National Security Assessment of the U.S. Shipbuilding and Repair Industry

U.S. Department of Commerce
Bureau of Export Administration
Office of Strategic Industries and Economic Security
Strategic Analysis Division

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This report was prepared by Stephen Baker, Chris Degnan, Josh Gabriel, and John Tucker of the Strategic Analysis Division.

Special thanks to: Jeff Beach, Ivan Caplan, Dennis Clark, and Lisa Jung of the Naval Surface Warfare Center, Carderock Division; William Slowik, Office of Naval Research; Ron Poulsen and Daniel Seidman of the Maritime Administration, Dept. of Transportation; and Ron Culpepper and Ric Trotta of Trotta Associates for their many invaluable contributions.

For further information about this report, please contact Josh Gabriel, Trade and Industry Analyst, 202-482-4043 or Stephen Baker, Trade and Industry Analyst, 202-482-2017.

Brad Botwin, Division Director
Phone: 202-482-4060 Fax: 202-482-5650 e-mail: bbotwin@bxa.doc.gov

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Executive Summary

The U.S. Department of Commerce, Bureau of Export Administration (BXA) performed this national security assessment of the U.S. shipbuilding and repair industry at the request and under the partial sponsorship of the Carderock Division, Naval Surface Warfare Center. BXA is delegated authority under Section 705 of the Defense Production Act of 1950, (50 U.S.C.§ 2061-2170) as amended, and by Executive Order 12656, to collect basic economic and industrial information to fulfill the Department's responsibilities regarding the health and competitiveness of defense-related sectors and technologies. The Office of Strategic Industries and Economic Security (SIES) is the operating unit within BXA with the responsibility for this data collection and analysis function.

This assessment of shipbuilding and repair was initiated in September 1999, and it is the first phase of a more extensive study of U.S. maritime activities. Additional assessments are planned for maritime related research and development, the shipbuilding supplier base, ocean resource recovery, and waterborne commerce. An initial goal of this effort was to characterize more fully the maritime sector in the United States. Additional objectives of these assessments are as follows:

- Illustrate the relationship between the maritime industry, national security, and the vitality of the U.S. economy.
- Identify opportunities for increased sharing of marine science and technology between public and private entities.
- Improve the use of public maritime capabilities toward advancing private industry competitiveness.
- Encourage cooperative efforts within the maritime industry among government, industry, and academia.

Over the course of the maritime industry assessment, SIES will utilize the expertise of various government agencies, universities, and private firms, including those listed below:

- Carderock Division, Naval Surface Warfare Center
- Maritime Administration
- Office of Naval Research
- U.S. Coast Guard
- National Oceanic and Atmospheric Administration
- Army Corps of Engineers
- Consortium for Oceanographic Research and Education
- American Shipbuilding Association

- Shipbuilders Council of America
- Massachusetts Institute of Technology
- Pennsylvania State University
- Trotta Associates, Inc.

The U.S. shipbuilding and repair industry is a strategic asset analogous to the aerospace, computer, and electronic industries. Frontline warships and support vessels are vital for maintaining America's national security and for protecting interests abroad. In emergency situations, America's cargo-carrying capacity is indispensable for moving troops and supplies to areas of conflict overseas. A domestic capability to produce and repair warships, support vessels, and commercial vessels is not only a strategic asset but also fundamental to national security. The U.S. government, through maritime legislation and the Department of the Navy, plays an essential role in the shipbuilding and repair industry's viability and long-term survival.

Assessment Findings

Industry Overview

1. Shipbuilding in the United States has historically been considered a strategic industry, supporting both military and commercial interests. Currently, the U.S. shipbuilding and repair industry consists of about 250 private companies and five publicly owned and operated repair yards. U.S. shipbuilding and repair revenues totaled $10.2 billion in 1998. About 10 percent of the companies accounted for 85 percent of these revenues. The shipyards on the Eastern and Gulf Coasts account for over 80 percent of the revenues for the entire industry.

2. The six largest shipbuilders, commonly referred to as the Big Six, account for two-thirds of the industry's total revenue (over $6.7 billion in 1998) and perform nearly 90 percent of all military work. Ninety-five percent of the revenues of these yards are defense-related. The Big Six accounted for about 11 percent of the industry's commercial revenues during the 1996-2000 period.

3. Corporately, the Big Six are structured as follows: Bath Iron Works (Maine), Electric Boat (Connecticut and Rhode Island), and NASSCO (San Diego) are part of General Dynamics' Marine Systems; Avondale (New Orleans) and Ingalls Shipbuilding (Mississippi) are part of Litton Ship Systems (which was recently purchased by Northrop Grumman); and Newport News Shipbuilding (Virginia), the largest of the Big Six, remains independent to date. On April 25, 2001, however, General Dynamics made a definitive agreement to acquire Newport News for $2.6 billion. Consummation of the deal may take several months pending Department of Defense (DoD) and other approvals.

4. Based on BXA survey data, the shipbuilding and repair industry employed nearly 89,000 private workers in 1998; another 23,000 people worked in publicly owned repair yards. Industry employment has dropped sharply since the early 1980s, when total private employment was close to 180,000 workers. Survey estimates indicated that employment would decline to about 83,500 in 2000. The Gulf Coast employs more shipyard workers (35 percent of the total) than any other region.

5. Production workers comprise about two-thirds of the total shipbuilding and repair workforce. The Big Six employ about 94 percent of the naval architects, engineers, and other marine professionals. Slightly less than 60 percent of their total workforce hours are attributed to production workers.

6. The industry has two market sectors: military and commercial. Ship construction and procurement methods in the two markets are quite different and generally incompatible.

7. The military share of industry revenues was about 70 percent in 1998; these revenues experienced modest growth (12 percent) in the 1996-2000 period, while commercial revenues, although much smaller, grew by more than 50 percent. (1999 and 2000 are based on shipyard estimates.)

8. The regions with the highest percentage of defense work are the Northeast (90.5 percent) and South Atlantic (81.2 percent). The regions with relatively higher percentages of commercial work are the Gulf Coast (49.5 percent), Pacific (34.2 percent), and Great Lakes (97.5 percent).

9. Significant consolidation in recent years has led to shipyard closings and mergers. Another recent development has been the creation of joint ventures between foreign and U.S. shipyards, primarily motivated by the desire to construct certain ship types within the United States and to compete in the U.S. market.

10. Orders for U.S. warships have declined 60 percent during the ten years since the end of the Cold War.

11. In recent years, ship repair revenues ranged between 30 and 40 percent of the industry's total revenues. This figure does not include repair expenditures by the U.S. Navy or Coast Guard at the five publicly owned repair yards.

Employment Concerns

1. Survey responses indicate that labor shortages have reduced profits, impacted construction costs, and delayed project completion for most shipyards. In addition, many shipyards subcontracted work normally done at the yard and turned away new business. A few yards also used contract labor. Labor shortages affected military and commercial yards about equally.

2. Due in part to job insecurity caused by uneven workload, harsh work environments, and a competitive labor market, labor turnover at some shipyards has been higher than in many other industries. Turnover is generally highest among production workers.

3. Both government and industry sources state that military procurement contracting practices can lead to overspecialization within the workforce. Narrowly defined job classifications (or titles) can cause idle time and reduce a shipyard's flexibility to utilize its workforce effectively. Also contributing to overspecialization are union activity and tradesmen certification requirements. In contrast, Kvaerner Philadelphia is applying the lean production business model used in Europe at its newly established commercial shipyard facility at the former Philadelphia Naval Shipyard. The company reported that it currently has only four job categories in order to maximize the flexibility of its workforce and is creating subcontractors to do major subassembly work.

4. The skill base of the U.S. shipbuilding industry is eroding, notably for welders, pipe fitters, and ship fitters. Shipyards also cited shortages of machinists, electricians and marine engineers. Shipyards compete with other industries and with each other for skilled labor.

5. A common response to acute labor shortages by some U.S. shipyards is to hire and train unskilled workers. Training unskilled workers imposes additional costs with no guarantee the workers will stay long enough for the yard to recoup its investment. Some commercial yards reported that worker morale, substance abuse, and work-related accidents due to inexperience posed additional challenges.

Productivity and Competitiveness

1. Based on Department of Labor information, productivity in the U.S. shipbuilding industry has not significantly improved since the mid-1980s, although gains have occurred since 1995 (up 12 percent). Compared to productivity increases in aircraft manufacturing (up 84 percent), for example, shipbuilding productivity has not kept pace. Reliable measures of construction productivity, which in some ways are analogous to those in shipbuilding, are not available.

2. Interviews with Navy officials who had recently conducted site visits to several foreign shipyards revealed that U.S. shipbuilders' productivity is lagging behind that of international shipbuilders. Starting from a small production base, major Korean yards reportedly had gains in productivity of 15 percent annually in the last decade. The Japanese shipyards have a continuous improvement program and have already exploited the easier gains. Recent gains in these Japanese shipyards have, therefore, leveled to about 2-3 percent annually.

3. Productivity in the shipbuilding and repair industry was profoundly affected by the slowdown in defense production levels at the end of the Cold War. In addition, procurement practices, such as change orders, and the uncertainty of annual appropriations are known to adversely impact productivity and production schedules. Three of the Big Six reported productivity aggregate gains equal to or greater than 15 percent in the past five years, while the other three reported gains of less than five percent.

4. Current U.S. DoD procurement policies do not adequately reward innovation in military ship construction practices, thereby indirectly encouraging shipbuilders to maximize labor hours.

5. Costs of maintaining excess capacity and underutilized capabilities (people and facilities) can be high for shipyards that focus on military work. Ship costs increase and competitiveness can be adversely impacted.

6. Based on Bureau of the Census data, U.S. shipbuilders subcontract about 40 percent of the value of their total revenues. The qualification procedure for military subcontractors is burdensome and expensive. Also, the reduced level of defense procurement has discouraged new subcontractors from entering the market (creating a sole-source environment), which can result in shipyards producing more items themselves.

7. In the five years between 1996-2000, capital outlays by the shipbuilding industry were $1.44 billion, including two new shipyards and several major upgrades. This outlay was about three percent of total industry revenues. The Big Six accounted for about half the capital expenditures and invested about 2.4 percent of their revenues. Four shipyards accounted for over half of the capital investment within the industry, and eight shipyards accounted for over 70 percent of the total.

8. Financial conditions and ample profitability highlight the shipbuilding industry as possessing a generally stable business base with low levels of debt. The receipt of progress payments from the Navy contributes to the industry's financial stability. Pre-tax profits for the U.S. shipbuilding industry averaged 6.75 percent of revenues for the period 1996-2000. Profits in the military sector exceeded 8 percent, while commercial profits were about 5.7 percent.

9. According to the survey, 81 percent of U.S. shipbuilders are optimistic that their competitive prospects will improve in the next five years.

Research and Development

1. U.S. warships are acknowledged to be the best in the world. Construction of these ships has advanced naval technology. Advancements include the integration of nuclear power and gas turbine propulsion, advanced weapons systems, state-of-the-art electronic communications, and stealth technologies.

2. A key reason for U.S. warship superiority has been the shipbuilding research and development (R&D) expertise that currently resides across the Enterprise, which is the term applied to the Navy's laboratories, acquisition commands, and certain shipbuilders and universities. Collectively, these organizations have conceived and designed most of the state-of-the-art hull, mechanical, electrical, power projection, air defense, and undersea warfare capabilities that are operational today. With reduced research and development budgets, some of that capability is now becoming fragmented. The shipbuilding industry's principal roles in the development process have been in the application of technology, detailed design, and manufacturing and system integration.

3. An existing effort to bolster the shipbuilding R&D infrastructure is the National Shipbuilding Research Project Advanced Shipbuilding Enterprise (NSRP ASE). This project is an industry/U.S. Navy partnership focused on improving the commercial competitiveness of the U.S. shipbuilding industry, thereby reducing the cost of Navy ships. NSRP ASE is the successor organization to the well-received MARITECH program that ended in 1998. The U.S. Navy and the 11 major shipbuilders that comprise NSRP are jointly funding R&D costs.

4. Based on survey information, less than one percent of industry employees are engaged in R&D at least part time; 25 percent of these employees have a four-year college degree.

5. U.S. shipyard R&D averaged about 1.23 percent of revenues from 1996-2000. Half of the R&D was company funded (0.64 percent of revenues), which compares with more than three percent for all U.S. manufacturing. The Big Six accounted for 80 percent of the R&D, averaging 1.49 percent of their revenues. The R&D range for the Big Six was from near zero to almost three percent. Slightly more than half their R&D was company-funded.

6. The U.S. Navy directly funded 42 percent of the R&D that took place in the shipbuilding industry. Most Navy R&D is devoted to the development of weapons and combat systems, which is not performed by shipyards.

7. While military technology is generally not exploited by the commercial shipbuilding sector, the Navy is attempting to exploit commercial off-the-shelf technologies for ship systems and hardware.

8. As part of recent DoD acquisition reform policies, the Navy is in the process of transferring its design and life cycle responsibilities to the shipbuilding industry. This transfer has been a part of an overall defense downsizing effort that began ten years ago.

9. Based on survey responses, shipyards expressed willingness to team with government, academia, and private entities. Larger companies were more in favor of teaming than were smaller companies.

Maritime Legislation

1. U.S. maritime legislation dates back to the late eighteenth century and has been enacted to preserve the industrial base and all facets of the maritime workforce. The shipbuilding industry is considered essential for national security, including wartime sealift operations.

2. U.S. shipbuilders must meet more stringent environmental standards and safety regulations than shipbuilders in most other nations.

3. The Merchant Marine Act of 1920 (the Jones Act) is the embodiment of government's relationship with the commercial shipbuilding industry. It limits the transport of cargo between U.S. ports to American made, owned, and crewed vessels.

4. The Merchant Marine Act of 1936, as amended, established the government's role in preserving a fleet of U.S. flag vessels, supporting commercial ship construction and providing operating subsidies. The construction and operating subsidies were withdrawn in the early 1980s, in part due to plans for construction of a 600-ship Navy. Withdrawal of the subsidies, however, accelerated a decline in industry employment and U.S. commercial shipbuilding revenues. (Based on U.S. Census data and adjusted for inflation, industry revenues were over $17 billion in 1981 and down to just over $11 billion by 1987.)

5. The Merchant Marine Act of 1936 also established Title XI government loan financing; the program was amended and expanded with the signing (in 1993) of the National Defense Authorization Act of 1994, which contained the National Shipbuilding and Conversion Act of 1993. As of March 1, 2001, MARAD had pending loans worth over $4.7 billion. (Note: The President's 2001 budget proposals recommend lower appropriations for this program.)

6. Most commercial market opportunities for vessels over 1,000 tons, such as oceangoing cruise vessels and double-hulled oil tankers, were/are created by government legislation (Project America and the Oil Pollution Act of 1990).

U.S. Position in International Shipbuilding

1. The U.S. commercial shipbuilding industry is generally not internationally competitive, particularly in the construction of vessels over 1,000 gross tons. Various sources report several reasons for this lack of competitiveness, including foreign government subsidies and other unfair trade practices, exchange rates, and lagging U.S. productivity. In some niches, however, the United States currently has a significant world market share based mostly on domestic sales. These niches include offshore oil platforms, yachts, fast patrol boats, and recreational vessels.

2. The United States ranks tenth in the world with about a one percent share in the construction of new commercial vessels over 1,000 gross tons (as of June 2000). By this measure, the leading commercial shipbuilding nations are South Korea (43 percent of the market); Japan (26 percent); China (7 percent); and Germany, Italy, and Poland (each with 3 percent).

3. Exports accounted for less than 2 percent of the industry's 1998 revenues. The United States does not export any of its newly constructed front-line warships, but it does export selected combat systems that are installed on these warships.

4. The supply base for the shipbuilding industry is primarily domestic. Only about four percent of the items and materials purchased by shipbuilders are of foreign origin. The primary reasons for foreign sourcing are customer-directed suppliers, items not available domestically, and better prices. Survey data indicates that the commercial sector is engaged in foreign sourcing to a somewhat higher degree than the military.

5. About 97 percent of U.S. international trade is carried on foreign-flagged vessels. Data from the U.S. Department of Transportation indicates that U.S. international trade is expected to double in 20 years. Waterborne commerce is the most energy efficient mode of transportation and the most environmentally friendly, factors that could increase market opportunities for U.S. shipbuilders.

6. An agreement to end most subsidies and supports in the international shipbuilding market was developed through the Organization for Economic Cooperation and Development (OECD). The U.S. Senate has yet to implement the agreement because of concerns that it will not achieve its intended goal.

7. The OECD predicted in late 2000 that overcapacity already existed in the international shipbuilding industry and that this overcapacity would approach 40 percent by 2005.

Shipbuilding Compared to Other Domestic Industries

1. Bureau of the Census data indicate that shipyard employment peaked at about 180,000 in 1981. Since then it has shrunk in two phases: first, after funding for the two commercial subsidies known as the Operating Differential Subsidy (ODS) and the Construction Differential Subsidy (CDS) ceased in 1982; and again after the collapse of the Soviet Union and subsequent defense downsizing. According to Census data, shipyard employment decreased to 95,000 in 1998.

2. As in the shipbuilding sector of the economy, employment declines were also experienced by the automobile and aircraft assembly sectors: the automobile sector decreased from about 360,000 to 240,000; the aircraft sector from 300,000 to 210,000 employees. Employment declines in the automobile and aircraft assembly sectors, however, were primarily due to increases in productivity, while employment declines in the shipbuilding sector were due to declines in the market.

3. U.S. shipbuilding is more labor intensive than other manufacturing industries. For example, in terms of the ratio of payroll to value added, the ratio for shipyards averaged about 63 percent in 1998, while auto assembly was only 28 percent and aircraft assembly was about 40 percent.

4. Production workers in the shipbuilding industry earn on average $15 an hour, excluding fringe benefits. Using the Gross National Product (GNP) deflator index to establish constant wage rates, real wages in the industry have actually declined in the last 20 years. Today, shipyard wages are barely above the national average for manufacturing. The average hourly wage for employees in aircraft ($24) and automobile assembly ($27) is significantly higher, and the gap is widening.

5. Output per employee in shipbuilding measured in constant dollars rose from about $83,000 in 1977 to $118,000 in 1998 (up 45 percent). Over the same period, auto assembly output per employee rose from about $452,000 to nearly $1 million (up 117 percent) and aircraft assembly output rose from $173,000 to about $326,000 (up 88 percent).

6. The aircraft and automobile manufacturing sectors outsource to a much greater extent than does the shipbuilding industry. Information gathered from site visits and interviews with knowledgeable sources indicates that some U.S. shipbuilders might benefit by expanding their use of second tier subcontractors.

7. As a ratio of value added (i.e., equals about 60 percent of shipbuilders' revenue), capital expenditures by the shipbuilding and repair industry (4.32 percent) averaged half that of all manufacturing (8.2 percent) from 1977-1998. (Note: The 4.32 percent figure is equivalent to about 2.59 percent of total revenues.)

Conclusions

1. Shipbuilding and repair is important to the national security of the United States. Frontline warships both enhance the national security and protect American interests abroad. It is essential that the capability and infrastructure needed to build these ships is resident in the United States because it provides added assurance that they can be built, repaired, and maintained during times of conflict.

2. The current U.S. commercial market for merchant vessels does not support the construction of the type of large sealift vessels needed in wartime. The projected market is unlikely to be any different.

3. The U.S. shipbuilding and repair industry is dependent on government policy for its long-term survival. Shipbuilding and repair is an important component not only of the nation's defense but also of America's transportation infrastructure.

4. Current maritime related statutes are only marginally effective in achieving the intended goals of maintaining a professional maritime workforce and providing adequate numbers of commercially viable sealift vessels.

5. To achieve more substantial gains in productivity, the Navy procurement system will need to include greater incentives for investment in productivity-enhancing technologies and processes.

6. Many shipyards have difficulty attracting and retaining an adequate supply of qualified production workers. Shipyard productivity increases could potentially allow for higher pay scales, which could help alleviate this concern.

7. Extensive modernization of the commercial shipbuilding industry could improve productivity and thereby reduce the costs for purchasers of American-made vessels. The market for large vessels in the United States, however, is limited and may not provide an adequate return on this investment. Also, exports may not be a market-expanding option because world class foreign producers have a 15-20 year competitive lead on U.S. shipbuilders and have been accused of being heavily subsidized.

8. Commercial demand for vessels manufactured in the United States will be influenced by the following:

   a. The Oil Pollution Act of 1990 requires that all tankers entering U.S. ports be double-hulled by 2015.

   b. More U.S. residents are taking cruises, which is expected to increase the demand for small- and mid-sized cruise/gambling ships operating between U.S. ports.

   c. Traffic congestion, a growing problem in most major cities, is expected to increase the demand for fast ferries.

   d. According to the Department of Transportation, maritime traffic on U.S. waterways is expected to double in the next twenty years, increasing the demand for barges, tugs, and bulk carriers.

   e. During the 1990-91 conflict in the Persian Gulf, the military chartered foreign-flagged ships to transport logistics supplies to the Middle East. This action highlighted the need for Roll-On/Roll-Off sealift vessels, possibly including fast ferries.

Recommendations

1. The nation needs a unified strategy for developing and maintaining an infrastructure to produce world-class ships at more competitive prices. The U.S. Navy and the Maritime Administration can play an important role in developing such a strategy. In addition to its economic and military benefits, this strategy could help exploit the energy savings and environmentally friendly aspects of waterborne transportation.

2. The U.S. Navy and the Maritime Administration should work with industry executives to review current maritime legislation and recommend changes that effectively balance long-term national security needs with the nation's economic health. Unilateral removal of domestic procurement or other restrictions affecting the U.S. shipbuilding and repair industry is inadvisable without a comprehensive national maritime vision.

3. The U.S. Navy should consider reforming current procurement practices to reward major defense shipyards for increasing productivity and/or reducing costs. Concurrently, long-term stability and predictability in DoD ship procurement budgets are essential. A panel of experts from both the legislative and executive branches and the shipbuilding industry should be established to determine

how to achieve this goal. This initiative could potentially provide substantial savings for the Department of Defense and U.S. taxpayers.

4. The U.S. Navy, the Maritime Administration, the shipbuilding industry, and institutions of higher learning should work together to develop a long-term R&D plan that supports the national maritime vision. The plan should address advanced ship concepts, platform efficiencies, improvements to manufacturing productivity, academic curricula to train the future workforce, and incentives to develop and maintain a world-class industry and associated R&D infrastructure. The plan should build on the Maritime Technology program (MARITECH) and its successor venture, the National Shipbuilding Research Project Advanced Shipbuilding Enterprise, both of which have promoted joint cooperation between government and industry.

5. The progress of the Kvaerner Philadelphia Shipyard should be monitored to determine if modern European shipbuilding practices can effectively be applied in the United States for economic benefit. Elements to be monitored should include the following: 1) the utilization of the workforce in light of the great reduction in job titles; 2) the ability of the outside education environment to train entry level employees; 3) the development of major turnkey subcontractors; and 4) Kvaerner Philadelphia's productivity relative to other American and international shipyards.

6. Similarly, a number of recent joint ventures between U.S. and foreign shipbuilders should be monitored for potential industrial base benefits for both commercial and military applicability.

7. The U.S. Coast Guard's Deepwater Project has the potential to promote national economic interests such as vessel and sub-system exports, domestic and international partnering opportunities, and efficient shipbuilding. The U.S. Department of Commerce, Bureau of Export Administration is cooperating with the Coast Guard to help achieve these goals.

Part I - Survey Results

1. Introduction

1.1 Background

This national security assessment of the United States shipbuilding and repair industry was initiated in September 1999, in response to a request from the Department of the Navy's Naval Surface Warfare Center, Carderock Division (Carderock), headquartered in Bethesda, Maryland. This is the first volume of a broader study of the U.S. maritime industry that, in addition to shipbuilding, will include assessments of maritime related research and development, the shipbuilding supplier base, ocean resource recovery, and waterborne commerce.

Carderock is one of the largest maritime research and engineering facilities in the world. Carderock's mission is to:

> "... provide research, development, test and evaluation, fleet support, and in-service engineering for surface and undersea vehicle hull, mechanical and electrical systems, and propulsors; provide logistics R&D; and provide support to the Maritime Administration and the maritime industry."

In consideration of Carderock's capabilities and mission, four primary objectives were set forth for this assessment and the broader study:

- Illustrate the relationship between the maritime industry, national security, and the vitality of the U.S. economy.
- Identify opportunities for increased sharing of marine science and technology between public and private entities.
- Improve the use of public maritime capabilities toward advancing private industry competitiveness.
- Encourage cooperative efforts within the maritime industry between government, industry, and academia.

The U.S. Department of Commerce, Bureau of Export Administration (BXA) is delegated the authority under Section 705 of the Defense Production Act of 1950, (50 U.S.C.§ 2061-2170) as amended, Executive Order 12656, and Executive Order 12919 to gather basic economic and industrial information from the private sector. The Office of Strategic Industries and Economic Security (SIES) is the operating unit within BXA with the responsibility for this data collection

and analysis. The U.S. Navy and the other services have cooperated with BXA on more than 30 national security assessments in the past 15 years. A complete list of these previous assessments is included in Appendix E.

For this assessment of the U.S. shipbuilding and repair industry, SIES utilized the expertise from other government agencies and private entities. These entities include the following:

- Maritime Administration
- Office of Naval Research
- U.S. Coast Guard
- National Oceanic and Atmospheric Administration
- Army Corps of Engineers
- Consortium for Oceanographic Research and Education
- American Shipbuilders Association
- Massachusetts Institute of Technology
- Pennsylvania State University
- Trotta Associates, Inc.

This assessment is the first phase of a more comprehensive study of various aspects of the maritime sector. In making its request to the Commerce Department and Carderock suggested a broader industry definition that encompassed all maritime activities. This definition is as follows:

> "... public and private entities engaged in an activity that supports the utilization of the oceans and/or inland waterways. This includes maritime manufacturing, commercial activities, merchant carriers, passenger carriers, maritime research and exploration, and maritime support services."

Maritime-related activities and technology support virtually all sectors of the U.S. economy, including food, mining, construction, manufacturing, transportation, wholesale/retail trade, finance/insurance, professional services, recreation, environment, energy, public administration, and education. While clearly maritime is an integral part of the economy, the industry lacks a generally accepted broad definition, unlike the aerospace or automotive industries. Organizations engaged in maritime activities then find it difficult to evaluate the potential value of their contribution to the industry as a whole. The suggested definition of the maritime industry is shown on page iii of the shipbuilding and repair survey, which can be found in Appendix B.

Information on other SIES national security assessments is available at the office website: http://www.doc-bxa.bmpcoe.org/.

1.2 Scope of this Report

This national security assessment covers the shipbuilding and repair industry. The industry encompasses firms engaged in private shipbuilding and/or repair, including shipyards that build/repair warships. Government-owned facilities that build/repair vessels were not surveyed. The assessment was officially initiated in September 1999, when this sector's survey was mailed. The survey was prepared with the assistance of the Maritime Administration (MARAD) and with inputs from the Office of Naval Research and Carderock. MARAD provided a mailing list of companies to be surveyed.

The survey was sent to 328 U.S. firms and 263 responses were received. Of the responding companies, 40 had exited the market and 24 were otherwise exempt from completing the survey. There were 199 completed surveys, including all U.S. shipbuilders with annual revenues greater than $50 million. Seventy-nine companies with $5 million or less in 1998 revenues were permitted an abbreviated response. A telephone survey of the 65 non-respondents revealed that 35 were small businesses and 10 had shipments over $5 million. The remaining 20 were not reached. Time constraints did not allow for follow-up surveys of these firms.

The Department of Commerce's Bureau of the Census collects economic statistics for over 1,100 industries that in the aggregate constitute the entire U.S. economy. Shipbuilding and repair is one of the industries covered, and the data provided a benchmark for gauging the completeness of the SIES industry survey data. Assuming the Census data accurately reflects the industry, the SIES data collection was nearly complete as shown in the following table.

Table 1.1 Comparison of Bureau of the Census Data With SIES Shipbuilding Survey Data: 1998 Values

Source of Data	Revenues ($000s)	Employment	Revenues/Employee
Census Data	$10,786,990	94,595	$114,033
Survey Data	$10,213,539	89,001	$114,758
Survey %	94.68%	94.09%	-

Source: U.S. DOC/Bureau of the Census and BXA/SIES 1999 Maritime Survey

1.3 Methodology

The industry survey was the primary source of shipbuilding and repair information. The survey was supplemented by site visits to five shipyards engaged in either defense or commercial shipbuilding and repair activities, which gave SIES analysts the opportunity to learn first hand about issues affecting the industry and observe the extent of technology integration into the design, procurement, and production phases of operations.

Statistical information published by the Bureau of the Census was frequently used to benchmark the industry (as above) and served as a guide for some analysis. In addition, SIES reviewed several years of the Department of Commerce's *U.S. Industry and Trade Outlook* sections on shipbuilding and repair, which the Maritime Administration prepares annually. The Industrial College of the Armed Forces publishes annual reviews of the shipbuilding industry that were beneficial. Numerous other publications from MARAD and the U.S. International Trade Commission were also consulted. Useful reference information was obtained from *Jane's Fighting Ships*, the National Shipbuilding Research Program, *Lloyd's Register*, *Defense News*, *Sea Technology*, and the Transportation Institute. SIES accessed online shipyard literature (including information on international yards), company brochures, annual reports, LEXIS/NEXIS searches, and news releases. Lastly, Federal agency expertise at MARAD, the Office of Naval Research, and Carderock was instrumental in shaping the report. See the Bibliography (Appendix D) for a detailed listing of source information.

1.4 Report Organization

This assessment consists of eight major sections in two parts. The first section includes introductory material. The second section contains an overview of the shipbuilding and repair industry, reviewing its capabilities and providing a geographic analysis of the industry by major regions. The third section covers employment, reviewing the industry's labor force, age distribution, labor skill shortages, training, and other factors. The fourth section provides an analysis of the industry's economic performance and competitiveness. The section includes reviews of the industry's competitive prospects, revenues, capital formation, income, financial balance sheets, and productivity. The fifth section discusses maritime technology and development needs. This section also reviews the industry's approach on cooperative ventures.

Part II starts with the sixth section, which contains an overview of the legal environment in which the shipbuilding industry operates. The seventh section provides an overview of the international shipbuilding sector. The eighth section compares long-term trends in the

shipbuilding and repair industry to those in the motor vehicle and aircraft industries over the period 1977-1998.

2. Industry Overview

2.1 Shipbuilding and Repair Industry Description

The official Office of Management and Budget (OMB) definition of the U.S. shipbuilding and repair industry is as follows:

> "... U.S. establishments primarily engaged in operating a shipyard. Shipyards are fixed facilities with drydocks and fabrication equipment capable of building a ship, defined as watercraft typically suitable or intended for other than personal or recreational use. Activities of shipyards include the construction of ships, their repair, conversion and alteration, the production of prefabricated ship and barge sections, and specialized services... Illustrative examples include: barge building; cargo ship building; drilling and production platforms, floating, oil and gas, building; passenger ship building; and submarine building."

OMB is the federal agency responsible for overseeing development of industrial classifications and publishing the Reference Manual (see Executive Office of the President, Office of Management and Budget). The current system, the *North American Industrial Classification System* (NAICS), was officially adopted in April 1997 to update and replace the Standard Industrial Classification System. The NAICS code for shipbuilding and repair is 336611.

At over $10 billion in annual revenues and nearly 90,000 private employees, the U.S. shipbuilding and repair industry plays a significant role both in the U.S. economy and national defense. U.S. Navy procurement accounts for about 70 percent of the industry's revenue. The commercial sector of the industry is less than half the size of the military sector, although it has shown recent signs of growth. Exports play a minor role in the U.S. industry and account for only 1 or 2 percent of total revenues.

About 250 companies comprise the U.S. shipbuilding and repair industry. This amount is down from more than 300 firms because of recent consolidations. Twenty-five firms account for 85 percent of the industry's revenues. The six largest companies, referred to as the "Big Six", represent two-thirds of the overall shipbuilding/repair business and 90 percent of the defense-related work. More than 100 smaller firms have annual revenues of less than $5 million and represent less than 2 percent of the industry's total revenues.

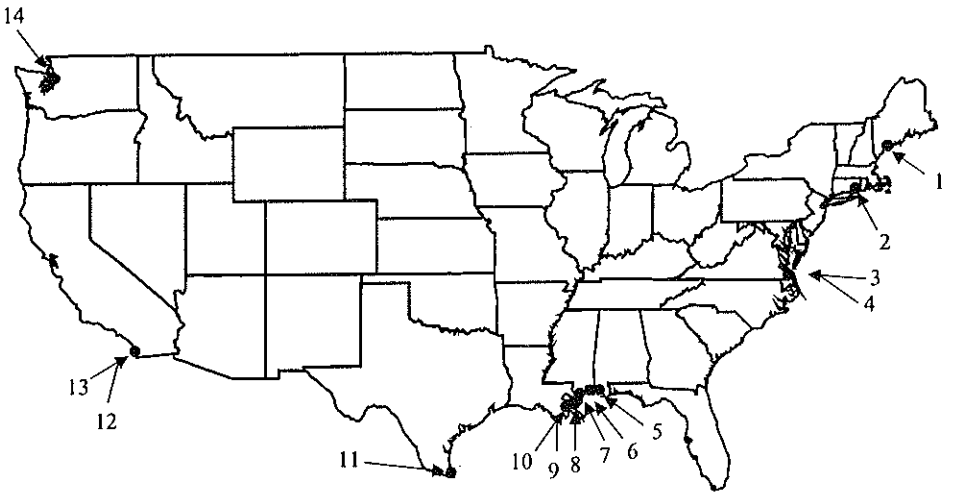
The shipbuilding and repair industry is located in coastal areas of the United States, specifically the East Coast (North Atlantic and South Atlantic), Gulf Coast, and Pacific Region. Shipyards

are also located in the Great Lakes region and along inland waterways. For the purpose of this survey, the regions were divided as follows. The number in parentheses represents the number of surveys received from each region:

North Atlantic—From Maine along the Eastern Seaboard to Norfolk, Virginia (37)
South Atlantic—From Norfolk, Virginia to the southern tip of Florida (27)
Gulf Coast— From the southern tip of Florida along the Gulf Coast to the Texas-Mexico border (73)
Pacific Region—From California to Washington, and including Alaska and Hawaii (44)
Great Lakes—Shipyards located on the shores of the Great Lakes (13)
Inland—Shipyards not located on either the Great Lakes or coastal regions (5)

The Gulf Coast includes several major yards such as Ingalls Shipbuilding and Friede-Goldman Halter in Mississippi, Avondale and Bollinger in Louisiana, and Bender in Alabama. The South Atlantic includes the nation's largest shipbuilder, Newport News Shipbuilding Company, located along the James River in Hampton Roads, Virginia.

Map 2.1 Shipyards With Over $100 Million in 1998 Revenues (Arranged in geographic order)



1. Bath Iron Works Corp.
2. Electric Boat Corp.
3. Newport News Shipbuilding and Dry Dock Co.
4. Norfolk Shipbuilding and Drydock Corp.
5. Bender Shipbuilding and Repair Co., Inc.
6. Litton Ingalls Shipbuilding, Inc.
7. Friede Goldman Halter, Inc.
8. Litton Avondale Industries, Inc.
9. Bollinger Shipyard, Inc.
10. North American Shipbuilding Co.
11. AMFELS, Inc.
12. National Steel and Shipbuilding Co.
13. Southwest Marine, Inc. (San Diego)
14. Todd Pacific Shipyards Corp.

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The North Atlantic region includes both Electric Boat in Connecticut and Bath Iron Works in Maine. The major shipbuilders in the Pacific region are National Steel and Shipbuilding Company (NASSCO) in San Diego, California and Todd Shipyard in Seattle, Washington. The two remaining regions include a few shipyards around the perimeter of the Great Lakes and inland waterways.

Public Shipbuilding and Repair Yards

Typically, public naval repair yards are used for more sophisticated repair functions. The Navy, through the Naval Sea Systems Command (NAVSEA), currently administers four yards. These yards account for $1.4 billion of the $2.1 billion the Navy appropriated for repair work in FY 1998. This amount was up from the $871 million appropriated the year before. The U.S. Coast Guard also maintains a facility for ship repair and construction. The Coast Guard facility at Curtis Bay near Baltimore, Maryland spends about $60 million per year for servicing its vessels. The shipyard employs nearly 600 workers. The location and employment information for the five public yards is given below:

Table 2.1 Public Repair Yards

Yard Location	Employees
Puget Sound Naval Shipyard (Bremerton, WA)	7,700
Norfolk Naval Shipyard (Norfolk, VA)	6,700
Pearl Harbor Naval Shipyard (Pearl Harbor, HI)	5,000
Portsmouth Naval Shipyard (Portsmouth, NH)	3,300
Coast Guard Yard at Curtis Bay (Baltimore, MD)	600
Total	**23,300**

In 1990, nine repair facilities were in operation. Based on the recommendations of the Base Closure and Realignment Commission, Congress closed four. The first yard closed in 1995 was the Philadelphia Naval Shipyard, which had been open for 194 years. In 1996, Mare Island Naval Shipyard and the Charleston Naval Shipyard were closed. The fourth, Long Beach Naval Shipyard, was closed in 1997. The closings have not meant dormancy for some of the facilities. For example, in a section of the former Philadelphia Naval Shipyard, the European firm Kvaerner ASA constructed a new shipyard and is now building its first container ship. Also, Braswell Services Group, Inc. and Detyens Shipyard, Inc. have leased property on the former site of the Charleston Naval Shipyard.

2.2 Industry Capabilities

U.S. capabilities for vessel construction fall into two main categories: military and commercial. Military vessels are generally more complex than commercial vessels and range from under a hundred to over a thousand feet in length. Four shipyards construct large combatant vessels, such as aircraft carriers, cruisers, destroyers, and submarines in specialized facilities. These facilities are generally not compatible with the production of commercial vessels. They carry more overhead, require additional personnel, and utilize specialty materials, subassemblies, and production methods.

In contrast, commercial vessels are generally less complex than military vessels. Currently, the largest commercial vessels made for the domestic market are about 900 feet in length. Offshore oil service vessels are getting larger, expanding from about 180 to 250 foot lengths, which offers more cargo capacity and cheaper hauling. Commercial capabilities, thereby, are configured to serve the available domestic markets. The largest oil tankers are nearly as large as aircraft carriers. The double-hulled oil tankers under construction for the Alaskan oil trade are being constructed at two U.S. shipyards. Both of these shipyards have constructed military auxiliary, noncombatant vessels for the U.S. Navy. Many shipyards are involved in the construction of smaller vessels, which are usually easier to build, for both the military and commercial markets. A number of other shipyards have recently built or are currently building vessels such as double-hulled barges, specialized tankers-chemical carriers, and Articulated Tug Barges (ATBs).

A new U.S. entry into large commercial shipbuilding is the European firm Kvaerner ASA. They have constructed new shipyard facilities on a portion of the former Philadelphia Naval Shipyard. Kvaerner ASA received about $430 million from state and local interests to construct the new shipyard that will build Jones Act (i.e., Section 27 of Merchant Marine Act of 1920, discussed in Section 6.3) vessels. Kvaerner Philadelphia is attempting to outsource much of the work to major subassemblers (described by Kvaerner representatives as a half-tier) and dedicate the shipyard to integration and final assembly. In discussions with the yard's management, the company will only have four job titles. For example, one classification will be *shipbuilder*, which will encompass all shipbuilding functions. This business model has worked well in Europe, but it has yet to be proven in the United States. Kvaerner Philadelphia's first vessel, now under construction, is a large container ship of about 712 feet in length originally designed in Europe.

Ship repair is also a critical capability. Repair includes both physical damage repair and normal maintenance, such as hull stripping and painting. In terms of complexity, military hull damage repair, nuclear re-fueling, and diesel engine overhaul are quite specialized with only a few yards

possessing these capabilities. More yards are capable of performing less complex work, such as topside repair, plumbing and heating maintenance, and air handling equipment servicing.

Newer vessels are being designed for greater longevity to operate longer between service intervals. Environmental issues associated with common maintenance functions, such as hull stripping and painting, have driven some of this work offshore because of added cost. Recently, the U.S. vessel repair industry has introduced riding crews that perform maintenance and major overhaul work while the vessel is in operation. This service both reduces downtime for operators and increases potential markets for repair and maintenance work. Without this service, operators would have to suspend vessel operations while repairs were completed. Two other potential market opportunities for ship repairers are cruise ships and ship scrapping. Overseas cruise ship operators are awarding U.S. ship repairers contracts based on geographic proximity and price considerations. Ship scrapping contracts for U.S. ship repairers could also increase marginally, due to concerns over the safety and/or environmental concerns of aging reserve fleet vessels.

Construction and Repair Capabilities

To assist in quantifying U.S. shipyard construction and repair capability, the survey data was organized into three tiers based on 1998 revenues. The 1st tier included 23 firms with revenues exceeding $50 million; the 2nd tier included 95 firms earning between $5 and $50 million; and the 3rd tier included 79 firms earning under $5 million.

Many shipbuilders and repairers have the flexibility to build or repair various types of vessels, but in actual practice work on a more limited range of vessels for lack of orders. The greatest number of firms (over 30) reported the capability to produce tugs, barges, and ferries. Twenty-eight firms reported the capability to produce oceangoing barges, 13 can construct combat vessels, and two can build nuclear powered vessels. Seven firms can manufacture offshore drill rigs, which is one of the specialties of the U.S. shipbuilding industry. Two firms reported the ability to produce military submarines, and two can produce other submersibles. Nearly half of all respondents perform repair work only.

The 23 1st tier firms reported an average capability to build 12 different classes of vessels along with the ability to repair 15. The most common vessel-types 1st tier firms could construct and repair were oceangoing barges, commercial dry cargo barges, and liquid cargo barges for operation in inland waterways, and commercial barges for harbor and coastal operations. The average 2nd tier yard was capable of building six types of vessels and repairing 11, typically with lengths less than 100 feet. The most common vessel types 2nd tier firms could construct were commercial towboats and tugs for inland waterway operation, as well as commercial barges and ferries designed for harbor and coastal operation. The most common vessel-types 2nd tier firms

could repair were commercial towboats, tugs, dry cargo barges, and liquid cargo barges for inland waterway operation, as well as commercial tugs and barges designed for harbor and coastal operation. The average 3rd tier yard was capable of building four and repairing eight types of vessels. The most common vessel types 3rd tier firms could construct were commercial towboats for inland waterway operation, commercial barges and ferries designed for harbor and coastal

Table 2.2 U.S. Shipbuilding and Repair Capabilities

Vessel or Platform Type	Construction				Repair			
Oceangoing and Great Lakes Commercial Vessels:	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
Container Ships	21	9	9	3	55	15	23	17
Other General Cargo Ships	17	8	8	1	72	15	38	19
Tankers (Crude Oil)	10	7	3	0	57	13	29	15
Tankers (Petroleum Product)	12	8	4	0	56	13	30	13
Tankers (LNG/LPG*)	9	6	3	0	42	10	25	7
Bulk Carriers	14	8	5	1	62	15	30	17
Passenger Vessels	30	8	14	8	76	15	38	23
Oceangoing Barges	37	14	18	5	96	18	50	28
Other	9	4	5	0	19	5	9	5
Inland Waterways Commercial Vessels:	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
Towboats	53	12	21	20	127	17	62	48
Dry Cargo Barges	50	13	21	16	121	18	62	41
Liquid Cargo Barges	42	13	19	10	98	18	55	25
Harbor/Coastal Commercial Vessels:	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
Tugs	53	12	25	16	127	17	62	48
Barges	57	13	27	17	129	18	63	48
Ferries	54	12	26	16	116	16	58	42
Petroleum Exploration & Production:	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
Drill Rigs	11	8	3	0	38	11	15	12
Supply Vessels	34	12	17	5	85	15	44	26
Private Vessels:	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
Commercial Fishing Vessels	44	10	19	15	105	16	50	39
Recreation Vessels	43	4	20	19	94	9	44	41
Research Vessels	38	11	14	13	98	16	46	36
Military Vessels:	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
Combatant Surface Vessels	17	9	7	1	62	16	30	16
Non-Combatant Surface Vessels	27	11	10	6	90	18	46	26
Submarines	4	4	0	0	17	6	8	3
Other	All	1st Tier	2nd Tier	3rd Tier	All	1st Tier	2nd Tier	3rd Tier
	30	7	17	6	29	8	14	7

* Liquefied Natural Gas/Liquefied Petroleum Gas

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

operations, and recreation vessels. The most common vessel types 3rd tier firms could repair were commercial towboats for inland waterway operation, as well as commercial tugs and barges designed for harbor and coastal operation. All tiers included yards specializing in "repair only" capabilities (1st tier: 17 percent of respondents; 2nd tier: 56 percent; and 3rd tier: 48 percent).

Repair capability typically outpaced construction capability because of the reduced capital investment and overhead associated with repair work relative to construction. Small firms are well represented in most categories of repair. The 2nd tier firms matched or exceeded the number of small firms in all categories of construction other than recreational and commercial fishing vessels. Additional capabilities included dredges, icebreakers, offshore construction vessels, trash skimmers, ocean survey, oil spill recovery, patrol and fire boats, pilot vessels, lifeboats, skiffs, floating dry docks, work boats, trailers, and barge mounted power plants. Ship construction and repair capabilities are presented in the table on the previous page.

Note that the 1st tier has representation in each vessel class and dominates the capabilities to produce larger vessels and military vessels. In addition to the Big Six, several 1st tier firms build vessels over 400 feet. For example, Alabama Shipyard recently built two 473 ft. chemical carriers and a 460-foot Articulated Tug Barge (ATB). Also, Gunderson Marine builds 600-foot barges; Halter Pascagoula is building two 579-foot car carriers, and Kvaerner Philadelphia, as noted, is building a 712-container vessel. Certain vessel types reported by larger firms were left blank because the vessels were not profitable to produce, even though the companies had the capability.

Actual ship construction and repair by vessel type is collected by the Department of Commerce's Bureau of the Census every five years, the most recent covering 1997 data. The breakout of 1997 ship construction and repair revenues is presented on the next page.

Table 2.3 1997 Ship Construction and Repair Revenues (Census Report)		
Shipbuilding and Repair	**Revenues (in $000s)**	
Non-propelled ships and barges		**$878,251**
Barges	$624,128	
Drilling-production platforms	$163,974	
Others, including dredges, floating docks	$90,149	
Military, propelled ships		**$4,638,092**
Non-military, self-propelled ships		**$947,865**
Self-propelled ships, 65' or longer	$195,413	
Fishing trawlers	$28,466	
Tugboats, tug-barges	$36,071	
Ferryboats	$32,299	
Support vessels for offshore drilling and mining	$166,967	
Others, incl. container and trailer ships, dry bulk carriers, and tankers	$479,125	
Others, nsk (not specified by kind)	$5,239	
Misc. others, value breakout not available	$4,285	
Ship repair, Military		**$2,166,001**
Conversions, reconversions	$1,358,831	
Repairs	$805,274	
Military Ship repairs, nsk	$1,896	
Ship repair, Non-military		**$1,082,168**
Conversions, reconversions	$261,532	
All other ship repairs, non-military	$816,841	
Ship repairs, non-military, nsk	$3,795	
Totals		**$9,712,377**

Source: U.S. DOC/Bureau of the Census, 1997 Economic Census Industry Series (Shipbuilding and Repairing)

2.3 Geographic Distribution of the Industry

Geography influences the development and design of vessel types used in U.S. domestic waterways and therefore has a competitive impact on the industry. The ocean coasts, Gulf of Mexico, and the Great Lakes comprise nearly 12,400 miles of shoreline. Another 12,000 miles of inland waterways connect the interior of the country to the major coastlines. This geography provides a vast natural water transportation network that facilitates waterborne commerce both within the United States and across oceans. Industries such as food, coal, oil, steel, and

chemicals benefit enormously because of the low cost and environmentally friendly water transportation system within the United States.

Waterborne commerce requires the use of barges, tankers, ferries, and an assortment of other vessels and support structures. Ports played an important role in the early settlement of the United States. In fact, every state capital east of the Mississippi River resides along a major waterway. The U.S. shipbuilding and repair industry has, therefore, historically oriented itself near the nation's natural ports and waterways. Over the decades, shipbuilding adapted to both the U.S. geography and the developing economy, creating regions of strategic importance and economic vitality.

2.3.1 Shipbuilding and Repair Revenues and Employment by Region

Survey data for 1998 was collected for all shipyards, including those with under $5 million in annual revenue. The 1998 data was the most complete information in the database, and was used to calculate revenues, employment, and other indicators on a regional basis.

Shipbuilding and repair revenues for the Gulf Coast region exceeded $3.5 billion in 1998, the largest share of the industry. The Gulf Coast supports an abundant fishing and offshore oil industry, provides commercial access to the heart of the country along the Mississippi River, and offers close proximity to the Panama Canal. No other region of the country possesses such a vast array of both commercial and natural assets in terms of the maritime industry. The South Atlantic region generated about $2.5 billion in revenue and the North Atlantic region accounted for $2.4 billion in revenue. These three regions, all in the Eastern half of the United States, accounted for over 83 percent of all U.S. shipbuilding and repair revenues.

The Gulf Coast region employs 36 percent of the shipbuilding labor force, the largest regional share; the South Atlantic region employs over 27 percent; and the North Atlantic region employs over 21 percent. The remaining three regions (Pacific, Great Lakes, and Inland) represent about 16 percent of the industry's workforce. The charts on the next page show each regional share of revenues and employment in 1998.

Chart 2.1 Industry Revenues: 1998 = $10.2 billion

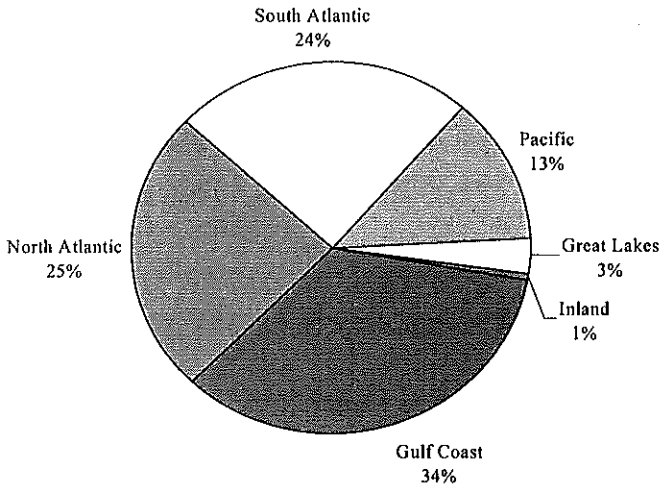
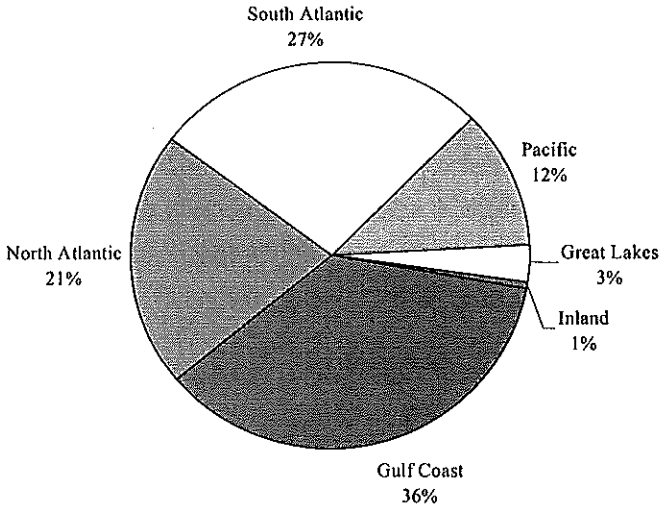


Chart 2.2 Industry Employment: 1998 = 89,001



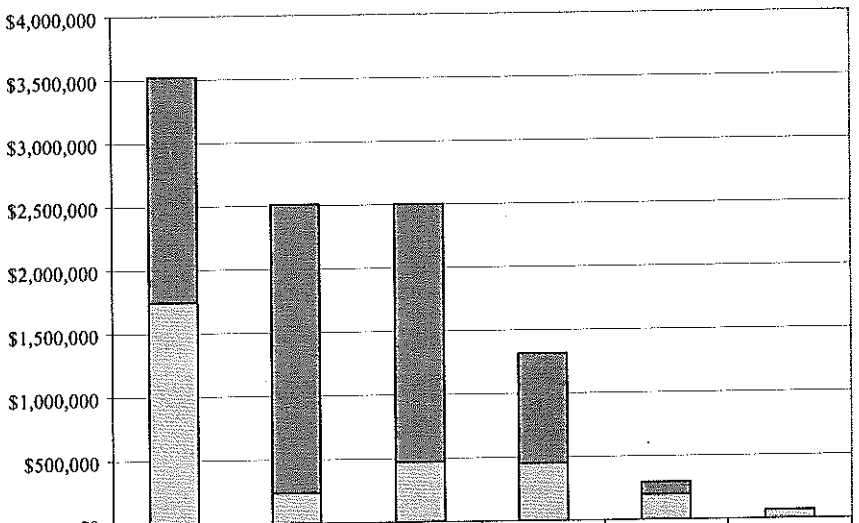
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

2.3.2 Defense v. Commercial Revenues by Region

Regional revenue data highlights the industry's strong dependence on defense work. Total estimated 1998 revenues were $10.2 billion, of which more than $7 billion originated from defense projects. In recent years, commercial markets grew the most in the Gulf Coast region, reducing dependence on defense work for some shipyards. The Pacific region also increased its proportion of commercial ventures. In contrast, major shipyards in the South Atlantic and North Atlantic continue to focus mostly on defense work. The Atlantic regions accounted for more than 61 percent of all defense revenues because of the presence of Newport News Shipbuilding, which makes aircraft carriers and nuclear submarines; Electric Boat, which makes nuclear submarines; and Bath Iron Works, which builds naval combatants. These three large shipyards are dedicated to defense work.

Future political and economic developments are expected to affect each region uniquely. The following chart presents the value of both defense and commercial revenues for 1998 by region.

Chart 2.3 Distribution of Defense and Commercial Revenues by Region, 1998 (in $000s)



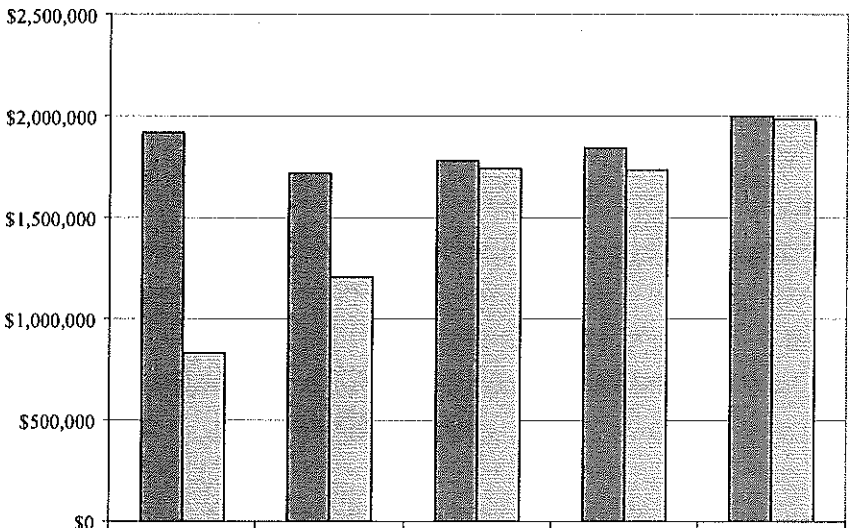
	Gulf Coast	North Atlantic	South Atlantic	Pacific	Great Lakes	Inland
Defense Revenues	$1,780,049	$2,270,988	$2,030,140	$866,258	$99,056	$1,663
Commercial Revenues	$1,741,760	$238,824	$471,213	$450,755	$196,630	$66,203

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Trends in Defense and Commercial Revenues by Region

The following graphs display the trends of defense versus non-defense revenues for each region from 1996 thru 2000.

Chart 2.4 Gulf Coast Revenues - 1996 to 2000
(in $000s)

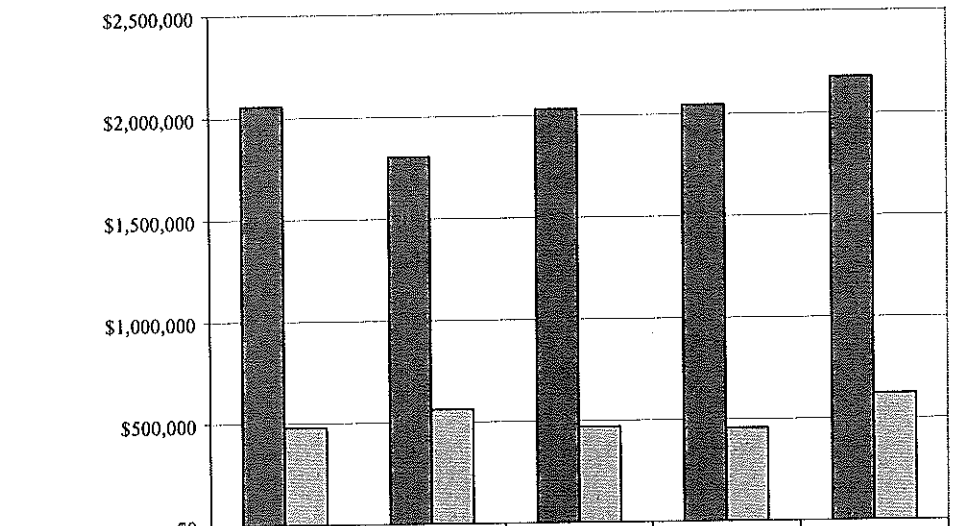


	1996	1997	1998	1999	2000
Defense Revenues	$1,919,418	$1,718,408	$1,780,049	$1,844,469	$1,999,083
Commercial Revenues	$830,868	$1,205,515	$1,741,760	$1,736,352	$1,985,055

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The data presented is consistent with the general information on the business plans of major companies on the Gulf Coast. Major yards in this region have opted to continue to pursue defense work while trying to venture into new commercial markets. During this time period, commercial revenues grew by over 138 percent, while defense revenues increased by only 4 percent. In 1998, the Gulf Coast accounted for about 55 percent of the industry's commercial revenues and 25 percent of defense revenues. If commercial growth continues as expected, the Gulf region may soon generate more of its revenues from commercial ventures than from military contracts. This makes the Gulf Coast unique in comparison to the revenue distribution of the other shipbuilding regions.

Chart 2.5 South Atlantic Revenues - 1996 to 2000
(in $000s)

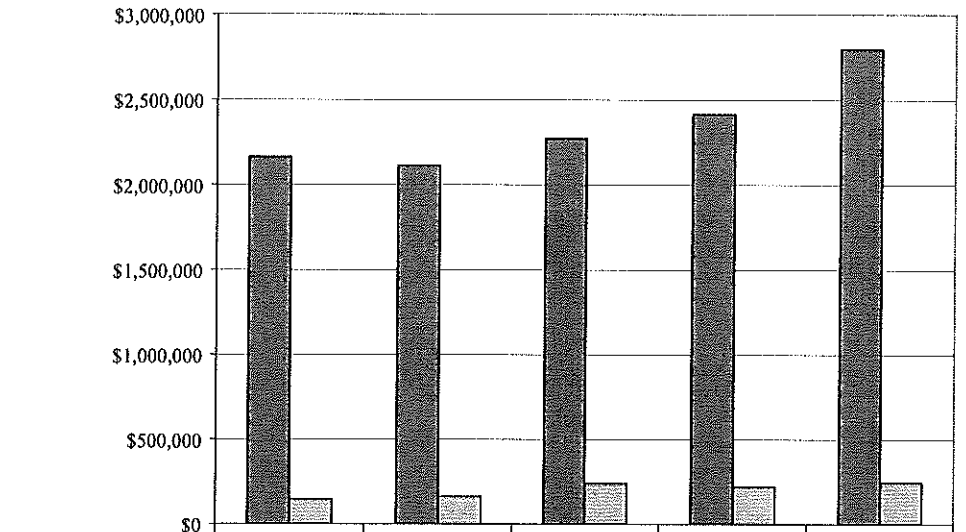


	1996	1997	1998	1999	2000
Defense Revenues	$2,056,326	$1,804,580	$2,030,140	$2,044,612	$2,177,946
Commercial Revenues	$480,977	$563,684	$471,213	$458,801	$623,463

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The South Atlantic region shows modest growth for both commercial and defense work, with defense work clearly generating most of the revenues for all five years. During this time period, commercial revenues grew by over 37 percent, while defense revenues increased by only 7.4 percent in the region. Despite the greater increase in commercial revenues, defense revenues were consistently three to four times greater than commercial revenues. Newport News dominates this region.

Chart 2.6 North Atlantic Revenues - 1996 to 2000
(in $000s)

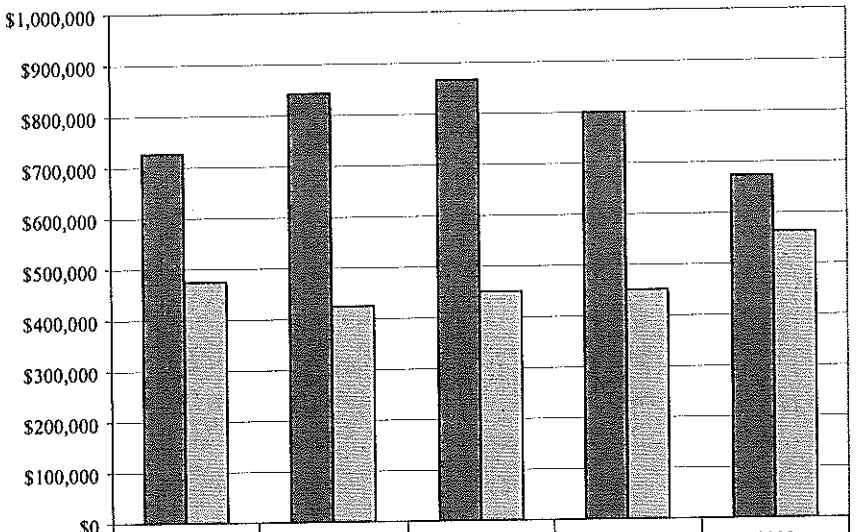


	1996	1997	1998	1999	2000
Defense Revenues	$2,162,788	$2,110,578	$2,270,988	$2,413,937	$2,797,050
Commercial Revenues	$146,658	$161,980	$238,824	$221,437	$245,848

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Revenue data for the North Atlantic region indicates a profound alignment towards defense work, which comprised over 93 percent of all revenues in 2000. While commercial revenues may have grown by over 44 percent and defense revenues increased by over 27 percent, defense revenues averaged between 10 and 15 times the commercial total. Major shipyards in the South Atlantic and North Atlantic regions appear to have tailored their organizations to specialize in defense work, and, as a result, have managed modest gains in revenues. In spite of the uncertainty of future military construction, domestic defense work is less risky for some than world market competition. The establishment of Kvaerner Philadelphia may introduce significant new commercial business to the North Atlantic region.

Chart 2.7 Pacific Revenues - 1996 to 2000
(in $000s)

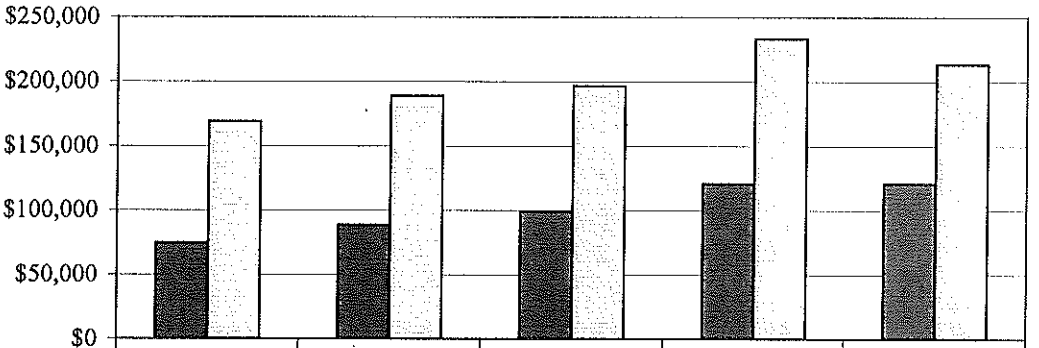


	1996	1997	1998	1999	2000
Defense Revenues	$726,290	$842,935	$866,258	$799,817	$673,494
Commercial Revenues	$474,290	$424,551	$450,755	$451,175	$563,299

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

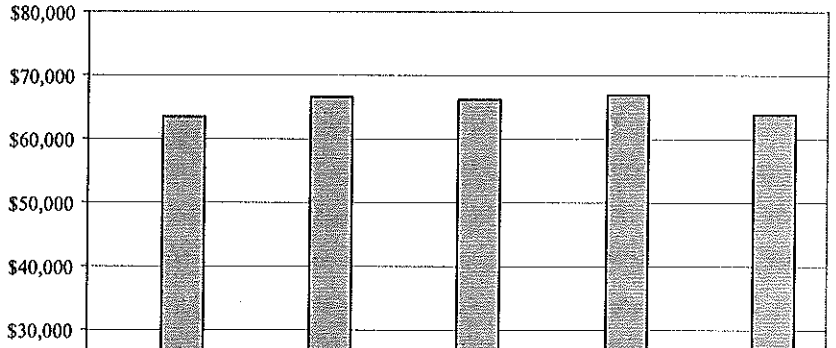
Revenue trends for the Pacific region for defense work receded in the 1996-2000 time frame. Since 1998, defense work was projected to drop significantly in the region and, like the Gulf Coast, may one day be outpaced by commercial work. Initially, commercial revenue dropped from 1996 to 1997. After 1997, however, commercial revenues gradually increased with a substantial expansion expected for 2000. Conversely, defense revenues increased from 1996 to 1998 but were expected to drop more than 22 percent by 2000. Geographic factors, such as the lack of navigable river systems as compared to the Gulf Coast region, limit waterborne commerce in the Pacific region. However, ferries and fishing vessels are important, and some offshore oil platforms are serviced.

Chart 2.8 Great Lakes Revenues - 1996 to 2000 (in $000s)



	1996	1997	1998	1999	2000
Defense Revenues	$74,476	$88,511	$99,056	$120,916	$120,872
Commercial Revenues	$168,909	$188,827	$196,630	$233,170	$213,644

Chart 2.9 Inland Revenues - 1996 to 2000 (in $000s)



	1996	1997	1998	1999	2000
Defense Revenues	$909	$709	$1,663	$731	$840
Commercial Revenues	$63,447	$66,592	$66,203	$66,941	$63,808

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Commercial revenues of the Great Lakes region have outpaced defense revenues by 2 to 1 for the last five years. In the Inland region, defense revenues generate only 1 to 2 percent of the total revenues. Since defense work is not the livelihood of either region, no measurable effort to change the composition of revenues is warranted or indicated. Both the Great Lakes and Inland regions provide unique commercial transportation services for vessels that operate within limited markets.

2.3.3 Ship Repair by Region

Ship repair is also critical to national security and expands the useful life of the existing fleet. A recent case in point is the USS Cole, which was severely damaged in a terrorist bombing in the Persian Gulf. The Cole is being repaired for $105.5 million at Ingalls Shipyard, the original builder. Aside from the Cole, the industry's repair capabilities include accident repair, maintenance, conversion, certification, and re-construction. Vessel operating conditions vary from one region to the next, and can dictate the nature and scope of repair work. Repair facilities in each region have adapted to serve their respective customers.

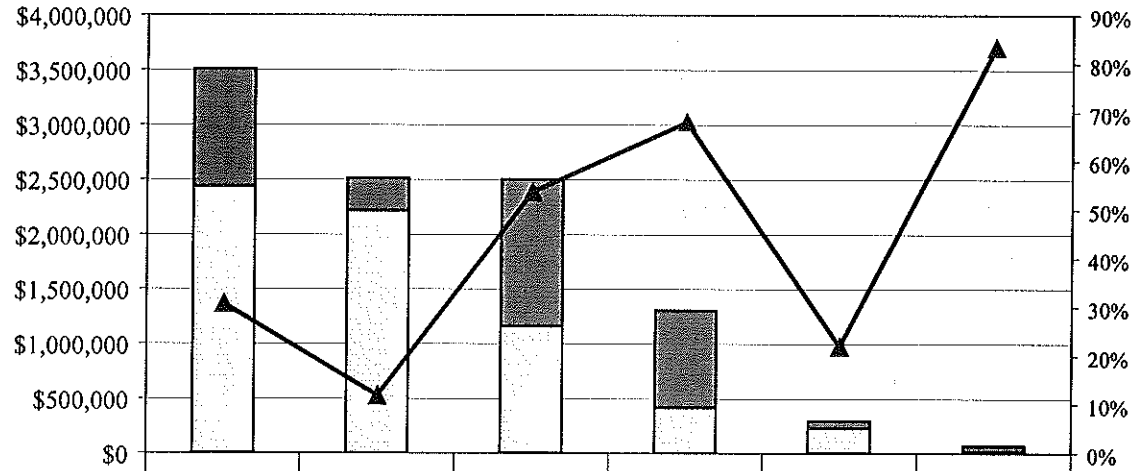
Repair yard profitability is dependent upon strategic scheduling of both the facility and its workforce. In regions where commercial shipping operations run continuously throughout the year, owners and operators need repair work completed quickly, as the vessel is their livelihood. Lucrative repair contracts may stipulate expensive penalties for delays. In regions where vessel operations are temporarily suspended, most repairs and vessel re-certifications are scheduled during the winter months. In the Great Lakes region, most repair work is performed between late December and March. Another factor influencing ship repair for this region is its fresh water environment. As the Great Lakes are isolated from the ocean environment, little corrosion-related hull repair is performed in the region.

The seasonal and limited nature of repair work in the Great Lakes and other Northern regions often means repair yards require other business opportunities in order to remain viable. Many yards in northern climates complement their ship repair work with vessel construction or other forms of construction work, allowing them to more fully utilize their workforce throughout the year. For many northern facilities, ship repair represents only a small portion of their total revenues. South Atlantic, Gulf Coast, and Pacific regions are able to perform repair and maintenance work year round and are less dependent on non-maritime work to offset seasonal fluctuations. As a result, larger vessel repair and defense repair work are usually performed in these regions.

Repair revenues typically represent a smaller portion of revenues when compared to construction revenues. The only exception is in the Inland region, where very little new construction is performed.

The following chart illustrates both the relative proportions and value of building and repair revenues by region:

Chart 2.10 Estimated Composition of Shipbuilding and Repair Revenues By Region, 1998 (in $000s)



	Gulf Coast	North Atlantic	South Atlantic	Pacific	Great Lakes	Inland
Repair Revenues	$1,074,838	$295,971	$1,341,576	$886,875	$64,744	$56,567
Ship Construction	$2,431,011	$2,213,291	$1,159,489	$416,811	$230,942	$11,299
Percent Repair	30.66%	11.80%	53.64%	68.03%	21.90%	83.35%

Publicly owned repair yards are not included.
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The Navy has a rule that ships be repaired within 100 miles of their homeport. Norfolk is the major homeport on the East Coast; therefore, much of the repair business goes to the South Atlantic region. Repair work accounted for about 36.5 percent of total industry revenues in 1998. The percentage of repair work varies from year to year, but it generally falls between 30-40 percent of the total.

Each region possesses its own unique profile of construction and repair revenues. The Gulf Coast region's revenue mix supports both large-scale commercial and military repair

requirements. The small proportions of repair performed in the North Atlantic are offset by a few large yards that specialize in the construction of complex military vessels. Revenue in the Pacific region has a sizeable repair component of almost 70 percent. Much less construction is being performed in recent years, with NASSCO accounting for a significant portion. The composition of revenues in the Great Lakes region suggests that vessels operating in fresh waters generate lower repair revenues. Inland repair revenues are derived from servicing river transport vessels. Little building activity takes place.

2.4 Factors Underlying Demand for U.S. Shipbuilding

Numerous market forces, both domestic and worldwide, affect the demand for new vessels and ship repair. Internationally, shipbuilding depends on the volume of world trade, which continues to grow, and on supporting economic activity. Additional factors that determine the demand for new vessel construction include the world's shipbuilding capacity and shipyard utilization rates, shipbuilder's costs and vessel prices, the availability of government subsidies or other supports, regulation-driven demands, foreign exchange rates, and the prospective vessel owner's cash flow. Wartime needs are another factor. For example, during the Gulf War, the military had to charter foreign-flagged ships to transport logistics supplies to the Middle East. This need created a demand for Roll-On/Roll-Off (RO/RO) sealift vessels after the war's end to enhance the capability of the Ready Reserve Fleet.

The tanker fleet comprises the largest single segment of the global merchant fleet. Hence, the level of new ship building demand in the oil and dry bulk trades is driven by trends in the world's major bulk shipping markets. Growing prosperity in many parts of the world and the demand for manufactured goods that accompanies it will affect demand in the general cargo and passenger industry sectors. The volume of container-shipped cargo is expected to expand at an annual average rate of 4.3 percent for the next several years.

Domestically, low prices for crude oil in the 1990s led to declines in U.S. investment in oil recovery and narrowed market opportunities for shipbuilders, repairers, and the associated skilled trades. However, higher prices in recent years have stimulated the demand for service vessels and offshore platforms. Ongoing government downsizing and the perceived lack of a major U.S. security threat serve to postpone a buildup of naval defense vessels. As a result, in lean or uncertain times, little if any capital is available for investment in new technologies, causing the industry to slip further from viability and world competitiveness. Lack of development in niche markets (the strategy of most successful foreign counterparts) serves to encourage U.S. industry leaders to align themselves with profitable but increasingly scarce defense work.

2.5 Current U.S. Orderbook and the Effects of Declining DoD Spending

Military Market

In the last decade, declines in naval budgets had a significant impact on the American maritime industry. Shipyards that once relied on the DoD for most of their business were confronted with either scaling back their business operations or re-orienting themselves within the industry to stay competitive. Shipyards that were formerly focused on military production started to enter the commercial markets. With the partial shift of military shipyards to commercial production, competition in the commercial area increased.

Reduced government procurement and slowed down production rates had additional detrimental effects on U.S. shipbuilding and the supporting supplier base. Multi-year procurement plans and budgets allow shipyards to project into the future and better justify new investment outlays. Lacking these guidelines for long-term planning, however, shipyards focus more on short-term initiatives in order to compete in the crowded market for declining ship orders. An orientation towards shorter-term projects makes long-term investments and improvements less justifiable and desirable. By failing to modernize and invest for the future, American shipyards hinder their overall market competitiveness.

A recent orderbook of shipbuilding in the United States, as compiled by *Marine Log* magazine, lists 149 commercial vessels and 157 military vessels on order. Because of their complexity and size, the orders for military ships total over $24 billion, versus the commercial orders, comprised mostly of smaller vessels, valued at less than $4 billion. Included are planning, construction, or refurbishing of four aircraft carriers at Newport News Shipbuilding totaling more than $4 billion. The budget for just these four aircraft carriers is greater than the entire value of the U.S. commercial orderbook. Submarines on order at Newport News and Electric Boat add up to almost $7 billion. Bath Iron Works is under contract to build 10 destroyers over the next six years. Combined with its other military orders, Bath has over $4 billion in its financial inventory. Between its Avondale and Ingalls shipyards, Litton Ship Systems (now owned by Northrop Grumman) has almost half of the current American military shipbuilding orders in dollar terms. Avondale is working on sealift and transport dock ships with a total value greater than $2 billion. Ingalls is constructing a series of 10 destroyers for more than $4 billion for the U.S. Navy. Ingalls is also upgrading two frigates for the Venezuelan fleet. Patrol boats and other support vessels make up the rest of the military orderbook.

The U.S. Navy ordered 44 ships over 1,000 light displacement tons (ldt) in 1999, which is down from the 102 ordered in 1989. Additionally, the Navy is now procuring an average of 7.5 ships per year as opposed to the 19 ships being produced annually during the 1980s. This average

represents a 60.5 percent decrease in the Navy's shipbuilding program and a 38.4 percent decrease in the size of the active fleet. Declining military orders have forced American shipyards to explore commercial ventures and export opportunities.

Shipyards previously focused on military markets are finding that they must alter their operations to compete for commercial orders. The technical specialization applied to a naval vessel is not applied to commercial ships, and the technology in both fields is advancing to such an extent that the two modes of construction are growing increasingly segregated. This specialization is demonstrated by Newport News' recent attempt to make a series of commercial vessels. The production processes and infrastructure required to make a successful line of commercial vessels were not an integral part of Newport News' operations and facilities despite the Virginia based company's status as one of the most successful shipyards in the country. Due to its focus on naval contracts and production for the U.S. military, Newport News could not make a viable venture into the commercial side of the maritime industry and had to close this portion of their operations.

Few complete military ships have been exported. A major reason is that foreign navies do not require the types and configurations of vessels built for the U.S. Navy. Potential export markets may exist for stripped-down versions of some warships if modified to the specifications of foreign buyers. The Navy, however, would need to certify these vessels in order for the U.S. to provide lifetime support. To date, the Navy has not provided this service.

The U.S. Coast Guard's Deepwater Project is an export opportunity with major spillover possibilities into the commercial area (see Section 2.6 for additional information). By design, deepwater assets must be interoperable with the U.S. Navy. Interoperability is an attractive option to many allied and friendly nations' navies and coast guards that are interested in purchasing or sharing production in the U.S. Coast Guard's Deepwater Project. An initial study done for the U.S. Coast Guard by AMI International, a Seattle-based maritime consulting firm, projects a worldwide market of more than $21 billion for corvette-sized ships in the next 20 years and a $47.4 billion market for frigates. The U.S. Department of Commerce, Bureau of Export Administration is cooperating with the U.S. Coast Guard to help the project reach its full potential.

Commercial Market

Despite recent increases in world ship production and total cargo carrying capacity, the absolute number of oceangoing commercial vessels produced in the U.S. continues to remain low in comparison to the production rates from international competitors such as Japan, Korea, and European nations. Industry analysts, however, are hopeful that recent developments in the

maritime industry will begin to provide opportunities for American shipbuilders and help the recovery process started in the mid-1990s. The U.S. already has substantial markets in military vessels and dredges and the potential for a high-speed ferry market. Other possible opportunities include rising interest in the American cruise ship industry and the replacement of all single-hulled tankers with double-hulled vessels in accordance with the Oil Pollution Act of 1990. International competition, especially in double-hulled tankers, may still prove difficult, however, as the tankers currently being built by NASSCO and Avondale will cost more than (three times by some estimates) similar ships built in Korea.

As of October 3, 2000, there were 149 commercial vessels on order with an estimated value of almost $4 billion. The highest-priced commercial items currently on order in the United States include cruise ships, various deepwater and submersible vessels, and oil tankers. Two cruise ships priced at $440 million each are on order from Ingalls, while Avondale will gross almost $500 million from its first three double-hulled oil tankers and an additional $400 million for its next two. NASSCO will be constructing three $210 million tankers and two $150 million (RO/RO) ships over the next five years. Friede Goldman Offshore landed six semi-submersible (oil rig) orders worth about $700 million, and AMFELS is committed to build two construction vessels, each priced at over $100 million. Kvaerner Philadelphia is working on an $70 million containership, which does not yet have a buyer. Smaller projects in U.S. shipyards include catamarans, ferries, riverboat casinos, yachts, barges, dredges, pilot boats, research vessels, supply ships, towboats, and tugs.

2.6 Notable Mergers, Acquisitions, and Teamings

Shipyards specializing in naval construction had several partnerships, subcontractor agreements, and ventures with major defense system integrator companies. Among the systems integrators entering into cooperative agreements with American shipyards were Boeing, SAIC, Lockheed Martin, and Raytheon. Also in the mid- to late- 1990s, some systems integrators acquired or enhanced their maritime capabilities by purchasing American shipyards. Bath Iron Works, NASSCO, and Avondale were each purchased during this time to help solidify marine subsidiaries for defense companies. Initiatives like the U.S. Coast Guard Deepwater Project make shipyards attractive to systems integrators. Another example of systems integrators partnering with shipyards is the development of the DD-21 land attack destroyer for the U.S. Navy. Two teams are currently in competition for the project: the Blue Team led by General Dynamics' Bath Iron Works and Lockheed Martin and the Gold Team led by Ingalls Shipbuilding, Raytheon, and Boeing.

U.S. Coast Guard Deepwater Acquisition Project

The Deepwater Acquisition Project is the most important modernization effort and the largest procurement in the 212-year history of the Coast Guard. Deepwater refers to any asset used 50 miles or more from land, including ships, helicopters, aircraft, sensors, communications, and logistics. The Coast Guard's current deepwater assets include 93 cutters and 206 aircraft that are approaching the end of their useful service life. The service's current inventory will begin being replaced in 2003, with the first cutters entering service in 2005-6. The program will cost over $15 billion for the next 15 years.

The Coast Guard's Deepwater Project has been designated a "Reinvention Laboratory" under the National Partnership for Reinventing Government. The Deepwater program is a plan for a single coordinated system rather than a series of distinct procurements. This unique procurement project has allowed the government to collaborate with industry to adopt a phased acquisition strategy. The Coast Guard will select one of three systems integrators to provide plans for the replacement of the Coast Guard's deepwater capabilities. The three integrators have each teamed with at least one shipyard as follows:

- Boeing with Avondale Industries in New Orleans, Louisiana
- Lockheed-Martin with Ingalls Shipbuilding in Pascagoula, Mississippi and a joint-venture between Halter and Bollinger Shipyards in Louisiana and Mississippi
- Science Applications International Corporation (SAIC) with Bath Iron Works in Bath, Maine and Marinette Marine in Wisconsin

The Coast Guard is scheduled to select one of the three systems integrators in January 2002. In addition to the orders placed by the Coast Guard, Deepwater ships and other related assets possess export potential that could potentially generate billions of additional dollars in new revenues for the U.S. shipbuilding industry.

Litton Ship Systems and Northrop Grumman

When Litton acquired Avondale Industries in 1999, it became the leading shipbuilder in the Gulf Coast Region. Litton united the Louisiana based Avondale Industries with Ingalls Shipbuilding from Pascagoula, Mississippi to form Litton Ship Systems (LSS). LSS also now includes the Litton Ship Systems Full Service Center, also stationed in Pascagoula, Mississippi.

In December 2000, Northrop Grumman Corporation agreed to purchase Litton Industries for $5.1 billion. This deal was completed in April 2001. Northrop Grumman had publicly stated that Litton would provide a new core competency as a major prime contractor and systems

integrator of surface ships for the U.S. Navy. The acquisition will make Northrop Grumman a leader in military electronics and will give the company a new niche in the international defense market. Northrop Grumman was left somewhat behind the leaders in the U.S. defense industry consolidation when its merger with Lockheed Martin was denied. This development may have also influenced the company's decision to purchase Litton.

General Dynamics, Bath Iron Works, and NASSCO

General Dynamics purchased Bath Iron Works in 1995 and NASSCO in November 1998, bringing them into its Marine Systems Branch with Electric Boat and AMSEA. This has made General Dynamics more of a competitor for naval construction contracts. With these shipyards, General Dynamics is hoping to modernize existing stocks of combat vessels, submarines, and naval auxiliary ships.

Newport News and Continental Maritime of San Diego

In 1997, Newport News of Virginia acquired Continental Maritime of San Diego. The transaction gives NNS the opportunity to operate on the West Coast and expand their product offerings. Continental Maritime gained new market access for their goods and access to new technologies that NNS can supply.

Friede Goldman and Halter

The merger of Friede Goldman and Halter, operating out of the Gulf Coast, consolidated many shipyards into one business. The conglomerate established itself into four units: Friede Goldman Offshore, which specializes in production and repair of drilling units and offshore equipment; Halter Marine, which builds and repairs oceangoing vessels for the commercial and government markets; Friede Goldman Halter Engineered Products Group, which designs and constructs marine equipment; and Friede Goldman Ltd, which specializes in marine engineering and naval architecture. Friede Goldman filed for bankruptcy under Chapter 11 reorganization on April 19, 2001.

International Cooperation

Several American shipyards have entered into cooperative agreements with foreign shipyards over the past five years. The primary reasons given for these ventures were gaining complementary expertise and sharing new technologies. Foreign shipyards entering into agreements with American yards included Kvaerner-Masa Yards of Finland, Samsung of Korea, Hitachi and Mitsui of Japan, and Danyard AS and Odense Steel Shipyard of Denmark.

Recent examples of international agreements include two Australian shipbuilders, Austal and INCAT. Austal specializes in high-speed aluminum commercial ferries. Through a joint venture and technology transfers with Bender near Mobile, Alabama, Austal will be able to compete in the otherwise protected American market for commercial ships. INCAT entered into an agreement with Bollinger Shipyards in Lockport, Louisiana. INCAT is Austal's chief competition in high-speed catamarans and ferries. The firm is interested in selling modified high-speed commercial ferries to the U.S. Navy.

Additional joint ventures between U.S. shipyards and foreign shipyards or ship designers include Nichols Brothers Boat Builders and Gladding-Hearn Shipbuilding teamed with INCAT Designs, Derecktor Shipyard teamed with Nigel Gee and Associates, Swiftships teamed with Rodriquez, Bellingham Bay teamed with Vancouver Ship and Kvaerner Fjellstand, and Dakota Creek teamed with AMD.

2.7 Other Issues

Material and Supplier Lead Times

Respondents were asked to describe detrimental effects of unscheduled delays in lead times for purchased materials or services experienced in the last five years. A large shipbuilder identified heaters, fans, valves, and controllers in this category. Seventeen medium-sized yards reported delivery delays of steel plate, aluminum, specialty metals, and castings. Additional logistical and outfitting items identified were winches, fittings, engines, and fiberglass. One respondent also experienced lead-time problems obtaining naval architecture services.

The actions taken to address delivery delays and shortages varied considerably. Immediate solutions to minor problems included substitution of material, buying the needed item from others, paying a premium for the item, and adjusting the production schedule. More problematic shortages sometimes necessitated waiting until the product became available, continuing production without including the product, or even laying off workers because certain production materials were no longer available. Long-term solutions to compensate for delays sometimes meant changing vendors, maintaining higher levels of material inventory, or purchasing material from the Federal Supply System. The effect of these delays often changed production schedules. Unscheduled material and supplier lead-times can make meeting delivery deadlines difficult. Additionally, problems with obtaining necessary materials or coordinating delivery from suppliers can adversely affect shipyard productivity and increase costs.

Foreign Sourcing

The domestic content requirements for defense products, which make up a large sum of American shipbuilding revenues, largely preclude foreign content. According to survey data, American shipyards spent $160 million on foreign sourcing in 1998, or about an estimated four percent of total purchased items and material. Firms used foreign sources to provide a wide variety of outfitting subassemblies, components, and services, as well as command, weapon, and radar systems. The most common reasons firms bought products from overseas were customer directed purchases (often by the U.S. Navy), the absence of a domestic source, and better pricing. A few firms also cited higher product quality as the rationale for overseas purchases. Goods were acquired from a total of 17 countries, with the greatest amounts from Israel, Italy, Canada, and Norway.

Major defense firms accounted for roughly 65 percent of the foreign purchasing, while making over 70 percent of industry revenues (1998). Commercial shipbuilders use foreign sources to a slightly greater extent, although they are still a minor portion of their total purchases. Material and equipment purchased by commercial yards include main propulsion diesels, anchor chains, and container cranes.

3. Employment

3.1 Employment and Hours Worked

The U.S. shipbuilding industry labor force is comprised of union and non-union semi-skilled laborers, skilled tradesmen, and other professionals. Architects, engineers, welders (including pipe-fitters and ship-fitters), outfitters, machinists, electricians, painters, machinery operators, carpenters, riggers, and many other skilled workers are employed in the industry. Production workers that manufacture or assemble accounted for about two-thirds of the maritime hours each year. Marketing and sales accounted for the smallest proportion of workforce hours. The table below shows the employment labor hours for U.S. shipyards from 1996-2000.

Table 3.1 Shipbuilding and Repair Workforce Hours

OCCUPATION CATEGORY	1996	1997	1998	Est. 1999	Est. 2000
Naval architects, marine engineers and other marine professionals	23,598,258	23,212,478	23,376,675	23,366,037	23,404,813
Production Workers a. That Manufacture/Assemble	47,315,789	46,574,339	50,047,891	47,792,040	47,666,795
b. That Outfit/Finish	31,376,303	24,886,235	22,898,177	21,871,105	21,126,337
c. That Repair Vessels	42,507,373	41,136,358	45,664,817	43,460,908	45,445,855
Marketing and Sales	721,610	741,417	933,944	1,004,807	763,068
Management and Administrative	19,245,592	20,331,414	22,377,457	22,189,160	21,443,446
All Other	10,755,535	10,176,908	9,808,398	9,185,545	8,595,470
Total Workforce Hours	175,520,460	167,059,149	175,107,359	168,869,602	168,445,784
Employment, number of people					
Total Employment	86,429	84,240	89,001	85,683*	85,401*

Note: Total hours for 1998 included 3.63 million hours for shipyards with less than $5 million in revenues. These firms were not required to provide this information for the other years.
*Total employment for 1999 and 2000 calculated from 1998 ratio of hours per employee.
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The number of skilled workers available to the U.S. shipbuilding industry is projected to decrease. Today, shipbuilding competes with several more stable and lucrative industries for its workforce. However, when work is plentiful, skilled workers are in high demand. In fact, demand can increase to the point that shipyards are forced to hire and train unskilled laborers. These recruitment and training activities slow production as new hires are evaluated and integrated into production processes. Continued reliance on a dwindling workforce erodes the

pool of skilled workers and leads to hiring workers who may be unskilled and unmotivated. Additionally, substance abuse is another factor that has adversely affected the workplace environment for some shipyards. Random drug testing is used to screen out problematic workers from the jobsite. The inherent challenges of shipbuilding can drive portions of the workforce to seek employment in other industries.

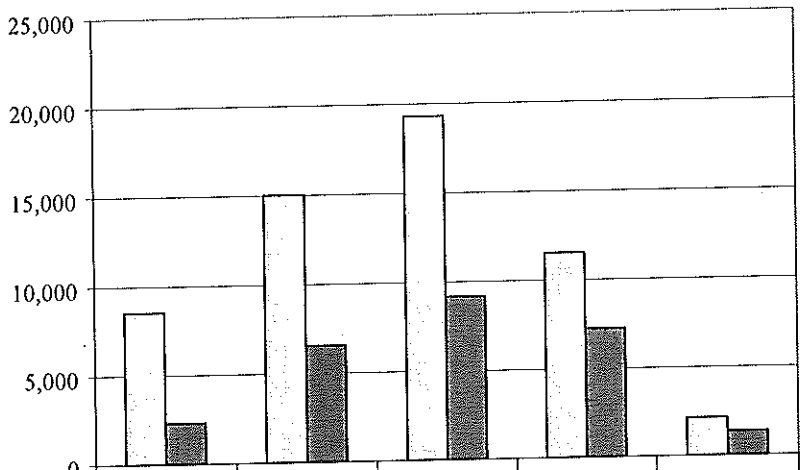
These factors are compounded during times of high prosperity. Shipyards have been known to experience in excess of 200 percent annual turnover, in spite of a third of the workforce remaining stable. For short-lived increases in work volume, firms use overtime or additional work shifts to keep the yard's output on schedule. However, more permanent arrangements may be necessary during sustained periods of prosperity. Many of the largest firms have established vocational training programs with high schools and technical schools to help fortify the pool of available workers. To reduce the burden on smaller yards seeking qualified workers, many hire through temporary agencies, requiring the person to work a probationary period before becoming a permanent employee of the yard. Without a reliable, skilled workforce, shipyards may be forced to forego process improvements in order to fund additional labor expenses.

3.2 Age Distribution

Many factors affect the average age of the shipbuilding workforce. Employment in the shipbuilding industry has declined by more than fifty percent in the last 20 years. The cyclical nature of the industry has led to frequent, unpredictable layoffs. Younger workers are more likely to be let go first, in favor of those with more seniority and experience; the union presence in the industry reinforces this effect. These factors likely raise the average age of employees in shipbuilding and in other manufacturing industries. One force working against this trend in the shipbuilding industry is the recent increases in hiring following a low period in the mid-1990s.

Most employees in American shipyards, whether involved in production or non-production work, are between the ages of 41 and 50, which is roughly comparable to all manufacturing. The following chart illustrates the average age and population of production workers in comparison to the rest of the shipbuilding and repair workforce.

Chart 3.1 Age Distribution of Shipbuilding and Repair Employment, 1999



	Under 30	31-40	41-50	51-60	Over 60
Production Workers	8,524	15,032	19,313	11,539	2,129
All Other	2,314	6,544	9,172	7,246	1,352

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

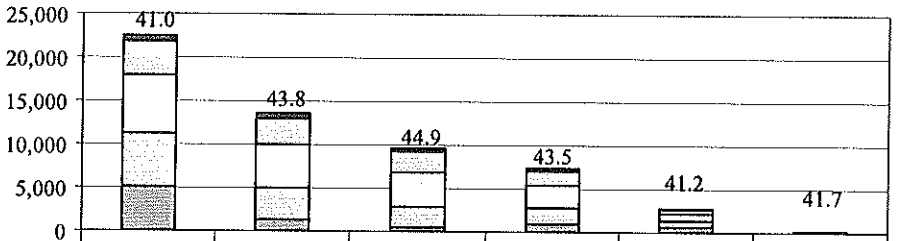
On a regional basis, the Gulf Coast employs more production workers under the age of 30 than any other region, and in fact, than all other regions combined. Gulf Coast employees under the age of 40 accounted for almost 48 percent, or nearly half, of the industry total. As reported previously, the Gulf Coast region expanded commercially in recent years, hiring large numbers of new workers. The younger workforce, however, may also relate to regional demographics. In contrast, the North Atlantic has the oldest workforce, with the lowest percentage of workers under the age of 30 of all regions. With over 90 percent defense work, the North Atlantic workforce was especially affected by declines in military spending following the end of the Cold War as younger workers were laid off first.

Nationwide, the average age of shipyard production workers is 42.1 years. In all regions, production workers over the age of 60 were the smallest group. This group composed 3.8 percent of the industry's total workforce and was only 2.4 percent of the workforce in the Gulf Coast.

As with production workers, the regional age distribution of non-production workers indicates little age difference between regions. Nationwide, the average age of non-production workers in the shipbuilding and repair industry is about 44 years. Neither does there appear to be any correlation between average age of workers and regional revenues. The following two charts detail the regional variations in age distribution for production workers and non-production

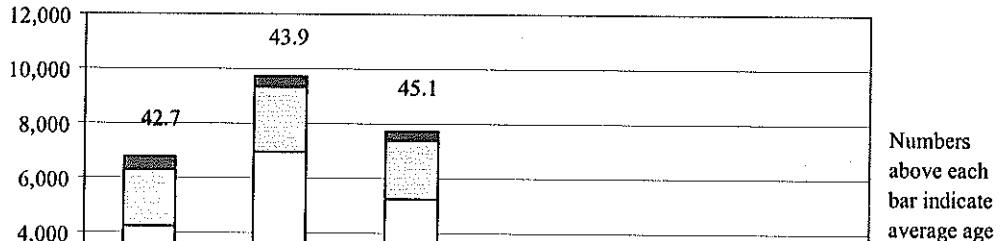
workers. The first chart shows the number of production workers and their age distribution by region, arranged in descending order of revenues.

Chart 3.2 Age Distribution of Production Workers By Region, 1999



	Gulf Coast	South Atlantic	North Atlantic	Pacific	Great Lakes	Inland
Age > 60	661	652	397	335	67	4
Age 51 to 60	3,879	2,969	2,391	1,640	518	29
Age 41 to 50	6,701	4,988	3,969	2,569	810	50
Age 31 to 40	6,176	3,670	2,349	1,881	682	44
Age < 30	5,053	1,297	483	917	636	28

Chart 3.3 Age Distribution of Non-Production Workers By Region, 1999



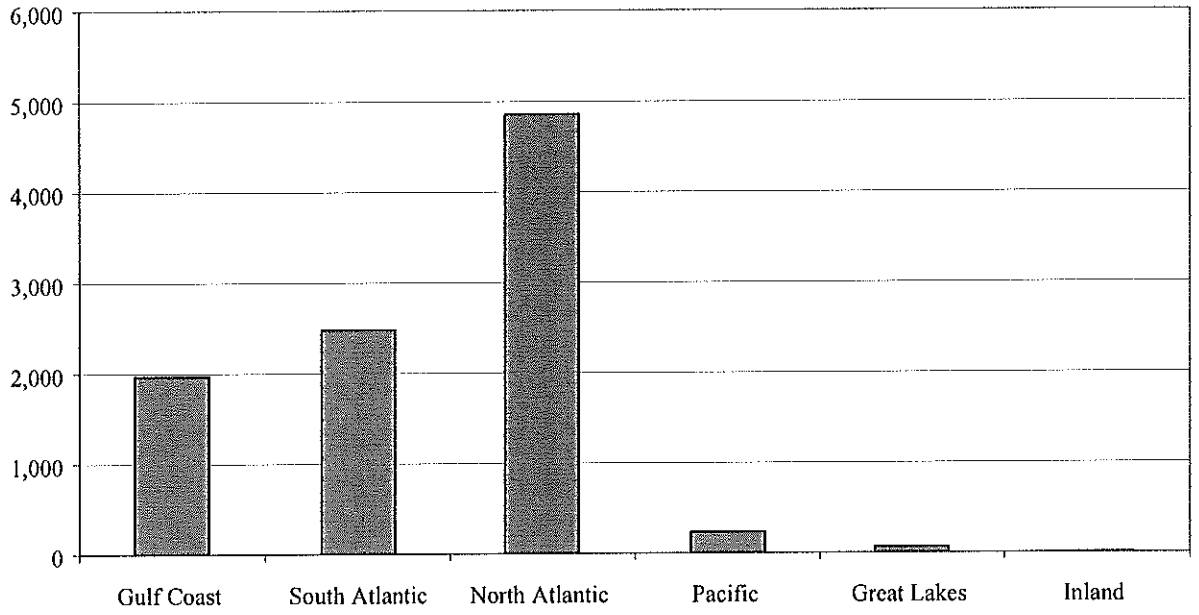
	Gulf Coast	South Atlantic	North Atlantic	Pacific	Great Lakes	Inland
Age > 60	493	386	347	72	32	0
Age 51 to 60	2,055	2,385	2,144	511	102	12
Age 41 to 50	2,035	3,308	2,911	665	186	15
Age 31 to 40	1,510	2,755	1,764	341	128	19
Age < 30	673	876	556	128	69	5

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

3.3 Breakdown of Non-Production Workforce

Nearly every facet of ship construction requires the expertise of naval architects, marketers, salespeople, administrators, and marine engineers. Employees in these fields are important not only for ship design and production and testing finished products, but for obtaining contracts and ensuring the shipyard operates at a profit. The next two charts illustrate the regional distribution of non-production workers in the U.S. shipbuilding industry.

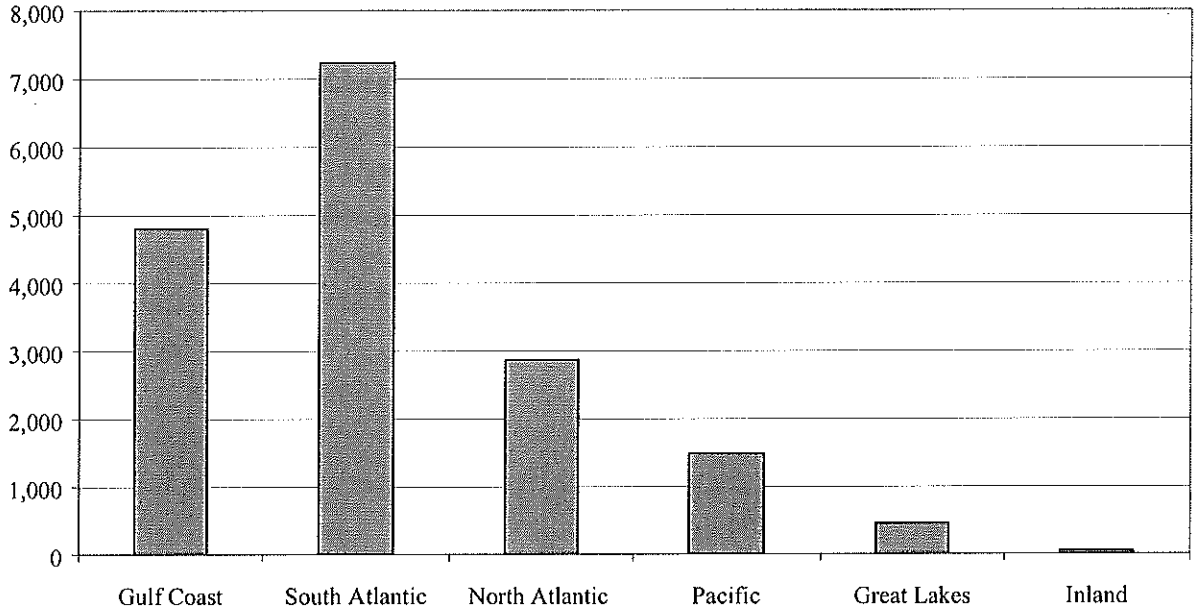
Chart 3.4 Architects, Engineers, and Other Marine Professionals By Region, 1999



Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Note that the number of marine professionals employed in the North Atlantic region (nearly 5,000) is higher than that for all other regions combined. The presence of major defense contractors accounts for this number, which indicates a somewhat top-heavy labor structure. Employment of large numbers of these workers in the South Atlantic is also attributable to concentrations of defense-related construction in the region. The Pacific and Inland regions contain mostly repair facilities and therefore require fewer professional employees. The number of professional employees in the Great Lakes and Inland regions are so comparatively small they barely show on the graph.

Chart 3.5 Marketing, Sales, and Administrative Employment By Region, 1999



Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The above chart shows the regional distribution of marketing and administrative employment in the shipbuilding sector. The distribution indicates that the largest number of these workers is in the South Atlantic, home of Newport News, the largest shipbuilding defense contractor in the country. The 32 shipyards in this region alone employ over 7,000 marketers, salespeople, and administrators. Compliance with Federal Acquisition Regulations (FAR) requires major prime contractors to employ large staffs dedicated to managing thousands of vendor transactions and small contracts, which are subject to periodic review and scrutiny. The 77 shipyards on the Gulf Coast, the region that accounts for most commercial ship work in the United States, came in second with nearly 5,000 marketers, salespeople, and administrators.

3.4 Labor Skills Shortages

U.S. shipbuilders face continuous difficulty in retaining an optimally sized and adequately trained workforce. Without steady growth or stability in the industry, yards are forced to layoff workers during poor economic periods and to recruit and train workers as work volume is restored. Each cycle of the industry erodes the labor force, sending a portion of its workforce to more stable industries and replacing them with unskilled labor. Vocational training programs strain to provide adequate numbers of qualified workers, and shipbuilding is in direct

competition for these workers with other industries. Over 70 percent of all respondents reported problems with worker shortages. Problems were also reported in the quality of training received in vocational schools by welders.

Survey respondents reported skill shortages for all groups of workers, including naval architects, marine engineers, and other professionals. The Big Six employ about 94 percent of these professionals, especially along the Eastern seaboard where defense work is concentrated. Skill shortages were reported in all three professional categories. Other shipyards, defense and commercial, along the Gulf and Pacific Coasts also reported shortages. Nearly all large shipyards that utilize the services of professionals indicated difficulties in at least one of the professional categories.

The following table provides a summary of regional shortages for skilled tradesmen:

Table 3.2 Skilled Tradesmen Shortages By Region

Region	Gulf Coast	South Atlantic	North Atlantic	Pacific	Great Lakes & Inland	Row Totals
Welders	33	13	4	17	5	**72**
Ship Fitters	30	18	3	11	5	**67**
Pipe Fitters	23	12	4	16	0	**55**
Machinists	11	12	4	16	3	**46**
Electricians	13	8	7	10	2	**40**
Steel Fabricators	17	6	1	12	0	**36**
Painters	9	5	3	12	3	**32**
Carpenters	6	3	6	11	1	**27**
Burners/Grinders	11	2	2	8	2	**25**
Crane Operators	7	7	2	8	1	**25**
Riggers/Erectors	2	7	1	8	1	**19**
Sheet Metal	1	8	0	9	0	**18**
Column Totals	**163**	**101**	**37**	**138**	**23**	-

Respondents = 146
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

About three-fourths of the shipyards reported various labor skill shortages, often in several categories. The highest incidents of labor shortages overall were for welders, ship fitters, and pipe fitters. Additional shortages were reported for electricians, machinists, and painters. The shortages may be aggravated by competition with other sectors of the economy, such as the construction or aerospace industries, especially in a growing economy.

The regions most affected by labor shortages are the Pacific and the Gulf Coast. The Pacific region features the highest percentage of shipyards reporting shortages in both professional and trade skills. One reason for this shortage in the Pacific region is that it competes with the aviation industry for its workforce, and a lack of steady work for both military and commercial shipbuilding encourages workers to relocate or work in the other industries. A similar phenomenon exists in the Gulf Coast region as cyclical demand in the economy for commercial shipbuilding and repair work exhausts the supply of skilled laborers. Competition with other industries in the region, such as off-shore oil production, draws workers away from shipyards.

Impacts of Labor Shortages

Respondents were asked to describe the impacts of any labor skill shortages. Firms were permitted to select as many impacts as needed to fully characterize the effect of labor shortages on their operations. Reduced profitability was the most prevalent response from all yards.

Table 3.3 Impacts of Labor Shortages	**Big Six**	**All others**
Reduced profitability	4	75
Raised cost of project	3	73
Subcontracted with other company(ies) to complete project(s)	2	69
Delayed completion of project	3	67
Turned away new business	3	55
Other*	1	3

* Written-in descriptions included: 'forced to rely on contract labor', 'increased use of overtime', 'increased training costs', and 'dissatisfied customer'.
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

According to respondents, labor shortages have led to delays in project completion, increased project costs, and lost business opportunities. The increased costs associated with skill shortages, such as lower output, further inhibit the ability of shipyards to pay and retain workers. The volatility of the industry makes shipbuilding a less than desirable career choice for many.

Corrective Actions to Skills Shortages

The following table summarizes the corrective actions taken by shipbuilders to address skill shortages. All firms with 1998 revenues above $5 million were asked to identify any labor skill shortages experienced in the last five years. For each skill shortage identified, respondents were asked to identify the remedy (or remedies) they applied to the problem. Five possible remedies

were given and write-in responses were accepted. The ranking is based on the number of incidents of labor shortages in the specific skill.

Skills	Ranking	Table 3.4 Corrective Actions To Remedy Labor Shortages				
		In-house apprenticeship – training program	Federal/state vocational training program	Recruitment from within industry	Agency contract hires	Recruit non-U.S. citizens
Marine Professionals						
Marine Engineers	1	1	2	9	7	3
Naval Architects	2	1	0	8	3	2
Other Professionals	3	2	1	9	3	6
Production Workers						
Welders	1	38	14	38	24	5
Ship Fitters	2	31	14	32	23	4
Pipe Fitters	3	21	10	30	17	2
Machinists	4	16	5	22	10	1
Electricians	5	14	6	21	10	0
Steel Fabricators	6	20	8	17	10	4
Painters	7	11	2	16	7	2
Burners/Grinders	8	10	2	10	5	0
Carpenters/Joiners	9	5	1	12	2	2
Crane Operators	10	6	0	8	2	0
Sheet Metal	11	6	2	9	6	0
Riggers/Erectors	12	7	2	6	3	1
Other	13	3	1	3	1	2
Total	-	**192**	**70**	**250**	**133**	**34**

Respondents = 146
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

The two most common actions taken to remedy labor shortages were 'recruitment within industry' followed by 'in-house apprenticeships'. However, over-reliance on recruiting from within the industry has led shipyards to compete for welders, ship fitters, pipe fitters, marine engineers, and naval architects. Contractors absorb some of the burden of bringing candidates into the industry, but they do not adequately address the shortage. Hiring non-U.S. citizens is not a viable option for most yards, as 70 percent of all shipyard work is defense-related and therefore limited to U.S. citizens.

3.5 Training Programs

The type and amount of training a shipyard provides its workforce can alleviate skill shortages and has a real impact on employee productivity and turnover. More than 57 percent of all respondents (71 of 124) offered some formal training to their employees. The same 71 respondents employ over 87 percent of the shipbuilding labor force. The Big Six, with 70 percent of the workforce, accounted for nearly 80 percent of all training hours. The data also shows that smaller shipbuilders and repairers generally do not offer formal training.

For firms offering training, respondents were asked to describe the types of training provided for each of the following groups: marine professionals, production employees, and other employees. Several types of training were listed, including in-house apprenticeships, vocational training, and other. Respondents were asked to indicate the number of training hours expended for each group in 1998. A summary follows:

Trainee Groups	Table 3.5 Training Programs		Hours in 1998	
	Big Six firms	Industry-wide	Big Six firms	Industry-wide
Marine Professionals	4- In-house apprenticeships	11- In-house apprenticeships	376,359	385,583
	1- Federal/State vocational training	2- Federal/State vocational training		
	3- Other	8- Other		
Production Employees	5- In-house apprenticeships	50- In-house apprenticeships	1,309,723	1,749,107
	2- Federal/State vocational training	23- Federal/State vocational training		
	1- Other	11- Other		
Other Employees	4- In-house apprenticeships	10- In-house apprenticeships	268,937	311,727
	2- Federal/State vocational training	5- Federal/State vocational training		
	2- Other	8- Other		

Note: Training listed as "other" includes: safety, equipment operator, clerical, and general skills training.
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

For all firms offering training, the largest proportion (71.5 percent) is given to production workers. The Big Six devote about 67 percent of total training hours to these workers. Much of this training is craft-related and is used for certification and apprenticeship programs. The Big Six also provide training in computer applications, environmental regulations, nuclear systems, and other disciplines unique to their operations. Professional workers consumed less than 16 percent of all reported training hours, nearly all of it by the Big Six. In total, the Big Six devoted 1.85 percent of all 1998 labor hours to training, the equivalent of one week per year per employee. Industry-wide (for all yards reporting training), the average is 1.6 percent of all labor hours (about 32 hours a year annually).

3.6 Employment of Non-U.S. Citizens Within Current Workforce

One method of easing industry-wide shortages of skilled workers is through offshore recruitment. Survey respondents were asked to indicate how many non-U.S. citizens were employed in the four major job categories listed in the following table. In total, only 2.7 percent of the U.S. shipbuilding and repair workers are non-U.S. citizens. Over 93 percent of all non-U.S. citizens employed at shipyards are engaged in production work.

Employment of non-U.S. citizens varies dramatically by region. Fewer non-U.S. citizens are employed in regions dominated by military shipbuilding. In regions where a higher proportion of commercial work is performed, more non-U.S. citizens are employed. The shipyards of the Pacific and Gulf Coast regions employ 95 percent of all non-U.S. citizens working in the industry; the North Atlantic employs four percent; and the South Atlantic employs only one percent.

Table 3.6 Employment of Non-U.S. Citizens

Employment Category	Non-U.S. Citizens
Naval architects, marine engineers, and other marine professionals	83
Production Workers	2,439
Marketing and Sales	16
Management and Administrative	80

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

3.7 Other Labor Concerns

There are a multitude of issues affecting U.S. labor in almost all industrial sectors, and the shipbuilding and repair industry is no exception. The survey attempted to capture additional labor concerns from respondents. Comments provided by respondents identified both national and regional problems within the shipbuilding and repair workforce. It should be noted that the surveys were completed during a period of strong economic growth in the United States.

As shown previously, skilled tradesmen, including welders, pipe fitters, ship fitters, machinists, and electricians, are in short supply nationwide. Not only is the current number of qualified tradesmen inadequate for the demand; it was reported that trade schools are graduating students unable to meet American Bureau of Shipping (ABS) standards for welding. Excessive turnover of skilled workers was cited as a concern in every part of the country.

Regionally, shipyards along the Gulf Coast raised several concerns regarding their workforce. Turnover and a lack of skilled workers, most notably welders, were the most prevalent concerns. Gulf employers also cited excessive injury claims resulting from a growing proportion of inexperienced workers entering the labor force. Poor work ethics and the inability of many new-hires to pass drug screening and periodic drug testing were also reported. One yard estimated that fewer than 30 percent of newly hired workers could pass a drug test, making periodic drug screening necessary. Gulf Coast shipbuilders cited few shortages of engineers or management positions, and no respondent attributed labor problems to a lack of work.

Pacific employers cited turnover and injury claims as their most problematic concerns. They reported that the pool of workers is not growing, resulting in increased competition for workers in other industry sectors. Union contract provisions that permit the journeyman portion of the workforce to accept short-term jobs with other employers while preserving their seniority on their primary jobs undermine output with little or no recourse for management. Retirement of skilled workers, lost production time from injury claims, and a shortage of work in the region were also cited as concerns.

Fewer concerns were identified for the North Atlantic and South Atlantic regions, but high turnover and a diminished worker pool were reported, as well as eroding work ethics. Shortages of qualified engineers were also identified. As noted previously, the North Atlantic and South Atlantic regions are the largest employers of naval architects and engineers, accounting for over 76 percent of all maritime professional employment.

Labor concerns of the Great Lakes region included excessive turnover, retirement of skilled workers, and a lack of work. Many yards in this region engage in complementary industries

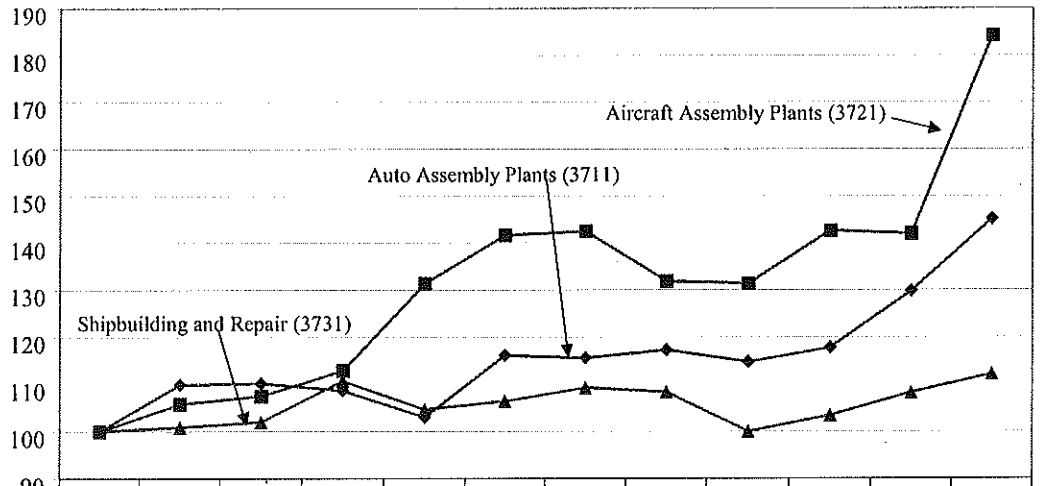
(such as construction) to offset seasonal variations in shipyard work volume. Welders and laborers displaced by slowdowns in the construction industry are available to work in repair yards during peak times. In many ways, shipbuilding and repair survives in the Great Lakes because of the construction industry.

4. Economic Performance and Competitive Issues

4.1 Overview

Productivity in the U.S. shipbuilding industry has not significantly improved since the mid-1980s, although some improvement is evident in the last few years. Shipbuilding productivity lags behind other manufacturing industries, namely auto and aircraft assembly, and is falling further behind international competitors. The official data published by the Bureau of Labor Statistics indicates that between 1987 and 1998, shipbuilding productivity increased only 12.2 percent, while that of auto assembly plants rose 45.1 percent and aircraft assembly jumped 84.2 percent. By 1990, shipbuilding productivity rose by 10.7 percent above the 1987 level, but in the next eight years the gain was only 1.35 percent. The trend lines for the three sectors are presented below.

Chart 4.1 Productivity Comparisons, 1987-1998
Index: 1987 = 100



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3711	100	109.9	110.2	108.7	103	116.1	115.6	117.2	114.7	117.8	129.8	145.1
3721	100	105.8	107.5	112.9	131.4	141.7	142.5	131.8	131.4	142.6	142	184.2
3731	100	100.9	102	110.7	104.7	106.4	109.3	108.3	100	103.4	108.2	112.2

Source: U.S. DOL, Bureau of Labor Statistics

Measures of productivity are sensitive to business cycles, as may be observed by the ups and downs on the chart. Productivity trends (based on output per employee hour) normally move in the same direction as the business cycles. In the chart, the year 1995 appears to be a cyclical low for each of the three industries shown. At that juncture, note that shipbuilding and repair had not gained at all from the 1987 level, while the two other industries showed marked improvement. Productivity changes between cyclical peaks or valleys may, therefore, be a more realistic baseline than yearly fluctuations on which to gauge actual productivity movements.

After 1990, declining defense expenditures and the slowdown in shipbuilding profoundly impacted shipbuilders as productivity actually declined. Shipbuilders take time to adjust to new circumstances. The slow shedding of employees, their chief variable cost, was a major part of the adjustment. In 1995, as the defense decline stabilized, the industry appears to have completed its adjustment and began to recover. In fact, the 12.2 percent gain for the entire 1987-1998 period was realized in the three-years following 1995.

Economic Performance

Despite lagging productivity, other performance indicators, such as revenues, financial balances and profits show that the shipbuilding industry is generally healthy. However, these indicators may be somewhat misleading because of non-market factors. U.S. Navy contracts, for example, allow for both a reasonable profit and scheduled progress payments for work accomplished. Automatic profits may dilute efficiency incentives, while progress payments reduce a shipyard's debt load. Also, the U.S. commercial market is isolated from international competition, which probably enhances the financial results of U.S. commercial shipbuilders.

Industry consolidation also affects performance. Over 60 firms exited the business or were merged into larger firms in recent years. Most of these companies did not provide performance data, which if available could have pushed the results marginally downward. Despite consolidation, persistent overcapacity in the commercial sector still managed to hold commercial profits below 6 percent, even in an expanding market. At the same time, defense shipyards operating at only about 50 percent capacity reported profits exceeding 8 percent.

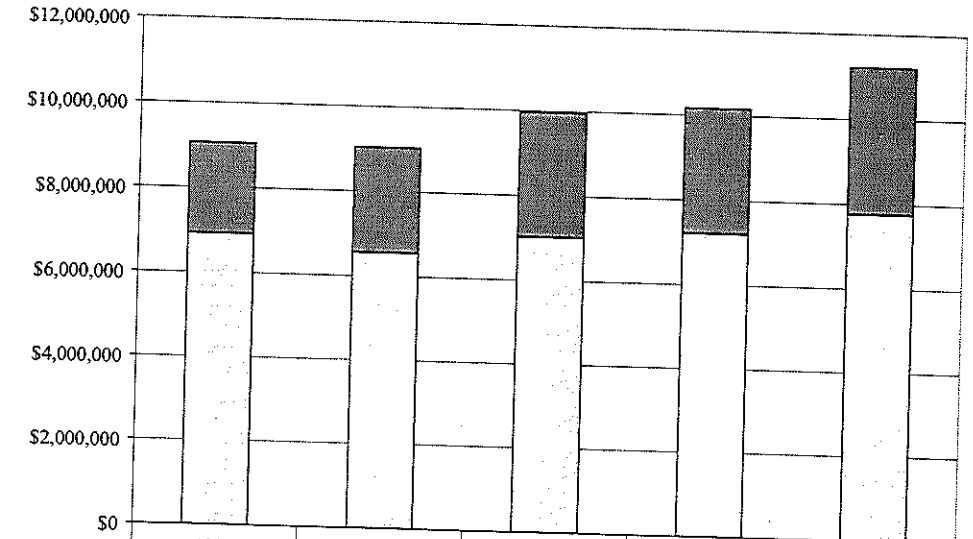
4.2 Shipbuilding and Repair Revenues

Revenues in the shipbuilding and repair industry increased steadily, with a minor pause in 1997, from $9.1 billion in 1996 to an estimated $11.2 billion in 2000, an increase of 24 percent. Defense revenues rose 12 percent, from $6.9 billion to $7.8 billion during the same period, while commercial revenues increased by more than 50 percent, from $2.1 to $3.5 billion. As a

consequence, the defense share of the market dropped from 76.5 to 69.1 percent. The revenue values are based on survey responses from 119 shipbuilders. Excluded are 79 small shipyards that reported revenues of less than $5 million; in 1998, the small shipyard group's total revenue equaled $209 million (2 percent of total revenues).

The following chart presents a graphic of the industry's revenues (1999 and 2000 values are estimates):

Chart 4.2 Shipbuilding and Repair Revenues, 1996 to 2000 (in $000s)



	1996	1997	1998	1999	2000
Commercial	$2,132,095	$2,494,560	$2,955,137	$2,955,407	$3,464,136
Defense	$6,922,519	$6,545,983	$7,012,627	$7,205,754	$7,758,980

Source: U.S. DOC/BXA 1999 Maritime Survey

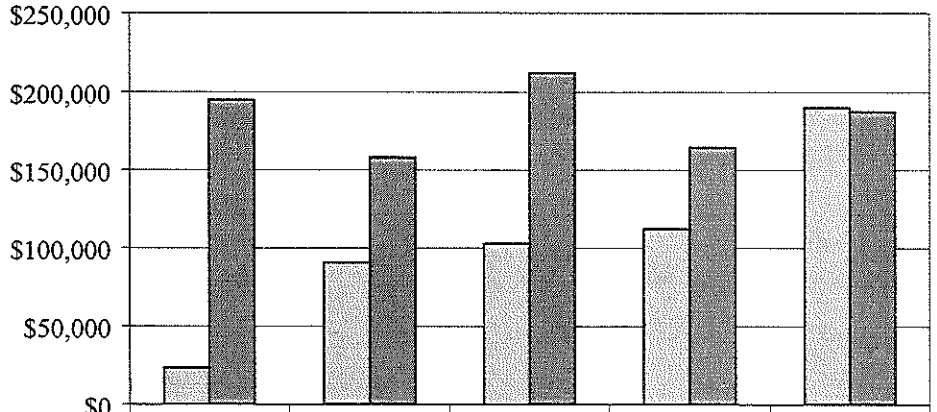
4.3 Capital Expenditures

Investment in the shipbuilding and repair industry increased steadily during the 1996-2000 period from $218 million to $378 million annually. The increase was due entirely to growing expenditures on new facilities; machinery and equipment investment held fairly steady over the period. During these five years, the shipbuilding and repair industry invested a total of $1.44 billion, which was about three percent of total industry revenues. Investments included two new shipyards and several substantial upgrades. Four companies, each reporting more than $100 million in new capital outlays for the five-year period, accounted for over half of the industry's

total. Another four companies accounted for an additional 21 percent. These eight firms represented over 71 percent of total investment but less than 60 percent of shipments.

The following chart shows the increase in facility (i.e., brick and mortar) investment and the relatively stable spending on machinery and equipment:

Chart 4.3 Shipbuilding and Repair Industry
Capital Expenditures, 1996-2000
(in $000s)



	1996	1997	1998	1999	2000
Brick and Morter	$23,705	$90,612	$102,704	$112,012	$189,979
Machinery & Equipment	$194,782	$158,109	$212,264	$164,613	$187,546

Source: U.S. DOC/BXA 1999 Maritime Survey

In all, 92 companies reported new capital expenditures in their survey responses. Twenty-three of these companies had 1998 revenues that exceeded $50 million. These larger companies accounted for almost 89 percent of new capital expenditures and 84.4 percent of industry revenues.

The Big Six accounted for $769 million of the capital outlays, or about 53.6 percent of the total. As a group, the Big Six invested 2.35 percent of their revenues back into the business. Investment by the Big Six accelerated near the end of the period. Big Six companies were the top three investors and four of the top eight investors. The other two occupied positions nine and ten. All other shipyards accounted for $667 million of the capital spending, which was 4.46 percent of their total revenues.

During the five-year period, capital spending per employee in the shipbuilding industry averaged $3,516; the Big Six averaged a little less, at $2,779. By comparison, all manufacturing was

$8,779 per employee, or about 2.5 times more than shipbuilding. The aircraft industry average, however, was not significantly higher than shipbuilding, at $3,806. The average for the auto assembly sector, on the other hand, was more than six times higher, at $21,578.

Table 4.1 Comparative Capital Spending per Employee

Industry	Average Employment	Average Capital Expenditures (in $000s)	Capital Expenditures per Employee	Time Period
Shipbuilding & Repair	81,633	$287,265	$3,516	1996-2000
The Big Six	55,012	$153,879	$2,779	1996-2000
All Manufacturing	17,089,676	$150,035,705	$8,779	1996-1998
Aircraft Assembly	201,326	$770,417	$3,806	1996-1998
Auto Assembly	231,525	$15,006,336	$21,578	1996-1998

Source: U.S. DOC/BXA 1999 Maritime Survey; Bureau of the Census

Investments to Improve Competitiveness, Past Five Years

Respondents were asked to identify actions they have taken to improve competitiveness in the last five years. A total of 102 companies responded to this question, including all but one of the firms with more than $100 million in 1998 revenues. Overall, respondents accounted for 94.5 percent of total revenues (1998) reported by the industry. Thirteen of 14 firms over $100 million accounted for 98.4 percent of their group's revenues. In addition, nine companies with less than $5 million in revenues provided a response.

Some shipbuilding companies reported investments to increase labor productivity, reduce overhead, and upgrade technology. Other companies offered health care packages and other benefits to attract labor or reduce high turnover rates. Still others provided training to increase skill levels within their workforce. A few raised wages and reduced the size of their workforce by offering early retirements. Several companies built new shipyards or modernized existing shipyards in major undertakings. These companies invested in robotic cutting machines, new unit and assembly steel areas, pontoon hull launchers, improvements in land-based launch systems, crane purchases, new pipe fabrication facilities, various labor saving technologies, and material handling equipment.

Many shipyards invested in computer technology and software, and several companies sought to integrate information technologies throughout their operations. Others mentioned teaming and partnering with other shipyards and with companies in other industries to acquire knowledge and

improve their competitiveness. A number of firms mentioned corporate commitments to re-engineering, best practices, integrated product teams, TQM, and continuous improvement.

Several firms were working to improve their supplier chain and reduce purchased materials costs by centralizing efforts and standardizing products for volume discounts. Other shipyards increased outsourcing in areas it made sense to cut costs.

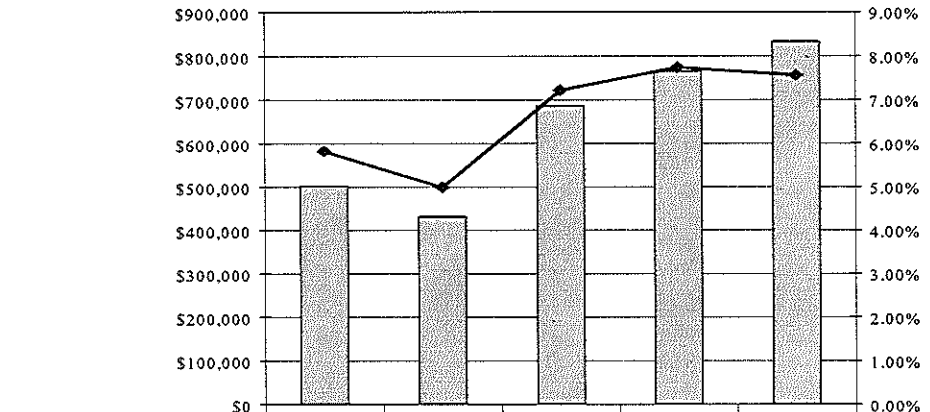
4.4 Profitability

During the 1996-2000 time frame, shipbuilding pre-tax profits as a percent of revenues ranged from 4.99 percent in 1997 to a high of 7.74 percent in 1999. The period saw a marked upward trend, although the final two years were estimates. For the five years, the industry reported pre-tax profits totaling $3.2 billion on revenues of $47.7 billion, which yielded an overall 6.75 percent average return. Shipbuilding pre-tax profits, however, were less than that of all manufacturing for the period, which averaged 8.31 percent (1996-1999). The value of manufacturing profits, it should be noted, reached record levels during this period. The same strong economy also helped increase business and profits for the shipbuilding industry.

The Big Six accounted for over 76 percent of the industry's total profits as compared with two-thirds of the industry's revenues. For the five-year period, the Big Six pre-tax profits averaged 7.47 percent of revenues with a significant upward trend over the period. The lowest return was reported in 1997, when profits were only 4.81 percent. In that year, Newport News reported significant losses related to its efforts to produce the Double Eagle tankers for the commercial trade. Newport News' high overhead costs were not recovered for this project and its profits were negatively impacted. With Newport News factored out of the 1997 values, the five-year average pre-tax profit for the Big Six would grow to 8.12 percent.

Each year a number of shipyards reported losses. Losses peaked in 1997, when 17 firms, including Newport News, reported losses that totaled $113.3 million; these firms represented nearly 26 percent of the industry's total revenues. In subsequent years, the number of firms in the loss column gradually diminished. In 2000, only seven firms reported (estimated) losses totaling just over $4 million. These firms accounted for less than 1 percent of the industry's total revenues. The following chart shows a clear improvement in profits, as industry revenues increased:

Chart 4.4 Shipbuilding and Repair Industry
Pre-Tax Profits (in $000s; % of Revenues)
1996-2000



	1996	1997	1998	1999	2000
Net Income, Before Taxes	$501,978	$430,723	$686,200	$764,908	$833,189
Percent of Shipments	5.82%	4.99%	7.21%	7.74%	7.55%

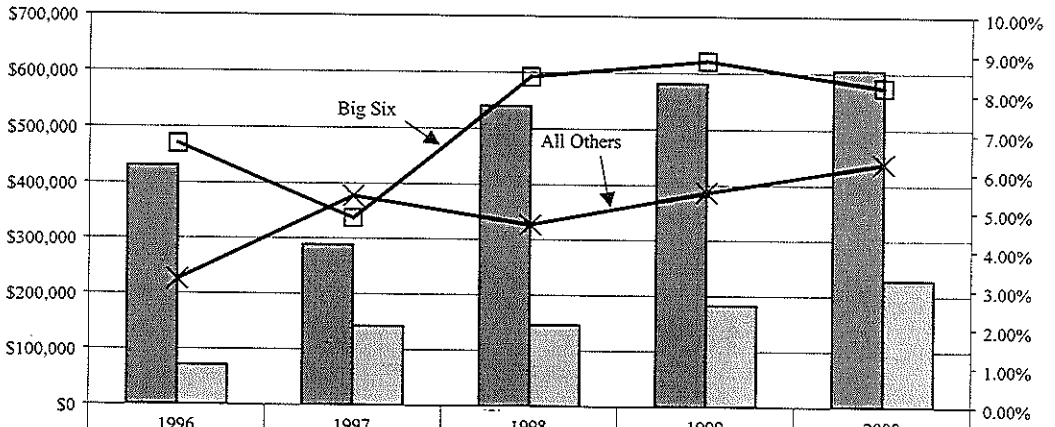
Source: U.S. DOC/BXA 1999 Maritime Survey

While profits for the Big Six were close to that for all manufacturing, profits for all other shipyards (113 firms) were considerably less. For the five-year period, the group of smaller shipyards averaged a 5.16 percent return on revenues compared with a 6.75 percent for the industry as a whole. They did experience an upward trend, as commercial revenues grew substantially. Defense revenues averaged 27.6 percent of their total revenues. Profits hit a low of only 3.22 percent in 1996 but finished the period with a high of 6.26 percent in 2000.

A breakout of other subgroups within the shipbuilding industry is also revealing. For shipyards with more than 75 percent defense revenues, profits averaged 7.76 percent for the period. For shipyards with no defense revenues, profits averaged 5.72 percent. For shipyards that engage only in repair activities, profits averaged 4.91 percent. All of these sub-sectors experienced an upward trend as did the overall shipbuilding and repair industry. The only sub-sector to report a loss in any year was the repair-only group, which reported a loss of 0.3 percent in 1996.

The following chart compares the pre-tax profits of the Big Six to those of all shipbuilders and repairers:

Chart 4.5 The Big Six vs. All Other Shipbuilders and Repairers
Pre-Tax Profits (in $000s; % of Revenues)
1996-2000



	1996	1997	1998	1999	2000
Big Six	$430,972	$288,625	$540,273	$581,734	$604,560
All Others	$71,006	$142,098	$145,927	$183,174	$228,629
% Big Six	6.72%	4.81%	8.45%	8.86%	8.20%
% All Others	3.22%	5.38%	4.67%	5.52%	6.26%

Source: U.S. DOC/BXA 1999 Maritime Survey

The following table shows the pre-tax profit levels as a percentage of the revenues of the shipbuilding and repair industry as a whole and for several sub-sectors within the industry. All manufacturing is also shown for comparability.

Table 4.2 Pretax Profit as a Percent of Revenues: Shipbuilding and Repair and Sub-Sectors Compared to All Manufacturing, 1996-2000

Industry Sector	1996	1997	1998	1999	2000	5-Year Average
Shipbuilding & Repair	5.82%	4.99%	7.21%	7.74%	7.55%	6.75%
Big Six	6.72%	4.81%	8.45%	8.86%	8.20%	7.47%
All Other, except Big Six	3.22%	5.38%	4.67%	5.52%	6.26%	5.16%
Defense Revenues>75%	6.12%	4.75%	8.08%	8.80%	7.98%	7.76%
Defense Revenues = 0%	4.44%	7.58%	5.65%	4.23%	6.49%	5.72%
Repair Only	-0.30%	5.46%	4.89%	6.21%	6.62%	4.91%
All Manufacturing	8.18%	8.45%	8.03%	8.60%	n/a	8.31%

Source: U.S. DOC/BXA 1999 Maritime Survey and U.S. DOC, Bureau of the Census, "Quarterly Financial Report"

4.5 Financial Balances

Financial statements were received from 94 survey respondents for the period 1996-1998. The following table shows the aggregated results and several financial ratios.

Table 4.3 Shipbuilding and Repair Industry Financial Balances, 1996-1998 (in millions of dollars)

Financial Item	1996	1997	1998
Total Revenues	$9,054.6	$9,040.5	$9,967.8
Current Assets	$2,375.1	$2,534.3	$2,851.9
Inventories	$736.3	$637.9	$539.6
Total Assets	$5,269.4	$5,579.5	$6,146.3
Current Liabilities	$1,785.6	$2,171.6	$2,271.9
Short-Term Debt	$180.5	$217.8	$224.9
Long-Term Debt	$1,246.8	$1,211.0	$1,354.4
Financial Ratios			
Current Ratio	1.33	1.17	1.26
Quick Ratio	0.92	0.87	1.02
Total Assets to Total Revenues	0.58	0.62	0.62
Long-Term Debt to Total Assets	0.24	0.22	0.22
Short-Term Debt to Current Liabilities	0.10	0.10	0.10
Total Assets per Employee	$61,097	$66,564	$70,498

Source: U.S. DOC BXA/SIES 1999 Maritime Survey

The *current ratio* (i.e., current assets divided by current liabilities) measures the short-term ability of shipyards to pay off liabilities payable within one-year (solvency). This ratio ranged from 1.17 to 1.33, which is aligned with all manufacturing and indicates that the industry is solvent. The *quick ratio* (i.e., [current assets minus inventories] divided by current liabilities) was in the 0.87 to 1.02 range. The quick ratio measures very short-term liquidity (or solvency). Shipyards' quick ratio was higher than that of all manufacturing. In interpreting this ratio, the value of inventories can be classified into three stages: materials, work-in-process, and finished inventories. Finished inventories are more liquid than the first two. Shipbuilding would normally be thought of as having a large work-in-process inventory when considering the time it takes to build a vessel. As a case in point, an aircraft carrier can be a work-in-process for several years. This factor should greatly reduce the quick ratio well below that of all manufacturing. However, the Navy provides shipyards with progress payments, which convert unfinished inventories into revenues before the final sale. This provision increases the value of the quick ratio and, for accounting purposes, reduces inventories. Repair-only firms carry only one-third

the inventory of the shipbuilders, even with progress payments. Their quick ratio is, therefore, even higher.

Based on the ratio of total assets to total revenues, the shipbuilding and repair industry is labor intensive. This ratio ranged from 0.58 to 0.61. All manufacturing's total-asset-to-total-revenue ratio ranged from 0.95 to 1.02. In simplest terms, U.S. manufacturing industries in general require about $1 in assets to generate $1 of revenue. In contrast, shipbuilding and repair required about 60 cents in assets to generate $1 of revenue, indicating a greater reliance on labor. Reinforcing the labor intensity observation is the value of assets per employee, which in 1998 stood at $70,498. This figure was only 30 percent of that for all manufacturing, $234,439.

The debt load of the industry was similar to that of all manufacturing. Debt would be higher if firms did not receive progress payments, which allows them to assume less debt or pay it off more quickly. Short-term debt (i.e., debts due in less than a year) was only 10 percent of current liabilities. Long-term debt was less than one-quarter the value of total assets, and went down slightly in 1997 and 1998.

4.6 Productivity

How Productivity Is Measured

Respondents were first asked to describe how they measured productivity. A total of 81 firms responded, including all 14 firms with 1998 sales exceeding $100 million.

All large firms measured productivity by comparing man-hours expended to product output or by inputs of raw material, such as steel, consumed in an activity or operation. Most of these input methods compared the amount of material converted from stock to product per man-hour. Typical metrics cited were the number of tons of steel processed per hour, the number of feet of metal tubing used per hour, or the number of square yards of surface area painted per hour. Nominal material waste was factored into the calculations. These metrics were then compared to rates derived from time and motion studies and other production work analysis. The metrics enabled management to track and document productivity against budgeted hours and budgeted cost for each type of task.

The Navy requires its contractors to adopt a DoD-approved Earned Value Management System that specifies productivity measures. This system impacts many of the large firms in the survey. Given the complexities of large ship construction, without such performance measures,

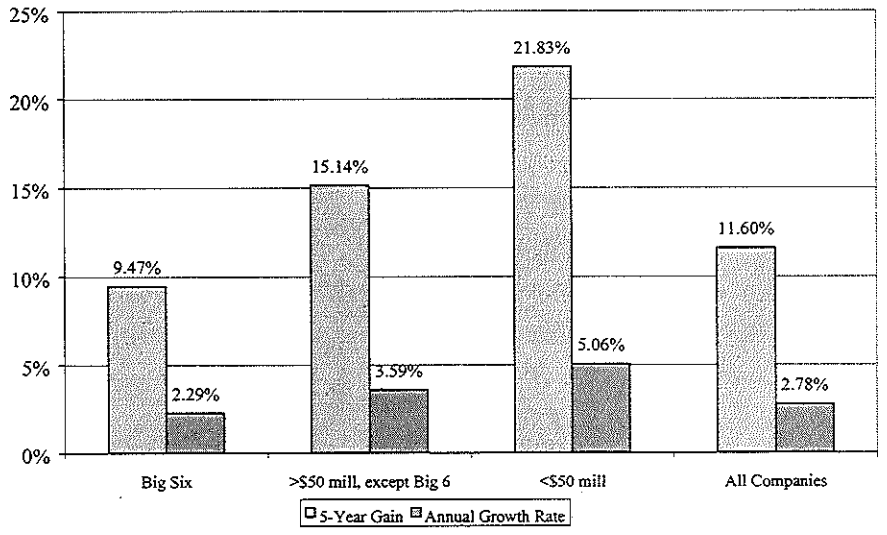
disruptions in one area of production create a ripple effect throughout the entire process as other materials arrive before they can be utilized.

The vast majority of 2nd tier firms measured productivity by comparing available information on production data with actual productivity, and they regularly compared the actual data to budgeted metrics such as labor hours or material costs. About ten percent of these firms admitted they conduct business with little or no attention to tracking or measuring production progress against a work schedule. Some tracked the number of vessels built or repaired annually, a method that does little to nothing to alert the business to periodic problems in its operations. Other measures including workforce morale, customer base growth, and perceived customer satisfaction were also identified. Given the variety of business activities of this segment of the industry, it is not surprising that it also has such diversity in its management philosophies.

Shipbuilder Reported Productivity Gains, Past Five-Years

The survey asked the shipbuilders to report productivity gains they experienced over the past five years. Responses to this question were received from each of the Big Six, plus 10 firms with revenues of over $50 million and 50 firms with revenues of less than $50 million. A weighted average gain based on each shipyard's 1998 employment hours was calculated for the three groups and for all 66 respondents combined. The following chart shows the weighted results.

Chart 4.6 Reported Productivity Gains, Past Five Years
(weighted by company employment hours, 1998)



Source: U.S. DOC BXA/SIES 1999 Maritime Survey

The taller bar on the left represents the five-year gain for each group; the shorter bar on the right represents the annual growth rate. The Big Six, for example, reported on average a five-year gain of 9.47 percent, which equals an annual productivity growth rate of 2.29 percent, shown by the shorter bar. During the same five-year period (1994-1999) all manufacturing increased more than 25 percent, as published by the U.S. Bureau of Labor Statistics.

Reports by individual shipbuilders varied from gains of zero to 100 percent (reported by two small shipyards). Three of the Big Six reported gains of 15 percent or more, but the other three reported gains less than 5 percent. The Big Six reported a total of 106 million work hours in 1998, which was 76 percent of the sample total. The 10 companies over 50 million (excluding the Big Six) reported 17 million hours. The greatest productivity gain reported in this group was 50 percent. Six of the 10 reported gains of 10 percent or less. The small group (under $50 million) included six firms that reported gains of 50 percent or more. Twenty-seven of the small group reported gains of 10 percent or less. The small group accounted for about 16 million work hours (11.5 percent of the total).

Vessels produced by the Big Six are also larger and more complex than the others and require a commitment to long-term planning to improve productivity. An improvement cycle can only happen with the cooperation of the Navy and Congressional Appropriations and should be measured over several years. This issue will be discussed in more detail in the next section. The smaller shipyards are generally commercially oriented and subject to stronger and more immediate competitive forces. Small yards are also more agile and can react faster to changing conditions.

The Big Six reported that their productivity would increase slightly faster in the next five years, from the prior rate of 2.3 to about 2.5 percent. All shipbuilders taken collectively expect productivity to continue to increase at about 2.8 percent annually in the next five years.

Issues Affecting Defense Manufacturing Productivity

The Big Six and other defense yards essentially build vessel hulls and integrate combat systems and other major systems into the hull structure. This is a complex engineering task. On front-line warships, these added systems can account for more than half the value of the finished vessel. For example, the nuclear reactor on a $5 billion aircraft carrier may cost $1 billion and the combat and other systems, another $1.5 billion. The hull and all the compartments, piping, wiring, equipment (steam turbines, reduction gears, shafting, pumps, generators, evaporators, air conditioners, laundry, etc.), and living quarters for 5,000 personnel costs about $2.5 billion.

The performance of the major shipyards in productivity improvement has much to do with Navy contracting policies. The major concerns are as follows:

1. Typical naval construction contracts are issued on a cost-plus basis, based on labor hours expended usually on the first two vessels of a type constructed. Subsequent orders are billed according to these labor hours. A consequence of this practice has been excessive specialization and job titles. If job titles are narrowly defined, the shipyard is afforded less flexibility to utilize its workforce effectively.
2. Regulatory oversight focuses on procedures and audits rather than production efficiencies. Process and construction innovations are not adequately rewarded.
3. At the Navy's insistence, shipbuilders maintain excess capacity and capabilities, which raises overhead costs. According to a Navy spokesman, the Big Six on average are operating at about 50 percent of their capacity.
4. Vessel designs are driven by Navy requirements. Less consideration is given to manufacturability and optimizing shipyard capabilities.
5. Make/buy options are not optimized. Qualification procedures for subcontractors are burdensome and expensive.
6. Long-term planning is made difficult by frequent production design revisions as well as uncertainties concerning annual appropriations. Design revisions such as change orders can adversely impact productivity and production schedules.

International Productivity Comparisons

Among shipbuilding nations, U.S. shipbuilders rank at or near the bottom in terms of productivity, and the gap is widening. As currently configured, the U.S. shipbuilding and repair industry has high labor, material, and overhead costs relative to the rest of the world. The higher costs in the United States result from low rates of productivity, not high wage levels. The prevailing absolute wage levels in Europe and Japan are actually higher than in the United States. European and Japanese shipyards, however, produce vessels more efficiently; that is, with far fewer labor hours. This disparity has increased in the last decade.

Substantial economies of scale are available to the shipbuilder that has a large enough market and incentives to invest. However, higher material costs are the penalty for low or slowed down construction volumes. Ironically, the United States is the world's most productive steel producer and a leader in forgings, castings, marine propulsion units, electronics, and many other products needed in shipbuilding, but these are not translated into advantages by U.S. shipbuilders. U.S. shipbuilding uses less than half a percent of the steel industry's output.

Also contributing to higher costs is the low number of ships constructed; larger U.S. shipyards produce fewer than three or four ships a year. The domestic market for large commercial vessels does not support a higher production rate; it is also a volatile and unpredictable marketplace. Additionally, because American shipyards are generally not internationally competitive, limited export opportunities reduce potential production rates. Commercial shipbuilders find it difficult to plan in this environment, adding risk to new investment. In contrast, the Korean company Hyundai delivered 52 vessels in 1999 totaling 3.2 million gross tons valued at $2.6 billion. Building many ships in series lends itself to automation and economies of scale. Building one or two ships does not. One U.S. shipyard reported that building the first vessel of a type requires about three times as many labor hours as the final three (of 30 vessels), almost a 90 percent reduction. Building more ships would also support economies in purchasing materials and supplies, provide steadier employment, and better utilize facilities and equipment.

Comparing productivity between the building of different types of ships, especially commercial and military, is difficult. A measurement called *compensated gross tons* (CGT) is one method but its accuracy remains questionable. CGT is a numeric coefficient that is intended to account for vessel complexity. Thus, an oil tanker, which is near the low end of complexity, can theoretically be compared to a much more complex cruise liner by multiplying the cruise liner's actual gross tons by the CGT coefficient.

According to Tom Lamb of the University of Michigan, "[CGT] is difficult to calculate for U.S. shipyards as there are no internationally agreed compensation coefficients for naval ships." The productivity rates for various shipbuilding countries cited in this report are "for total employees, not just production workers." The most accuracy comes when comparing the construction of similar types of ships in different countries, such as a Panamax containership built in a European country compared with one constructed in South Korea. Recently, 9,000 TEU (Twenty-Foot Equivalent Unit) container vessels built by European manufacturers were priced at around $100 million each, while Korean shipbuilders were able to sell similar vessels for about $65 million. One example illustrating high Japanese productivity involves a destroyer built along American design lines. Although the Japanese firm made some changes and modified the hull to make it suitable for construction in its shipyard, the Japanese yard needed less than one-half of the man-hours.

Japanese shipyards are now at the point where they can no longer make dramatic improvements in productivity. Their "continuous productivity improvement" processes are yielding diminishing returns of only two to three percent per year, as opposed to 15 percent or more per year in the past. South Korean shipbuilders, however, have strengthened productivity at an average of about 15 percent annually over the last five years. Because they are earlier in the quality improvement process, greater progress is still possible.

Most European shipbuilders have attempted to become more efficient through outsourcing rather than by improving their own employees' productivity. Becoming more efficient by pushing work to subvendors, however, may be difficult in the current U.S. environment unless the market is enlarged and the work becomes steadier. Resistance to greater outsourcing in American yards may also come from the existing workforce. Highly specialized union workers make up a majority of the workforce. Additional management staff is required to plan the division of labor. Internationally, in contrast, most planning is done on the shop floor, which eliminates some supervisory layers.

Shipbuilding has become an accessible industry for developing nations. The cost of entry into the industry is not high. Basic requirements include some land and appropriate waterways and in mild climates, most ship construction can be done outdoors. Developing nations may choose to enter shipbuilding to provide an outlet for the products of their other industries. For example, when Japan and South Korea first entered the market, part of their motivation was to find alternative markets for the output of their steel and engine factories. Japan and South Korea also use shipbuilding to produce vessels for the transoceanic transport of domestically manufactured automobiles and other products of their country's businesses, which often operate within the same conglomerate.

At the same time, it has become increasingly difficult for developed nations to compete, because developing nations can enter the shipbuilding market so easily, build lower cost ships, and increase worldwide capacity. There is speculation that Poland, still among the top six shipbuilding nations in terms of gross tonnage, may have no remaining active shipyards within the next year or two because of increased global competition. South Korean shipbuilders, once efficiency returns diminish, may explore consolidation to eliminate redundancy, as is currently being advocated by many in the Japanese industry. South Korean and Japanese shipbuilders are also trying to break into the lucrative cruise liner market currently dominated by European firms. China, with more yards and growth potential than any other country, will most likely become more efficient and build higher-quality ships over the next few years.

4.7 Competitive Prospects

Companies were asked to assess their competitive prospects, indicating whether they would improve greatly, improve some, stay the same, decline some, or decline greatly. The results in the following table indicate that the shipbuilding and repair industry is optimistic about the next five years. Of 99 firms that reported their competitive outlook, almost 81 percent saw things

improving either greatly or some. Twenty-two percent of the companies reported that their competitive prospects will improve greatly. Only five percent think their prospects will decline.

This optimism comes in part from the strong economy of recent years and from a belief that the Jones Act and Title XI (see Section 6) will be continued. Potential market growth in offshore oil platforms and servicing, merchant fleet replacement, and the prospect of higher naval budgets are factors as well, although future naval budgets are less clear with the new administration. In addition, the industry has emerged from a cyclical trough that bottomed in the mid-1990s after a protracted decline. Some companies invested in major overhauls of their yards and incorporated new technologies. Federal and state governments were also active in supporting the industry.

To temper this optimism, reports were not received from about 60 companies, some of whom may have gone out of business. Many of these companies would probably be more pessimistic had a response been received.

The most optimism resides with firms with more than $50 million in 1998 annual revenues. Of the 22 companies in this group (see table below), 19 believe their prospects will improve, and 10 of these are in the *improve greatly* category. The larger firms gained the most from the MARITECH program (see Section 6.6), and several will gain business from the Oil Pollution Act of 1990, which calls for the double hulling of oil tankers. They will also supply most of the warships the Navy will need in the coming years.

Table 4.4 Company Reported Competitive Prospects

Groups of Companies by Revenue Levels	Total Count	Improve Greatly	Improve Some	Remain Same	Decline Some	Decline Greatly
All Firms	99	22	58	14	5	0
=> $50 million	22	10	9	3	0	0
< $50 million	77	12	49	11	5	0
Repair Only	38	3	23	8	4	0
Defense Revenues = 0	46	10	26	9	1	0
Percentage Distribution						
All Firms		22.2%	58.6%	14.1%	5.1%	0.0%
=> $50 million		45.5%	40.9%	13.6%	0.0%	0.0%
< $50 million		15.6%	63.6%	14.3%	6.5%	0.0%
Repair Only		7.9%	60.5%	21.1%	10.5%	0.0%
Defense Revenues = 0		21.7%	56.5%	19.6%	2.2%	0.0%

Source: U.S. DOC/BXA 1999 Maritime Survey

The group of companies with revenues below $50 million are also optimistic, but slightly less so than the larger group. Nearly 80 percent of these 77 companies think that their competitive prospects will improve in the next five years. Most of them (64 percent) are in the category *improve some*, which may be interpreted to mean that they are cautiously optimistic. Only 12 of the 77 (16 percent) companies were greatly optimistic. Also, group with revenues under $50 million in annual revenues included five companies that see their prospects on the decline.

Repair-only companies were the least optimistic group, although nearly 70 percent reported improving prospects. The repair group recorded the lowest percentage in the *improve greatly* (7.9 percent) category and the highest in the *decline some* category (10.5 percent). Repair companies accounted for four of the five yards listed in the *decline some* category. Companies with no defense revenues appear to be about as optimistic as firms with defense revenues.

5. Maritime Technology

5.1 Overview

The U.S. shipbuilding industry is a world leader in the design and integration of complex naval ships. A key reason for this superiority has been the shipbuilding R&D expertise that currently resides across the Enterprise—that is, in the Navy's laboratories, acquisition commands, and with certain shipbuilders and universities. The Enterprise provides the sophisticated technologies required by military combat vessels, including nuclear power, noise attenuation, fully submerged hydrofoils, streamlined submarine hull forms, missile systems, advanced electronic communication and countermeasures integration, and logistic support. In addition, Enterprise subgroups have conceived and designed most of the state-of-the-art hull, mechanical, electrical, power projection, air defense, and undersea warfare capabilities that are operational today. With reduced R&D budgets, some of that capability is now becoming fragmented.

While defense procurement has fallen in recent years, it still represents about 70 percent of total shipbuilding revenues. However, with low production rates and the lack of a truly competitive market, there appears to be little incentive in the defense sector to invest in manufacturing technologies to improve efficiencies. The shipbuilding industry's principal roles in the development process have been in the application of technology, detailed design, and manufacturing and system integration. As part of recent DoD acquisition reform policies, the Navy is in the process of transferring its design and lifecycle responsibilities to the shipbuilding industry. The Navy is also attempting to exploit commercial-off-the-shelf technologies for ship systems and hardware. This change is part of an overall defense downsizing effort that began ten years ago.

In commercial ship production, U.S. shipyards are significantly behind foreign competitors in ship construction, design, shipyard layout, and production engineering. This significant difference seems to be the result of long-term investment by foreign yards in process technology. The difference is highlighted in the MARITECH ASE Strategic Investment Plan, dated August 14, 1998, and published by the National Shipbuilding Research Project (NSRP), which states that production processes in the United States are organized from a custom job rather than a world class manufacturing perspective. A single-craft work environment continues to be the norm, and non-value added activities such as narrowly defined job titles or manufacturing processes that could be more cheaply subcontracted have yet to be engineered out. As a result, labor content (man-hours required per compensated gross ton) in U.S. yards can be more than double that of world-class competitors.

U.S. Research Environment

For the U.S. industrial base as a whole, the R&D environment is more robust than ever. According to a 1999 study by the Industrial Research Institute (IRI), "U.S. industry is doing more long-range high-risk, discovery type research than ever before." From 1994 to 1999, U.S. industrial research grew from $97.1 billion to a projected $166 billion, more than twice the level of spending by the federal government, which in 1999 was approximately $70 billion. By contrast, Japanese industry spent $95 billion in 1998. According to the study, "The United States is the world's top patron of industrial research and development, giving it a powerful weapon in the trade wars to produce a new wave of innovative goods and services."

Most industrial R&D goes into engineering development, making prototypes, and testing products. A lesser amount goes into applied research, which focuses on making new products in the future. Basic research increased 79 percent to $10.9 billion, growing even faster than overall research and development. IRI found that the increase came mainly from companies doing business in the life and information sciences. According to IRI, the growth in these industries comes in reaction to strong global competition and is made possible by healthy corporate profits and cash flows. The idea that the economy is increasingly knowledge-driven and that raising intellectual capital is a good way to manage the corporate enterprise is spreading, and many companies have established specialized research facilities that mimic Xerox's Palo Alto Research Center (PARC) or Lockheed-Martin's renowned Skunk Works in Palm Dale, California to help foster innovation.

5.2 Research and Development Expenditures

The shipbuilding industry has not participated in this new environment of rapid growth in R&D. Fundamental issues that need to be addressed are motivating the industry to invest in R&D, developing the technology needed for new products, and improving industry efficiency and competitiveness. These technological improvements should include management practices as well as traditional R&D developments. Management must believe that investment in R&D will return profits and increase shareholder value. A major impediment to investment is the way in which defense contracts are implemented. The Navy must find innovative ways to provide incentives for industry to invest in technology.

Respondents to the survey provided a summary of their maritime-related research and development expenditures for 1996-1998 and estimates for 1999 and 2000. For the purpose of this study, maritime R&D was broken into four sections:

- *Basic research* was termed as systematic study directed towards greater knowledge and observable facts without specific applications towards processes or products.

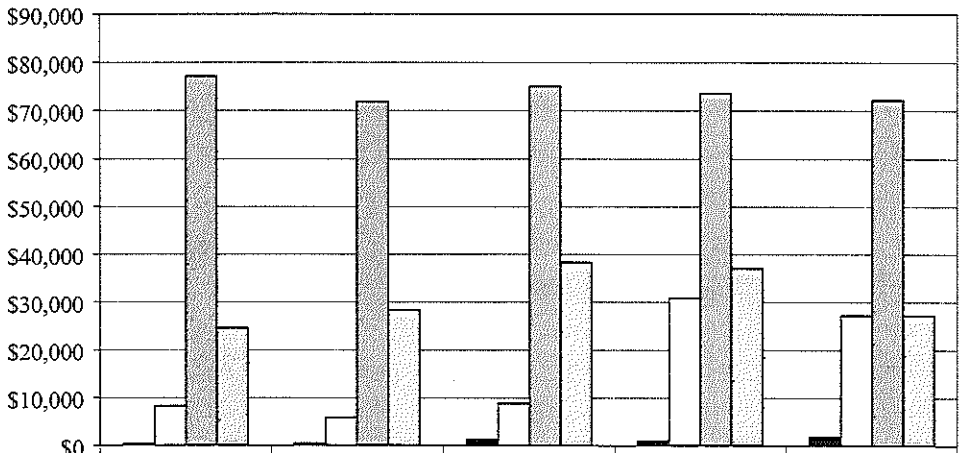
- *Applied research* was defined as gaining knowledge or understanding in order to determine the means to achieve a specific goal, such as production of useful materials or better systems and methods.

- *Development* was termed as the design or testing of prototypes for feasibility and risk reduction.

- *Systems/process studies* was defined as studying to improve or optimize economic operations through systematic review.

R&D activity was reported in 21 of the 118 respondents, indicating that R&D is not widely pursued by this community. The data is provided in the chart below:

Chart 5.1 R&D Performed by the Shipbuilding and Repair Industry, 1996-2000 (in $000s)



	1996	1997	1998	1999	2000
Basic	$400	$525	$1,225	$1,025	$1,825
Applied	$8,223	$5,817	$8,768	$30,796	$27,188
Development	$77,151	$71,886	$75,092	$73,555	$72,181
System/Process Studies	$24,542	$28,346	$38,257	$36,997	$27,164

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

As highlighted in the chart above, the majority of R&D expenditures were for development, which averaged 60.7 percent of the total for the five-year period. A smaller amount went for

systems/process studies (25.5 percent) and applied research (13.3 percent). Applied research expanded greatly in the final two years because of one company's input. Little expenditure was for basic research (0.8 percent), all of it reported by one shipyard.

Total R&D spending averaged almost $122 million annually during the 1996-2000 period. The high was in 1999, when its value reached $142.3 million. Over the five-year period, an upward trend can be observed. As a percent of the industry's total revenues, R&D spending was calculated at 1.23 percent. The company-funded portion of this R&D was about half, or 0.64 percent. In contrast, the aerospace industry's total was more than 12 percent of total revenues during this time period; 4 percent of which was company-funded.

The Big Six shipyards accounted for about 80 percent of industry R&D and two-thirds of industry revenues. Their ratio of R&D spending to revenues was 1.49 percent, of which about half was company-funded, considerably less than for the aerospace sector. This ratio highlights the limited research infrastructure in shipbuilding.

Chart 5.2 R&D Performed by the Big Six, 1996-2000
(in $000s)

	1996	1997	1998	1999	2000
Basic	$0	$0	$0	$0	$0
Applied	$2,296	$4,317	$5,234	$28,361	$25,763
Development	$73,088	$66,324	$61,816	$50,857	$50,581
System/Process Studies	$21,915	$24,864	$26,824	$22,321	$22,759

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

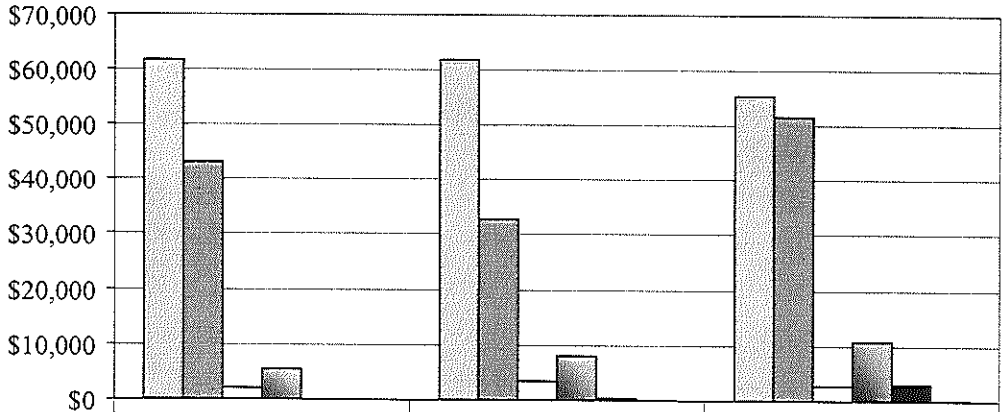
Analysis of the reported R&D personnel data indicates that only about one percent of industry employees are engaged in R&D. One-fourth of these employees have at least a college degree. Several companies appeared unable to provide a definitive number for people engaged in R&D,

which left the impression that it is not tracked. Also, the small number of shipyard R&D personnel impacts their ability to interface with supporting organizations, such as universities and government laboratories that might provide R&D input to shipbuilders.

Sources of R&D Funding

Respondents were asked to identify the source of R&D funding for the three-year period from 1996 to 1998. Sources listed in the survey included company-funded, the U.S. Navy, other U.S. DoD, other U.S. government, U.S. private entities, foreign governments, and foreign private entities. The chart below shows the amount of funding by source:

Chart 5.3 Shipbuilding and Repair: Sources of R&D Funding, 1996-1998 (in $000s)



	1996	1997	1998
Company-funded	$61,784	$61,888	$55,346
US Navy	$43,043	$32,676	$51,593
Other DoD	$2,139	$3,482	$2,785
Other Govt	$5,549	$8,105	$10,808
US private entity	$0	$485	$3,056
Foreign private	$0	$100	$100

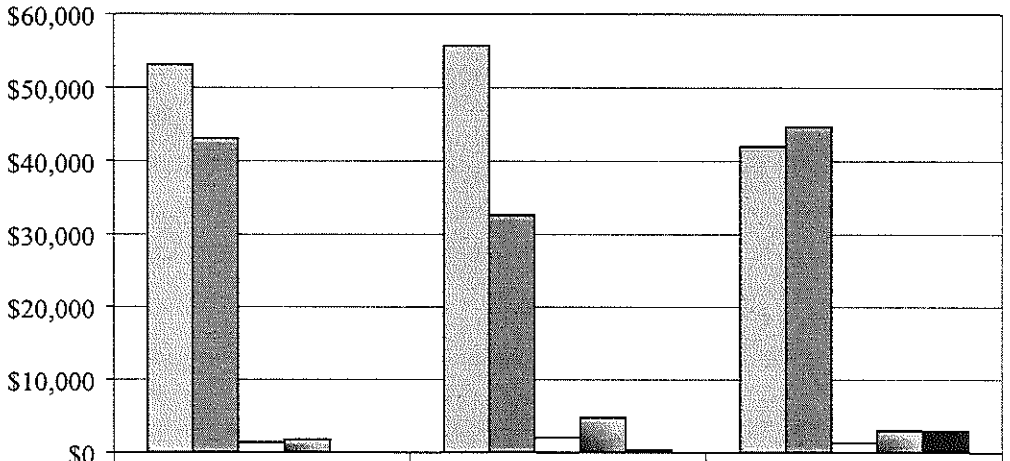
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Total funding for the three years was $338.6 million, or an annual average of $112.9 million. Company funded R&D amounted to $179 million, which was 52.2 percent of the total funded. The Big Six accounted for 84.2 percent of the company funded R&D. The U. S. Navy funded $127.3 million, 41.7 percent of the total. The Big Six received nearly 95 percent of the Navy's funding. Other government entities sponsored $32.9 million, or nearly five percent of the total.

Most of this, $24.5 million, was by non-DoD agencies, such as the National Oceanic and Atmospheric Administration, Maritime Administration, and the Energy Department (although specific agencies were not specified). U.S. private entities were responsible for about $3.5 million (1.2 percent). All of the foreign private funding, $200,000, went to one (non-Big Six) firm, and no foreign government reportedly supplied U.S. shipbuilders with any R&D funding. Other than funding from the Navy, the Big Six received less than half (about $17.6 of the $36.6 million total) of all other outside funding.

The Big Six funded $150.7 million themselves and received $120.4 million from the U.S. Navy for the three years 1996-1998. These two sources combined financed 93.9 percent of the Big Six's R&D.

Chart 5.4 Big Six: Sources of R&D Funding, 1996-1998 (in $000s)



	1996	1997	1998
Company-funded	$53,123	$55,685	$41,926
US Navy	$43,041	$32,646	$44,670
Other DoD	$1,381	$2,019	$1,353
Other Govt	$1,753	$4,771	$2,968
US private entity	$0	$385	$2,956

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Shipbuilding is a good example of the problems highlighted in the November 2000 Defense Science Board assessment of how the Pentagon can improve the health of the U.S. defense industrial base. It concluded "that the Defense Department must move aggressively to help

American companies attract and retain top talent as well as improve overall profitability by continuing changes to profit policies and boosting investment in defense research and development."

5.3 Technology and Development Needs (Strengths/Weaknesses)

Because over 70 percent of all U.S. shipbuilding revenues are defense-based, most technological advancements for ships in the U.S. are developed in government research facilities rather than within the shipbuilding industry. Much of the development is directed towards advanced propulsion systems, noise abatement, weapons, and communication systems, and has little application to commercial shipbuilding. In an attempt to identify the technology capabilities and needs of the U.S. shipbuilding industry, respondents were asked to assess their specific capabilities as *strong*, *weak* or *not a concern* for 21 maritime technology categories. The charts below present the self-assessment data for both large- and medium-size firms.

Table 5.1 Self Assessment of Technology Capabilities
Firms with Revenues over $50 Million

Maritime Technology Category	Strong	Weak	N/A
Cost Estimating/Cost Benefit Analysis	20	2	1
Safety/Vulnerability and Survivability System and Components	14	2	6
Noise Abatement and Quieting Systems and Components	9	2	8
Electromagnetic Signature and Silencing Systems and Components	5	3	14
Propulsion and Energy Systems and Components	15	1	6
Auxiliary Machinery Systems and Components	15	1	7
Electrical Machinery Systems and Components	15	1	7
Cargo Handling/Hull and Deck Machinery Systems and Components	15	1	7
Habitability and Outfitting Systems and Components	15	1	7
Undersea Vehicle Deployed Systems and Components	3	3	16
Hull Forms and Propulsors Systems and Components	12	3	8
Material and Applications	15	1	7
Structural Systems and Components	17	0	6
Small Craft Systems and Components	6	2	15
Amphibious and Land-Based Vehicles Systems and Components	3	2	17
Naval Architecture and Integrated Ship Design and Support	11	7	5
Shipbuilding and Manufacturing Technology	15	5	2
Analytical and Experimental Aerodynamics	1	2	19
Environmental Quality Sciences Systems	10	4	8
Logistical Support Systems	8	5	8
Electrochemical Power Systems and Components	3	0	19

Based on reports from 23 firms.
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Table 5.2 Self Assessment of Technology Capabilities Firms with Revenues under $50 Million			
Maritime Technology Category	**Strong**	**Weak**	**Not a Concern**
Cost Estimating/Cost Benefit Analysis	55	5	13
Safety/Vulnerability and Survivability System and Components	35	7	32
Noise Abatement and Quieting Systems and Components	19	10	45
Electromagnetic Signature and Silencing Systems and Components	4	6	62
Propulsion and Energy Systems and Components	44	5	26
Auxiliary Machinery Systems and Components	47	4	24
Electrical Machinery Systems and Components	42	8	25
Cargo Handling/Hull and Deck Machinery Systems and Components	35	7	32
Habitability and Outfitting Systems and Components	40	5	30
Undersea Vehicle Deployed Systems and Components	2	8	65
Hull Forms and Propulsors Systems and Components	30	9	36
Material and Applications	42	11	22
Structural Systems and Components	50	4	18
Small Craft Systems and Components	30	2	42
Amphibious and Land-Based Vehicles Systems and Components	8	6	60
Naval Architecture and Integrated Ship Design and Support	18	15	40
Shipbuilding and Manufacturing Technology	28	13	33
Analytical and Experimental Aerodynamics	2	7	64
Environmental Quality Sciences Systems	14	10	49
Logistical Support Systems	17	11	45
Electrochemical Power Systems and Components	3	7	61

Based on reports from 75 firms.
Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Both large- and medium-sized firms reported weaknesses in *logistical support systems*, *naval architecture and integrated ship design and support*, and *shipbuilding and manufacturing technology*. In addition, medium-sized firms reported weaknesses in *naval architecture and integrated ship design* and in *environmental quality sciences*.

5.4 Technology and Development Needs (Specific)

For technologies identified as weak in the previous question, survey respondents were asked to describe specific maritime technology or development needs. A total of 4 large- and 27 medium-sized firms addressed acknowledged weaknesses. An overview of each follows:

Large Firms

Large firms indicated a need to better understand Integrated Logistical Support (ILS) systems. ILS systems support services have become increasingly important because the average age of ships in service has increased. ILS in the context of Navy materials was also identified as a

weakness. Vendor automation for technical and support data, effective computer modeling capabilities for lifecycle costs, and standardized configuration management programs were also identified as weaknesses.

Performing effective cost/benefit analysis was an area in which one firm was trying to gain proficiency. System safety analysis was cited as a technology currently being addressed using subcontractors, although the firm expressed a desire to develop in-house capability in this area. Other respondents indicated the need for better methods to analyze production efficiencies and enhance production techniques.

2nd Tier Firms

Medium-sized firms also indicated a need to better understand a broad range of technologies and disciplines. Respondents cited weaknesses in all production management skills that addressed designing for manufacturability, tooling for vessel assembly, improved methods for estimating, cost collection, and variance analysis. Other areas of concern included advanced outfitting processes and capabilities, electrical/electronic systems and components, maintenance and operations of ship systems, cargo handling, deck machinery systems, and diesel engine noise abatement. Where practical, firms outsource work to subcontractors that is too costly or difficult to perform with existing personnel. Others that relied on contractors expressed an interest in developing in-house expertise.

One respondent suggested that environmental regulations warrant an industry-wide study. It was stated that while there is currently a group of small companies working to understand and effectively respond to both existing and developing environmental regulations, they are in no position to develop the technological environmental improvements needed by the industry.

5.5 Teaming with Other Organizations

Respondents were asked to give their opinion of teaming with the government, academia, private entities, foreign entities, or other organizations not listed. The data received from respondents was separated for large- and medium-sized firms to show their respective preferences.

Table 5.3 1st Tier Firms' Opinion of Teaming					
Organization Type	**Favor Strongly**	**Favor**	**Neutral**	**Disapprove**	**Disapprove Strongly**
Government	72%	18%	9%	0	0
Academic	50%	30%	20%	0	0
Private	54%	36%	9%	0	0
Foreign Entities	36%	18%	45%	0	0

Based on 11 firm reports

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Large firms show a strong preference for teaming with the government and private entities (90 percent), and the academic community (80 percent). Teaming with foreign entities was viewed less favorably (55 percent). This preference may be related to the dependence of large firms on defense programs, the size of projects large maritime firms typically undertake, and the associated overhead that must be absorbed with each project. No other organization types were cited, and no large firms disapproved of teaming arrangements.

Nearly all respondents provided information on their previous teaming experiences. According to respondents, occasionally the purpose of teaming was to provide technology not otherwise available within the company. At other times, teaming allowed firms to perform short-term work using idled engineering and design staffs of competitors, or to complement the expertise of a partner on major government-sponsored projects.

Table 5.4 2nd Tier Firms' Opinion of Teaming					
Organization Type	**Favor Strongly**	**Favor**	**Neutral**	**Disapprove**	**Disapprove Strongly**
Government	27%	31%	32%	4%	5%
Academic	23%	29%	43%	2.7%	2.7%
Private	35%	37%	27%	1.3%	0
Foreign Entities	11%	20%	55%	9.3%	5.3%
Other	2.7%	0	0	1.3%	0

Based on 75 2nd Tier firm reports

Source: U.S. DOC/BXA/SIES 1999 Maritime Survey

Second tier firms reported a marginal preference for teaming with private entities over teaming with the government, followed by the academic community and lastly by foreign entities.

Engineering subcontractors were included under the 'Other' category and were ranked *favored strongly* by two companies. Several firms disapproved of teaming with the government, foreign entities and the academic community though no explanation was provided. A sizeable proportion of respondents (27 percent) neither favored nor disapproved of teaming, suggesting greater skepticism of teaming among smaller firms.

About one-fourth of all 2nd tier respondents provided information about previous teaming experiences. A wide variety of partners, including the government, universities, industry associations and environmental regulators participated in these teaming relationships. The firms reported relationships that supported vessel construction, conversion and repair projects, outfitting and maintenance work, ship disposal, safety projects, training programs for trade skills development, foreign licensing agreements, and technology sharing. In some instances, teaming with former competitors enabled both firms to compete successfully for work that otherwise would have gone to another firm. Teaming has also been responsible for improving environmental stewardship and for enhancing relationships with regulatory agencies.

Based on the acceptance of teaming by the industry and on the perceived need for increased R&D, the industry may be receptive to mechanisms that would foster cooperative research activities. Cooperative ventures could make R&D investments more affordable and reduce the associated risk.

Part II - Supplemental Information

6. History of U.S. Government Programs and the Role of the Merchant Marine

Little can be understood about the American shipbuilding and repair industry without first understanding underpinning laws and federal government involvement. The primary reason for reviewing the legal background is the long-standing status of shipbuilding as a strategic industry. The industry's importance goes beyond building the nation's warships and serving the waterborne transportation needs of the United States; shipbuilding is an integral part of American economic security and national defense. A tanker that transports oil for home heating can also serve a role in national security as a naval supply ship. Therefore, a vital role served by American domestic shipbuilders is to provide the government with adequate vessels for service in naval auxiliary roles and sealift operations. Some of these sealift fleets will be discussed later in this section.

The expansion of global trade, the end of the Cold War, and advances in ship technology all over the world are a few of the recent developments that confront the U.S. shipbuilding industry. The following section discusses a few of the most important U.S. government maritime policies as they are applied to the shipbuilding industry.

The following four statutes are vital to the current status of the American shipbuilding industry:

- The Passenger Vessel Services Act (PVSA) of 1886 (46 App. U.S.C. 289) —passengers transported between two points within the United States by water must be carried on an American built, flagged, owned, and operated vessel.
- The Merchant Marine Act of 1920 (46 App. U.S.C. 861 (1999)) —established a method of transfer of government-owned vessels to private owners after World War I. Section 27 of this act, known as the Jones Act, mandates that waterborne commerce carried between two points within the United States be transported on an American built, flagged, owned, and operated vessel.
- The Merchant Marine Act of 1936 (46 App. U.S.C. 1101 (1999)) —established a system of federal financial assistance for the shipbuilding industry, including Title XI loans.
- Oil Pollution Act of 1990 (OPA-90) (33 U.S.C. Sec. 2701-2761) —mandates that all liquid bulk tankers entering U.S. ports be double-hulled by the year 2015.

The legislative issue of paramount importance to the shipbuilding industry is Section 27 of the Merchant Marine Act of 1920, also known as the Jones Act. The other pieces of legislation in the following section were chosen due to their significance for both the immediate and long-term future of the industry. The PVSA has protected the American cruise ship industry for over 100 years and is currently providing a market for at least one shipyard trying to establish itself in the passenger cruise vessels industry. The Merchant Marine Act of 1936 outlines the government programs and subsidies that continue to apply to the industry today. The OPA-90 was primarily passed as environmental legislation in order to ensure that liquid bulk cargo transported to American ports was transported in double-hulled tankers. This requirement should lead to opportunities for American shipyards for either tanker upgrades or new tanker construction.

6.1 Brief History of Maritime Legislation

Maritime legislation in America finds its foundation in some of the very first acts passed by an American sovereign government in the late 1700s. This legislation came at a time when navies were the principal force of a nation's military and were relied upon to represent a country's prestige and power. Following the American Revolution, the First Congress passed legislation aimed at protecting the U.S. shipbuilding industry by prohibiting or limiting ships built or flagged in foreign nations. It was believed that allowing foreign ships to trade in America would result in the United States not being able to provide for its own economic and national security needs. Many in Congress felt it necessary to ensure that the maritime infrastructure of the U.S. was economically protected and preserved for reasons of self-sufficiency.

Most forms of maritime-related legislation passed by the U.S. Congress have centered on this theme of self-reliance. Allowing foreign vessels to infiltrate the American market may foster dependence on foreign-flagged ships, thereby hindering American efforts to protect itself in a time of emergency. Politically, barring foreign vessels from certain rights and privileges in American markets also helps to ensure that the American shipbuilding industry possesses a significant presence in the domestic market, which leads to greater prosperity for the industry and keeps workers employed.

6.2 The U.S. Passenger Vessel Services Act of 1886

The U.S. Passenger Vessel Services Act of 1886 (PVSA) declares that passengers being transported by water from one point within the United States to another be carried on an American built, flagged, owned, and operated vessel crewed by U.S. citizens. The PVSA was passed to ensure that the American economy directly benefited from the commerce that took

place within its borders and on its waterways. Another rationale for the PVSA was that it could help provide an adequate maritime infrastructure that would protect American jobs and economic security.

Currently, only one American-built vessel operates in the U.S. oceangoing passenger cruise ship fleet. This ship is the *S.S. Independence*, which was built in 1951 and which operates between the Hawaiian Islands. Despite the small cruise ship market, supporters of the PVSA claim there is a need to protect this segment of the American maritime industry. Supporters claim protection is needed because foreign competitors are not subject to U.S. laws and regulations and pay little, if any, taxes for their operations. The PVSA ensures that any future American cruise vessels would be manned, owned, and built by American citizens and benefit the U.S. economy. For example, the Australian firm Austal entered into a joint venture with Bender in order to enter the American passenger vessel market and, therefore, demonstrates what many feel is the utility of the PVSA.

Over one hundred years after it was passed, the protection provided by the PVSA helped the U.S. federal government develop the 1997 U.S. Flag Cruise Ship Pilot Project. Shortly afterward, Ingalls and American Classic Voyages Company (AMCV) formed Project America. Project America is a contract between Ingalls Shipyard in Pascagoula, Mississippi and AMCV for two 256-meter, 1,900 passenger oceangoing cruise ships. These ships will be the first ordered from an American shipyard since the *S.S. Independence* nearly fifty years ago. Ingalls has already invested $130 million and is receiving Title XI funding for the project. The first ship is scheduled for delivery in early 2003 and the second a year later.

Opponents of the PVSA believe that a lack of foreign competition has stunted growth, not just in the production of U.S. cruise vessels but also in the American tourism industry. One of the consequences of the PVSA is that American tourists are forced to board cruise ships from foreign ports in order to reach destinations not serviced by U.S. flagged cruise ships, thus hurting potential economic growth for U.S. port cities in the way of both revenues and employment opportunities.

Senator John McCain (R-AZ), as Chairman of the Senate Commerce, Science, and Transportation Committee, is leading the current movement to change the PVSA to allow foreign-flag cruise vessels to operate between U.S. ports where U.S.-flag service does not exist. In late January 2001, McCain introduced S. 127, the United States Cruise Vessel Act. The legislation would permit a two-year time span in which foreign-built cruise ships could be flagged in the United States and used in the domestic market. Cruise ship owners who flag foreign-built ships will be required to contract a U.S. shipyard for one more vessel than the total number of foreign-built vessels they bring into domestic operations. All repair and maintenance

work on the foreign-built cruise ships will be done in American shipyards. It is hoped this proposed legislation would open potential cruise routes and expand the American tourism industry.

6.3 The Merchant Marine Act of 1920 (The Jones Act)

According to Section 1 of the Merchant Marine Act of 1920, "It is necessary for the national defense and for the proper growth of its foreign and domestic commerce that the United States shall have a merchant marine of the best equipped and most suitable types of vessels sufficient to carry the greater portion of its commerce and serve as a naval or military auxiliary in time of war or national emergency, ultimately to be owned and operated privately by citizens of the United States." This preamble has served as a basis for federal government involvement in the shipbuilding industry ever since. The Act outlined the process by which the excess merchant vessels created by the Shipping Board during World War I could be transferred from government ownership to private operators. The federal government sold its excess merchant vessels at a low enough price that American operators were soon able to greatly increase the presence of American made ships in international trade.

The Jones Act

The Merchant Marine Act of 1920 also had a lasting effect on waterborne commerce. At a time when American politics were becoming increasingly isolationist, Senator Wesley Jones of Washington added Section 27 to the law, which restricted the use of foreign-flagged vessels from waterborne trade between two points within the United States. Since 1920, the law now known as the Jones Act has established the legislative foundation for the American maritime industry. The Jones Act requires that all cargo shipped between two points within the United States be transported on board a vessel built and flagged in America that is owned and crewed by U.S. citizens.

Since its passage, the Jones Act has continually been justified because it provides the nation with a valuable merchant marine fleet and mariner crews in times of emergency. Supporters label this fleet "the fourth arm of the American military." In his capacity as Chairman of the Joint Chiefs of Staff, General Colin Powell stated, "I have come to appreciate first hand why our merchant marine has long been called the nation's fourth arm of defense...We are a maritime nation. We must be able to project power across the seas. This means that not only do we need a strong Navy, but a strong maritime industry as well." The Jones Act serves the interest of the U.S. because it provides a fleet of sealift-capable vessels, a workforce of experienced and

knowledgeable people, and a shipbuilding industrial base that can be used to protect American economic and military security. Furthermore, according to Presidential National Security Directive 28 dated October 5, 1989, cabotage laws such as the Jones Act are preserved "to ensure that sufficient military and civil maritime resources will be available to meet defense deployment and essential economic requirements in support of our national security strategy."

Not only does the Jones Act serve a critical role in national defense and maritime infrastructure, it also maintains American vessel ownership, provides investment opportunities, and provides job opportunities for merchant mariners. These employment opportunities are valuable in providing jobs for American citizens and maintaining a viable labor pool for the merchant marine. The Jones Act also protects the American shipbuilding industry from some forms of unfair international competition from overseas shipyards, such as subsidies from foreign governments and the tax exemption status given to foreign-flagged vessels. Ships made for the American market must comply with environmental standards and safety regulations. These are enforced by the U.S. Coast Guard and can make American vessels more costly to construct and operate, but also less environmentally hazardous.

The U.S. Transportation Command (USTRANSCOM) issued a report in 1996 entitled *So Many, So Much, So Far, So Fast* that raised the issue of the health of the American shipbuilding industry in its role in national defense. It was reported that during the Gulf War the U.S. maritime industry could not supply enough vessels to meet the sealift demands of the U.S. military. Although U.S. flag vessels were largely responsible for transporting cargo across the Atlantic, problems arose in activating U.S. flagged ships for service, and the U.S. military contracted foreign-flagged vessels to assist in delivery of cargo to the Gulf. In fact, statistics from the USTRANSCOM report showed that foreign-flagged vessels delivered over 40 percent of all cargo in January, over 38 percent in February, and over 69 percent in March of 1991.

The cause for concern was not the performance of U.S. sealift ships, which was admirable, but of the volume of cargo on foreign-flagged ships during the hostilities. The use of foreign-flagged vessels can have two detrimental side effects for national defense. One was demonstrated during the Gulf War, as some of the contracted foreign-flagged ships refused to enter the Persian Gulf during the conflict. Another is that their use contributes to the erosion of America's own capabilities. Although U.S. military forces were ultimately successful in the Persian Gulf and the sealift operations were declared to be impressive, it is likely that the state of U.S. shipbuilding will necessitate the use of foreign-flagged vessels during a U.S. military conflict again, especially if the next conflict is larger in scale and longer in duration.

General Hansford T. Johnson, then Commander in Chief of USTRANSCOM, said of sealift operations during the Gulf War that "it worked okay this time but what if foreign governments

don't go along with the operations [next time]?" Following the Gulf War, MARAD and USTRANSCOM set about improving U.S. sealift capabilities, expanding the number of roll on/roll off (RO/RO) vessels in the Ready Reserve Force (RRF). These vessels are necessary for vehicle transport and sealift transportation. During the Gulf War, the U.S. chartered 105 RO/RO vessels, of which 41 were foreign-flag charters. The lack of RO/RO vessels during the war spurred the Navy to acquire foreign-built RO/ROs and place them in the RRF. The need for foreign-flagged vessels during hostilities and the response of the Navy in buying foreign-flagged RO/RO vessels after the war revealed that the Jones Act, by itself, did not provide for all wartime needs.

As with the PVSA of 1886, potential reforms for the Jones Act are consistently under discussion in Congress. In May 1999, Senator Sam Brownback (R-Kansas) introduced S.1032 (Freedom of Transport Act of 1999) in order to allow non-U.S. built trading ships to operate within the United States. Under the proposed legislation, foreign-built ships would be permitted to transport goods on American inland waterways but would have to be crewed by American citizens and comply with U.S. safety and environmental standards. This, supporters claimed, may not only help to lower the cost of shipping on U.S. waterways but also increase demand for American ship repairers due to an expansion in volume.

6.4 Merchant Marine Act of 1936, as amended

In the mid-1930s, the U.S. government was finding it difficult to coordinate its sealift needs with private ship operators. The high cost of operating ships under the U.S. registry hindered the operations of private ship owners. The government wanted to find a way to subsidize private shipbuilders and operators in order to offset high operating and construction costs. American politicians were also hoping a resurgence of the industry would increase employment opportunities for American merchant mariners and shipbuilders during the Great Depression. The result was the Merchant Marine Act of 1936, an act Andrew Gibson and Arthur Donovan (authors of *The Abandoned Ocean*) label "the most comprehensive legislation ever enacted by the federal government." Though amended, even after more than 60 years, some of its programs still exist and it continues to serve as "the basic legislation that defines American maritime policy today."

The Merchant Marine Act of 1936 introduced two subsidy programs to help finance the American shipbuilding industry: the Construction Differential Subsidy (CDS) and the Operating Differential Subsidy (ODS). The CDS helped fund shipyards constructing and rebuilding ships used in foreign trade. The ODS offered government assistance for American vessels operating in foreign commerce for the United States. These subsidy programs were vital to the survival of

the U.S. commercial shipbuilding industry and helped American shipyards compete in the international market. In 1982, however, funding for these two subsidy programs ended. It was claimed that proposed budgets for a 600-ship Naval fleet would infuse sufficient funds to American shipyards to keep them fully operational. After funding for the subsidies stopped, however, employment and output in the shipbuilding and repair industry declined drastically. The number of oceangoing ships over 1,000 gross tons produced in the United States fell to zero between 1987 and 1989.

Title XI and the Capital Construction Fund

Two financial programs initially established by the Merchant Marine Act of 1936, as amended, still remain in effect today. Title XI of the Merchant Marine Act of 1936 established a Federal Ship Financing Guarantee Program to provide full faith guarantees from the U.S. government for shipyard projects such as ship construction, reconstruction, financing, and other modernization plans. Nearly all forms of commercial maritime vessels are eligible for Title XI funding, which is currently administered by MARAD. The U.S. Congress appropriated $30 million for the program for FY2001.

The scope of the Title XI program was expanded with the signing in November 1993 of the National Defense Authorization Act of 1994, which contained the National Shipbuilding and Shipyard Conversion Act of 1993. The goal of this act was to assist U.S. shipyards in becoming internationally competitive. The 1993 Act allowed Title XI guarantees to be extended to ships being built for export as well as for modernization of U.S. shipyard facilities. As a result of the 1993 legislation, interest and approvals in the Title XI program have increased. As of March 1, 2001, MARAD had pending loans worth over $4.7 billion. The legislation also established a National Shipbuilding Initiative program to support the industrial base for national security objectives.

Another financial assistance program established by the Merchant Marine Act of 1936 that is still used today is the Capital Construction Fund (CCF). The CCF offers ship owners and operators tax deferrals for the construction, reconstruction, or purchase of vessels from U.S. shipyards. The aim of the CCF was to create enough incentive for ship owners to buy vessels from U.S. shipyards so that they could then in turn be entered into service for both foreign and domestic trades. Avondale Industries is using funds it has withdrawn from the CCF administered by MARAD to help complete its order of double-hulled tankers for Polar Tankers, Inc. (a subsidiary of Phillips Petroleum).

6.5 Oil Pollution Act of 1990

The Oil Pollution Act of 1990 (OPA-90) started a phase-out period that will eventually require all liquid bulk tankers entering U.S. ports to be double-hulled by 2015. This legislation, although environmental in nature, could offer two promising opportunities for U.S. shipbuilders: either the existing single-hulled fleet of tankers must be upgraded, or new orders will be placed for double-hulled tankers. The need for double-hulled tankers gives the U.S. shipbuilding industry the opportunity to enhance its production capabilities in the Jones Act domestic market. Entry into the international double-hulled market appears unlikely.

It has been estimated that about one-third of the world's aging single-hulled petroleum tanker fleet enters U.S. ports. Realizing the potential for growth in tanker construction, American shipyards have started to make capital investments in order to prepare for the expected surge in demand for double-hulled tankers. Although it was reported in *Industry Outlook 2000* that the construction boom expected as a result of OPA-90 has not yet materialized, MARAD cites evidence showing that a number of medium and small shipyards are expected to deliver double-hulled tankers before the end of 1999.

Also, the OPA-90 enters into force at a pivotal time in terms of new opportunities for oil exploration. The recent boom in offshore oil and gas exploration in the Gulf Coast region is already aiding the American shipyards located in the area. *Industry Outlook 2000* reported in 1999 that the demand for offshore supply vessels and offshore tank barge construction for the region had increased, as had demand for repair services for vessels calling at U.S. ports on the Gulf Coast. This increased tanker presence on the Gulf Coast in combination with the OPA-90 contributed to a shortage of skilled labor in the area.

Thus far, two shipyards have received orders for double-hulled tankers. ARCO Marine, which has since been purchased by Phillips Petroleum Co., placed the first order for three crude carriers from Avondale in 1997 and 1998 for close to $500 million. Polar Tankers, a Phillips subsidiary, has since exercised its option for two more tankers worth an additional $400 million. On September 15, 2000, British Petroleum announced that it was awarding NASSCO a contract for three of its own double-hulled crude oil tankers. The contract is worth $630 million and will employ the services of one-third of NASSCO's workforce stationed in San Diego.

6.6 Policies of the 1990s

Although peacetime naval budgets were at record highs during most of the 1980s, the commercial shipbuilding sector lost most of its already limited share of the international market.

Commercial production increased slightly at the start of the 1990s with the Gulf War, but this short conflict did not create the prolonged demand on the market needed for the U.S. shipbuilding industry to start a period of sustained increases in output. Early in the tenure of the Clinton administration, the federal government announced a plan for the American shipbuilding industry called "Strengthening American Shipyards: A Plan for Competing in the International Market." This plan was incorporated into the National Defense Authorization Act of 1993. One of its most significant provisions called for improving commercial competitiveness through the creation of the MARITECH program.

MARITECH

MARITECH was initially created as a five-year, $220 million federal program, which was administered by the Defense Advanced Research Projects Agency (DARPA) in the Department of Defense with the assistance of MARAD. It was aimed to help American shipbuilders adopt modern technologies to improve their competitiveness and to build a stronger infrastructure for the American maritime industry. Through MARITECH, American shipbuilders matched or exceeded the funds expended by the federal government for various shipyard related projects. This federal support would not only assist American shipyards, but would also benefit the U.S. Navy, as American commercial and defense shipbuilding capabilities were updated simultaneously.

The five-year program assisted the American shipbuilding industry in improving its competitiveness through better marketing, greater use of technology, development of new and better ship designs, and improved overall productivity. It was believed that by helping the U.S. shipbuilding industry improve its competitiveness, the shipbuilding industrial base would be preserved during a time of defense downsizing. Although government and industry jointly funded MARITECH, the program was led primarily by private industry. Several firms cited MARITECH as one of the reasons for increases in their business.

Following the fifth and final year of MARITECH in 1998, the desire to extend the program led to the MARITECH Advanced Shipbuilding Enterprise (ASE), with Navy RDT&E investment established at $20 million per year for 10 years beginning in FY 1999. Total funding was subsequently reduced to $77 million, although current Navy leadership intends to fully fund the project for FY 2001 and FY 2002. Responsibility for MARITECH ASE was given to the Naval Sea Systems Command (NAVSEA) and focused on researching and developing technologies that are intended to reduce the cost of warships for the U.S. Navy. Another focus of MARITECH ASE is helping U.S. shipyards compete internationally. The program was renamed NSRP ASE to reflect the role of the National Shipbuilding Research Program, a group comprised of eleven leading shipyards.

Maritime Security Program

In 1996, Congress passed the Maritime Security Act, which created the Maritime Security Program (MSP). Currently supervised by MARAD, MSP is designed to provide the U.S. government with an active core of privately owned, U.S. flagged, and U.S. crewed dry-cargo vessels that can protect and serve U.S. interests yet still be commercially viable in the international marketplace. MSP vessels can be built either abroad or domestically. The maintenance of this MSP fleet also supports the skilled workforce of the maritime industry, replaces the Operating Differential Subsidy program, and helps preserve the presence of U.S. flagged ships in foreign trade. MSP, which currently includes 47 ships, offers compensation to participants in the ten-year program who invest in projects to improve the efficiency of their operations and reduce costs. The $100 million appropriated annually helps offset the higher cost operators incur for keeping their ships on the U.S. register. MSP funding for each of its vessels was set at $2.1 million per year and, in return, MSP vessels must be made available to the DoD during a time of war or national emergency. Therefore, in exchange for supplying funds to MSP vessels, the U.S. government gains access to commercial vessel capital assets that are estimated to be worth $8.5 billion.

6.7 Government Assistance: Industry Comments

American shipyards view their relationship with the government primarily in a positive way and favor U.S. government assistance and cooperation. The most popular forms of U.S. government support are the Jones Act and Title XI financing. Keeping the Jones Act in place and extending government-funded programs were the most common answers to a question in the BXA survey regarding how the U.S. government can be most helpful to the industry. In fact, most commercial shipyards directly linked their future to government support.

Some of the shipyards surveyed cited alternatives to federally financed programs. Partnerships with state or local governments and research institutions have helped support several American shipyards. These non-Federal agreements will increase in importance as the maritime industry continues to explore commercial opportunities.

6.8 Role of the Merchant Marine in National Security

Part of the reason the health and competitiveness of the shipbuilding industry is linked with federal programs is the role of the merchant marine in supporting American national defense and economic security. Privately owned American merchant vessels are used not only for their cargo

carrying capacity in waterborne commerce, but also as a naval auxiliary fleet capable of sealift operations, including humanitarian assistance and military maneuvers. The partnership between the American shipbuilding industry and the federal government is evident in several programs outlined below.

National Defense Reserve Force

The National Defense Reserve Force (NDRF) was created as part of the Merchant Ship Sales Act of 1946. The NDRF consists of inactive merchant vessels that can be activated during a national emergency in 20 to 120 days. NDRF ships are docked at three ports: James River, Virginia; Beaumont, Texas; and Suisun Bay, California. Historically, NDRF ships were activated to handle increased shipping volume during the Korean War, the closing of the Suez Canal, the Berlin Crisis, and the Vietnam War. As of September 30, 1999, of the 312 ships in the NDRF, 111 were ready for disposal. Obsolete ships of the NDRF will be scrapped while others will be prepared for enrollment in the Ready Reserve Force.

Ready Reserve Force

The Ready Reserve Force (RRF) is a quick response subset of the NDRF. The RRF has been active in American military operations for much of the 1990s, supporting U.S. forces in the Persian Gulf, Somalia, Haiti, and the former Yugoslavia. During the Gulf War, 79 RRF ships handled 22 percent of all military supplies. As of June 30, 1999, following tests conducted by the DoD, nearly 100 percent of operational RRF ships received full mission-capable readiness ratings. The 91 total ships that comprise the RRF, the world's largest source of national emergency contingency shipping, are maintained by both the DoD and Department of Transportation and acquire their readiness status from MARAD.

Voluntary Intermodal Sealift Agreement

The Voluntary Intermodal Sealift Agreement (VISA) attempts to match the capabilities of commercial vessels with DoD requirements and prepare the vessels for possible deployment for military purposes. VISA is overseen by the Joint Planning Advisory Group (JPAG), which is comprised of representatives from both government and industry. JPAG Deployment is carried out in three stages. Commercial ships can still maintain their private schedules in Stages I and II but are subject to mandatory DoD preference in Stage III. VISA provides DoD with "assured access" to commercial intermodal capacity and links military transportation with the advanced system of waterborne commerce. MARAD recently announced a two-year extension of this program until February 2003.

Military Sealift Command

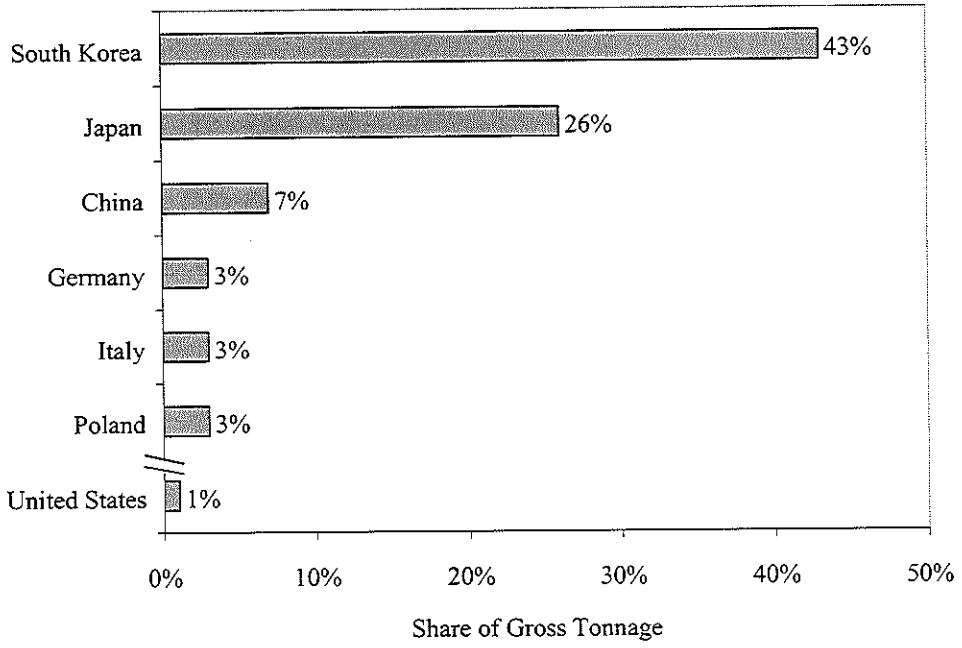
The Military Sealift Command (MSC) was officially created in 1970 and took over for the Military Sea Transportation Service. MSC provides U.S. military forces with a variety of goods ranging from ammunition to food during times of both peace and war. The Naval Fleet Auxiliary Force (NFAF) is an important part of MSC because it acts as a supply unit for U.S. Navy ships at sea. NFAF ships supply oil, ammunition, and other military items while also serving medical and tow needs for operating U.S. naval forces. MSC relies heavily on U.S. shipyards because it uses 'T' ships, vessels owned by the U.S. government and manned by American civilians. According to MARAD, these vessels receive a significant portion of money from the Navy's ship conversion and construction program. As of September 30, 1999, 12 T-ships were either on order or under construction at three American shipyards, Halter Marine, NASSCO, and Avondale. The total contracted price for this work is close to $2 billion.

7. International Shipbuilding Sector

7.1 The U.S. and International Competition

The United States is not currently a major player in the international commercial shipbuilding marketplace, ranking 10th in the world orderbook as of June 30, 2000. The chart below shows the six leading shipbuilding nations and how the United States compares with them:

Chart 7.1 Shipbuilding World Orderbook
June 30, 2000

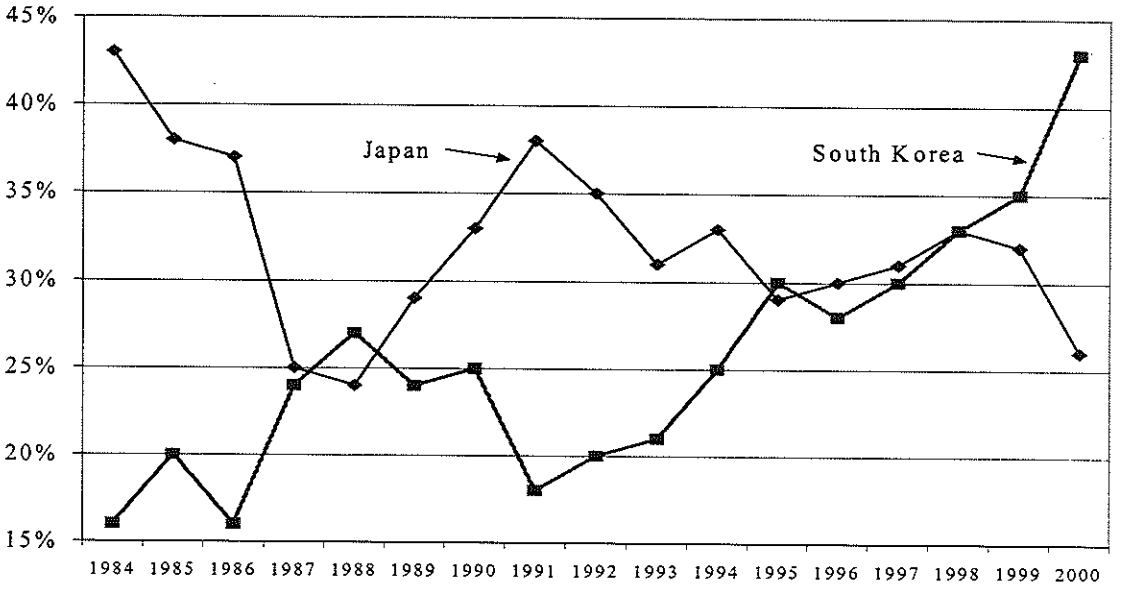


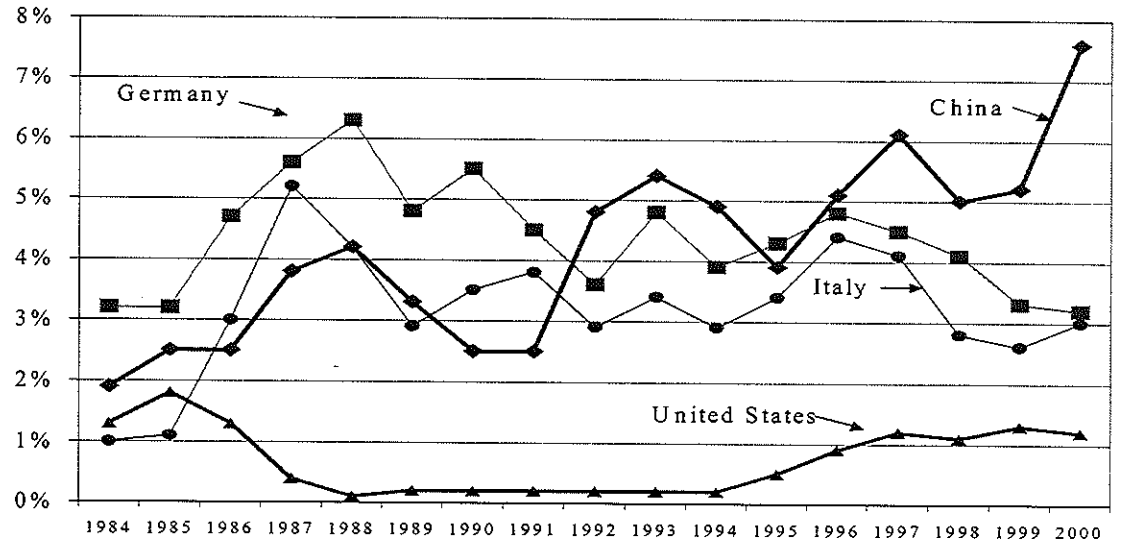
Source: *Lloyd's Register* (Taiwan, Croatia, and Finland, ranked 7-9 are not listed)

South Korea has gone from having only 3 percent of the market in 1979 to almost 15 times that share just over 20 years later. The United States has dropped from 9 to 1 percent in the same time period. Japan, the world leader in 1979, has a slightly higher share of the market now at 26 percent (compared with 23 in the mid-1980s). However, Japan has lost business and its dominance in the last five years to Korea and it faces increasing competition from China. China, a non-factor two decades ago, has demonstrated the potential to greatly increase its market percentage due to its huge production capacity. Much of Korea and Japan's gain was Europe's loss. European commercial shipyards owned half the market in the 1970s but now possess less than a fifth.

Korea has widened its lead greatly in the past year, landing about half of the new orders in terms of tonnage for the first six months of 2000. The Korean orderbook increased from 19 million gross tons on June 30, 1999 to almost 29 million a year later, increasing its world share by eight percentage points. The historical trends in market share are shown on the following two graphs. South Korea and Japan are shown on the top graph because their market shares are far greater than those of the other countries.

Chart 7.2 Shipbuilding World Orderbook
Gross Tonnage, 1984-2000





Source: *Lloyd's Register*

7.2 South Korea

South Korea has become the dominant country in the shipbuilding industry through the collaboration of government and industry and, according to many U.S. and European shipbuilders, collusion and dumping. The Korean shipbuilding industry, dominated by the multi-industry conglomerates known as *chaebols*, began its ascent as part of a national industrialization plan in the 1970s, then more than doubled its shipyard capacity in the mid-1990s. Hyundai is the largest shipbuilder in the world, by itself claiming a 13 percent share of the world market, almost all of which consists of ships for export. Other familiar names in the Korean industry include Daewoo and Samsung.

One probable explanation for recent Korean dominance comes from the results of the 1997 Asian monetary crisis. Following the crisis, South Korea received the largest-ever International Monetary Fund loan, $58 billion, in order to stabilize its currency. The Korean *won* fell from about 800 to the dollar in 1997 to 1,400 in 1998, a 75 percent decline. It then recovered somewhat to about 1,130 by 2000, but was still down more than 40 percent from prior levels. The European Union accused the South Korean government of using much of their IMF funds to subsidize Korean shipyards. As new Korean ship prices continued to drop and Korean market share climbed, competitors in other countries accused Korean *chaebols* of consistently selling under cost and colluding on bids. It is possible that Korean yards would compete in this way to acquire foreign capital for servicing short-term debt obligations; to increase long-term market share; and to utilize available resources, including the extra shipyard capacity, laborers, and steel. The *chaebols* are also able to hide shipbuilding losses in other sectors of their conglomerates.

A May 2000 European Commission report claimed that South Korean yards were selling ships between 11 and 32 percent below cost. Despite promises by the Korean Export-Import Bank that it would not lend to builders charging less than 95 percent of the international going rate for a particular ship, the European Union believes Korean shipbuilders are still selling well below market prices. The E.U. has threatened to ask the World Trade Organization to hear its grievances after May 1, 2001 if no agreement is reached with Korea on pricing regulation.

Lower labor costs in Korean shipyards compared to those in other countries' yards make a significant contribution to Korea's competitive advantage. Over the past decade, the average Korean shipyard has been spending less than half as much per worker per hour as have American and European yards, and only about one-third of what Japanese shipyard facilities pay, on average. This discrepancy with Japan, along with recent devaluation of the Korean won versus the Japanese yen, has helped push Korea over Japan in market share.

Korean yards produce ships in every major commercial category, including tankers, container ships, bulk carriers, and other cargo vessels. They are now also starting to increase their competitiveness in specialty items such as cruise ships, ferries, double-hulled tankers, offshore oilrigs and platforms, and small military ships. American and especially European builders had previously exploited these areas, but Korea's growth in these sectors does not bode well for American or European yards.

7.3 Japan

Japan's advantage over its competition in shipbuilding has been its worker productivity, which has consistently been the highest in the world. There has also been a history of government financial support for the industry, and, as in Korea, industrial conglomerates, or *keiretsu,* are the major shipbuilders. Japanese market share has fallen over the last two years in several categories, in part because of the stronger yen, and not only against the Korean *won* but also against the U.S. dollar. Share of tanker production dropped from 46 percent in 1998 to 38 percent a year later, and the percentage of the world's container ship orders placed in Japan fell from 25 in 1998 to 12 the following year. Meanwhile, South Korea's share of the same market went from 31 to 58 percent. Japanese yards, like some in Europe, are starting to phase out the building of certain types of cargo ships for which they cannot bid competitively with Korean and, in some cases, Chinese shipyards.

7.4 China

Shipbuilding in China has not grown as quickly as predicted by some industry experts, who projected a 10 percent or higher market share by the turn of the century. Inefficiency has been the biggest problem. Typical Chinese yards employ 9,000 to 12,000 workers, but these workers are not always kept busy; idle time is at least 17 percent of hours paid. China has experienced some wage inflation, but because so much of the labor costs are paid by the state, it is difficult to accurately gauge labor costs and compare them to those in other countries. In addition, wage inflation has not been uniform across geographic regions of China.

Evidence suggests that productivity gains have lagged behind costs. Poor management, corruption, lack of technical knowledge, mandates to use local suppliers regardless of cost, underutilization of the more than 800 yards, slow delivery times, and centralization have held China back in the shipbuilding market and may stunt further growth. The issue of centralization was addressed in 1999 when the China State Shipbuilding Corporation was split in two, with one entity in the north and one in the south. Chinese builders have become competitive

internationally, particularly in dry cargo and crude oil carriers, but their market share may not rise dramatically until some of the issues listed above are addressed. New orders have gone up substantially in the last year, however, with Chinese shipyards landing 19 percent of the 1999 worldwide orders in terms of tonnage. Prices for Chinese ships average about 10 percent below international market value.

Korean and Japanese Adjustment to Competition from China

With some analysts forecasting that China will overtake South Korea in market share by 2010, Japanese and Korean shipbuilders are currently trying to prepare for this eventuality. Kawasaki of Japan and Samsung of Korea have each gone into joint ventures with Chinese shipyards. Daewoo, which is in dire financial straits, is trying to sell its shipbuilding business, so far without success. Hyundai has spun off its heavy industry division, which includes shipbuilding, and that new company intends to cut shipbuilding as a percentage of its sales from 50 to 25 percent over the next decade. Daewoo and Samsung plan similar reductions. Every major Japanese shipbuilder except Hitachi lost money in 1999, so these companies are beginning to close yards and explore alliance and merger possibilities.

7.5 Australia and New Zealand

The volume of ships produced in Australia and New Zealand is miniscule compared to the rest of the world. Combined, the two countries had less than 0.05 percent of the world commercial orderbook in terms of gross tonnage as of June 30, 2000. Australian shipbuilders are, however, world leaders in the construction of fast ferries and other high-speed catamarans, and almost all of the ships constructed are exported. As mentioned earlier in this report, Austal and Incat are cooperating with American shipbuilders Bender and Bollinger to build some of these vessels in the United States. Tenix, which has shipyards in both Australia and New Zealand, has launched seven of a line of ten guided-missile frigates, eight for the Australian navy and two for New Zealand's navy. Australian shipbuilders also produce submarines, minehunters, and hydrographic vessels. Tenix exports patrol boats to several Pacific Rim nations and also has produced research vessels, fishing vessels, ferries, and general-use craft.

7.6 Europe

The two leading European shipbuilding countries, Italy and Germany, are each being threatened with loss of business to South Korea. Italy specializes in cruise ships and ferries, while the Germans have found a market in military vessels. Labor costs in Germany are the highest in the world. In Italy and other European countries, labor costs tend to be slightly lower than in Japan,

not much different from in the United States, but much higher than in Korea. The peak of European building came in the mid-1970s, when almost two-thirds of all ships built were tankers. Asian builders currently dominate the tanker market, forcing many European yards to close. Today, European yards are trying to maintain their viability by building other types of ships.

Kvaerner ASA's Ongoing Exit

The leading European shipbuilding company during the 1990s, Kvaerner ASA, is now exiting the industry. It has reduced the number of yards it operates from 13 to 3 since announcing its intentions in the spring of 1999. Kvaerner ASA has been in the shipbuilding business for almost 40 years, but it no longer sees the industry as an area of great profit potential. After Kvaerner ASA doubled its size by acquiring British engineering and construction corporation Trafalgar House in 1996, the Asian financial crisis and slumping oil prices resulted in a decrease in business and huge financial losses for Kvaerner ASA, prompting a change in CEO and restructuring. Reasons given by Kvaerner ASA for selling its shipyards include continued depressed prices for ships and the lack of a good fit between shipbuilding and the firm's other operations.

Before the sell-off, Kvaerner ASA was the third-largest shipbuilding company in the world and operated shipyards in Norway, Scotland, and Russia, in addition to its remaining shipyards in Finland, Germany, and the United States. These yards led the way in value-added vessel production, including container ships, liquefied gas carriers, offshore platforms, cruise liners, cable-laying ships, and icebreakers. Kvaerner ASA's philosophy is to continue to operate its unsold shipyards at maximum efficiency and continue to take orders until buyers are found. The Masa-Yards in Finland continue to produce cruise ships, the Warnow Werft yard in Germany remains a leading builder of container vessels, and the rebuilding of the former Philadelphia Naval Yard to construct Jones Act-compliant cargo vessels for sale in the United States and internationally is almost complete. Kvaerner Philadelphia's first product, a 30,000 deadweight ton container ship, is scheduled to be delivered in August 2002, and the yard also intends to pursue tanker and liner business.

World Overcapacity

Long-term overcapacity in international shipbuilding has become a major concern. In December 2000, the Organization for Economic Cooperation and Development (OECD) published a report that not only outlined the difficult conditions of the international shipbuilding market but made predictions that overcapacity would be approaching 40 percent by 2005. The entry of developing nations into the market, increased productivity, the development of new shipyard

facilities, and the conversion of naval shipyards to commercial production were cited as reasons for this problem. Overcapacity has caused shipyards to charge lower prices for their products.

7.7 The OECD Agreement

One way the European Union and the United States have attempted to normalize international competition is by signing the "Agreement Respecting Normal Competitive Conditions in the Commercial Shipbuilding and Repair Industry," commonly known as the OECD Shipbuilding Agreement of 1994. South Korea, Japan, and other OECD countries have also signed. The purpose of the agreement is to end export subsidies, grants, favorable loans, debt forgiveness, and other assistance, which governments have, or allegedly have, provided to domestic shipbuilders. The Agreement includes a 200,000 gross ton annual purchase limitation on the Jones Act and threatens to degrade the Passenger Vessel Services Act and Title XI funding levels. The Agreement would also subject these maritime laws to judicial review by the World Trade Organization. The Big Six and other American shipbuilders, while initially for the Agreement, do not want to give up the Title XI funding program and have concerns that the Agreement does not provide an effective tool to deal with foreign governments' unfair trade practices. The U.S. Congress has not yet ratified this agreement.

Since the OECD agreement has not been implemented, shipbuilders around the world continue to be subsidized and protected by their national governments. The European Union, however, ended most shipbuilding subsidies at the close of 2000, but it reserves the right to apply a "defensive temporary support mechanism" to protect its shipbuilders against foreign predatory pricing tactics. American shipbuilders have not reached consensus concerning ratification of the OECD Agreement. Some smaller shipbuilders believe they would be more competitive internationally if other countries had to remove barriers and subsidies, while the Big Six would rather keep the current system.

7.8 U.S. Position

There are several reasons why the United States is no longer a major commercial shipbuilder. Other countries offer substantial subsidies to their builders, while the U.S. government ended much of its financial support for commercial ship construction in the early 1980s and cut back on expected naval expansion in the 1990s. Capital expenditures, wages, and other construction costs are lower in some competing nations, particularly South Korea and China. As discussed in Section 4.6, productivity in American shipbuilding lags behind that of European and Asian

shipyards. These obstacles to expanding market share are exacerbated by a constricting market, combined with an expanding global production capacity.

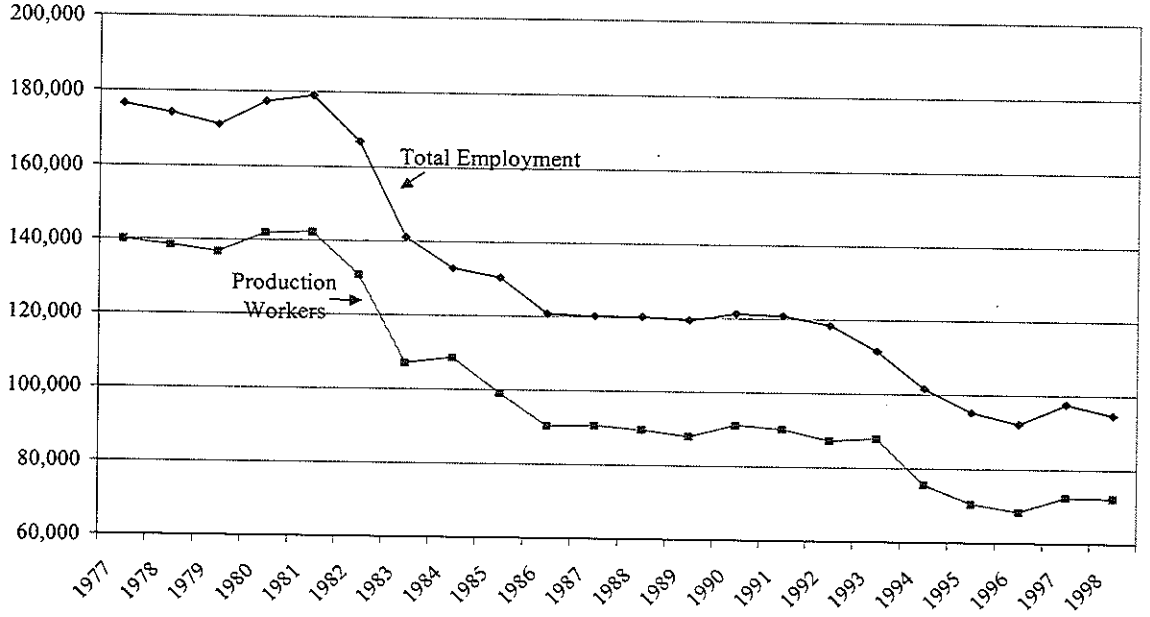
8. Cross Industry Comparisons and Analysis

The performance of the shipbuilding and repair industry was compared and contrasted to two other major transportation industries, aircraft and automobile assembly, using U.S. Bureau of the Census published data from 1977-1998. While each industry is very different, insights into how one operates can shed light on the others. Auto and aircraft assembly were selected because they represent sectors that engage in final assembly of major equipment. The aircraft sector is more like shipbuilding in terms of defense work, but it differs in the amount of series production and in international competitive considerations. A finished aircraft is also smaller than modern warships but may rival them in complexity. The automotive sector is different in many ways, but it represents an industry that made the transition toward what is known as "lean manufacturing" in the last 20 years. Lean manufacturing includes aspects such as just-in-time delivery, continuous improvement, outsourcing of larger subassemblies, and flatter management. The auto sector epitomizes high volume production and economy of scale. The sector also operates in a nearly pure commercial market, unfettered by defense procurement policies or constraints. These comparisons examine economic trends to see how developments in shipbuilding and repair compare with trends in the other industries and in the overall manufacturing sector.

8.1 Trends in Shipbuilding and Repair Employment and Revenues

The shipbuilding and repair industry has experienced continual declines in employment since the early 1980s. The Reagan Administration's desire to construct and maintain a 600-ship Navy coincided with the decision to stop funding subsidies for the commercial shipbuilding industry in 1982. This withdrawal of government support to the commercial shipbuilding sector precipitated a decline in employment that bottomed out in 1986. A second decline began after 1991 due to defense downsizing. Census data shows a decrease since 1981 by almost half in both total employment and the number of production workers in the industry.

Chart 8.1 Shipbuilding and Repair Employment (1977-1998)



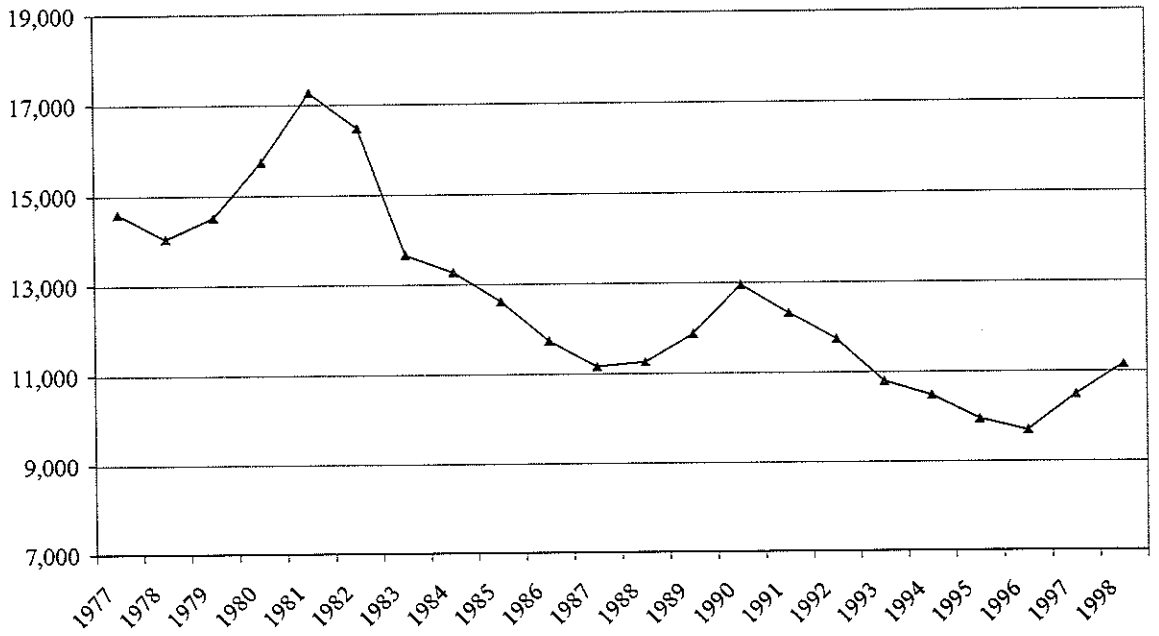
Source: U.S. DOC/Bureau of the Census

Trends in Revenues

The next graph shows similar fluctuations in shipyard revenues. During the 1977-1998 period, total revenues (in constant 1998 dollars) for shipbuilding and repair were highest in 1981. Once American commercial vessels were forced to compete in the global market without government subsidies, revenues declined quickly, and then, with defense cuts, declined again during the first half of the 1990s.

Chart 8.2 Shipbuilding and Repair Revenues, 1977-1998

(in constant 1998 $000)

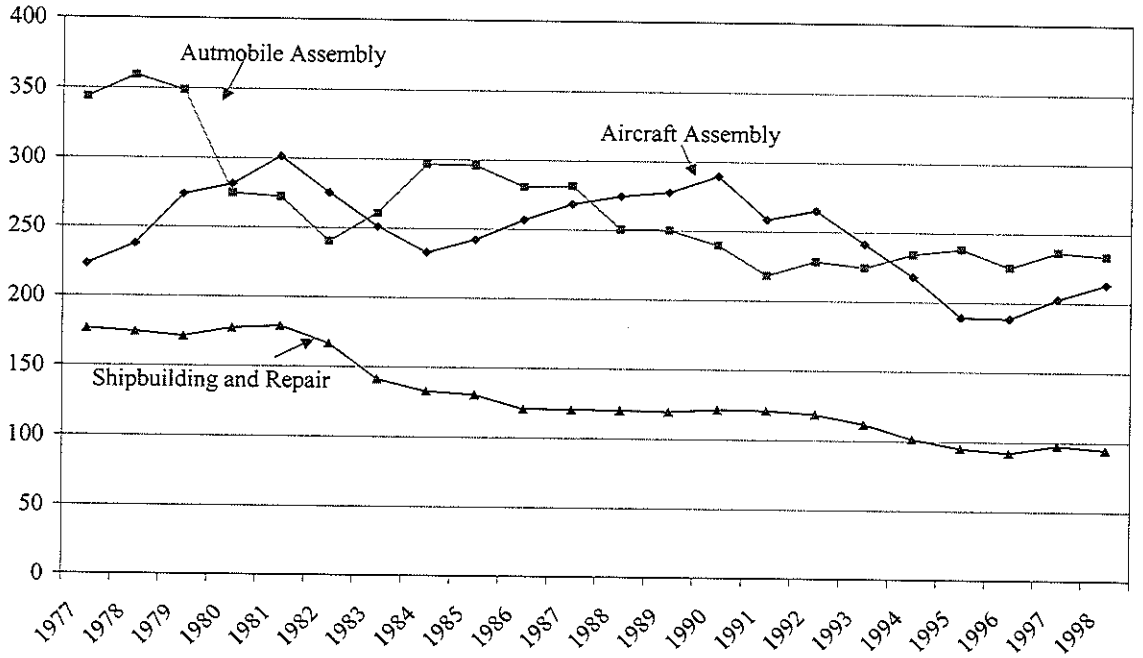


Source: U.S. DOC/Bureau of Census

Comparisons with Auto and Aircraft Assembly

Employment levels in the auto and aircraft assembly industries also decreased. Automotive assembly was affected by a major recession in the early 1980s, but it has managed to recover over the past two decades. Aircraft assembly employment experienced volatility and, as with shipbuilding, employment fell with defense downsizing.

Chart 8.3 Total Employment Across Three Industries in Thousands, 1977-1998



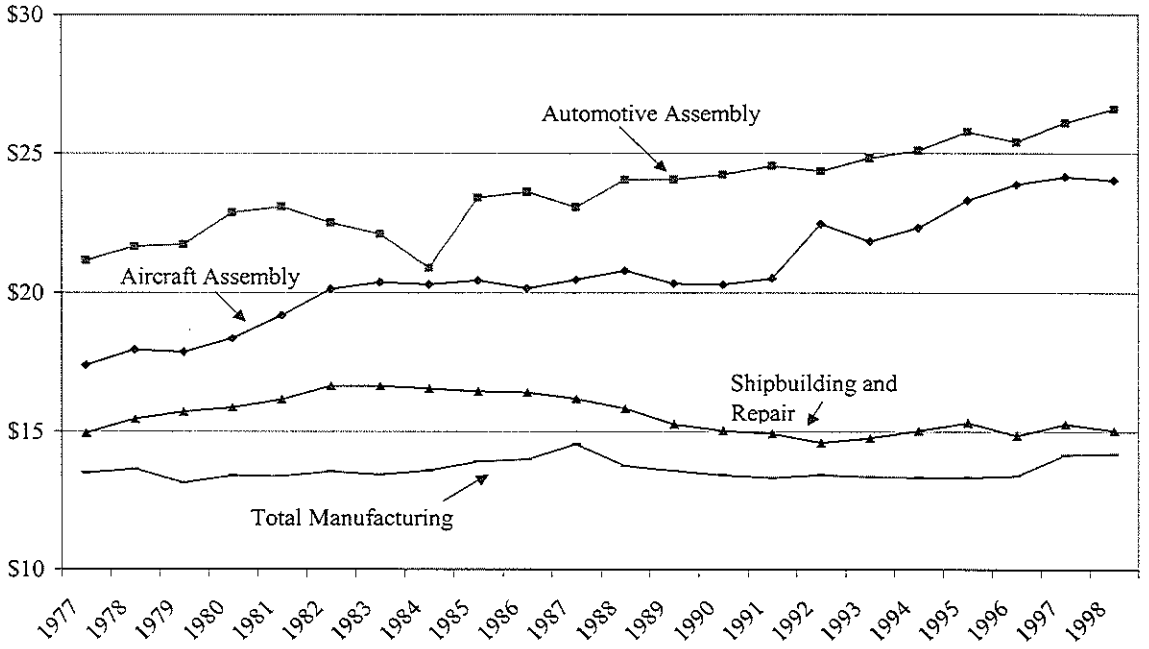
Source: U.S. DOC/Bureau of the Census

8.2 Trends in Wage Scales

Although shipbuilding and repair production workers make more per hour than the average for all manufacturing ($15 v. $14 per hour), wage rates in the comparable automotive ($27 per hour) and aircraft industries ($24 per hour) are noticeably higher. In fact, the wage rates (in constant 1998 dollars) in the other two industries have been increasing for most of the 1990s, while wage rates in the shipbuilding and repair sector and in all manufacturing changed little in real terms.

As discussed below, the automobile and aircraft industries are more productive than shipbuilding in an absolute sense. These industries are exposed to international competitors, which forces them to make investments in productivity improvements that effectively substitute capital for labor. The higher wage levels in the automobile and aircraft sectors reflect this higher productivity.

Chart 8.4 Changes in Wages per Hour, 1977-1998
(Constant 1998 Dollars)



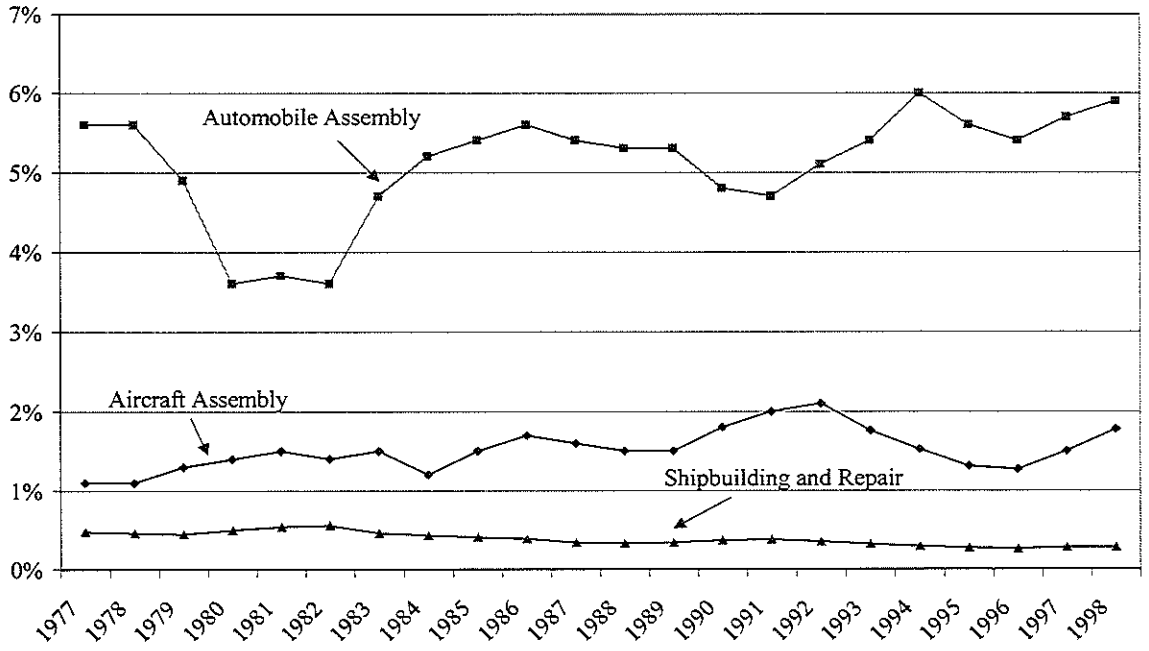
Source: U.S. DOC/Bureau of the Census

8.3 Trends in Manufacturing Shares

Despite overall growth in manufacturing output in the United States, shipbuilding and repair continues to contribute a small and declining percentage of the national total. Conversely, automobile and aircraft assembly contributions to the national total increased in recent years. The shipbuilding and repair industry accounts for about one-third of one percent of the manufacturing output in the United States, and was at its lowest level in 1998. Between 1982 and 1997, the share of total manufacturing captured by shipbuilding and repair decreased every year except for two, 1990 and 1991, when ship construction increased slightly in response to the demand created by the Gulf War.

Aircraft and automobile assembly fluctuated as a portion of total manufacturing output over the period, but both industries have seen their percentages rise in recent years. With the exception of 1993, automobile assembly reached its highest share in 1998. Aircraft assembly also reached higher levels in 1998.

Chart 8.5 Trends in the Share of Total U.S. Manufacturing 1977-1998



Source: U.S. DOC/Bureau of the Census

8.4 Trends in Payroll as a Percentage of Value Added

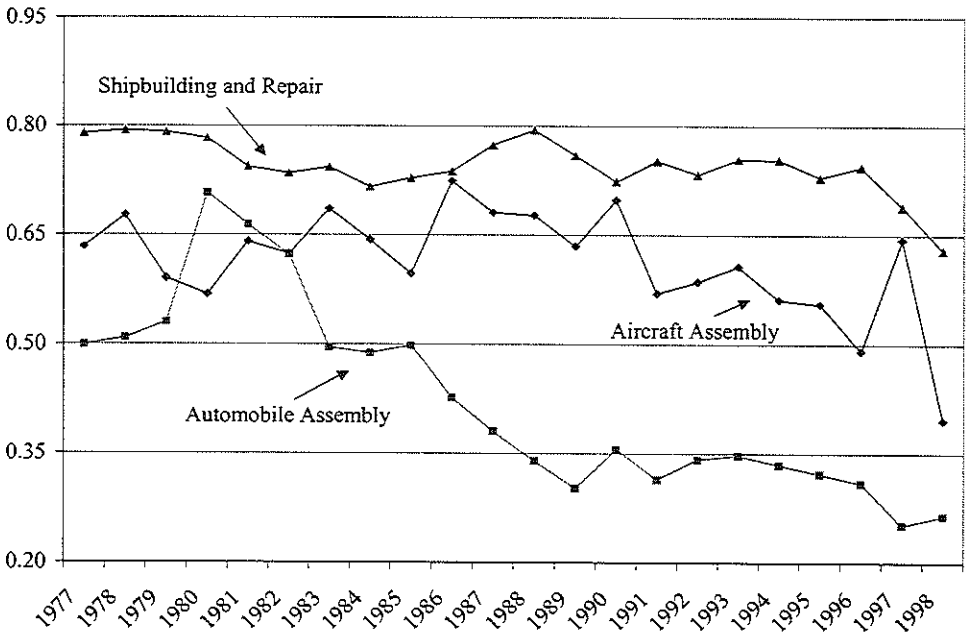
Value added is the difference between total revenues and material costs, adjusted for changes in inventories over a one-year period. For example, if a company purchases steel and makes it into a ship, the difference between the cost of the steel and the selling price of the ship is the value added by the shipyard. Based on Bureau of the Census data, U.S. shipbuilders subcontract about 40 percent of the value of their total revenues. This means that value added represents about 60 percent of total revenues.

Shipyards have the highest percentage of payroll to value added among the three transportation industries. This measure is an indicator of relative labor intensity. The percentage of payroll to value added in shipbuilding was consistently over 65 percent until 1998, whereas auto assembly declined from almost 70 percent in the early 1980s to less than 30 percent in recent years. Additionally, the percentage for shipbuilding and repair is higher than the average for all U.S. manufacturers (not shown on the chart), which has also dropped steadily over the past twenty years.

The dramatic decline in automobile assembly payroll as a percentage of value added can be attributed largely to the introduction of lean manufacturing techniques and their integration with the workforce, greater reliance on just-in-time delivery, and outsourcing larger modular components. The aircraft industry is now engaged in a similar process.

Shipbuilding and repair lags behind other industries in this regard. Instead of out-sourcing certain ship components, some shipyards rely on in-house capabilities, which can hurt on overall shipbuilding productivity and make shipyard operations less profitable and more labor intensive. With its European business model, Kvaerner Philadelphia may demonstrate that lean manufacturing is feasible for shipbuilding in the United States. The commercial market, however, may not be large enough to support the process profitably.

Chart 8.6 Trends in the Ratio of Payroll to Value Added 1977-1998



Source: U.S. DOC/Bureau of the Census

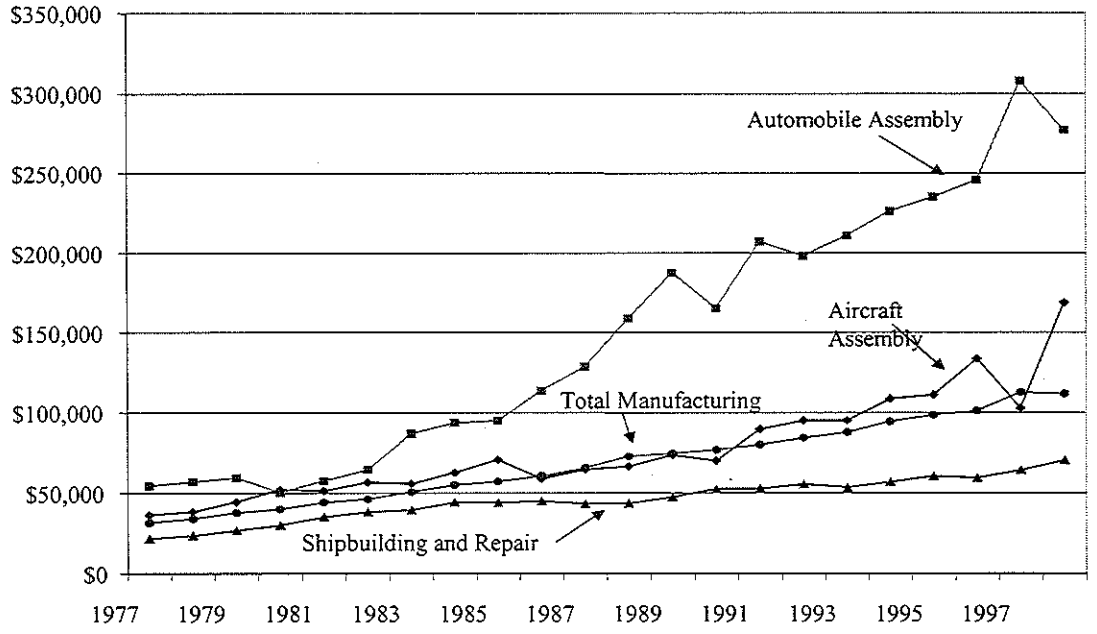
8.5 Trends in Productivity

Value Added per Employee

In 1998 shipbuilding and repair employees added less value to finished products per person ($70,000) than auto ($277,000) or aircraft assembly ($169,000). During the 1977-1998 period,

shipyards lost ground with respect to this indicator to these industries and to all manufacturing ($111,000 in 1998). The following graph presents value added per employee (in historic dollars). It illustrates that shipbuilding and repair has been consistently below the national manufacturing average in value added per employee. Automobile assembly's ratio was almost four times that of shipbuilding and repair in 1998, compared to about 2.5 times in 1977. .

Chart 8.7 Value Added per Employee
1977-1998

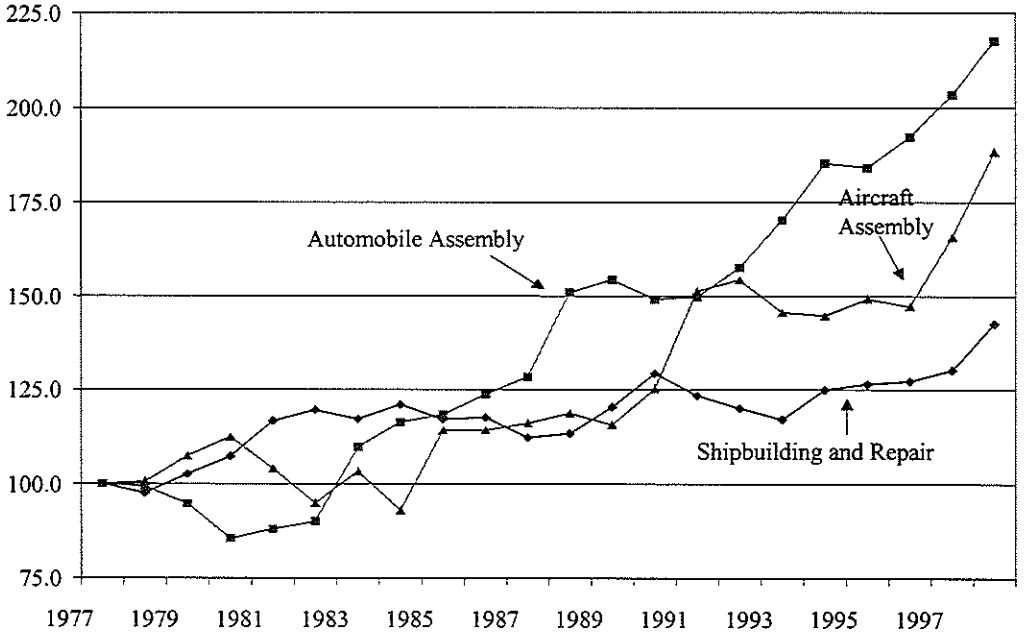


Source: U.S. DOC/Bureau of Census

Output per Employee

Trends in output per employee reveal shipbuilding and repair workers are not keeping pace with the automobile and aircraft assembly workers. Between 1977 and 1998, employee output in shipbuilding and repair (index 1987=100) rose only about 45 percent, while automotive and aircraft assembly improved over 210 and 185 percent, respectively. Since 1995, automotive and aircraft assembly increased productivity by about 40 percent, while the shipbuilding industry saw productivity increase about 20 percent. An unknown portion of the shipbuilding increase was due to the closing of less efficient facilities during an ongoing consolidation of the industry.

Chart 8.8 Output per Employee (Real Dollars)
1977-1998



Source: U.S. DOC/Bureau of Census

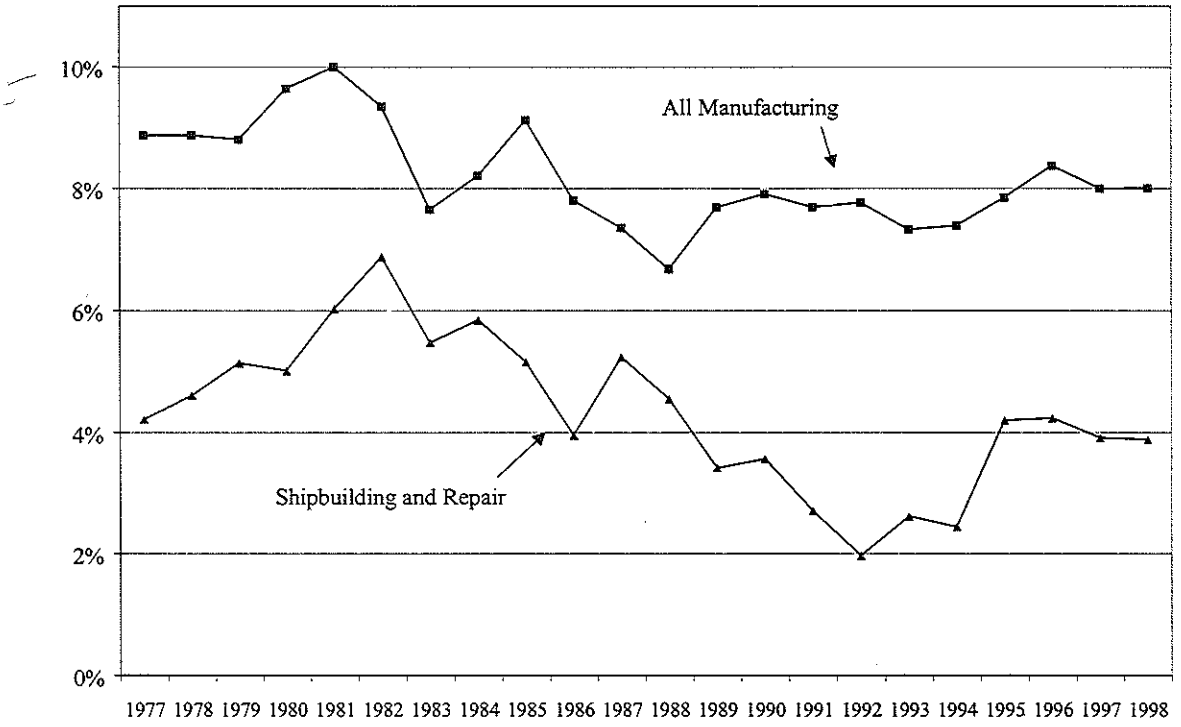
8.6 Trends in Capital Investment per Value Added

Capital expenditures as a percentage of value added in the shipbuilding and repair industry averaged about 4.3 percent from 1977-1998, which is half the rate of all manufacturing. Shipyard investment peaked in 1982 at 6.9 percent, and then dropped off sharply until 1992, when it reached a low of less than 2 percent, the same pattern as that shown for industry revenues and employment in previous graphs. Capital expenditures remained at low levels until 1995, when they again climbed above 4 percent; they hovered near that level through 1998.

Manufacturing investment in general averaged 8.2 percent of value added from 1977-1998, peaking in 1981 at 10 percent. That year saw large investments in oil field equipment as installation of new oil wells reached an all time high. The automobile assembly industry invested over 30 percent of value added in response to the increased import of smaller cars from Japan. Total manufacturing investment fell to a low in 1988 of 6.7 percent of value added following the massive consolidations and mergers in the preceding years, but since then, capital spending has been close to 8 percent.

The automobile and aircraft assembly industries capital expenditure ratio averaged 9.8 and 4.7 percent respectively (not shown on chart). Like the shipbuilders, investment was very volatile. The automobile sector played catch up through most of the 1980s, when major investments led to great gains in productivity. Aircraft assembly is becoming more of a design and integration operation, with less actual manufacturing taking place at the assembly plants, so the capital investment required is decreasing.

Chart 8.9 Capital Expenditures per Value Added, 1977-1998 (in Percent)



Source: U.S. DOC/Bureau of Census

Appendix A

Letters Requesting and Accepting the Assessment

DEPARTMENT OF THE NAVY
NAVAL SURFACE WARFARE CENTER
CARDEROCK DIVISION

CARDEROCK DIVISION HEADQUARTERS
DAVID TAYLOR MODEL BASIN
9500 MACARTHUR BOULEVARD
WEST BETHESDA, MD 20817-5700

IN REPLY REFER TO:
10000
Ser 012/9809
08 July 1998

Mr. William Reinsch
Under Secretary for Export Administration
US Department of Commerce
Room 3898
Washington, DC 20230

Dear Mr. Reinsch:

Over the past few months, I have had the opportunity to meet with staff from your Office of Strategic Industries and Economic Security to discuss a variety of issues impacting the industrial base. I've been impressed with the knowledge resident in your staff. As a result, I am proposing a major joint BXA-Naval Surface Warfare Center (Carderock) initiative, a National Security Assessment of the U.S. Maritime Industry. I believe that the technical and engineering talents resident at Carderock would mesh well with the analytical skills and survey capabilities of your office.

To facilitate this office, Mr. Norman Yarbrough, Operations Research Analyst, and myself plan on working with you and your staff in launching this effort as well as assisting you in other national security matters related to the maritime industry. In addition, we will transfer via a MIPR, $50,000 total to support the study effort. Security clearances and the MIPR will be forwarded under separate cover.

A factor in our decision is BXA's continuing relationship with organizations such as the American Shipbuilders Association, the Shipbuilders Council, the Consortium of Oceanographic Research and Education, and the National Shipbuilding Research Program (NSRP). As you know, our goal is to disseminate information that can stimulate the maritime industry in the United States, and it is vitally important that we work with these groups.

If you have any questions or concerns, please contact me at 301/227-1037. I look forward to working with your organization starting in March to begin an outline of the study and development of the survey.

Sincerely,

JOEL PATTON
Director, Business Development

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Export Administration
Washington, D.C. 20230

August 10, 1998

Mr. Joel Patton
Director, Business Development
Department of the Navy
Carderock Division Headquarters
David Taylor Model Basin
9500 MacArthur Blvd.
West Bethesda, MD 20817-5700

Dear Mr. Patton:

Thank you for your letter to Under Secretary Reinsch requesting that BXA's Office of Strategic Industries and Economic Security (SIES) conduct a national security assessment of the U.S. maritime industry. As you mentioned, the industry and engineering knowledge of your staff and the survey and analytical skills resident in SIES will complement one another quite well.

We would be happy to cooperate with you on this very worthwhile effort. I look forward to learning the results. I have designated Brad Botwin, Director of the Strategic Analysis Division within SIES, as the point of contact for this effort. You can reach him at 202-482-4060.

Sincerely,

R. Roger Majak
Assistant Secretary

Appendix B

Survey

U.S. Department of Commerce
Bureau of Export Administration

OMB Control No. 0694-0113
expires 5/31/02

SURVEY FOR NATIONAL SECURITY ASSESSMENT OF THE U.S. MARITIME INDUSTRY: BUILDING AND REPAIRING OF SHIPS, BOATS, AND OTHER MARINE PLATFORMS

THE OVERALL ASSESSMENT OBJECTIVES

- Illustrate the relationship between the maritime industry, national security, and the US economy.
- Identify opportunities for increased sharing of maritime science and technology between public and private entities.
- Expand the use of public maritime capabilities toward advancing private industry competitiveness.
- Encourage cooperative efforts within the maritime industry among government, industry, and academia.

This survey is being conducted to develop a comprehensive assessment of the U.S. maritime industry. The assessment partners include: Department of the Navy's Carderock Division, Maritime Administration, U.S. Coast Guard, National Oceanic and Atmospheric Administration, Army Corps of Engineers, U.S. International Trade Commission, Consortium for Oceanographic Research and Education, American Shipbuilders Association, Shipbuilders Council of America, Trotta Associates, Inc., and Pennsylvania State University.

RESPONSE TO THIS SURVEY IS REQUIRED BY LAW

A response to this survey is required by law (50 U.S.C. app. Sec. 2155). Failure to respond can result in a maximum fine of $10,000 or imprisonment up to one year, or both. Information furnished herewith is deemed confidential and will not be published or disclosed except in accordance with Section 705 of the Defense Production Act of 1950, as amended (50 U.S.C. App. Sec. 2155).

Burden estimate and request for comment: Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB Control Number.

Public reporting burden for this collection of information is estimated to average 4 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to BXA Information Collection Officer, Room 6881, Bureau of Export Administration, U.S. Department of Commerce, Washington, D.C. 20230, and to the Office of Management and Budget, Paperwork Reduction Project (0694-0113), Washington, D.C. 20503.

GENERAL INSTRUCTIONS

1. **WHO MUST RESPOND** — Public or private entities involved in the building or repairing of ships, boats and other marine platforms at any time since January 1, 1998. **Your response is due October 25, 1999.**

   Small-Business - If the maritime portion of your 1998 business revenues is less than $5,000,000, please complete only the following portions of this survey:

   a) Part I (all)
   b) Part II, question #1 (1998 data only),
   c) Part III, question #1 (1998 data only),
   d) Complete and sign the certification on page 16, and return the survey to the address in item 5 below.

2. **EXEMPTIONS** — Firms not identified in item 1 above and otherwise not involved in maritime activity are exempt from completing the survey. If your firm is exempt, please complete only page 1, identifying your company, and the certification on page 16. Please detach and return these two pages to the address in item 5 below.

3. **USE OF ESTIMATES** — If information is not readily available from your records in exactly the form requested, you may furnish estimates and designate by the letter "E".

4. **POINTS OF CONTACT** — Questions related to the questionnaire should be directed to Mr. John Tucker, Senior Industry Analyst, (202) 482-3755, or Mr. Stephen Baker, Trade and Industry Analyst (202) 482-2017, U.S. Department of Commerce. Either person may be reached by FAX on (202) 482-5650, or by e-mail: *jtucker@bxa.doc.gov* or *sbaker@bxa.doc.gov*

5. **BE SURE TO SIGN CERTIFICATION** — Before returning your completed questionnaire, please be sure to sign the certification on page 16 and identify the person and phone number should we need to contact your firm.

Return pages 1-16 of completed survey in enclosed envelope by October 25, 1999 to:

Brad Botwin, Director
Strategic Analysis Division
BXA/SIES, Rm. 3876, M-1
U.S. Department of Commerce
Washington, D.C. 20230

THE MARITIME INDUSTRY

Builders and repairers of ships, boats, and other marine platforms represent a major subsector of the overall maritime industry. Maritime-related activities and technology are embedded in virtually all sectors of the U.S. economy (food, mining, construction, manufacturing, transportation, wholesale/retail trade, finance/insurance, professional services, recreation, environment, energy, public administration, and education). Yet, while these activities are significant, the maritime industry is lacking a generally accepted broad definition. This makes it difficult for organizations involved in maritime-related activities to evaluate the potential value of their contribution to the overall industry.

A suggested broad definition of the maritime industry includes, "all activities relevant to the manufacture, processing, and transportation of maritime vessels, products, and personnel in the commercial and government sectors." Accordingly, the industry is a diverse group of public and private organizations with very different interests and capabilities. The following provides a perspective of the elements of the maritime industry.

Composition of Maritime Industry

1 Food
- 1.1 Commercial Fishing and Aquaculture

2 Maritime Mining
- 2.1 Ocean Energy Recovery
- 2.2 Mining Petroleum and Natural Gas
- 2.3 Minerals

3 Maritime Construction
- 3.1 Heavy Construction

4 Maritime-Related Manufacturing
- 4.1 Ship Building and Repairing (vessels 122 m. or more)
- 4.2 Boat Building and Repairing (vessels less than 122 m.)
- 4.3 Search and Navigation Systems and Instruments
- 4.4 Military Equipment
- 4.5 Maritime Cargo Handling Equipment
- 4.6 Offshore Oil Drilling Equipment
- 4.7 Dredging Equipment
- 4.8 Power Distribution and Industrial Controls
- 4.9 Manufacturing Sub-Industries Not Otherwise Identified

5 Maritime Transportation
- 5.1 Deep Sea Transportation of Freight
- 5.2 Deep Sea Transportation of Passengers
- 5.3 Waterway Transport
- 5.4 Maritime Cargo Handling
- 5.5 Terminal Operations and Maintenance
- 5.6 Maritime Salvage

6 Maritime Wholesale and Retail Trade
- 6.1 Maritime Wholesale Trade
- 6.2 Maritime Retail Trade

7 Maritime Finance and Insurance
- 7.1 Maritime Finance
- 7.2 Maritime Insurance

8 Maritime-Related Professional Services
- 8.1 Maritime Engineers and Technical Specialists
- 8.2 Ship Cleaning and Maintenance
- 8.3 Miscellaneous Maritime Related Services
- 8.4 Environment
- 8.5 Oceanography/Ocean Science and Engineering

9 Maritime Recreation/Tourism
- 9.1 Marinas
- 9.2 Other

10 Government
- 10.1 UN Maritime Affairs
- 10.2 Maritime-Related U.S. Federal Departments/Agencies
- 10.3 National Defense
- 10.4 Channel Waterway Maintenance and Operation
- 10.5 Ecology/Environmental Administration

11 Academia and Associations

12 Other Maritime-Related Activity

National Security Assessment of the Maritime Industry Survey Contents

DEFINITIONS

ESTABLISHMENT — A U.S. facility in which (or from which) maritime activity is conducted or managed.

FIRM or COMPANY — A public or private entity engaged in maritime activity. An individual proprietorship, partnership, joint venture, university, government agency, association, corporation (including any subsidiary corporation in which more than 50 percent of the outstanding voting stock is owned), business trust, cooperative, trustees in bankruptcy, or receivers under decree of any court, owning or controlling one or more establishments.

MARITIME INDUSTRY — The public and private firms engaged in an activity that supports the utilization of the oceans and/or inland waterways. This includes maritime manufacturing, commercial activities, merchant carriers, passenger carriers, maritime research or exploration, and maritime support services.

PRODUCTION WORKERS — Persons, up through the line supervisor level, engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, or shipping. In addition, persons engaged in supporting activities such as maintenance, repair, product development, auxiliary production for your firm's own use, record keeping, and other services closely associated with production operations at your firm. Employees above the working supervisor level are excluded from this item.

MARITIME RESEARCH AND DEVELOPMENT — Basic and applied research in the engineering sciences, as well as design and development of prototype products and processes. One of the following two conditions must be met: 1- The source of funding is from a maritime entity(ies); and/or 2- The purpose of the activity is to support the maritime industry.

Research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, if the purpose of such activity is to do one or more of the following things:

1- BASIC RESEARCH — A systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.

2- APPLIED RESEARCH — A systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. It is a systematic application of knowledge toward the production of useful materials, devices and systems or methods, including design development and improvement of prototypes and new processes to meet specific requirements.

3- DEVELOPMENT — The design, development, simulation, or experimental testing of prototype or experimental hardware or systems, to validate technological feasibility or concept of operation, to reduce technological risk, and to provide test systems prior to production approval.

4- SYSTEMS/PROCESS STUDIES — Studies to improve or optimize economic operations by systematic review of production systems and processes.

SCIENTISTS AND ENGINEERS — Persons engaged in research and development work or production operations that have at least a four-year college education in the physical sciences or engineering (or work experience equivalent).

REVENUES — Dollar revenues for one calendar year for maritime activities, net of merchandise returned for which payment was not received, sales discounts, or other non-payments for goods or services rendered of domestically produced maritime products and services shipped or supplied by your firm. Such revenues should include sales to or receipts from unrelated parties in the United States and the rest of the world, but should exclude shipments of products produced by other manufacturers for resale under your brand name.

DEFENSE REVENUES — The defense portion of net revenues, expressed as a percentage from 0% to 100%. Defense business may be identified by those purchase orders with a DO or DX rating. Defense business may also be identified by a contract number from the Defense Department, NRC, CIA, FAA, NASA, or the US Coast Guard. In addition, orders from customers producing products for defense purposes, and items tested and certified to military specifications shipped to qualified distributors.

UNITED STATES — The term "United States" includes the fifty States, Puerto Rico, the District of Columbia, the island of Guam, Trust Territories, and the Virgin Islands.

PART I FIRM IDENTIFICATION

NOTE: Detach pages 1-16 and return in furnished envelope.

Definition

FIRM or COMPANY — A public or private entity engaged in maritime activity. An individual proprietorship, partnership, joint venture, university, government agency, association, corporation (including any subsidiary corporation in which more than 50 percent of the outstanding voting stock is owned), business trust, cooperative, trustees in bankruptcy, or receivers under decree of any court, owning or controlling one or more establishments.

1. **COMPANY NAME AND ADDRESS** — Please provide the name and address of your firm or corporate division.

_____
Company or Division Name

_____
Street Address

_____
City, State, Zip code (Country)

2. **OWNERSHIP** — If your firm is wholly or partly owned by another firm, indicate the name and address of the parent firm and extent of ownership.

_____
Parent Name

_____
Street Address

_____
City, State, Zip code (Country)

Extent of Ownership:_____% Year acquired_____

PART I (continued) FIRM IDENTIFICATION

3. **ESTABLISHMENT INFORMATION** — Please indicate with a check (✓) in the columns below the type(s) of vessels your establishment is currently able to construct and/or repair.

Vessel or Platform Type	Construction	Repair
Oceangoing & Great Lakes Commercial Vessels:		
Container Ships		
Other General Cargo Ships		
Tankers (Crude Oil)		
Tankers (Petroleum Product)		
Tankers (LNG/LPG)		
Bulk Carriers		
Passenger Vessels		
Oceangoing Barges		
Other (specify): _____		
Inland Waterways Commercial Vessels:		
Towboats		
Dry Cargo Barges		
Liquid Cargo Barges		
Harbor/Coastal Commercial Vessels:		
Tugs		
Barges		
Ferries		
Petroleum Exploration & Production:		
Drill Rigs		
Supply Vessels		
Private Vessels:		
Commercial Fishing Vessels (Including Factory)		
Recreation Vessels		
Research Vessels		
Military Vessels:		
Combatant Surface vessels		
Non-Combatant Surface Vessels		
Submarines		
Other (specify below):		

PART I (continued) FIRM IDENTIFICATION

4. **MERGERS AND ACQUISITIONS** — For any maritime-related mergers, acquisitions, divestitures, joint ventures, partnerships, or other cooperative agreements your firm was a party to during the last five years (i.e., since January 1, 1994), please provide the following information regarding each type of agreement, type of firm and objective of agreement.

If none, check (✓) here ___ and go to next question.

Year	Please use letter code(s)			Name(s) of other Firm(s)
	Type Agreement	Type of Firm	Objective of Agreement	

Type of Agreement

a. Merger (i.e., stock exchange)
b. Acquisition (i.e., cash payment)
c. Divestiture
d. Joint Venture
e. Partnering
f. Teaming
g. Other (specify):
   1. _____
   2. _____
   3. _____

Type of Firm

a. Shipyard
   1. Shipbuilding
   2. Ship Repair
   3. Boatbuilding
   4. Boat Repair
b. Subcontractor
c. Vendor/Supplier
d. Other (specify):
   1. _____
   2. _____
   3. _____

Objective of Agreement

a. Expand product offerings
b. Increase share of existing markets
c. Achieve economies of scale
d. Achieve other efficiencies
e. Gain access to new technology
f. Gain complementary expertise
g. Gain market access
h. Other (specify):
   1. _____
   2. _____

PART II EMPLOYMENT INFORMATION

1. **ANNUAL WORKFORCE HOURS** — On the upper portion of the table, please enter the *total paid annual work hours* associated with each occupation category on the following table **for your maritime activities only**. Enter data for 1996-1998, and estimates for 1999 and 2000. On the lower portion of the table, please enter the number of people as requested.

ANNUAL MARITIME-RELATED HOURS					
OCCUPATION CATEGORY	**1996**	**1997**	**1998**	**Est. 1999**	**Est. 2000**
Naval architects, marine engineers and other marine professionals					
Production Workers a. That Manufacture/Assemble					
b. That Outfit/Finish					
c. That Repair Vessels					
Marketing and Sales					
Management and Administrative					
All Other					
Total Maritime-Related Hours					
MARITIME EMPLOYMENT (Number of People)					
Total Maritime Employment					
PERSONS ENGAGED IN R&D					
Total Persons Engaged in R&D					
a. With less than a 4-year degree					
b. With a Bachelor's degree					
c. With a Master's degree					
d. With a Ph.D.					

2. **AGE DISTRIBUTION OF CURRENT MARITIME-RELATED WORK FORCE** — Enter the number of people in each employment category by age in the table provided:

Employment Category	Less than 30 years of age	30 to 40 years of age	40 to 50 years of age	50 to 60 years of age	Over 60 years of age
Naval architects, marine engineers and other marine professionals					
Production Workers					
Marketing and Sales					
Management and Administrative					

PART II (continued) EMPLOYMENT INFORMATION

3. **LABOR SKILL SHORTAGES** — In the last five years, has your firm experienced problems in hiring persons with the occupational skills (at any level) in the categories listed on the table below?

If no, check (✓) here ___ and go to next question.

If yes, please place a check in the column labeled 'Skills Shortages' for each skill listed. Additionally, for each skill shortage identified, select one of the following corrective actions (A-E) that best describes the measures taken, and enter an A, B, C, D or E, as appropriate. If none of these corrective actions were taken, write a brief description of the corrective action used by your firm.

CORRECTIVE ACTIONS:

A. In-house apprenticeship – training program.
B. Federal/state vocational training program
C. Recruitment from within industry
D. Agency contract hires
E. Recruit non-US citizens

Skills	Skill Shortage (✓)	Actions taken to remedy shortage Select from above (A-E) or write-in
Marine Professionals		
a. Naval Architects		
b. Marine Engineers		
c. Other Professionals		
Production Workers		
a. Carpenters/Joiners		
b. Burners/Grinders		
c. Crane operators		
d. Electricians		
e. Machinists		
f. Painters		
g. Pipe fitters		
h. Riggers/Erectors		
i. Sheet Metal		
j. Ship Fitters		
k. Steel Fabricators		
l. Welders		
m. Other (specify):_____		
n. Other (specify):_____		

4. **EMPLOYMENT OF NON-US CITIZENS WITHIN CURRENT WORK FORCE** — Please enter the number of non-US citizens in your current labor force by employment category:

Employment Category	Maritime-Related	Total Company
Naval architects, marine engineers and other marine professionals		
Production Workers		
Marketing & Sales		
Management and Administrative		

PART II (continued) EMPLOYMENT INFORMATION

5. **IMPACTS OF LABOR SHORTAGES** — Please note any impacts of labor shortages on your firm with a check (✓) in the table below:

Impacts of Labor Shortages	Yes	No
Turned away new business		
Delayed completion of a project or projects		
Subcontracted with other company(ies) to complete project(s)		
Raised cost of project		
Reduced shipyard (company) profitability		
Other (specify):_____		

6. **TRAINING PROGRAMS** — Do you have a training program?

If no, check (✓) here ___ and go to the next question.

If yes, please indicate in the table below the types of training provided and estimate the total man-hours devoted to the training in 1998.

Types of training Programs
a) In-house apprenticeship – training program.
b) Federal/state vocational training program
c) Other (specify):_____

Trainee Groups	Training Programs	Hours in 1998
Marine Professionals		
Production Employees		
Other Employees		

7. **OTHER LABOR CONCERNS** — If in the **last five years** you experienced any other labor concerns that adversely affected your maritime operations (such as shortages of certain skills, high turnover, excessive rate of retirement of experienced workers, unanticipated liability claims, etc.) please describe them below:

_____

_____

PART III FINANCIAL PERFORMANCE

1. **MARITIME REVENUES AND INCOME** — Please enter the revenue and income information **(in $000)** as specified below for the years 1996-1998, and provide estimates for 1999 and 2000. Include only dollar amounts that apply to your U.S. maritime operations. If your financial information for 1996-1998 is not readily retrievable in the format requested, please provide estimates and place an "E " by the entry.

MARITIME REVENUES AND INCOME (in $000)					
REVENUE CATEGORY	**1996**	**1997**	**1998**	**Estimate 1999**	**Estimate 2000**
Maritime Revenues:					
Domestic Revenues					
Export Revenues					
Total Maritime Revenues					
Percent Defense Revenue of the Total	%	%	%	%	%
Net Income Before Taxes					

2. **MARITIME FINANCIAL DATA** — Please enter the financial information **(in $000)** as specified below for the years 1996-1998. Include only dollar amounts that apply to your U.S. maritime operations. If your financial information for 1996-1998 is not readily retrievable in the format requested, please provide estimates and place an "E " by the entry.

MARITIME FINANCIAL DATA (in $000)			
FINANCIAL LINE ITEM	**1996**	**1997**	**1998**
Current Assets			
Current Liabilities			
Inventories			
Total Assets			
Short Term Debt			
Long Term Debt			

3. **MARITIME NEW INVESTMENT** — Please enter the total dollar amount of new investment **(in $000)** in maritime activities for 1996-1998.

MARITIME NEW INVESTMENT (in $000)					
Category	**1996**	**1997**	**1998**	**Estimate 1999**	**Estimate 2000**
New Machinery and Equipment					
New Plant					
Total New Investment					

PART IV MARITIME TECHNOLOGY

1. **RESEARCH AND DEVELOPMENT** — On the upper portion of the table below, please enter your firm's maritime-related research and development (R&D) expenditures for 1996-1998, and estimates for 1999 and 2000. This includes R&D conducted by your firm for others, or on your own behalf, and R&D paid for by your firm but contracted to another. On the lower portion of the table, please enter the source of funding for R&D for 1996-1998, by the categories listed.

If none, check (✓) here ___ and go to next question.

Definition

MARITIME RESEARCH AND DEVELOPMENT - Basic and applied research in the engineering sciences, as well as design and development of prototype products and processes. One of the following two conditions must be met: 1- The source of funding is from a maritime entity(ies); and/or 2- The purpose of the activity is to support the maritime industry.

Research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, if the purpose of such activity is to do one or more of the following things:

1- BASIC RESEARCH — A systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.

2- APPLIED RESEARCH — A systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. It is a systematic application of knowledge toward the production of useful materials, devices and systems or methods, including design development and improvement of prototypes and new processes to meet specific requirements.

3- DEVELOPMENT — The design, development, simulation, or experimental testing of prototype or experimental hardware or systems, to validate technological feasibility or concept of operation, to reduce technological risk, and to provide test systems prior to production approval.

4- SYSTEMS/PROCESS STUDIES — Studies to improve or optimize economic operations by systematic review of production systems and processes.

RESEARCH AND DEVELOPMENT EXPENDITURES (in $000)					
CATEGORY	**1996**	**1997**	**1998**	**Est. 1999**	**Est. 2000**
Basic Research					
Applied Research					
Development					
Systems/Process Studies					
Total R&D Expenditures					
SOURCE OF R&D FUNDING (in $000)					
Your Firm					
U.S. Navy					
Other U.S. Dept. of Defense					
Other U.S. Government					
U.S. Private Entity					
Foreign Government					
Foreign Private					

PART IV (continued) MARITIME TECHNOLOGY

2. **MARITIME TECHNOLOGY AND DEVELOPMENT NEEDS (Part 1)** — On the table below, please enter a check (✓) in the appropriate column to the right that indicates your company's relative strength for each **Maritime Technology Category** listed in the left column.

Maritime Technology Category	Strong	Weak	Not a Concern
1. Cost Estimating/Cost Benefit Analysis			
2. Safety/Vulnerability and Survivability System and Components			
3. Noise Abatement and Quieting Systems and Components			
4. Electromagnetic Signature and Silencing Systems and Components			
5. Propulsion and Energy Systems and Components			
6. Auxiliary Machinery Systems and Components			
7. Electrical Machinery Systems and Components			
8. Cargo Handling/Hull and Deck Machinery Systems and Components			
9. Habitability and Outfitting Systems and Components			
10. Undersea Vehicle Deployed Systems and Components			
11. Hull Forms and Propulsors Systems and Components			
12. Material and Applications			
13. Structural Systems and Components			
14. Small Craft Systems and Components			
15. Amphibious and Land-Based Vehicles Systems and Components			
16. Naval Architecture and Integrated Ship Design and Support			
17. Shipbuilding and Manufacturing Technology			
18. Analytical and Experimental Aerodynamics			
19. Environmental Quality Sciences Systems			
20. Logistical Support Systems			
21. Electrochemical Power Systems and Components			
22. Other (specify):			
23. Other (specify):			
24. Other (specify):			
25. Other (specify):			

PART IV (continued) MARITIME TECHNOLOGY

3. **MARITIME TECHNOLOGY AND DEVELOPMENT NEEDS (Part 2)** — For those maritime technologies in the previous question you identified as "weak," please briefly describe your specific technology transfer or development needs.

_____

_____

_____

_____

_____

4. **TEAMING WITH OTHER ORGANIZATIONS** — Please place a check (✓) below the column headings that best describe your opinion of teaming with the following **Organization Types.**

Organization Type	Favor Strongly	Favor	Neutral	Disapprove	Disapprove Strongly
Government					
Academic					
Private					
Foreign Entities					
Other (specify):_____					

Have you had a teaming relationship with any of these types of organizations in the last three years?

If no, check (✓) here ___ and go to the next question.

If yes, please describe your experience:_____

_____

_____

_____

_____

_____

PART V COMPETITIVE FACTORS AND BENCHMARKING

1. **COMPETITIVE PROSPECTS** — Place a check (✓) beside one of the following that best describes the competitive prospects for your firm's maritime operations in the next five years.

Improve Greatly__ Improve Some __ Stay Same __ Decline Some __ Decline Greatly __

Identify your two major U.S. competitors: 1)_____ 2)_____

Identify your two major foreign competitors: 1)_____ 2)_____

2. **PAST ACTIONS TO IMPROVE COMPETITIVENESS** — What actions have you taken in the last five years to improve your competitiveness?

_____

_____

_____

_____

3. **FUTURE PLANS TO IMPROVE COMPETITIVENESS** — What plans do you have to increase your competitiveness in the next five years?

_____

_____

_____

_____

4. **U.S. GOVERNMENT ASSISTANCE** — What additional actions, policy changes, regulatory reforms, or assistance could the Federal Government take to improve your competitiveness?

_____

_____

_____

PART V (continued) COMPETITIVE FACTORS AND BENCHMARKING

5. **PRODUCTIVITY** — Please answer the following questions:

a) Briefly explain in the space provided below how you measure productivity at your company.

_____

_____

_____

b) How much has productivity increased for your company in the last five years? _____ percent

PART V (continued) COMPETITIVE FACTORS AND BENCHMARKING

9. **COMPETITIVE STATUS BENCHMARK** — Please complete the following table, ranking each variable according to its competitive importance to your business as *H=high, M=medium, or L=low,* in the second column. Enter a check (✓) in the appropriate column on the table's right that best describes your status relative to worldwide competitors. Extra space is provided at the bottom of the page to add additional variables you wish to bring to our attention.

Competitiveness Measured Against Worldwide Competition				
Based on your last 10 competitions:	Competitions Won _____ Competitions Lost _____			
Your Customer's View	**Competitive Importance (H - M - L)**	**Do your customers view you as:**		
		Strong	**Needs Attention**	**Weak**
On-Time Delivery				
Product Quality				
Price				
Customer Support Capabilities				

Self-Assessment	**Competitive Importance (H - M - L)**	**How would you evaluate yourself?**		
		Strong	**Needs Attention**	**Weak**
Production Technologies				
Long-Term Planning				
*Soft Technologies				
Workforce Experience				
Customer Relations				
Supplier/Vendor Relations				
Productivity				
Credit Worthiness				

*Soft technologies are intangibles, such as organization of workflow, workforce development, management methods, and other practices that affect efficiency and human behavior in the work environment.

Other Competitive Factors	**Competitive Importance (H - M - L)**	**How do these factors impact your firm?**		
		Helps Business	**Neutral**	**Hurts Business**
Government Assistance Programs				
Material Costs				
Labor Costs				
Capital Availability/Costs				
Business Location				
Government Health & Safety Regs.				
Availability of Market Opportunities				
Labor/Management Relations				

Additional Variables (Optional)	**Competitive Importance (H - M - L)**	**How do these factors impact your firm?**		
		Helps Business	**Neutral**	**Hurts Business**

c) How much do you anticipate productivity will increase in the next five years? _____ percent

6. **EXPORT OPPORTUNITIES** — What would it take for your firm to increase your maritime exports?

_____

_____

_____

7. **EFFECT OF DECLINES IN DEFENSE EXPENDITURES** — How have declines in defense spending impacted your firm, and what strategies have you developed to deal with it?

_____

_____

_____

8. **EFFECTS OF OTHER GOVERNMENT EXPENDITURES (Federal, State, Local)** — How have other government expenditures impacted your firm?

_____

_____

_____

Appendix C

International Shipyard Profiles

PART VI SUPPLIER INFORMATION

1. **MATERIAL AND SUPPLY LEADTIMES** — If you experienced unscheduled extensions of lead times or supply interruptions of essential goods or services in the last five years that adversely affected (or affect) your maritime operations, please describe them below, and the actions you took to resolve them.

If none, check (✓) here ___ and go to next question.

Problem Item	Year	Duration (in months)	Actions Taken

2. **FOREIGN SOURCING** — Please complete the following table for your top five foreign-sourced maritime items in terms of 1998 purchases (e.g., supplies, components, subassemblies, or services).

Reasons for foreign sourcing:

a. domestic source not available
b. higher quality
c. lower price
d. quicker delivery
e. long-term relationship
f. part of global strategy
g. customer directed supplier
h. other (specify)

Item Description	1998 $ Value Imported	Country of Origin	Reasons (use above codes)

PART VI (continued) SUPPLIER INFORMATION

3. **MAJOR SUPPLIER IDENTIFICATION** — An important part of this study includes an assessment of the health and condition of the U.S. ship/boat building and repair supplier base. To identify the most important suppliers (excluding distributors), please provide a listing of your *top 20* U.S. suppliers (subcontractors, vendors, manufacturers) in terms of total 1998 purchases. ***You must either photocopy this page and use the following format for each supplier, or provide a printout that contains the same information.***

U.S. Supplier Identification Information			
Company Name		**Point of Contact**	
Address		**Phone**	
City, State, Zip code		**1998 $ Value**	
Product Supplied			

U.S. Supplier Identification Information			
Company Name		**Point of Contact**	
Address		**Phone**	
City, State, Zip code		**1998 $ Value**	
Product Supplied			

U.S. Supplier Identification Information			
Company Name		**Point of Contact**	
Address		**Phone**	
City, State, Zip code		**1998 $ Value**	
Product Supplied			

U.S. Supplier Identification Information			
Company Name		**Point of Contact**	
Address		**Phone**	
City, State, Zip code		**1998 $ Value**	
Product Supplied			

U.S. Supplier Identification Information			
Company Name		**Point of Contact**	
Address		**Phone**	
City, State, Zip code		**1998 $ Value**	
Product Supplied			

CERTIFICATION

The undersigned certifies that the information herein supplied in response to this questionnaire is complete and correct to the best of my knowledge. The U.S. Code, Title 18 (Crimes and Criminal Procedure), Section 1001, makes it a criminal offense to willfully make a false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

_____ _____

(Date) (Signature of Authorized Official)

_____ _____

(Area Code/Telephone Number) (Type or Print Name and Title of Authorized Official)

_____ _____

(Area Code/Telephone Number) (Type or Print Name and Title of Person to Contact about this Report)

Please check (✓) here ( ) if the above representations certify that your firm is exempt from completing this survey as explained in the General Instructions. Please explain the basis of your exempt status below:

_____

_____

Please check (✓) here ( ) if you would like to receive a free copy of the final report.

GENERAL COMMENTS

Please use the space below to provide any additional comments or information you may wish regarding your operations, or other related issues that impact your firm.

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International Shipyards

Note on American Shipyards:

As the U. S. Government's commercial maritime industry advocate, the Maritime Administration (MARAD) established the National Maritime Resource and Education Center (NMREC) to assist the U.S. maritime industry in improving its competitiveness, both in the domestic and international commercial market. The NMREC serves as a major information source and facilitator within the Government for the maritime industry by providing expertise, information, and reference material.

The web pages of over 100 U.S. shipbuilding and repair companies are available on the World Wide Web on the NMREC home page (http:/www/marad.dot.gov/nmrec). Select Links and then either U.S. Shipyards Alphabetical or U.S. Shipyards By Region.

Blohm and Voss GmbH
(www.blohmvoss.com)

Blohm and Voss, along with Thyssen Nordseewerke, is a part of ThyssenKrupp Werfen, a business sub-unit of the German industrial group ThyssenKrupp Industries. Blohm and Voss started operation in 1877 and are located at the port of Hamburg. Between 1995-1996, Blohm and Voss split into three separate entities. Blohm and Voss GmbH is the primary shipbuilder; Blohm and Voss Repair GmbH carries out repairs, service, and conversions; and while Blohm and Voss Industrietechnik GmbH handles mechanical and systems engineering.

Blohm and Voss makes vessels for the commercial market, including cargo ships, fast ferries, and mega yachts. In the defense market, Blohm and Voss relies primarily on its line of MEKO corvettes, frigates, and patrol vessels.

Recently, Blohm and Voss underwent a restructuring of its production process in order to improve on production coordination and transport times. The primary method to achieve this goal was to build two covered floating docks with sliding roof sections. This form of "short-route" production puts workshops and materials directly under the covered dock and in closer proximity to ship production.

China State Shipbuilding Corporation (CSSC)

CSSC is one of two entities formed by the split of the China State Shipbuilding Corporation group. It operates three large shipyards: Jiangnan, Hudong, and Guangzhou, as well as smaller yards in the southern half of China. Sales rose 3.9 percent in 2000 to about $1.5 billion, and CSSC received orders for 136 ships. CSSC is

constructing China's biggest shipyard, Waigaoqiao in Shanghai, which is scheduled to complete vessels by 2003 and be fully operational by 2006. The new yard will be able to construct Very Large Crude Carriers (VLCCs) in addition to the small oil tankers, bulk carriers, containerships, and liquefied gas carriers, which CSSC shipyards are already producing.

CSSC employs about 95,000 people.

China Shipbuilding Industry Corporation (CSIC)

The other company formed by the split of the former CSSC Group was CSIC with shipyards located predominantly in northern China. CSIC yards include Bohai, Xingang, Shanhaiguan and Dalian New Shipyard, which is building five VLCCs for Iran's state oil corporation. CSIC builds most of China's warships and also constructs containerships. Both CSSC and CSIC shipyards do extensive repair work. Sales for CSIC shipyards rose 9 percent in 2000, to $1.4 billion.

CSIC employs about 170,000 people.

Daewoo
(www.dhi.co.kr)

Daewoo established its shipyard at Okpo Bay on Koje Island, off the southeastern coast of the Korean peninsula, in 1978. Shipbuilding and related sectors were spun off from Daewoo Heavy Industries Ltd. in October 2000, and Daewoo Shipbuilding & Marine Engineering Co., Ltd. (DSME) was formed. DSME builds containerships, bulk carriers, crude oil tankers, LNG/LPG carriers, Roll-On/Roll-Off carriers, naval and other specialty ships, offshore drilling rigs, and both onshore and offshore plants. The Okpo facility has two dry docks and three floating docks. Its Number 1 dry dock is the largest in the world and holds a 900-ton gantry crane. Okpo also has an in-house paint shop, boasts indoor production facilities equipped with modern equipment, and utilizes robotic welding. DSME also is involved with Daewoo Mangalia Heavy Industries Co., Ltd., a joint venture with a Romanian shipyard.

In 2000, DSME received an estimated $3.7 billion (U.S.) in orders. Daewoo prides itself on its flexibility. Not only does the shipyard at Okpo employ the latest technologies, its workforce is said to have high labor morale and positive relations with management.

Daewoo continually has ships on order and has increased its orders to such a level that it can produce ships in series, reducing time and cost in ship production. Daewoo also boasts a high level of welding and paint quality.

According to March 2001 data, Daewoo employed about 10,500 total workers and used approximately 5,000 subcontractors.

Hyundai
(www.hhi.co.kr/english/shipbuilding.html)

Hyundai is the leading shipbuilder in the world. Its production facility in Ulsan, on the southeastern tip of the Korean Peninsula, produced its first ship in 1974. By 1999, Hyundai accounted for 13 percent of the world shipbuilding market. In 1998, Hyundai received orders for 59 ships worth $3.2 billion (U.S.), and in 1999 the firm received orders for an additional 63 ships valued at $3.4 billion (U.S.). Some of Hyundai's shipbuilding capabilities include fully automated steel-cutting lines, on-site paint shops, welding robots, and nine separate dry docks for specialized ship production. Ships built at the Ulsan yard include nearly every type of vessel for the commercial market and limited types of naval vessels.

Hyundai's shipbuilding research and development largely originates at the Hyundai Maritime Research Institute (HMRI), which has a large towing tank with a full width wave maker. In terms of development, Hyundai relies heavily on computer-aided hull and propeller designs and computer assistance in manufacturing. Its primary research functions are devoted to optimum hull form development, resistance and propulsion, offshore engineering, and structure and vibration. Additional research and development comes from the Hyundai Industrial Research Institution (HIRI). HIRI has previously helped increase productivity by improving such functions as the quality of welding.

At the end of 1999, the Hyundai shipyard at Ulsan employed 1,080 management personnel, 1,160 engineers, and 8,720 technical and skilled workers. Additionally, computers assist in nearly every facet of production, including daily staff administration, stock purchasing, research, ship design, and manufacturing.

One of Hyundai's strengths is repeat business, which allows the shipyard to produce vessels in series. This type of production increases efficiency and leads to increases in profit. With series production, Hyundai has shortened build times, increased quality, and raised productivity above that of most shipyards in the world.

Ishikawajima-Harima (IHI)
(www.ihi.co.jp)

This company's first shipyard opened in 1853, the same year in which Commodore Perry's fleet arrived in Tokyo Bay. IHI was a Japanese pioneer in the construction of steamships and offshore platforms, and the company built the world's first two VLCCs. Now a 96-company group, IHI operates 17 shipyards. The company was second among Japanese builders in 2000 in ship gross tonnage completed, highlighted by five double-hull VLCCs. IHI also constructs high-speed ferries, LNG carriers, floating cranes and platforms, dredges, navy ships (including destroyers), and other specialty vessels.

Shipbuilding turned from a loss to a profit area for IHI in the period spanning April-September 2000.

Kawasaki
(www.khi.co.jp)

Kawasaki established its first shipyard in 1878 and has become Japan's second-largest ship and heavy machinery builder. Operating out of two shipyards (Kobe and Sakaide), Kawasaki builds high-speed ferries and jetfoils, LNG/LPG carriers, tankers (including double-hulled), bulk carriers, containerships, research submersibles, submarines, offshore platforms, floating docks, and other special-purpose vessels. These yards also repair and modify ships. Kawasaki is also renowned for the quality of its marine engines, turbines, and steering systems.

Kawasaki Heavy Industries lost over $100 million between April and September 2000 and has explored merger possibilities with fellow Japanese shipbuilders Ishikawajima-Harima and Mitsui, which would form the biggest shipbuilding unit in Japan. It has also offered workers over 50 improved severance packages to try to cut labor costs. Another branch of the Kawasaki *keiretsiu*, Kawasaki Steel, is forming an alliance with fellow steel manufacturer and shipbuilder NKK.

Kvaerner ASA
(www.kvaerner.com)

Kvaerner ASA, an Anglo-Norwegian engineering and construction group, was once the largest shipbuilding company in Europe. Founded in Oslo in 1853, Kvaerner ASA opened its first shipyard in 1965 and owned 13 yards in six countries before announcing in April 1999 that it would exit shipbuilding. All of Kvaerner ASA's major shipyards have since been sold except for the Masa-Yards in Finland, the Warnow Werft Yard in Germany, and the Kvaerner Philadelphia Shipyard. While the sale of these yards remains pending, they continue to construct ships. Kvaerner ASA has carved a market niche in passenger cruise vessels, container ships, and LNG/LPG carriers.

Kvaerner ASA Shipbuilding employs about 6,500 people.

Mitsubishi
(www.mhi.co.jp)

This conglomerate's involvement with shipbuilding dates back to 1884, when Mitsubishi began to lease the Nagasaki Shipyard from the Japanese government. Shipbuilding and marine structures are now part of the Shipbuilding and Ocean Development Division of Mitsubishi Heavy Industries, Ltd. and account for about 10 percent of the company's sales. Mitsubishi is Japan's biggest shipbuilder but is cutting back its workforce due to the first company-wide loss in 35 years, partially due to a strong yen and competition from Korean shipyards. The company aims to allow almost 10 percent of its 6,000 shipyard workers to retire or resign. Mitsubishi hopes that its shipbuilding operations will again be profitable by 2003, thus not requiring mergers or other agreements with current competitors.

In addition to the Nagasaki Shipyard, Mitsubishi also builds ships at their Kobe and Shimonoseki yards, and the company repairs and converts vessels at the Yokohama Dockyard. Mitsubishi has been successful in building high-value large ships, including cruise liners, ferries, and LNG/LPG carriers. The company can build almost any kind of ship or marine structure, including patrol vessels for the Japanese Defense Agency and Coast Guard, but Mitsubishi is de-emphasizing the construction of crude and other bulk carriers. They were once the industry leader in this sector but can no longer compete with Korean shipyards on cost.

Odense Steel Shipyard
(www.oss.dk)

The Odense Steel Shipyard was founded in 1917 at the Odense Canal in Denmark. The A.P. Moller Group owns Odense Steel Shipyard Ltd. Odense Steel Shipyard Ltd. heads the Odense Steel Shipyard Group, consisting of operations in Denmark, Estonia, Lithuania, Egypt, Germany, and China.

Odense opened a new shipyard at Lindo in 1959 to expand capacity. The shipyard builds large container vessels and oil tankers, building the world's first double-hulled supertanker in 1993.
Operations at the Lindo shipyard were set back when a storm disabled the yard's gantry crane in December 1999. The yard is currently renting cranes for heavy lifting until a new crane facility can be constructed. The yard estimates this construction will be completed by Spring 2001.

Samsung
(www.shi.samsung.co.kr)

Samsung Heavy Industries is another leading shipbuilder in the world market operating out of Korea. Its Koje shipyard has three dry docks, three production plants (hull shop, outfitting center, and paint shop), and highly developed automation processes. Samsung primarily makes tankers, container vessels, bulk carriers, and offshore vessels.

The Samsung Ship Model Basin (SSMB) conducts research and development for Samsung shipbuilding. SSMB not only holds the world's largest commercial towing tank, but it also houses a cavitation tunnel that can be used for such functions as full model testing and underwater noise measurements.

Recently, Samsung has been trying to develop a prototype for a 9,000 twenty-foot equivalent unit (TEU)-class jumbo container vessel, the world's largest. Samsung also hopes to develop a prototype 14,000 TEU-class containership. Samsung is also producing the first ultra-deep-water drill ship to operate in the Gulf of Mexico. This ship will be equipped with a double-hull so that it can comply with the Oil Pollution Act of 1990 and, therefore, call at U.S. ports.

One of the reasons Samsung has been successful is that repeat business makes up 52 percent of its new orders, which allows its shipyard to be more productive. The European market makes up 47 percent of its business, followed by other Asian countries at 28 percent, Korea with 16 percent, and the U.S. with 9 percent.

Appendix D

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Bibliography

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Appendix E

List of Prior National Security Assessments