

STATEMENT FOR THE RECORD

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**Testimony Before The
House Armed Services Committee
Subcommittee on Seapower and Expeditionary Forces**

**Tuesday, March 20, 2007
2:00 pm
2212 Rayburn House Office Building Committee Room**

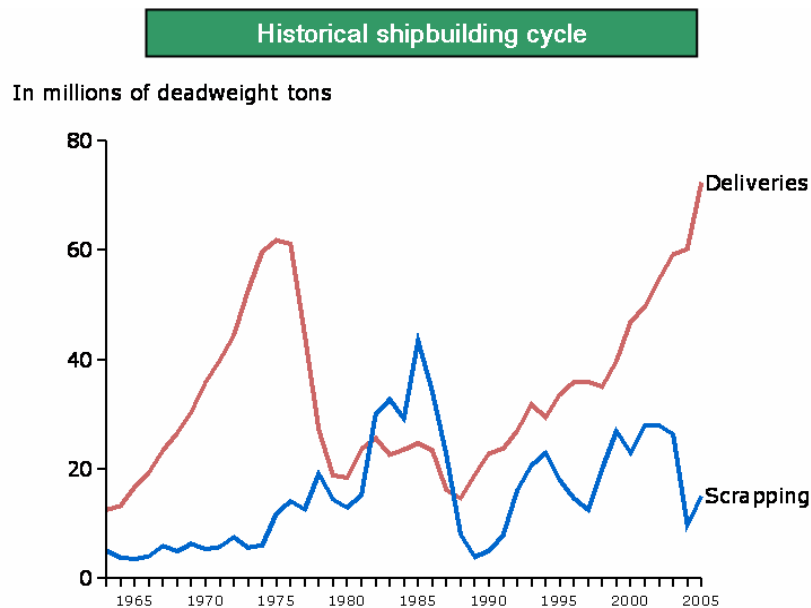
Chairman Taylor, ranking member Bartlett, distinguished members of the subcommittee, thank you for the opportunity to appear before you today to discuss the state of the U.S. shipbuilding industry and what may be done to modernize the industry. Today I represent the entire shipbuilding segment of Northrop Grumman Corporation, which is Newport News and Ships Systems.

Before beginning a specific discussion about modernization, it is important to make clear the objective of such a discussion. We believe the objective is to build ships with the capabilities that meet the Navy's and Coast Guard's needs at lower cost than today. That being said, we must recognize that facility modernization alone will not achieve that objective. Such modernization must occur in combination with (or even after) process changes (whether they be internal to the shipbuilder or between the shipbuilder and its key customers) in order to realize true benefit for the Navy, Coast Guard, industry participants, and most importantly, the U.S. taxpayers.

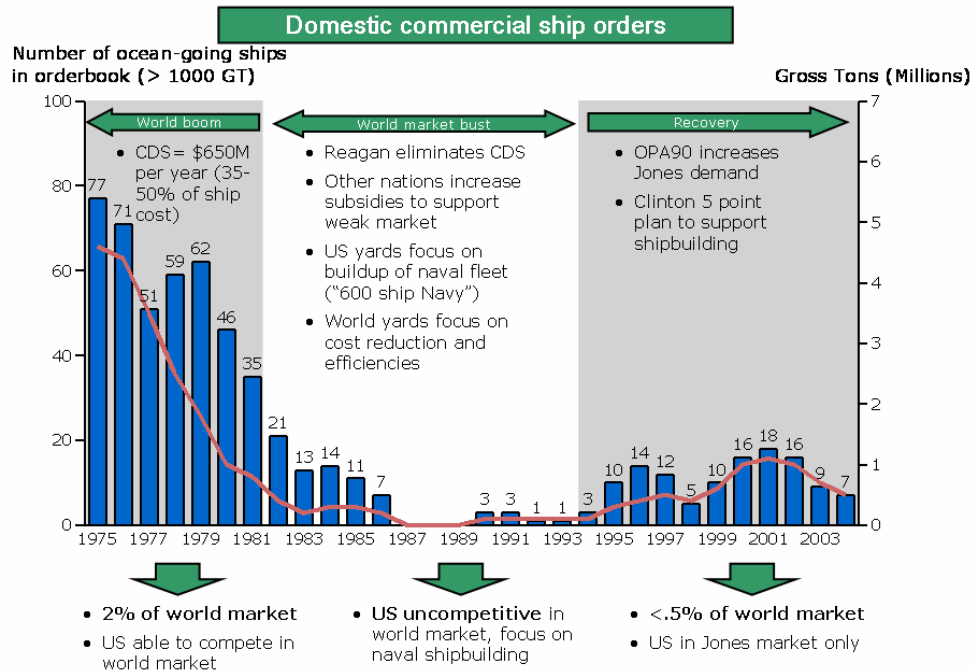
It is important when assessing the state of shipbuilding in this country, and what can be done to modernize, to understand how we arrived at our current state. Since the 1970s, U.S. military shipbuilding, U.S. commercial shipbuilding, and global commercial shipbuilding have each taken distinctly different paths. In 1969, in response to the U.S. Navy's plan to build a new class of destroyers and large deck amphibious ships, then Litton Ingalls Shipbuilding Company embarked on an ambitious plan to develop a completely new production process. The result was a production facility designed to support the revolutionary modular build approach to shipbuilding. At the time, modular production was cutting edge and was quickly adopted by both military and commercial shipbuilders worldwide. Since the introduction of modular building more than 30 years ago, the focus of U.S. military shipbuilding has shifted away from production process improvements toward advanced weapons and ship technologies and a capability to integrate these capabilities onto naval vessels. As a result, the U.S. military has the most technologically advanced ships in the world, a fact that comes with a fundamental cost to the nation in order to maintain the dominance of our naval forces. At the same time, the U.S. military shipbuilding process and associated facilities have significant room for improvement when compared to best-in-class commercial shipbuilders who have primarily focused on production process improvements and cost reduction since the early 1970s.

U.S. commercial shipbuilding peaked in the mid 1970s along with a spike in the cyclical global shipbuilding market. Historically, the cyclicity of shipbuilding demand has been primarily driven by significant swings in replacement demand, which tend to peak at about 30-year intervals. This occurred in the mid 1970s with a volume of over 60 million deadweight tons being delivered in the form of new ships in 1975. Global ship production did not reach that level of output again until 2004. During the mid-1970s boom, the U.S. federal government subsidized up to 50% of the construction cost of commercial ships built in the U.S. under the Construction Differential Subsidy program.

The subsidy was paid to the U.S.-flag ship owner rather than the shipbuilder and was only available for those ships built in the United States that were registered under the laws of the U.S. and operated in international trade. This program supported production of commercial ships in U.S. yards despite the disparity in costs of production between those yards and foreign shipyards.



This subsidy along with the Jones Act, also known as the Merchant Marine Act of 1920, helped sustain commercial shipbuilding in the United States through the 1970s. However, two events in the early 1980s dramatically changed the path of commercial shipbuilding in the U.S. First, the global market for commercial vessels, which was supply constrained in the 1970s, experienced a significant downturn in demand. Second, at the same time demand was declining, in 1981 the Construction Differential Subsidy was terminated. As a result, commercial shipbuilding activity dropped dramatically, and investment in domestic shipyards similarly declined. Today, U.S. commercial shipbuilders are not competitive in the global market, with costs that are two to three times higher than international low cost producers. This is highlighted by the fact that in 1979 the U.S. share of world commercial tonnage was 9%; by 2006 the U.S. market share was less than 1%.

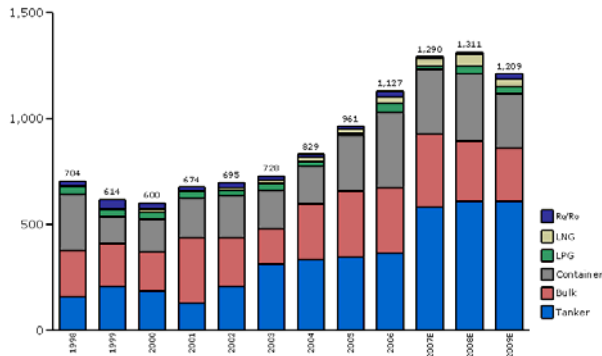


While U.S. commercial shipbuilding has been in decline, global shipbuilding has grown significantly. During the down cycle that followed the boom of the mid-1970s, the commercial shipbuilders that survived focused heavily on all aspects of cost reduction. Successful players in this market leveraged natural advantages, such as lower labor costs, and artificial advantages, such as government support, to create initial leadership positions. As the market began its current up-cycle in the mid to late 1990s, commercial shipbuilders have further reduced costs and increased efficiencies by focusing on standardization and mass production. For example, in 2006 Hyundai Heavy Industries delivered 49 container ships and China State Shipbuilding Corporation delivered 37 bulk cargo ships. In contrast, all U.S. yards delivered a total of 7 Jones Act ships in 2006.

Today, the worldwide commercial shipbuilding market is booming again. The number of vessels being delivered globally each year has been growing at greater than 6% per year and topped the 1000 mark for the first time in 2006. The growth in this \$75 billion market has been driven by a combination of increased demand for shipping capacity and very strong ship replacement dynamics. In fact, the "replacement cycle" dynamics appear to be very similar to the dynamics experienced in the mid-1970s, when replacement volume previously hit a peak. Forecasts for future global shipbuilding demand vary, but several analysts expect some of the replacement demand to enter another down-cycle and thus the overall demand to level off or even decline. Nevertheless, the rapid growth of the commercial market has resulted in significant additional investment and expansion from major shipbuilding countries, who continue to increase their shipbuilding capacity and capabilities.

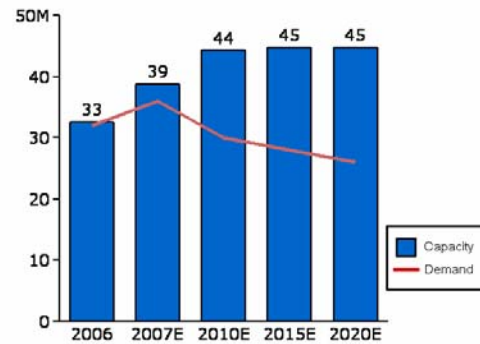
Vessel deliveries worldwide

World deliveries, vessels >10k GT
of vessels



Worldwide capacity & demand

In millions of compensated gross tons

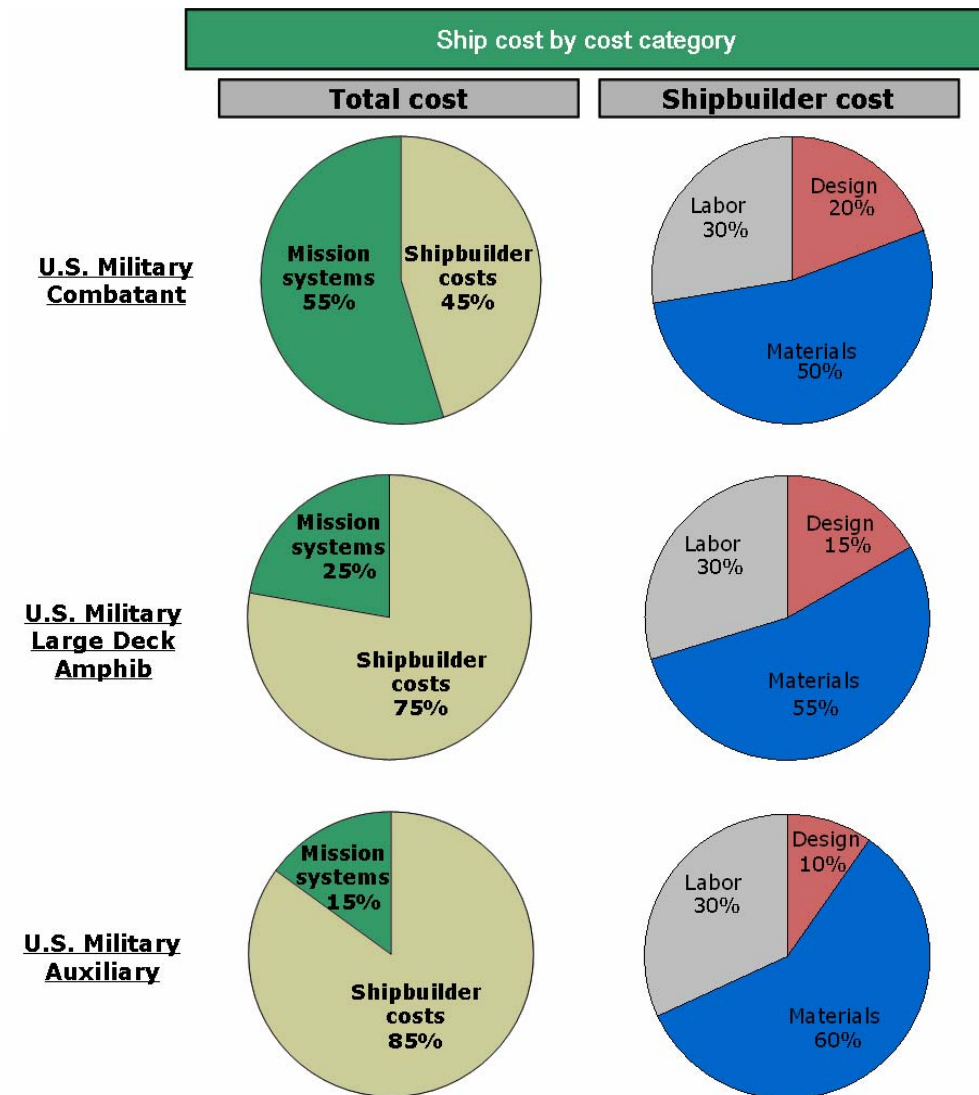


When considering modernization for the U.S. shipbuilding industry, it is thus instructive to look at these best-in-class shipyards across the globe. Several of you, as well as many leaders from my organization, have visited a number of these production facilities. What we have learned is that best practice commercial shipbuilding is characterized by an intense focus on design for production, which includes elements such as standard designs, the use of proven systems and subsystems, standard parts and components, limited customization, minimal to no change vessel to vessel, and large production runs. All of which facilitate an efficient and affordable production process.

In contrast, U.S. naval shipbuilding, which represents over 90% of annual U.S. shipbuilding production in terms of value, is a very different business model. Naval shipbuilding is characterized by complex, continuously evolving designs, advanced technology systems, many changes and small production runs. These characteristics necessitate a flexible, custom shop production process that can meet military requirements that vary widely by ship type, from program to program, and sometimes by hulls within a given program.

Within a surface combatant ship, 55% of the total ship cost is comprised of combat systems that are procured directly from the original equipment manufacturers by the U.S. Navy and provided to the shipbuilders. These combat systems are a critical enabler behind our warships being able to fulfill the mission requirements of the U.S. Navy and Coast Guard, and the investments in these systems have resulted in significant weapon systems advancements. These systems can also impact shipbuilder costs by introducing additional complexity (e.g., systems integration) into the production process. In fact, they could, in some instances, work against each other. Consider a hypothetical example, where radar system advancements result in the addition of equipment to the ship. This could result in the redesign of a set of compartments on the ship, which increases the cost of ship production and in turn limits the learning curve benefits associated with repeatedly producing the same ship design.

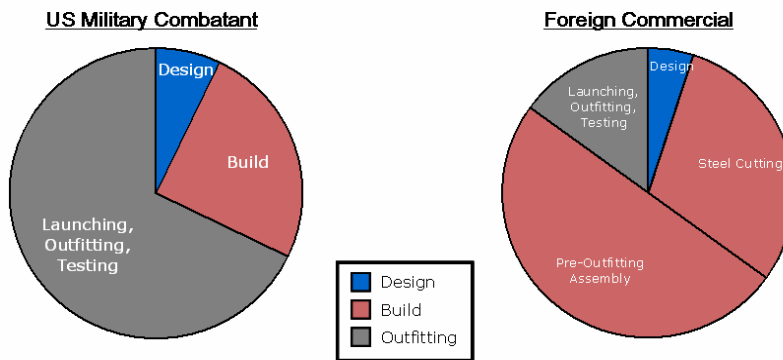
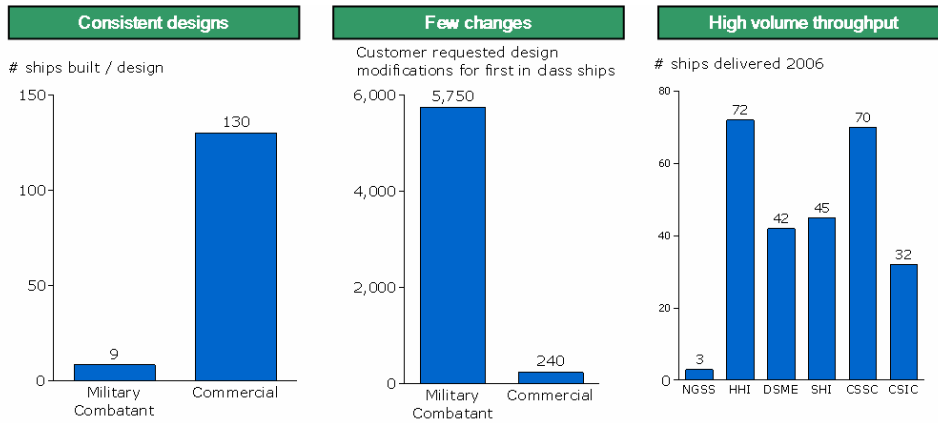
We must recognize that advancements in the combat systems and mission systems of the ship do impact the real costs associated with ship production as well as total ship costs. As a result, while the shipyards should and are taking action to address their shipbuilding cost structures, those efforts will impact only approximately 50% of the total cost of the ship for a surface combatant, approximately 75% for a large deck amphibious ship, and 85% for an auxiliary vessel; and the improvements could be offset by the effects of mission system design changes.



To illustrate the differences between best-in-class commercial and U.S. military shipbuilding consider the following examples:

- Best-in-class commercial ship programs average 240 changes per first-in-class ship and just 2 per follow-on ship, while the U.S. Navy LHD program had about 5,750 changes from LHD 1 to LHD 2 and an average of about 3,550 additional changes for each follow-on ship.

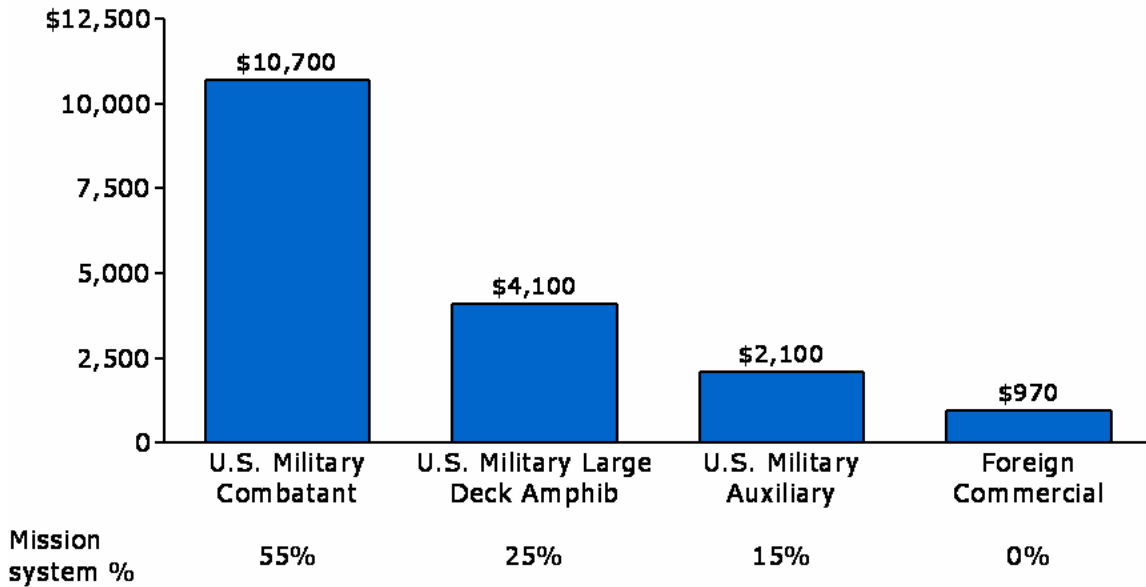
- The split of value chain activities differs significantly between military and commercial shipbuilding. Steel cutting, pre-outfitting and assembly make up about 70% of activity for a commercial ship, but only about 20% of activity for a surface combatant. Furthermore, integration and testing represents only about 15% of commercial shipbuilding's value stream, but 70% of the value stream for a surface combatant.
- Commercial shipbuilders tend to have much larger runs of standard designs. Commercial shipbuilders average over 130 ships produced per design while the average for U.S. military programs is just 9.



All of these differences result in a very different cost structure between military and commercial programs. On an equivalent ton basis, best-in-class commercial ships cost about \$970 per ton. In contrast the cost per ton for military combatants is \$10,700, for large deck amphibious ships is \$4,100, and for auxiliary ships is \$2,100.

Comparison of total ship costs

Total ship cost (\$/cgt)

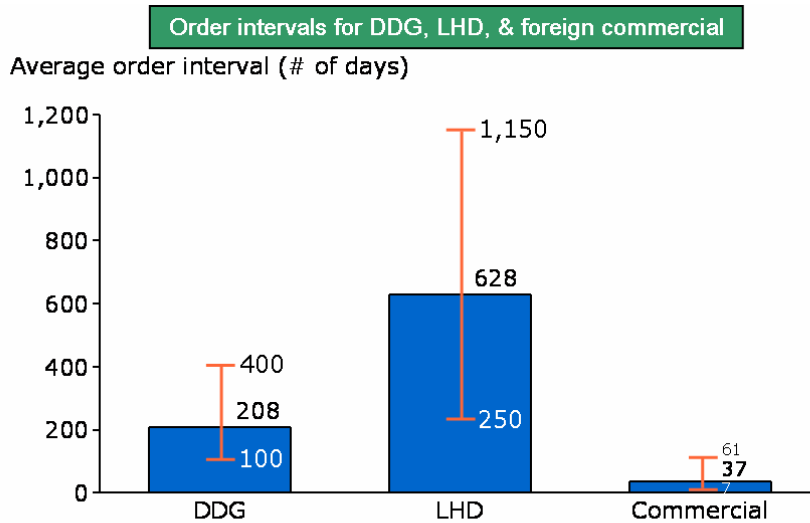


While separate and distinct businesses, some techniques developed in best-in-class commercial yards can be applied to military ship production. These techniques, including the production of more hulls for each given design (run lengths), better managed time gaps between ships (order intervals), and reduction of change within and between ships, represent opportunities to reduce the costs of U.S. Navy and Coast Guard ships.

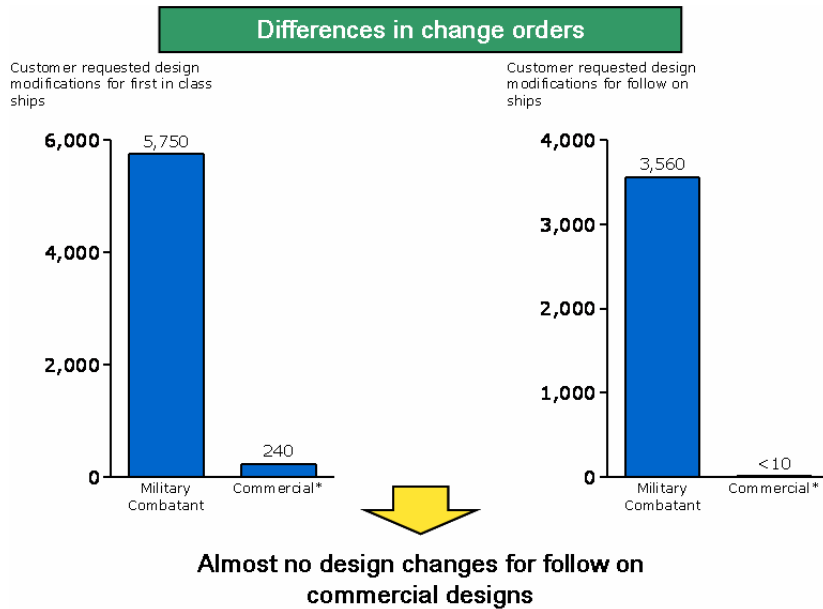
Additionally, and perhaps more importantly, a much greater collective focus on design for production would identify opportunities to reduce the complexity that currently exists in military ships. This complexity reduction could take many forms – common hull designs, standardization of units or modules within ships, designs that contain much less curvature, etc. But they are all driven by the notion of designing ships with the production of the ship in mind, so that total production costs can be reduced while not sacrificing the ship’s mission. This notion dominates the global commercial market; it does not define the U.S. military market. In fact, near-term budgetary concerns often disincentivize relatively modest upfront alternative design analyses even if such analyses were expected to substantially reduce production costs in the out years.

The length of production runs and order intervals represent significant opportunities. Even on military programs characterized by relatively long production runs (by military ship standards), the interval between orders is rarely standard and can be a key driver in increased costs. The order rate for DDG 51 class ships has varied from a high of five ships per year to a low of two. Lengthy breaks in production can completely eliminate learning curve efficiencies, driving up labor costs that represent ~30% of the shipbuilder’s portion of the cost of a ship. We estimate that the changing production

interval on DDG 51 class ships produced by NGSS has added as much as 15 million labor hours and \$430 million to the overall cost of the program. Additional cost savings from longer production runs and managed production intervals can also be found in lower material costs that represent ~50-60% of the shipbuilder's portion of the cost of a ship, as suppliers would be able to come down their experience curves at a greater rate and shipbuilders would be able to buy materials in higher quantities. Best-in-class commercial programs maintain short intervals between ships that result in steep learning curves due to continuous experience gain. High steady rate serial production of standard designs in combination with a focus on design for production also permits commercial shipbuilders to automate many production processes.



Change orders represent another area of opportunity to learn from best-in-class commercial shipbuilders. We estimate that change order activity on NGSS built Arleigh Burke destroyers have added as much as 6 million labor hours to production at a cost of \$160 million. In addition to experience loss, change orders impact shipbuilders' design costs (incremental design requirements, change/configuration management costs), labor costs (schedule disruption, rework labor) and material costs (replacement material). The elimination of such changes could dramatically reduce ship production costs, but must be considered in light of the need to deliver the most advanced technological solution to the warfighter. Strong systems engineering skills among the U.S. Navy, U.S. Coast Guard, and shipbuilder teams are necessary to balance these valid, yet competing, demands.



As mentioned previously, design for production is the norm in commercial ships, but not in military ships. Even given the need for battle hardening in military ships we find little commonality of design for key systems across different classes of ships. This drives complexity in the manufacturing process both at the shipyard and amongst vendors. This lack of commonality drives up the labor portion of the shipbuilder’s costs by eroding the remainder of the learning experience in our production work force due to the lack of repetitive processes.

Additionally, design and production processes vary from program to program. For example, design tools vary from program to program despite the investment made by the government in some cases to develop those tools, resulting in higher design costs. This adversely impacts the shipbuilder’s ability to specialize, to automate and to develop a specialized vendor base. Best-in-class commercial yards are able to focus on standardizing key production activities, automating those activities and thus leveraging the learning curve.

Thus, in summarizing the comparisons of our U.S. Navy and Coast Guard shipbuilding model to the best-in-class commercial shipbuilders, the models and results from a cost standpoint are quite different. The question then for all of us (shipbuilders, weapons systems providers, and U.S. Navy, Coast Guard and Congress) becomes how much learning from the global commercial shipbuilding business can we apply to our U.S. military shipbuilding business? We believe there are meaningful lessons to be learned with two very important observations:

1. Most of the opportunities begin with process changes that can be enabled by supporting equipment or facilities.
2. Under the current ship procurement model, no single party can drive these improvements alone. A collective effort is required to get all elements of these potential process changes aligned.

With those observations in mind, it is important to recap the key lessons learned from the analysis of global commercial shipbuilding:

1. Commercial shipbuilders have an intense focus on design for production, which results in more cost effective designs and reduced complexity throughout the shipbuilding system.
2. Most commercial shipbuilders produce a much greater number of ships for a given design and are able to maintain tighter timing between the production of sequential ships.
3. Commercial shipbuilding has much fewer changes that occur to the design of the ship, both during production and between ships in a class.

The result of these and other differences is a significant cost differential between best-in-class commercial production and the production of U.S. Navy and Coast Guard ships. We do not presume that we can close this entire cost gap, as the nature of the mission requirements of military ships is much different than that of commercial ships. However, we do believe that several elements of the lessons learned from best-in-class commercial shipbuilding can be employed to decrease the costs of military ship production in the U.S.

We, the shipbuilders, can independently address some of these opportunities. Northrop Grumman has proceeded down this path. We engaged the same experts that completed the Department of Defense shipbuilding benchmarking study to help us identify what we must do to achieve best-in-class standards for our facilities, processes and for our work force. We are improving our design for production capability, acquiring a new, more flexible, proven production planning tool, investing in facilities improvements and new equipment, increasing our focus on process improvement and investing in better training for our work force. We will continue down this path with the goal of producing more affordable ships for the U.S. Navy, Coast Guard, and American taxpayer.

However, it is our belief that a much greater amount of cost reduction can be achieved if the U.S. Navy, the Coast Guard, Congress, and the shipbuilding community work together to attack these critical issues. Clearly most of the lessons learned cross organizational boundaries. Design for production must balance mission requirements, ship design standards (NVR, ABS) and shipbuilder facility, equipment and process capabilities (both current and planned). Production runs and order intervals are influenced by Navy and Coast Guard strategy, Congressional funding, and shipbuilder performance. Design changes are driven by maturing technologies in both the shipbuilding and mission systems arenas, evolving Navy and Coast Guard requirements, and changes in the production process. We believe that if these groups work together to address the opportunities, the result will be more affordable ships for the American taxpayer.

For example, working together we could modify our design requirements and processes to significantly increase the amount of off the shelf material that is acceptable on military ships. We could jointly develop “quick connects” to join electrical or pipe runs through the ship that both meet acceptable survivability and reliability requirements of the Navy

and Coast Guard and are much less costly to produce. We could develop a roadmap to achieve a standard ship design process on one design tool to provide greater standardization across platforms. Finally, we could jointly invest in the development of a stronger vendor base, through more standard requirements, smoother production cycles, and possibly capital investment.

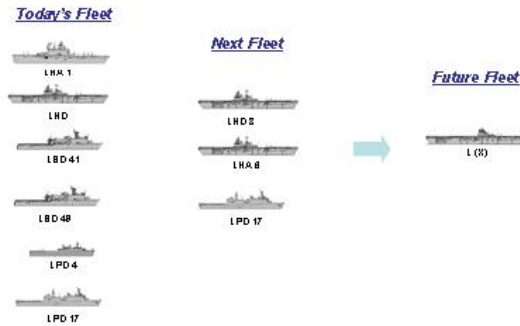
We expect that some of these solutions will require capital investment. As mentioned previously, most of these capital investments should follow process changes and solutions; it is our view that investing this capital now without addressing the issues identified above would not be the most prudent use of the taxpayer's dollar. When it comes time to pursue such investments, we believe that the American Shipbuilding Association's proposed CAPEX legislation would provide one effective vehicle to fund improvements in production efficiencies while providing the U.S. Navy, Coast Guard, and Congress the ability to measure the true value of those improvements in program specific terms.

Examples of potential investments that could be consistent with a design for production path and potentially be funded through the American Shipbuilding Association's CAPEX legislation include:

1. Technology upgrades to shipbuilders' pre-production processes (impacts shipbuilder's design, labor and material costs)
2. Investment in heavy machinery assembly and grand block assembly buildings which would enable the creation, and more importantly, testing of much larger grand blocks in the production process (impacts shipbuilder's labor costs)
3. Investment in thin panel technology and equipment that could significantly reduce the amount of heat straightening that currently needs to be performed on thin panels (impacts shipbuilder's material and labor costs).

Furthermore, we applaud the Chief of Naval Operations, Commander Naval Sea Systems Command and PEO Ships for their interest in common hull designs, common mission systems and common HM&E equipment which we believe will promote larger production runs, reduced complexity and more affordable ships. Standardization can also extend past just the concept of common hulls. At a micro level, we can work better together to standardize parts, systems and geographical elements (e.g., masts, compartments) within a hull. We also could use some of those standard elements across different hull designs. Additionally, we could expand the standardization of functional modules to encompass much more of the system components of the ship (something on which we have made substantial progress working with General Dynamics on the DDG 1000 design).

Potential Amphibious Strategy



We can reduce to one ship type

Potential Combat System Strategy



We can neck down combat systems baselines

These three charts were taken from "Future of Shipbuilding Strategies", presented by RDML Chuck Goddard to the ASNE Ships and Ship Systems Technology Symposium, 14 November 2006

Unique HM&E Varieties in the Fleet

- Masts & Kingposts - 47
- Diesel Engine - 187
- Gas Turbine Engine - 30
- Reduction Gear - 641
- Clutches & Couplings - 1,113
- Shaftings - 141
- Bearings - 383
- Propulsors - 125
- Rudder - 34
- Motors - 7,125
- Ship Service Generators - 57
- Emergency Generators - 53
- Frequency Converters - 52
- Pumps - 4,171
- Valves - 37,709
- A/C units - 123
- Distilling Plants - 82
- Air Compressors - 203

We need more commonality to reduce total cost

Together, we can also address the issue of production intervals. The Navy should request and Congress should authorize more multi-year contracts and block buys. Shipbuilders should then do their part by making investments to ensure that associated learning curve labor savings and material cost reductions are realized. The U.S. Navy, Coast Guard, Congress and industry should also review the current CNO's 313-ship plan to see if something could be done to address production intervals. All parties can work together to develop change order management approaches that both significantly reduce the number of changes that occur during a ship's production and between ships, and provide a better way to manage the impact of changes that do need to occur.

To pursue these opportunities and more, we recommend that this committee authorize a joint study to analyze and provide specific process and capital investment recommendations to reduce the cost of U.S. Navy and Coast Guard ships. This initiative should, at a minimum, have representation from the major shipbuilders, the major mission system and propulsion system developers, the Navy, and the Coast Guard. Such a study should certainly evaluate the opportunities we have highlighted in this statement, but also include the evaluation of substantial ideas from other industry participants, the

Navy and the Coast Guard. Northrop Grumman would be thrilled to be an active leader of such an initiative.

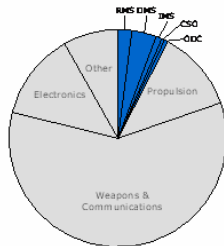
In summary, we believe the modernization of the shipbuilding industrial base will require the collaboration and commitment of private industry, the Department of Defense, Coast Guard and Congress. Our analysis shows a number of areas in processes, facilities, and technology where changes can yield significant improvements. We at Northrop Grumman have embarked upon and are committed to a comprehensive effort to change those things we can. We stand ready to work with the U.S. Navy, the Coast Guard, and Congress to facilitate as we are able those things that are the purview of the Government.

Thank you again for the opportunity to appear before you today to discuss this subject of vital importance to our national security.

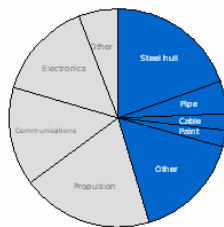
Appendix:

Differences in ship materials

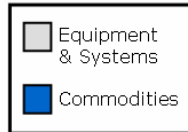
US Military Combatant



Foreign Commercial



PRELIMINARY



• Quality requirements

- Military:
 - ▶ MILSPEC, must undergo rigid testing for function, interaction & reliability
 - ▶ Greater SKU complexity, 10x number of pipe part types vs. commercial
- Commercial:
 - ▶ Testing for basic functionality

• Customization

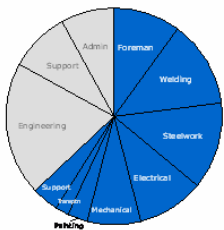
- Military: High degree of customization
 - ▶ Requires special production & vendor involvement
 - ▶ Few substitution options
- Commercial: Little to no customization
 - ▶ Almost always use OTS material
 - Readily available with many substitution options



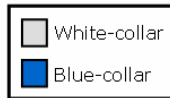
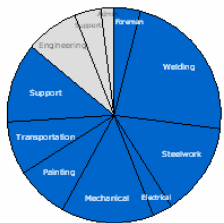
Material on Military ships is more costly due to quality & customization requirements

Differences in labor requirements

US Military Combatant



Foreign Commercial



	Military	Commercial
Total labor requirements	4M hrs	0.5M hrs
Focus of labor	Hull, Auxiliary, Electrical Systems	Hull
White- to blue-collar workers	1:2	1:6
% of Electricians*	16%	1%
Blue-collar supervisors to workers	1:6	1:20



Drastic work force differences between commercial and military

- Military: Large number of white-collar & supervisors result in much higher overhead costs
- Commercial: Small number of white-collar & supervisors restrict ability to handle military requirements