MARITECH PROGRAM IMPACTS ON GLOBAL COMPETITIVENESS OF THE U.S. SHIPBUILDING INDUSTRY AND NAVY SHIP CONSTRUCTION

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Preface

This is the final report of a study conducted by the Potomac Institute for Policy Studies under the sponsorship of the MARITECH Program Office at the Defense Advanced Research Projects Agency (DARPA). The Economic Strategy Institute (ESI) contributed to the study through the development and analysis of overarching economic indicators.

The Potomac Institute for Policy Studies (the Institute) is a not-for-profit organization dedicated to the development and support of non-partisan analysis of technology and technology policy. The Institute has conducted studies that provide insight into the impact of new technologies and processes on our society, the proper relationship between government and industry in meeting future needs, and the state of the U.S. industrial base.

The Institute would like to thank the MARITECH Program Office, led by Mr. Bob Schaffran, for the collective insights and information shared by the staff throughout our investigations. We would also like to thank the many Shipyard personnel and shipbuilding industry experts who contributed so substantially to this study. Views expressed in the following are our own, however, and do not necessarily reflect the opinions of the MARITECH Program Office or other contributors.

This survey study was conducted over three months. It featured on-site interviews with nearly one hundred people (some of whom are identified in Annex A), coupled with considerable analysis. The analytical portion of the study included an examination of the individual shipyards, principally by the Potomac Institute for Policy Studies, and an economic analysis performed by the Economic Strategy Institute (found at Annex B).

The study does not purport to be an in-depth microeconomics analysis, although the ESI contribution provides a significant understanding of the economic backdrop for the U.S. shipbuilding situation. Our primary hope is that we have presented an aggregated view of MARITECH participants, both government and industry (but principally the latter). We did not, as a rule, validate data provided by the shipyards to describe their MARITECH experiences, except to compare it with that provided by government managers and with pertinent published information. We feel, however, that we have captured the essence of MARITECH's impact. Further, we believe the case summaries contain a wealth of information that can be usefully exploited by further analysis.

The Office of the Assistant to the Secretary of Defense (Public Affairs) has cleared this report for open publication.

Approved for Public Release - Distribution Unlimited

List of Common Acronyms and Definitions

ASE	MARITECH **A**dvanced **S**hipbuilding **E**nterprise Program
AOE	Fast Combat Navy support Vessels
AOTR	**A**greement **O**fficer's **T**echnical **R**epresentative
Big 6	The "Big 6" shipyards, that construct Navy ships, are: Avondale, Bath Iron Works, Electric Boat Corporation, Ingalls, NASSCO, and Newport News.
Bulk Carrier, Bulker, Dry Bulk*	Vessels that range in size from small coastal craft to ships of over 150,00 deadweight capacity which are designed for the carriage of bulk commodities.
CAD/CAM	**C**omputer **A**ided **D**esign/**C**omputer **A**ided **M**anufacturing
cgt*	**C**ompensated **G**ross **T**ons -- Unit of measurement developed to measure level of shipbuilding output.
Container Ships *	Vessels designed to carry full loads of containers in fixed cell guides.
COMPASS	**C**ommercial **O**bject **M**odel of **P**roducts / Processes for an **A**dvanced **S**hipbuilding **S**ystem - It seeks to develop a comprehensive, affordable, Windows-based ship design and data management system that integrates and manages the data required for ship design, construction and lifecycle support, and will be scalable for use by shipyards of all sizes.
COSCO	**C**hina **O**cean **S**hipbuilding **Co**mpany
DARPA	**D**efense **A**dvanced **R**esearch **P**rojects **A**gency
dwt*	**D**ead**w**eight **T**onnage - The number of tons of 2,240 pounds that a vessel can transport of cargo, stores and bunker fuel. It is the difference between the number of tons of water a vessel displaces "light" and the number of tons it displaces when submerged to the "load line."
E-CAT	A high speed, low wake, fuel efficient catamaran ferry.
FIRST	**First** Principles Approach for Ship IPPD - This project will develop an integrated product and process environment based on "first principles" (such as manufacturing constraints) to rapidly conceive, analyze, and estimate alternative ship designs with an emphasis on providing production and life-cycle level of detail information during pre-contract design.
FFG	**F**ast **F**rigate, **G**uided Missiles
General Cargo Ships*	The most versatile in the merchant fleet as individual units can also carry bulk cargo.

gt*	**G**ross **T**onnage -- The total of all the enclosed spaces within a ship, expressed in tons, each basic unit of which equals 100 cubic feet (2.831 cu. m).
IMTA	**I**nternational **M**ultimodal **T**ransport **A**ssociation
INCAT	**In**ternational **Cat**amarans
IPDE	**I**ntegrated **P**roduct **D**ata **E**nvironment
IPPD	**I**ntegrated **P**roduct and **P**rocess **D**evelopment
IS, IT	**I**nformation **S**ystems, **I**nformation **T**echnology
ldt*	**L**ight **D**isplacement **T**onnage -- The actual weight of an empty ship.
LPD	Amphibious Transport Dock
LSD	Dock Landing Ship
LST	Tank Landing Ship
MARAD	U.S. Department of Transportation's **Mar**itime **Ad**ministration
MariSTEP and STEP	**Mari**time **St**andard for the **E**xchange of **P**roduct is a is a MARITECH sponsored project targeting prototype implementations of the emerging STEP shipbuilding application protocols. This project will develop and test prototype STEP-compliant translators to facilitate the transfer of ship three-dimensional product model data between different companies with different computer-aided design and manufacturing systems via a neutral file format.
MEJ	**M**ARITECH **E**ngineering **J**apan
MMCS	**M**ulti-**M**ission **C**argo **S**hip
NIIIP	**N**ational **I**ndustrial **I**nformation **I**nfrastructure **P**rotocols - will allow the sharing of information throughout an enterprise (among separate business areas). This is difficult because of the heterogeneity of computing environments, the pervasiveness of legacy systems, and the rapidly changing information technologies and protocols.
NSnet	**N**ational **S**hipbuilding **Net**work - NSnet is an electronic communications network for the maritime community which will bring the technological strengths of DARPA and the Nation (Information Technology) to the maritime industry.
NSRP	**N**ational **S**hipyard **R**esearch **P**rogram is a unique cost shared government and industry program. Its mission is to assist the US shipbuilding and repair industry in achieving and maintaining global competitiveness with respect to quality, time, cost and customer satisfaction.
NSSC	**N**ational **S**hipbuilding and **S**hipyard **C**onversion Act of 1993
OECD	**O**rganization for **E**conomic **C**ooperation and **D**evelopment
OPA-90	**O**il **P**rotection **A**ct of 1990
OSV	**O**ff-shore **S**upply **V**essel

PWBS	**P**roduct-oriented **W**ork **B**reakdown **S**tructure
Reefer	Refrigerated Cargo Ship
RO/RO	**R**oll-**O**n/**R**oll-**O**ff (ship loading)
SBD	**S**imulation **B**ased **D**esign is used as an environment for concept and contract design using IPPD.
SC (as in SC-21)	**S**urface **C**ombatant (Ship)
SHIIP	**Sh**ipbuilding **I**nformation **I**nfrastructure **P**roject - This project will develop technologies that allow a shipbuilder to reduce the time and cost of ship construction through a new shipbuilding methodology that leverages off new, innovative information (intra-net) systems, by developing an advanced electronic shipyard information infrastructure.
SPARS	**S**hipbuilding **Par**tners And **S**uppliers - is a deployment project to establish Virtual Enterprise (VE) technologies for shipbuilding. The VE will represent customers, partners, subcontractors, and suppliers using NIIIP technologies.
SSN	Attack Submarines
SWATH	**S**mall **W**aterplane **A**rea **T**win **H**ull
Tankers (Chemicals) *	Class of vessel specifically designed to cater to the liquid chemicals market, capable of transporting various grades of chemicals, solvents, and acids.
Tankers (Gas)*	There are two categories: (1) Liquid Natural Gas (LNG) Tankers and (2) Liquid Petroleum Gas (LPG) Tankers
Tankers (Oil and Product)*	Vessels principally involved in carriage of crude oil and its derivatives.
TOTE	**T**otem **O**cean **T**railer **E**xpress
TQM	**T**otal **Q**uality **M**anagement
UCSD	**U**niversity of **C**alifornia, **S**an **D**iego
ULCC*	**U**ltra **L**arge **C**rude **C**arriers - Large tankers of no official size but variously described as being one between 350,000 dwt and 550,000 dwt.
VLCC*	**V**ery **L**arge **C**rude **C**arriers - Large tankers of no official size but variously described as being one between 100,000 dwt and 350,000 dwt.
VE	**V**irtual **E**nterprise - A temporary consortium of independent member companies which come together to exploit fast-changing worldwide product manufacturing opportunities.
ZOLT	**Z**one **O**utfitting **L**ogic **T**echnology

* Data from Hans J. Peters, *The Maritime Transport Crisis*

Executive Summary

The U.S. shipbuilding industry is faced with a difficult task, one of achieving success in a global market that features tough and skilled competitors, who are most often subsidized to an extent that the U.S. industry has not experienced since 1981. Simultaneously, its principal customer, the Navy, has cut back procurements. The industry must become competitive, or face an uncertain future. It must make the gains necessary to compete in the global market, to ensure its share of domestic ship orders, and to be able to deliver affordable and effective Navy vessels. MARITECH has moved the industry toward these goals along a broad front of process improvements, new technologies, facilities modernization, and new markets. The job is far from over. The U.S. shipbuilding industry is not yet able to compete internationally, but MARITECH has been an important start that should be continued.

Background. The MARITECH Program began with the National Defense Authorization Act for FY1993, Public Law 102-484, which required the President to present a plan to Congress for the revitalization of the U.S. shipyards.[1] Its principal goal was to encourage the U.S. shipbuilding industry to expand into the international commercial market. It has been managed by the MARITECH Program Office, operating under the Defense Advanced Research Projects Agency (DARPA). MARITECH will be transferred to Navy management during the coming year. MARITECH's five objectives are to: encourage and support proactive market analysis and product development; develop a portfolio of U.S. designs; develop innovative design and production processes and technology; facilitate government and industry technology transfer activities; and encourage formation of consortia for short- and long-term technology investment strategies.

The purpose of this report is to document the findings and recommendations of the MARITECH Review Project – an independent examination of the MARITECH Program and its accomplishments. The review was conducted by the Potomac Institute for Policy Studies and reinforced by an economic analysis prepared by the Economic Strategy Institute (see Annex B).

Major Conclusions. It would be wildly optimistic to expect MARITECH to create a globally competitive shipyard industry in five years with $220M. ***But, MARITECH has accomplished much. Its impact on the shipyards visited by the Review Team was surprisingly pervasive. Nearly all facets of U.S. shipyard operation are undergoing change, much of this change is due to MARITECH.*** For example, MARITECH projects contributed significantly to improving business and construction processes. These projects increased productivity, a key to global competitiveness. MARITECH's influence

[1] The five objectives of the President's Plan developed in response to this act were to: ensure fair international competition through OECD; improve competitiveness, through the MARITECH Program; eliminate unnecessary government regulation; finance ship sales through Title XI loan guarantees; and assist international marketing.

is particularly impressive because the funding of the program was relatively low, considering the problems it tackled.

The Navy is already benefiting from commercial shipbuilding practices and standards. Those benefits will grow with active Navy involvement. However, differences in business and construction philosophies between the Navy and the commercial sector make it difficult for Navy shipyards to enter the commercial market. The Navy will receive full benefit of commercial wisdom only when U.S. shipyard processes and practices are up to international standards. But, these standards are best attained through global competitiveness -- possible for Navy shipbuilders only if the Navy reduces the shipyard's dualism by accepting commercial processes and practices to the degree possible. This "catch 22" must be resolved by the Navy, and the MARITECH follow-on program, the MARITECH Advanced Shipbuilding Enterprise Program (ASE), can be an excellent vehicle for that resolution.

The U.S. shipbuilding industry is beginning to progress. With MARITECH's aid, the industry has built 9 new ships (with 17 under construction), and has produced 31 new ship designs. In June 1997, the U.S. orderbook for ships (100 gross tons or larger) totaled more than 640,000 gross tons, good enough for thirteenth place in the global rankings. That compares to less than 220,000 gross tons for a twenty-third place ranking as recently as December 1995.[2] ***As of April 1997, there were 21 commercial ships on U.S. orderbooks, with a total contract value of approximately $1 billion. The budgetary impact of these sales result in sufficient direct and indirect activity to produce enough tax revenue to nearly pay for the whole five-year program.[3]***

But, there are downsides. Despite signs that foreign subsidies may diminish in the future, they currently pose a decided disadvantage to U.S. shipyards. Even if the field were level, American shipbuilders are behind the rest of the world in productivity. Finally, although many Navy leaders have supported the industry's need to become competitive in the global shipbuilding market, the Navy is not yet a fully active partner in that pursuit.

Some specific examples of industry accomplishments, aided by the MARITECH Program, are listed below.

Alabama: Alabama shipyard built a pipe fabrication facility, adopted a 3D capability to reduce interference. This, and cutting machines driven by CAM data, saved 20% on production labor hours on Dannebrog tankers.

Avondale: A new steel handling and fabrication facility yielded 10-20% productivity improvement (+ 2% annually), and will save LPD-17 production costs.

Bath Iron Works (BIW): The self-adaptive robotic welding project to automate the welding of 5,000 to 10,000 structural beam erection joints, will save about $500K per ship, and reduce high cost and injury of rework. BIW established relationships with Kværner Masa and Mitsui that remain intact today, and imported technologies and

[2] Lloyd's Register, June 1997.
[3] See ESI Report, "Overarching Economic Considerations" in Annex B.

processes that are applied to Navy shipbuilding (claiming annual cost avoidance of $11M to $13M on construction of AEGIS destroyers).

Bender Shipbuilding: Bender will reduce the cost of operations and ship construction time by 50% through their MARITECH project, Organization of Work in a 2nd Tier U.S. Shipyard. New CAD and layout software reduced re-piping and re-running pipe time by 30%, saving 4-5,000 man-hours per ship (uses software with plasma machine to precut pipe holes).

Bollinger: MARITECH put Bollinger "on the map" in the domestic offshore liftboat industry. Liftboat leg construction simulation saves 10% in material and production (cost & time) -- using this software reduces proposal preparation time by a factor of four. AutoCAD shared with all engineers/designers reduced the design process by a factor of five.

Electric Boat: An approximate cost avoidance of $20M per ship was realized through SHIIP, MariSTEP, and SPARS.

Gladding-Hearn (G-H): Partly as a result of the MARITECH program, it has seen a doubling of sales volume, and consequently, increased its workforce by 30%. G-H has a two year backlog of orders (triple its pre-MARITECH backlog). G-H estimates that the current market should drive the fast ferry business for approximately the next ten years.

Halter Marine: Halter is currently building a 42.5M High Speed, Low Wake Pax Ferry that will be debuted at the IMTA in New Orleans in October 1998. It created an electronic infrastructure linking their yards. Halter is using extended aluminum deck and stiffeners (extrusion vice panel with stiffener welded), which results in less distortion, labor savings and lighter weight design.

Ingalls Shipbuilding: Self-adaptive robotic welding could increase its robotic welding from 2-5% to 5-9% per ship.

Marinette Marine: Marinette initiated enterprise IS to link design, production, business, subcontractors and suppliers and built an international vendor database for current price and performance information on customer-preferred vendors. It also adopted just-in-time inventory practices. Its integrated design/production change process reduced re-work rates to 1% from 12%.

NASSCO: This Shipyard improved material and interim product flow which should result in a 25% reduction in steel cost and cycle time. It improved block pre-outfitting procedures which decreased time from launch to delivery from 12 to 8 months on Navy Sealift Ships, and also resulted in the seventh ship having 35% fewer production man-hours than the first.

Newport News (NNS): NNS plans to increase robotic welding from 4% to 15-20% which will yield 25-50% reduction in welding time. It estimated a 50% reduction in schedule and costs when all computers have been networked into a MARITECH overarching computer management decision tool.

Nichols Brothers: Nichols implemented ZOLT (PWBS) in all design/production/ business centers, yielding a 20-30% production time reduction between vessels and the better material flow saved 3 months production time on tugs and aluminum ferries.

Todd Pacific: Worker input changed T-beam slot-cutting operation from 12 hours to 4 minutes. Todd realized a 30% steel shop productivity increase (35% time and effort savings between Ferries 1 & 2 -- an additional 17% between 2 and 3). Through accuracy control improvements, Todd reduced ship-ways work man-hours from 100,000 on Ferry 1 to 50,000 on Ferry 2, to projected 40,000 hours on Ferry 3.

Recommendations.

Initiate a MARITECH follow-on program, ASE, in the Navy. Both the Institute's review of 14 shipyards, and ESI's economic analysis, strongly support continuation of the efforts begun under MARITECH for another five years. The goal of ASE should be to continue to move U.S. shipyards toward world class commercial shipbuilder status, ***and to find ways for the Navy to facilitate and benefit from the pursuit of those commercial goals***. MARITECH should be a major part of the deliberations by the Executive Control Board of the National Shipbuilding Research Program (NSRP) and the Navy, as they define the ASE Program.

An important issue is the focus of the ASE. Its principal focus must remain on global commercial competitiveness, or it will lose considerable impact on the shipyards and Navy shipbuilding alike. But this is not enough, for if the program is successful in improving shipyard performance, but the Navy fails to apply commercial practices to naval shipbuilding, benefits to the Navy will be indirect, at best.[4] For this reason, the Navy should be responsible for the second program goal – the adoption of commercial practices into the Navy.

Some specific suggestions for ASE are presented below.

- **Place less emphasis on marketing and new ship designs.**
- **Place more emphasis on business and construction processes, technology improvements, and training and education (to include sharing lessons learned and resolving terminology differences in business/design/production processes).**
- **Develop and acquire supporting technologies as justified by the processes they enable (e.g., information technologies, automated welding, IT).**
- **Institute an ongoing assessment process at the beginning of the program.** This process should continuously evaluate, collect lessons learned, and make recommendations concerning progress and performance along critical paths.

[4] In fact, the program may end up favoring non-Navy yards. Partly because they cannot rely on Navy business for survival, virtually all of the these yards see their future in the global commercial market (as opposed to three out of the "Big 6" Navy yards). This, and the fact that they do not have to accommodate Navy practices, has allowed them to optimize their operations for commercial success.