being used in the commercial shipping industry and are being tested by the US Navy (including use on USS *Makin Island* (LHD-8)). The Office of Naval Research’s Sea Warfare and Weapons Department “...is developing advanced switches and power controllers that will allow bi-directional distribution of power, permitting storage of excess power for later use rather than dissipating it.”⁶⁷

Ship designers have borrowed a hybrid energy concept from the popular Toyota Prius cars and applied it to the propulsion and ship services functions of the DDG-51. Much like the goals of the Prius, the goals for the hybrid electric drive on the DDG-51 is to reduce fuel consumption and reduce dependence on foreign fossil fuels.⁶⁸ Roger Sexauer, president of DRS Technology’s Power and Environmental Systems Group, believes that with the hybrid drive, the Arleigh Burke class ships can operate on electric motors up to 12 knots, saving 12,000 barrels of fuel per ship per year.⁶⁹ Fuel

consumption is not the only impetus for this new technology. An increased power requirement for ship combat services is also a primary concern. “Future high energy weapon systems will require electric power beyond what is currently generated on US Navy warships. Future ships will also need to be more energy efficient and cost less to operate than current ships in the fleet.”⁷⁰

Numerous other approaches to conserving fuel (thus reducing air pollution) are being used or are under research and development by commercial industry. In addition to the tried and true speed reduction being used by many firms,⁷¹ some novel possibilities include cavity cushions (air cavities designed into hulls to reduce frictional drag) and microbubbles (tiny bubble streams injected beneath a ship's hull to reduce frictional drag), as well as large sail-like kites tethered to ships and flying at altitudes up to 300 meters.⁷² Cold ironing, in which onshore electrical power is provided to a docked ship, allows it to run its systems without running its diesel generators. This is being provided and required at certain ports around the world, including Los Angeles and San Diego.⁷³

Scientists are developing methods to generate and store energy using every conceivable source. Stored energy in the form of batteries was introduced in the late 19th century. The increasing demand for battery energy has led to a major R&D effort to improve and redesign energy storage. Most people think of wind, sunlight, and ocean waves as sources of sustainable energy. Scientists are looking for less obvious energy sources such as viruses, bacteria, and dirt. Interest in earth-friendly solutions for energy needs makes the potential for commercial and societal profits an appealing investment opportunity for many researchers.

Reduced energy consumption and costs can also have an effect on reducing the environmental impact of ship operations.

Reduced Environmental Cost

Although emission controls have reduced pollution from new cars and trucks by more than 90%, most ocean-going ships operate without any pollution controls at all...Pollution from ships is also affected by the fuel they use. Marine vessels other than oceangoing ships have been required to use cleaner fuels, but oceangoing ships generally use bunker fuel, a fuel that contains a high level of contaminants: the average fuel used by oceangoing ships contains 27,000 parts per million (ppm) sulfur, for example—almost 2,000 times as much as would be allowed in trucks operating on US roads.”⁷⁴

Large carbon particulates known as soot are also of grave concern. An article by Harvey Leifert in *Natural History Magazine* noted, “An extensive survey of shipping lanes along the Gulf Coast of the United States concludes that tug boats emit far more soot than any other kind of vessel and four times more than previously estimated. What's more, large cargo ships emit twice the soot attributed to them, with serious implications for global warming and air quality near major ports... Ships now contribute less than 2% of all airborne soot—which warms the atmosphere—but global shipping is expected to increase by as much as 6% annually. That bodes ill for the climate, particularly the Arctic.”⁷⁵

Turning to water pollution we find several ways in which ships are negatively impacting our oceans, coastal waters, marine life, and, potentially, humans. In an article titled “Green Ships: Keeping Oceans Blue,” Dr. Petros Katsioloudis of Old Dominion

University enumerated five sources of water pollution from cruise ships (though the categories are applicable to all ships), namely: sewage, gray water, hazardous waste, solid waste and oily bilge. He noted the following on sewage, “According to the Environmental Protection Agency (EPA), vessel sewage is more concentrated than domestic sewage because people on vessels use less volume of water for sanitary purposes than do people on land. The discharge of sewage from vessels into the water contributes to the degradation of the marine environment by introducing disease-causing microorganisms and excessive nutrients...Their impact is usually on inshore waters, used for growing and/or harvesting shellfish, as well for recreation...The consumption of raw or partially cooked shellfish that have been exposed to untreated sewage can thus lead to viral diseases such as hepatitis.”⁷⁶

Reduced Manpower Costs

“The cost of a ship’s crew is the single largest incurred over the ship’s life cycle.”⁷⁷ To optimize ship operations within effectiveness and efficiency requirements, the variables of cost (e.g., manning, technology, design, etc.) and risk (e.g., readiness, safety, etc.) must be identified, analyzed, tested, approved and implemented. It has been 15 years since the Naval Research Advisory Committee published its influential paper on reducing ship manning⁷⁸ and 10 years since their follow up report on optimizing surface ship manning.⁷⁹ These works spurred renewed efforts within the Navy to design new ships to operate with comparatively reduced crew sizes and to evaluate current fleet operations/systems to identify/implement solutions to gain manning efficiencies, while meeting operational requirements.

The “Navy lacks a process to systematically address impediments to innovation in all new ship programs.”⁸⁰ Recommendations from that report state that: “a human systems integration assessment be performed as concepts for the system are developed and alternative concepts are evaluated; human systems integration analyses, including trade-off studies of design alternatives, be used to establish an optimized crew size goal that will become a key performance parameter in the program’s requirements document; and human systems integration assessments be updated prior to all subsequent milestones.”

From the relative paucity of published material on the subject (including reports from NPS⁸¹, GAO⁸², and CNA⁸³; various articles in *Proceedings*, and others) over the past 10 years, the impression is left that high-level emphasis on this topic has flagged. No doubt, contingency operations have deservedly required senior leader focus during the past decade. Nevertheless, with budgets tightening, the time has come for updated analysis of this important topic by the NRAC and others, as well as substantive re-emphasis by the Secretary of the Navy and the Chief of Naval Operations.

SUMMARY OF RECOMMENDATIONS & CONCLUSION

To weather this storm, the shipbuilding industry requires bold, imaginative and courageous approaches to rebalance the force and the industry accordingly. It should pursue means to align our strategy with our capacity, and find way to achieve efficiency

through public and private partnership and recapitalization of the industry. Additionally, it must preserve necessary research and developmental funds to foster pursuit of new technologies and processes to reduce life cycle costs and minimize environmental impact.

Converging elements, such as globalization, international security issues, mismatched naval strategies, a diminishing shipbuilding industrial base and impending fiscal constraints, will continue to challenge the industry. Industrial, and even cultural, inertia will resist change and realignment away from the status quo.

Alignment of our national security and defense strategy with a national shipbuilding industrial policy and strategy will allow the country to pursue cost effective solutions to finance the right capacity and capability at public and private shipyards. In our analysis of the strategic shipbuilding environment, it seems clear that we must rebalance strategy and capacity to a point where we maximize efficiency.

To continue sustaining national security “from the sea,” the American shipbuilding industry must align public and private industrial capacity & capability with the Navy’s strategy and naval force structure objectives to sustain a cost effective and fiscally responsible national strategy.



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