R&D in the Maritime Industry: A Supplement to an Assessment of Maritime Trade and Technology

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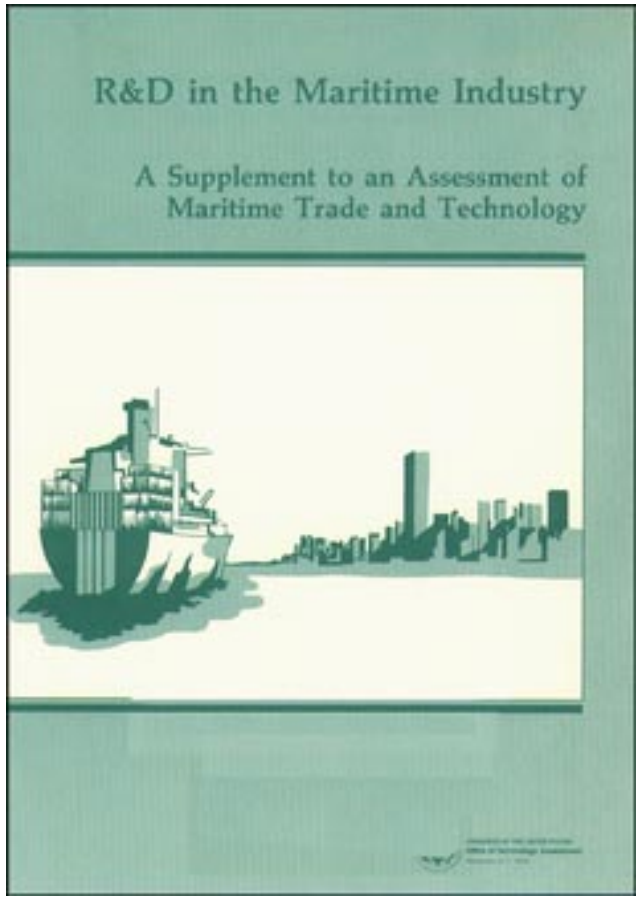

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Foreword

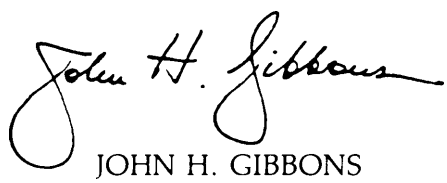
Since the publication of "An Assessment of Maritime Trade and Technology" by OTA in October *1983,* various proposals have been made to provide incentives for research and development (R&D) in an effort to enhance the industry's competitive position. Consequently, the Senate and House Subcommittees on the Merchant Marine jointly requested OTA to analyze the Federal role and/or incentives for improved maritime R&D including new institutional arrangements, financing and priority setting. This supplement is in reply to that request.

In order to investigate the subject in more detail than our original assessment, OTA conducted an industry-wide survey, receiving replies from approximately *85* U.S. ship and barge operating and building firms. Respondents to the survey represented about one-half of the firms and work force in these two major sectors of the U.S. maritime industry. The results of that survey and other analyses are contained in this supplement.

The OTA survey provided some valuable basic data on R&D activities and views about problems and opportunities from a broad spectrum of the maritime industry. After preparing a draft report on the survey, OTA circulated it for comments and held a workshop to discuss survey results and proposals for possible changes in Federal institutions. OTA sincerely appreciates the assistance provided by the workshop participants and others who offered comments on the draft report. We especially appreciate the help of Dr. Leslie Kanuk who advised on the design of the survey itself and the evaluation of the responses.

It appears from our analysis that, while aspects of the Federal maritime R&D effort are useful and productive, a number of problems limit the benefits to industry and hinder the pursuit of such national goals as technological preeminence. Problems identified with existing Federal maritime R&D include: difficulty with government contracting procedures, limited dissemination of R&D results, restricted involvement of some sectors of the industry, and difficulty with initiating cooperative R&D in some sectors.

The major issue highlighted by the OTA survey and analyses is whether the Federal role in maritime R&D is adequate or whether it should be enhanced for the benefit of both the maritime industry and the Nation as a whole. While a wide diversity of opinion exists concerning the need for and the nature of a new maritime R&D institution, the value in a new approach is the promise of addressing some of the more important problems noted above. One or more of a range of alternative approaches could be put in place. Since the existing institutions also have valuable aspects, it is important to preserve the successful elements in any future changes.



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Introduction

CONGRESSIONAL INTEREST IN MARITIME R&D

In 1982, in response to their concerns about the viability of U.S. maritime industries as well as the future U.S. position in world trade, the House Committees on Merchant Marine and Fisheries and on Ways and Means jointly requested the Office of Technology Assessment (OTA) to undertake an analysis of maritime trade and technology issues. In particular, the committees asked OTA to evaluate long-term trends in global seaborne trade and maritime technology in relation to the U.S. maritime industry. This study was completed in the course of the following year and the final report, "An Assessment of Maritime Trade and Technology," was presented to Congress in October of 1983.

In conducting this study for the Committees, OTA reviewed the status of American maritime technology and surveyed the members of the Society of Naval Architects and Marine Engineers (SNAME) Ship Technical Operations Committee for their views on U.S. maritime technology. As a result of this work, OTA found that the U.S. generally has lagged behind foreign competitors in applying technological advances to much of the U.S.-flag fleet and to the technology of constructing ships. OTA concluded that to achieve a competitive position in world shipping and shipbuilding, it is important for the United States to regain technological preeminence in these areas.

Following these conclusions, OTA examined the role of R&D in stimulating technological innovation in the shipping and shipbuilding industries. OTA's analysis suggested that there is a need for a more effective R&D program, and that Congress could help establish a more specific Federal role in maritime research. The elements of a congressionally defined Federal role, as outlined in the OTA report, might include:

1. identifying R&D objectives as a subset of an overall maritime policy;
2. determining what U.S. industry can do better itself and formulating indirect incentives for industry R&D;
3. stimulating coordination and transfer of technology within the industry and from military, foreign, and other sources;
4. focusing on high-risk areas and long-range problems that are not adequately addressed by industry or elsewhere, the solution of which could contribute to national goals; and
5. establishing new or modified institutional arrangements to encourage, coordinate, and foster R&D with either *or* both private and Federal support.

In response to these findings, both the Senate and House Subcommittees on the Merchant Marine asked OTA to take a more in-depth look at maritime R&D, addressing those issues raised in the original OTA report. The findings of that analysis are described in this supplement.

DEFINITIONS OF R&D

For this study, OTA ascribes to a definition of R&D used by the National Science Foundation (NSF).[1] The NSF defines "research" as: ". . . systematic study directed toward fuller scientific knowledge or understanding of the subject studied." Development is defined as: ". . . the activity (that is) directed toward the creative application to practical affairs of that knowledge gained from research and that frequently in itself involves the discovery of new knowledge."

[1]National Science Foundation, ***Federal Funds for Research and Development: Fiscal Years 1979, 1980, and 1981,*** Vol. XXIX. Surveys of Science Resources Series. NSF 81-306 (Washington, DC: U.S. Government Printing Office, 1981).

In relation to the shipping and shipbuilding industries, these inclusive definitions would encompass all activities related to designing new or improved products, technologies, techniques or procedures to improve the operation or construction of ships. While this supplement mainly uses the term "R&D" to refer to most of the activities under discussion, it should be noted that the greatest portion of these activities in the U.S. maritime industries fall under "development" rather than "research. "

SCOPE AND DESIGN OF THIS SUPPLEMENTAL STUDY

This OTA supplemental study does not attempt to examine in detail any programs of ongoing research or to evaluate gaps or needs in current Federal maritime R&D. Instead, its primary objective is to investigate those institutional or policy issues that broadly influence the quantity and quality of R&D in the United States. For example, the study focuses on issues such as the effect of the tax, patent, and antitrust laws on research activities by the industry. It also examines the ability of the current Federal organizational structure to provide a focus for maritime R&D and to stimulate industry participation in this program.

In addition to a review of the existing literature, conversations with U.S. Navy and Maritime Administration personnel, and discussions with representatives of shipyards and ship operating companies, much of the information in this study comes from a survey sent to *80* U.S. ship operating firms and 50 U.S. shipyards, of which *66* operators and 48 builders met the survey criteria (see below). The survey queried both operators and shipyards on the percentage of their operating budgets spent on R&D in the past five years and in the current year. Information was also requested on what share of the total amount spent by these firms on R&D was contributed by the Federal Government. Finally, the respondents were asked to evaluate the effect of specific Federal policies on their decisions to commit resources to R&D and to register their support for various policy options for promoting R&D. The survey also solicited suggestions for other potential policy options.

The OTA ship operating survey was sent to U.S. ship operating firms selected because of their affiliation with major industry associations—the American Institute of Merchant Shipping, the Council of American-Flag Ship Operators, and the Federation of American-Controlled Shipping. A number of unaffiliated operators were also selected from published sources.

OTA's shipbuilding survey was sent to the members of the Active Shipbuilding Industrial Base (ASIB), most of whom are also members of the Shipbuilders Council of America. The ASIB designates those firms that are currently building or seeking to build ships for the U.S. Navy and includes all of the larger U.S. shipyards and a number of yards that specialize in medium-sized and smaller military vessels, such as patrol boats. In addition, OTA sent questionnaires to smaller (so-called "second-tier") shipyards that are members of the American Waterways Shipyard Conference. These yards build a variety of vessels including fishing boats, barges, drilling rigs, and tug boats.

Table 1 shows the make-up of the survey sample. Out of the original group who were solicited, a number of operators or builders were disqualified because they were either not in the business OTA had assumed, they had just gone out of busi-

Table 1 .—R&D in the Maritime Industry: U.S. Ship/Barge Operators and Builders OTA Survey and Response Data

	Operators		Builders	
	Number	Percent	Number	Percent
Original sample . . .	80		50	
Firms disqualified (not in business, etc.).	14		2	
Net qualified firms in survey	66	100	48	100
No response	18	27	12	25
Total respondents .	48	73	36	75

NOTE Percentages are rounded, and may not add up to 100 in some tables

ness, or they were foreign-owned companies. For example, some major petroleum companies recently disposed of their operating fleets and now only charter ships for their needs; two shipbuilders went out of business while OTA was conducting the survey; two companies thought to be operators turned out to be only brokers.

Thus, the net size of the sample (i.e., the number of qualified firms included) in the OTA survey was *66* operators and *48* builders. Of that group, *73* percent of the operators *(48* firms) and 75 percent of the builders *(36* firms) responded to the survey. Those firms who responded are listed in appendix D. Most of the firms who did not engage in any R&D did not complete the entire survey form; however, the others reported almost all the information that was requested.

The survey sample therefore represents a sizable portion of the U.S. maritime industry. For example, the 23 operator firms that had some R&D activities and reported on the survey forms represent 50 percent of the total U.S. flag fleet tonnage plus about 3 million gross tons of the U.S. owned, foreign flag fleet. These *23* firms include seven liner companies, one roll on/roll off (Ro/Ro) operator, 14 bulk and barge operators, and one cruise operator.

The U.S. shipyards responding to the survey represent 75 percent of the major yards (considered the Active Shipbuilding Industrial Base) plus 22 of the so-called "second tier" yards. The *36* yards responding represent about 50 percent of the total U.S. shipyard employment base. Of these, 22 (61 percent) completed the survey forms in their entirety.

OTA also asked each respondent to identify his or her position in the organization, The replies were in three general categories—about one-third were presidents or chief executive officers of the firms, one-third were vice presidents, and one-third were division managers responsible for R&D, engineering, transportation, or planning functions. It appears from these data and other responses, that most firms gave serious attention to our survey and tried to provide comprehensive and accurate information.

Changes in Federal policies supporting the U.S. shipping and shipbuilding industries, combined with a worldwide slump in commercial shipping and shipbuilding, have caused severe problems in a number of sectors of the U.S. maritime industries. These problems, leading to a decline in traditional markets and a concentration of some of the major firms in a few growing market segments (e. g., liner shipping and military ship construction), were analyzed in the 1983 OTA study. Most of that analysis is still very timely and many of the problems facing the industry are still very evident.

Thus, the survey of R&D activities may have met with some skepticism. Many responses were qualified to reflect a view that R&D is far down the list of priorities in an industry which is fighting for day-to-day survival. Some respondents insisted that the Federal Government must change its policy towards supporting the industry and its markets before it would make sense to develop new technology to either build or operate ships. On the other hand, there is also a segment of the industry, reflected in the survey, which does not want Federal Government involvement in anything but support of basic research and educational facilities. This segment believes that the present Federal policy trends are beneficial.

Given this wide divergence of views within the U.S. maritime industries, it is not clear that a cohesive national policy towards R&D, or an institutional framework for R&D, can gain adequate support. In any case, it would be important to integrate approaches to Federal involvement in R&D with the major elements of an overall national maritime policy.

SUMMARY OF FINDINGS

OTA's approach to this analysis has been twofold: first, to understand the existing impediments to R&D investment in the maritime industry; and second, to examine ways in which the Federal Government might encourage or facilitate maritime R&D, either directly or indirectly. In the case

of the former, OTA's survey has provided an unambiguous answer: the marketplace is the final arbiter. The low and unsteady demand for U. S.-built ships, for instance, either at present or anticipated in the near future, has forced the shipbuilding industry to be extremely conservative in devoting funds to R&D. In comparison with the effects of the marketplace, interest rates and the availability of capital were found to be only slightly influential factors. This is presumably because many firms are extremely hesitant to borrow money for R&D unless the future of the industry looks relatively promising.

On the other hand, some believe that R&D itself can be a driving force for improvement in both the marketplace and the productive capability. On the whole, Government policies were considered by the survey respondents to have only a moderate effect on R&D decisions. When respondents were asked about specific Government policies, their responses did not indicate a clear pattern of the effects of these policies.

In the shipbuilding industry, the phase-out of subsidies was most clearly regarded as a factor discouraging R&D investment; but a significant number of respondents also felt the phase-out of subsidies had a negligible effect on R&D. The ocean-going ship operators, on the other hand, reported that the phase-out of subsidies had little effect on their R&D investment. * The shipbuilding respondents were almost equally divided as to whether the U.S. tax code had negative, positive, or negligible effects on investment. The ship operators were equally divided about the impact of Coast Guard regulations. Otherwise, the respondents indicated that other policies had little or no effect on their R&D investment. Policies that OTA suspected might affect investment—such as antitrust statutes, patent law, OSHA safety regulations, rail and truck deregulation—apparently were not significant, although some respondents were in favor of modifying antitrust laws.

*It should be noted that while construction subsidies for the ocean-going fleet have virtually been eliminated for the past 2 years, existing operational subsidies, in fact, have not.

In response to the survey findings and other available information, OTA formulated a number of policy options. These options fall into four categories: 1) increasing direct Federal support, 2) encouraging the industry to invest more in R&D, 3) encouraging cooperative industry R&D, and 4) facilitating inter- and intra-industry technology transfer. The OTA analysis also produced a number of indications about the potential efficacy of these options to the maritime industry. For instance, most of the firms responding to the relevant portion of the survey (hereafter called "respondents") believed that increasing direct Federal funding for maritime R&D would act as an incentive for further private investment. Respondents were also favorably disposed toward a revision of the antitrust laws to permit joint ventures and toward measures to provide them with loan guarantees and tax deferments on funds committed to R&D (despite their ambivalence when asked whether antitrust laws and the limited availability of capital were impediments to investment). With respect to coordinating maritime R&D, respondents endorsed the concept of a central government/industry sponsored maritime R&D institution. However, most of the survey respondents were hesitant about their own participation in such a scheme; therefore, it is likely that the Federal Government would not only have to spearhead such a concept, but that the industry might be financially unwilling or unable to provide consistent support for it. On the subject of technology transfer, the respondents indicated that for many firms, access to U.S. Navy and foreign R&D results is a problem. A number of positive suggestions to facilitate technology transfer were made, such as publication of an annual catalog of completed and ongoing research activities.

While a wide diversity of opinion exists concerning the need for and the nature of a new maritime R&D institution, OTA's industry survey and subsequent workshop discussions led to the following principal findings regarding the features of a new institution should it be supported:

1. Some existing Federal efforts and programs (e.g., the National Shipbuilding Research Program) are valuable and effective. Any new institution should incorporate successful existing elements and gradually phase-in new initiatives.

2. Any new institution should have adequate contracting flexibility.
3. Any new institution should have the capability of initiating joint government/industry cooperative ventures in specific areas.
4. Methods should be developed for any new institution to encourage participation of a broad industry group and to utilize industry guidance in developing program goals and selecting R&D projects.
5. Any new institution should include programs for adequate technical information retrieval and for wide dissemination of R&D results.
6. Any new institution should maintain and enhance the most productive existing programs providing direct support of basic research, research at educational facilities, and unique national laboratories.
7. Any new institutions should seek to incorporate methods that facilitate innovations in the private sector and encourage adoption of advanced technologies within the U.S. maritime industries.

Section II

A Profile of R&D in the Maritime Industry

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INDUSTRY R&D ACTIVITIES

Tables 2 and 3 display survey data concerning past and present R&D expenditures in the maritime industry. These data provide an overview of the number of firms who fund R&D projects and the relative amount of that funding.

Ship Operators

For operators (table 2), over one-third *(38* to *40* percent) of the respondents said their firms supported some research and development work. The average percentage of operating budgets spent on R&D was 1.2 percent for the current year and 1.3 percent for the past five years. The largest percentage of operating budget spent on R&D was 4 percent for both the current year and the past five years.

Table 2.—U.S. Ship Operators R&D Expenditures: Percent of Operating Budgets Reported for R&D
(Total of 48 Respondents)

Range of percentage of operating budget	Past 5 years		Current year	
	Number	Percent	Number	Percent
None or "nil"	30	63	29	60
up to 1 %	11	23	12	25
Over 1%-2%	4	8	5	10
Over 2%	3	6	2	4
Total respondents	48	100	48	100
Total with some R&D ., ...	18	38	19	40
Average percent spent on R&D . . .	1.3%		1.2%	
Largest percent spent on R&D . .	4.0%		4.0%	

Table 3.—U.S. Shipyard R&D Expenditures: Percent of Operating Budgets Reported for R&D
(Total of 36 Respondents)

Range of percentage of operating budget	Past 5 years		Current year	
	Number	Percent	Number	Percent
None or "nil"	15	42	17	47
up to 1%	13	36	12	33
Over 1%-2%	5	14	4	11
Over 2%	3	8	3	8
Total respondents .	36	100	36	100
Total with some R&D	21	58	19	53
Average percent spent on R&D . .	1.3%		1.7%	
Largest percent spent on R&D . . .	4.0%		8.0%	

NOTE Percentages are rounded and may not add up 10 100 in some tables

The data shows very little difference in R&D expenditures for the current year vs. the past five years and indicate that R&D activity in the ship and barge operating industry has been fairly constant. This suggests that R&D investments probably will not change in the near future. Those firms with no R&D did not indicate that they may start some R&D projects and several indicated that R&D was not appropriate to their line of business.

Shipbuilders

In the shipbuilding industry (table *3), 19* firms responding to OTA's survey reported that they were involved in R&D activities in the current year and 21 firms in the past five years. This is a slightly higher percentage *(53* percent and *58* percent) of firms conducting research than was found in the ship operating industry.

Of those respondents conducting research in the shipbuilding industry, the average amount a firm spent on R&D in the past five years was 1.3 percent of their operating budget. This amount rose slightly to 1.7 percent in the current year. The largest percentage of operating budget spent by a shipbuilding firm on R&D in the past five years was 4 percent. In the current year, the most any shipyard spent was *8* percent of its operating budget,

Thus, of those firms responding, slightly fewer are investing in R&D today than during the preceding five years. At the same time, the fraction of their operating budgets devoted to R&D has increased. These indications of a change in R&D involvement by shipyards is consistent with the apparent growing concentration of U.S. shipbuilders in fewer,

larger firms, as was reported in OTA's "Assessment of Maritime Trade and Technology" in 1983.

Both operators and shipyards parceled their research funds into different types of research. Ship operators spent most of their R&D budgets on improving ship operations (40 percent) and information systems (30 percent). The rest of their budgets were spent on ship design (12 percent), shoreside operations (7 percent), inland operations *(3* percent), and on miscellaneous R&D projects *(8 percent). Table 4* shows the breakdown of these expenditures. Shipyards (table 5) put most of their money—about 49 percent of their expenditures—into R&D on shipbuilding methods and techniques, presumably to increase construction productivity. But they also spent significant portions of their R&D budgets on ship or barge design (30 percent) and subsystem design and development (6 percent). The remainder was spent on miscellaneous R&D (5 percent).

Table 4.—U.S. Ship Operators R&D Expenditures by Category (20 Firms Reporting Some R&D) Average Percent for each Category

Category	Average percent expenditure in category	Highest percent in category
Ship operations (including cargo handling)	40	100
Shoreside operations (terminals)	7	30
Inland operations	3	50
Ship design	12	60
Information management	30	100
Other:		
Market studies	8	50
Equipment safety		
Medical		

Table 5.–U.S. Shipyard R&D Expenditures by Category Average Percent for each Category-For 21 Respondents Who Had Some R&D Expenditures

Category	Average percent expenditure in category
Ship or barge design	30
Subsystem design	16
Shipbuilding/construction technology	49
Other:	
Technology transfer.	5
Materials	
Weapons	
Ocean engineering.	

THE FEDERAL ROLE IN MARITIME R&D

The Federal Government through the U.S. Navy's Manufacturing Technology (ManTech) Office and the Maritime Administration (MarAd) sponsors a substantial Maritime R&D program. Funding by these two agencies is currently about $35 million annually (figure 1). The Navy, of course, sponsors many other research efforts that are of interest to the commercial maritime community, but the ManTech program is the one that deals directly with U.S. shipyards. Appendices A and B describe the MarAd R&D program and the Navy's ManTech program.

As is shown in figure 1, the Navy's ManTech program was initiated in FY 1977 and has grown to be a dominant source of Federal funds for the maritime R&D industry today. It is all directed at improving ship construction technology with the goal of reducing costs and delivery times of naval ships while improving the quality of the end product. Figure 2 illustrates the relative attention (measured by funding) given to various R&D subjects. Very specific manufacturing techniques such as laser metalworking and robotic painting are given high priority because it is felt that these offer the potential for significant cost reduction. The major shipyards and suppliers with naval construction contracts participate in this program. Currently eight shipyards are participating.[2]

The MarAd R&D program elements are illustrated in figure 3. The largest element funds the Kings Point research center and the Computer-Aided Operation Research Facility (CAORF). Funds for CAORF also come from users including

[2]Naval Materials Command, "Navy Manufacturing Technology Program Effectiveness Report, Fiscal Years 1977-1983, " June 1984.

Figure 1 .—Maritime Administration and Navy "ManTech" R&D Program Expenditures, Fiscal Years 1975-85

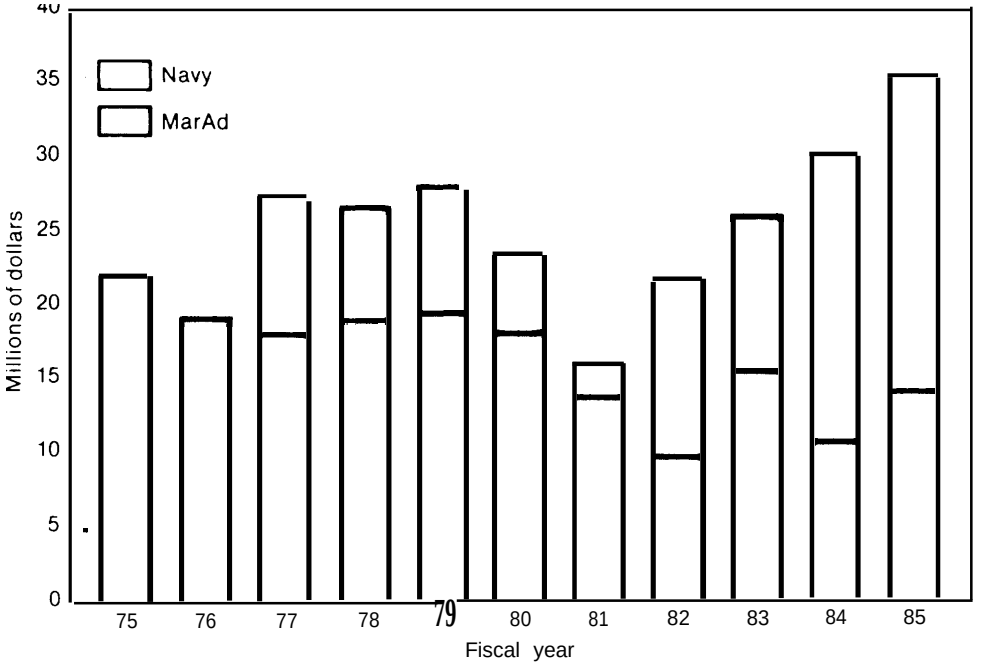
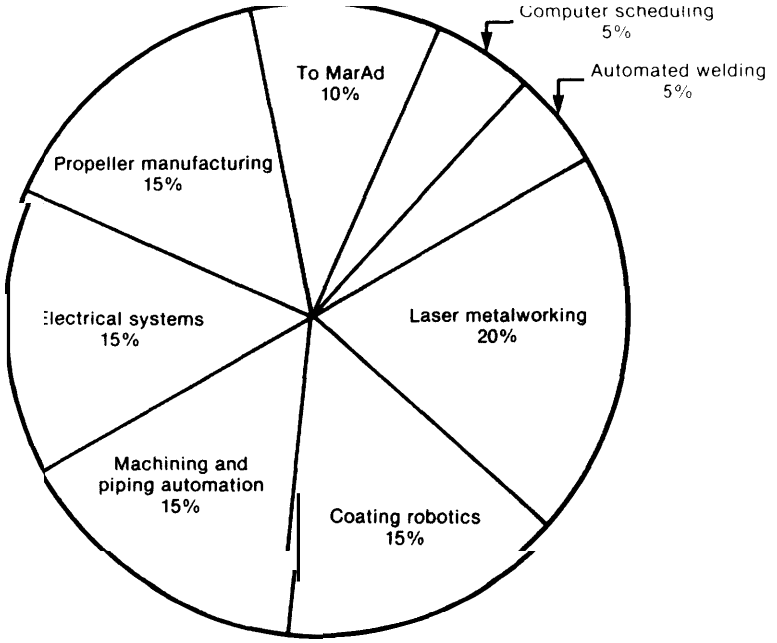


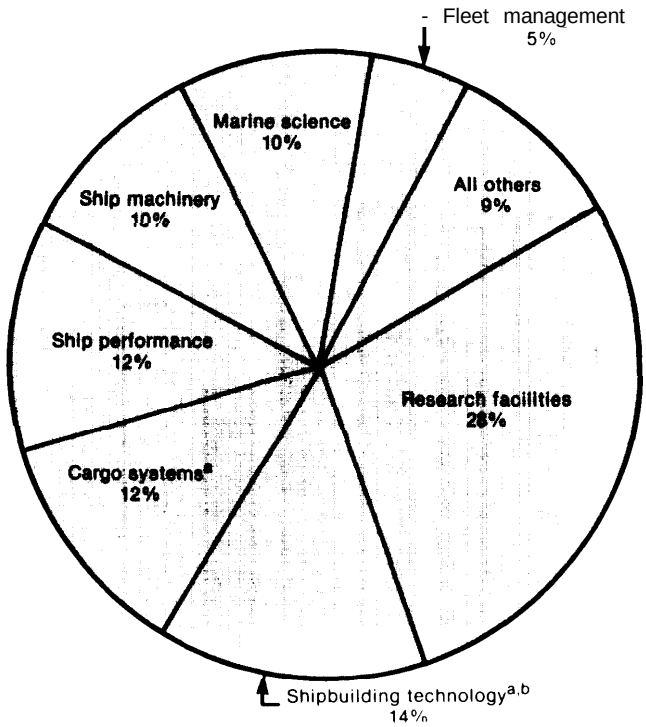
Figure 2.—Navy ManTech Program Fiscal Year 1985 Breakdown of R&D Subjects



NOTE Ail subjects are elements of shipbuilding technology development with goals of reducing costs or improving the product at those yards building Naval ships

SOURCE: Naval Material Command

Figure 3.—MarAd R&D Program Major Elements in Fiscal Year 1985



[a]These two programs incorporate cooperative industry cost—sharing projects with current participation of six shipyards (shipbuilding) and seven liner operators (cargo).
[b]This program, at $2 million in fiscal year 1985, also has an additional $2 million contribution from the Navy ManTech Program.

SOURCE: MarAd.

other agencies. The shipbuilding technology (NSRP) element is also a major focus. MarAd funds plus equal Navy ManTech funds support this joint government/industry cost sharing effort which has similar goals to the entire ManTech program. The National Shipbuilding Research Program *(NSRP)—[also* discussed later in this study]—currently funds cooperative projects at six to eight of the major shipyards. During FY 1985, over two-thirds of NSRP funding goes to three major shipyards. The shipyards participating in the NSRP are, with few exceptions, the same as those participating in the Navy's ManTech program.

Another government/industry cooperative effort with participants from the liner industry is also funded under the MarAd R&D program. This is the Cargo Handling Cooperative Program—listed as part of "cargo systems" in figure 3. This program funds a joint industry cooperative which currently includes seven of the major liner operators. Two other MarAd R&D program elements (Ship Performance and Fleet Management) include projects with industry participation—but not through a cooperative group such as NSRP or the cargo handling cooperative. These other projects have participants including barge operators, tanker operators, and liner operators. Descriptions of these and other MarAd program elements are included in appendix A.

Despite the major Navy and MarAd R&D programs and many other Federal R&D efforts, only a portion of the respondents to the OTA survey reported that they received any Federal support for R&D. Tables *6* and 7 show the number and percentage of responding ship operators and shipbuilding firms which received Federal R&D funding and which Federal programs provided that funding.

For U.S. ship operators (table *6),* most respondents received no Federal support for R&D efforts. In the current year only two respondents (4 percent of the total respondents and 11 percent of

Table 6.—U.S. Ship Operators R&D Firms Reporting Federal Funding Support for R&D

	Past 5 years		Current year	
	Number	Percent	Number	Percent
Total respondents	48		48	
Respondents with no R&D	30		29	
Respondents with some R&D	18	100	19	100
Respondents engaged in R&D and receiving Federal funding	8	44	2	11

Table 7.–U.S. Shipyard R&D Firms Reporting Federal Funding Support for R&D (Past 5 Years and Current Year are the Same)

	Number	Percent
Total respondents	36	
Respondents with no R&D	15	
Respondents with some R&D	21	100
Respondents engaged in R&D and receiving Federal funding	11	52

NOTE Percentages are rounded and may not add up to 100 in some tables

Table 6a.—U.S. Ship Operators R&D Firms Responding to Question of Whether to Increase Direct Federal R&D Funding

	Number	Percent
Should Government increase direct R&D to the private sector?		
No	4	27
Yes	11*	73
	15	100
No response	33	
	48	
Which agencies should provide R&D development funding?		
MarAd	1	9
Navy and MarAd (together)	10	91
	*11	100

NOTE Percentages are rounded, and may not add up to 100 in some tables

the respondents with their own R&D) received any Federal funding. These numbers were down substantially from those of the past five years where 17 percent of the total respondents and 44 percent of the respondents with their own R&D received some Federal funding. Also of interest is the wide variation in the percentage of Federal support provided to operating firms—between 3 and 67 percent of a firms' total R&D expenditures. The Federal programs from which respondent U.S. ship operators received R&D funding were all within the Maritime Administration.

OTA also asked whether the respondents would advocate an increase in direct Federal R&D funding. Table 6a displays the operator's responses. Seventy-three percent of the firms that responded to this question replied yes, and all but one recommended joint Navy and MarAd funding. Some firms, however, qualified their affirmative reply. Three stated that the MarAd funding should be directed only at more basic research, primarily through universities and in support of educational programs. Two stated that MarAd funding should be subject to industry participation both in establishing goals and priorities and in selecting the most appropriate projects.

Table 7 displays the data on Federal funding for R&D in the U.S. shipbuilding industry. Only 11 respondents (30 percent of the total and 52 percent of shipbuilders with some R&D of their own) reported receiving Federal support. These percentages were the same for the current year as for the past five years. Of those who received funds, the average amount received was 21 percent of the total funds spent by the firm on R&D but the range was from a low of 1 percent to a high of 71 percent. This large variation indicates very different approaches to Federal involvement in shipyard R&D among these firms. Many firms find no support for the type of R&D they consider necessary; others find a mixture of Federal and private initiatives will meet their needs; while still others depend upon Federal funding for almost all of their R&D work.

The shipyard survey respondents received R&D support from both Navy and MarAd programs in roughly equal numbers. It is interesting to note from these data that the MarAd National Shipbuilding Research Program (NSRP) reached only 22 percent of the respondents to the OTA survey. Since the survey sample included a substantial portion of the U.S. shipbuilding industry, one conclusion is that NSRP probably reaches only one-quarter of the U.S. shipyards. Since this one Federal program is considered by many to be very successful in the areas where it does work, it may be useful to consider how it could be broadened to include more of the industry.

Table 7a presents data on whether shipyard respondents advocate increasing Federal R&D funding. Of the firms that replied to this question, 64 percent said yes and 36 percent said no. Of the nearly two-thirds that favored increased direct funding, eight firms thought MarAd should be the funding agency; however, these firms are the same U.S. shipyards who presently participate in the MarAd program. Several firms qualified their call for increased Federal support by suggesting that: 1) MarAd should develop new policy directions before increasing any R&D funding; 2) future R&D should be focused on fewer, more important problems; and *3)* Navy and MarAd should combine their R&D programs.

The OTA survey also questioned the industry about access to R&D results of the U.S. Navy and its foreign counterparts and asked for any suggestions of ways to improve that access. Tables *8* and 9 show the responses to these questions. Only *30* percent of the ship operators reported that they had access to U.S. Navy R&D, and *52* percent reported access to technological advances from foreign R&D. Although some respondents thought that the Federal Government should not become involved or more involved in this area, several operating firms made suggestions of Federal action to improve access to R&D results. Most of the suggestions were for MarAd or another central agency to screen and select the most useful reports, to translate foreign documents

Table 7a.– U.S. Shipyard R&D
Firms Responding to Question of Whether to Increase Direct Federal R&D Funding

	Number	Percent
Should Government increase direct R&D to the private sector?		
No	*8*	*36*
Yes	14*	*64*
	22	*100*
No response	14	
	36	
Which agencies should provide R&D funding?		
MarAd (national shipbuilding R&D program)	8	*57*
Navy	3	*21*
Navy and MarAd (together)	3	*21*
	14	100

NOTE Percentages are rounded, and may not add up to 100 in some tables Percentages in each row are calculated using the total number of firms responding to the item in that row

Table 8.–U.S. Ship Operators R&D
Firms Reporting Status of Access to Other R&D

Do you have access to technical advances from:	U.S. Navy R&D?		Foreign R&D?	
	Number	Percent	Number	Percent
Yes	*7*	*30*	12	52
No	16	70	11	48
	23	100	23	100

Suggestions reported for Federal action to improve access:

1. MarAd or other Federal agency should screen, translate, publish, and disseminate useful reports abstracts/ catalogs (through SNAME, NTIS, Industry Journals, or trade organizations such as AWO, FACS) . . . . . 8 firms
2. Establish cooperative information exchange among Government agencies (Navy-MarAd), SNAME, and universities . . . 1 firm
3. Allow Government work to be used in civilian application . . . . . 1 firm

NOTE: 3 firms stated that there is no need for government involvement in this area.

Table 9.–U.S. Shipyard R&D
Firms Reporting Status of Access to Other R&D

Do you have access to technical advances from:	U.S. Navy R&D?		Foreign R&D?	
	Number	Percent	Number	Percent
Yes	12	55	9	41
No	10	45	13	59
	22	100	22	100

Suggestions reported for Federal action to improve access (15-firms reporting):

i. Publish/distribute reports, abstracts, catalogs (through SNAME, industry groups, GPO) . . . . . 10 firms
2. Sponsor seminars and meetings—present and update specific R&D results (invite all shipyards) . . . . . 5 firms
3. Establish institution responsible for collection and dissemination of all maritime R&D
   (2 firms suggest "NASA" model)
   (1 firm suggests part of larger maritime R&D facility)
   (1 firm suggests joint Navy/industry study group) . . . . . 3 firms
4. Establish Government-controlled technical library with broad direct access . . . . . 1 firm
5. Disseminate through Federal bid requests . . . . . 1 firm
6. Fund additional education and training through SNAME ship production committee . . . . . 1 firm

NOTE Percentages are rounded, and may not add up to 100 in some tables Percentages in each row are calculated using the total number of firms responding to the item in that row

when of significant use, to publish abstracts or catalogs or reports, and to actively disseminate these materials to the industry. Suggestions were made to use professional organizations, industry and trade organizations, and journals whenever possible.

Shipbuilders reported better access than operators to U.S. Navy R&D results (55 percent), but only 41 percent had access to technological advances from foreign R&D. Many more suggestions of Federal action to improve access, however, were made by the shipyards. As with operators, the most frequently offered suggestion was to screen, publish, and disseminate reports, abstracts, and catalogs. Several firms suggested more elaborate approaches including: sponsoring regular seminars; establishing a new technology transfer institution similar to the National Aeronautics and Space Administration (NASA) model; and forming a joint Navy/Industry study group to solve the problem.

One shipyard wrote: "It is recommended that the Navy sponsor periodic reviews . . . to present to invited shipyards the results of recent projects . . . These meetings would not only encourage a dialogue between the Navy R&D community and the shipbuilding industry, but also better enable the shipyard to plan their own R&D programs. " It was suggested that both publications and seminars might be offered through the major industry trade associations. Alternatively, these might be offered through the government/industry sponsored maritime research facility described elsewhere. One shipyard also suggested that the maritime industry needed an organization equivalent to NASA, which would collect and disseminate research information on an industry-wide basis. (The possibility of such an organization is discussed later.) On an intra-agency basis, organizations such as MarAd and the U.S. Navy might periodically review their own completed and ongoing research and report on its progress through widely distributed publications or seminars. In any case, it was pointed out that greater information exchange among the U.S. Navy, SNAME, MarAd, the naval architectural schools, and others was needed.

Several distinct sources of R&D are applicable to the maritime industry, In addition to MarAd research, the U.S. Navy, the foreign maritime industry, and industries related to the maritime industry are all potential sources of applicable technologies and processes. The U.S. Navy, for instance, also conducts R&D applicable to the civilian merchant marine. In 1978, for instance, over *$64* million in the Navy research budget was judged to be applicable to the commercial sector.[3] In part, the results of this R&D find their way into commercial application because some shipyards conducting Navy R&D also build commercial ships. In theory, all of the shipyards could have access to the results of Navy research which have commercial application, even if such research is conducted at one particular shipyard.

One mechanism for disseminating Navy R&D results to the civilian sector is U.S. Navy representation on SNAME's Ship Production Committee; the Navy representative is supposed to track Naval R&D applicable to shipbuilding and keep the Committee informed of ongoing developments.[4]

In addition to the Navy representative on the Ship Production Committee (SPC), there are several other formal mechanisms for reviewing and disseminating R&D to the civilian sector. For example, through the industry Independent Research and Development (IRAD) program, DOD personnel advise participating firms of DOD needs which industry could address in their respective IRAD programs. Both informal and formal shipyard and industry reviews are conducted by DOD representatives to critique IRAD programs and make industry aware of complementary DOD efforts. Also, the Navy's ManTech Program includes End of Project Demonstrations at the research facility with invitations extended to all interested parties. The Ship Structures Committee, much like the SPC, disseminates technical information. Navy laboratories conduct var-

[3]Booz-Allen and Hamilton, Inc., Analysis of Foreign Maritime Research, Contract Report for the Maritime Administration, NTIS #PB81-176364, 1981, p. 228.

[4]Robert Shaffron, MarAd National Shipbuilding Research Program, personal communication, Apr. 30, 1984.

ious onsite technical reviews and briefings. However, because of the size and decentralization of the Navy, it is extremely difficult for some private firms to monitor these R&D activities. Respondents to the OTA survey indicated that the Navy R&D programs were very difficult to monitor and that results were difficult to obtain.

Maritime Administration program managers are responsible for monitoring foreign military R&D results; however, as the OTA survey confirms, it is difficult to give this responsibility adequate attention when it is essentially a secondary priority. More formal approaches for gaining information on foreign technology have been employed from time to time. The National Shipbuilding Research Program, for instance, has sponsored teams of industry experts to visit overseas shipyards to investigate foreign technologies. These teams typically are interested in specific technologies (e.g., welding). There is, however, no formal, ongoing civilian effort to monitor foreign maritime technologies. The Navy's Office of Naval Research also maintains scientific liaison offices in Japan and Europe, but not with the express purpose of providing foreign maritime technology to private industry.

Finally, technologies developed in other industries, such as the aerospace and automotive industries, may be borrowed by the maritime industry. Many industries may share a common technological base, each drawing upon a common pool of information, and each making its own contribution to the pool. While the professionals of the maritime industry, both within Government and in industry, are no doubt aware of major developments in other industries, there is at present no systematic attempt to collect and disseminate this information to the maritime industry.

It should be noted that the results of the OTA survey suggest a different conclusion about the Federal role in maritime R&D than a number of other recent studies.

Somewhat surprisingly, most of the shipyards and operators did not report receiving Federal funds. Within some industry and government groups, it has been a widely shared belief that most long-term research conducted by industry and government is tied to Federal R&D programs. This belief was supported by a 1978 survey of private shipbuilding and ship operating firms, which found that the U.S. Government underwrote *82.8* percent of the $114.1 million spent on maritime R&D in that years In addition, most shipbuilding productivity-related research and development was thought to exist today largely as the result of the National Shipbuilding Research Program, * which is funded by MarAd, the U.S. Navy, and the shipbuilding industry.[6] The OTA survey shows that while an important segment of the industry is directly involved with Federal R&D programs, a large number of firms are not.

'Naval Materials Command, op. cit.

● The National Shipbuilding Research Program (NSRP)-Ship Production Committee (SPC) is jointly sponsored by MarAd ($2.0 million per year), the U.S. Navy ($2.0 million per year) and shipbuilding industry (equivalent $2.0 million in management and support). The program is contracted via MarAd and is administered by SPC panels. The NSRP-SPC as a broad-based committee representing the shipbuilding industry has direct influence over these shipbuilding productivity related developments.

[6] National Research Council, "Productivity Improvements in U.S. Naval Shipbuilding," National Academy Press, 1982, p. 2.

FACTORS AFFECTING R&D

Market Demand and Financing

The OTA survey asked ship operators and shipyards about the extent to which interest rates, availability of finance capital, Government policies and programs, market demand, and competitive pressures affected their decisions to invest in R&D. Tables 10 and 11 present the responses. Ship operators and shipyards both responded that market demand and competitive pressure overshadowed other factors. The vast majority of respondents indicated that both market demand and competitive pressure are very influential factors.

In a recent analysis of the Federal role in R&D, the Congressional Budget Office wrote, 'The most

Table 10.—U.S. Ship Operators R&D—Factors Reported to Influence R&D Investment

Factor	Very Influential		Somewhat Influential		Not Influential	
	Number	Percent	Number	Percent	Number	Percent
Interest rates	2	10	6	29	13	62
Availability of capital	6	29	7	33	8	38
Government policies and programs	8	38	9	43	4	19
Market demand	15	68	4	18	3	14
Competitive pressure	13	59	6	27	3	14
Other:						
Operating efficiency	1					
MarAd R&D budget	1					
Profitability	1					

Table 11 .—U.S. Shipyard R&D—Factors Reported to Influence R&D Investment

Factor	Very Influential		Somewhat Influential		Not Influential	
	Number	Percent	Number	Percent	Number	Percent
Interest rates	O	0	14	64	8	36
Availability of capital	2	9	17	77	3	14
Government policies and programs	11	50	7	32	4	18
Market demand	20	91	2	9	0	0
Competitive pressure	17	77	5	23	0	0
Other:						
Environmental	1					
Probable future use	1					

NOTE Percentages are rounded, and may not add up to 100 in some tables Percentages in each row are calculated using the total number of firms responding to the item in that row

potent factors that affect private innovation decisions are probably beyond the reach of specific R&D policies. Expectations about macroeconomic conditions and the intensity of competition within an industry may be the most significant determinants of its technological performance. In a strong economy, firms have the funds and the market prospects to justify increased commitments to R&D. Robust sectoral markets may have a counteracting effect, however, since they lessen the urgency to pursue other new products and processes. This implies that private innovation is likely to be strongest under dual conditions of a healthy macroeconomy and strong sectoral competition."[7]

Some of the most important conditions necessary for stimulating R&D investment include a strong aggregate demand, relatively stable demand growth, and predictable earnings. When business conditions are good, and incomes and demand are growing rapidly and predictably, business firms can anticipate an expanded market, and make their investments accordingly. When demand is stagnant, or uncertain, investment in new plant and equipment is deterred, and R&D aimed to tap new markets may look like a very risky proposition. Some economists have suggested that R&D is so much riskier than other forms of investment that firms are loathe to rely on borrowing to finance R& D.*

To determine the effects that borrowing might have on the maritime industry in particular, OTA asked survey respondents whether the availability of finance capital and interest rates were "very, " "somewhat," or "not influential" factors in their decisions to invest in R&D. The answer was slightly different in the two sectors of the maritime industry (tables 10 and 11). The ship-

[7]Congressional Budget Office, "Federal Support for R&D Innovation," April 1984, p. 71.

[8]Ibid., note 6.

building sector clearly viewed interest rates and capital availability as somewhat influential factors, though not as important as market demand and competition. On average, the ship operators, on the other hand, tended to look on these factors as unimportant, although a significant minority of the operators indicated that capital availability was influential.

Thus, for those firms responding to the OTA survey, private R&D investment is primarily a function of profitability and demand. Since the major U.S. shipbuilding industry has traditionally been an industry of low profits and low and unsteady demand, these conditions have resulted in a conservative investment strategy on the part of many shipbuilding companies. Certain shipbuilding companies have been able to reinvest more of their profits than they normally would only because they are owned by large conglomerates which are willing to take the risks associated with the investments.[9]

The key factor driving profits in some sectors of the commercial shipbuilding industry appears to be the lack of an orderly, sustained demand for U.S.-built ships. The lack of demand stems from two interrelated factors: 1) the high cost of building a ship in the United States; and 2) the high cost of operating U.S.-flag ships. Wage scales are one cause of these high costs in these shipbuilding and sea transport industries, although the high cost of U.S. materials has also contributed to the shipbuilding dilemma.[10] Some shipbuilders claim an even more basic causal factor of lack of demand; that is, no sustained Government policy to build ships as part of a defense strategy for sea lift in the event of an extended conflict.

In the inland barge and towboat industry, as well as the so-called "second tier" shipyards, a somewhat different problem is evident. During the 1970s, high growth and expanding markets coupled with tax incentives to invest in capital equipment, spurred an explosion in new building. In the past few years the markets contracted due to export declines and the strong dollar. At present, the industry is struggling to dispose of a large excess supply of vessels and barges.

Federal Policies/Regulations

The OTA survey asked firms to select those Federal policies or regulations which they felt either encouraged or discouraged R&D investment and then to rank order the selections. The response data are shown in tables 12 and 13 for operators and shipyards respectively. The data are widely scattered. Most firms reported that most factors have little or no effect. However, two factors having an encouraging ranking for both operators and shipyards were the tax code and patent law.

For most operators responding to the question, rail and truck deregulation and OSHA safety regulations appear to have little effect. The Federal subsidy phase-out did not appear to have an effect for most of these operators either. Coast Guard manning regulations seem to have a somewhat discouraging effect on investment. For responding shipyards, however, subsidy phase-out was seen as a more important factor discouraging investment.

The survey, thus, does not support any strong conclusions about the effect of these policies. It may be useful, however, to discuss a few of these policies which have been given attention in other analyses and reports. For this reason, the following discusses antitrust law, patent law, and subsidy phase-out, in turn.

Antitrust Law

Many of the U.S. maritime industry's foreign competitors do not function under laws that restrict research collaboration. Japanese antitrust law does not prohibit firms from conducting cooperative research in targeted areas such as computers, microelectronics, electronic instruments, lasers, optical communication, robots and aerospace. French antitrust law does not bar joint research in such areas as aerospace, telecommunications, microelectronics, energy, and conservation equipment. Similarly, West Germans have not been prevented from conducting joint research and development.

[9] Edward M. Kaitz & Associates, Inc., "The Capital Budgeting Process of the U.S. Shipbuilding Industry: An Analysis of Defense Industry Behavior," 1979, p. 3.

[10] Edward M. Kaitz & Associates, Inc., "The Profitability of the U.S. Shipbuilding Industry (1947-1976)," 1978, p. 61.

Table 12.–U.S. Ship Operators R&D
Federal Policies/Regulations Reported to Affect R&D Investment

	Encourages investment		Discourages investment		Little or no effect	
Federal policy	Number	Percent	Number	Percent	Number	Percent
Antitrust statutes	1	5	3	14	18	82
Patent law	5	23	0	0	17	77
Tax code	7	32	2	9	13	59
Rail and truck deregulation	4	18	2	9	16	73
OSHA safety regulations	2	10	*3*	*14*	*16*	*76*
C. G. manning regulations	6	27	8	36	8	36
Phase-out ODS/CDS	3	14	7	32	12	55

Table 13.—U.S. Shipyard R&D—Federal Policies/Regulations Reported to Affect R&D Investment

	Encourages investment		Discourages investment		Little or no effect	
Federal policy/regulation	Number	Percent	Number	Percent	Number	Percent
Antitrust statutes	0	0	*3*	*14*	*19*	*86*
Patent law	5	23	1	5	16	73
Tax code	7	32	5	23	10	45
OSHA safety regulations	3	14	3	14	16	73
Phase-out ODS/CDS	1	5	11	58	7	37

NOTE Percentages are rounded, and may not add up to 100 in some tables Percentages in each row are calculated using the total number of firms responding to the item in that row.

One approach to funding expensive, long-term R&D is for one or more firms to share the cost. However, some firms have perceived ambiguities in the antitrust statutes, which have inhibited attempts to establish joint ventures among domestic firms. Although there is neither a statutory prohibition nor any court rulings that explicitly discourage formation of R&D joint ventures, American corporations have been extremely hesitant to enter into research joint ventures, because of the spectre of treble damages for violations of antitrust laws. [11]

A new law may change this situation in the future. The Research and Development Joint Venture Act of 1984 modifies existing antitrust statutes to specify that joint research and development ventures will not violate the law. The Act specifically, however, excludes those ventures that will exchange sales, marketing and similar types of commercial information, and those that restrict or require the participation of any party in another research and development program. In addition to modifying the antitrust statutes in this way, the Act also takes two other steps to encourage joint ventures: first, it permits joint ventures to file a statement of intent, which the Attorney General or Federal Trade Commission is obliged to publish in the Federal Register; second, if this statement of intent has been properly submitted and published in the Federal Register, the Act limits the amount that may be recovered on a claim to the amount of actual damages sustained by the claimant. [12]

While U.S. antitrust laws in the past have been criticized for discouraging research cooperation between U.S. firms, neither shipyards nor ship operators responding to this question on the OTA survey felt that these antitrust laws had a serious effect on their investment in R&D. This may be partly because many in the U.S. maritime industry do not have much desire to collaborate among themselves anyway, presumably because of competitive forces. However, countries like Japan and Korea have found effective ways to cooperate and coordinate their R&D in basic processes, procedures, and standards. They rely on the mainte-

[11] U.S. House of Representatives, Committee on Science and Technology, "Japanese Technological Advances and Possible U.S. Responses Using Research Joint Ventures, " Statement of William Baxter, Department of Justice, June 29-30, 1983, p. 151.

[12] The Research and Development Joint Venture Act of 1984.

nance of competitive positions through management efficiency, labor-management collaboration, marketing, and product design.

Patent Law

A report by the Office of Science and Technology Policy found that existing patent laws do not provide sufficient protection to enable private firms to dependably capture the value of private aeronautical R&D.[13] Since the maritime and aeronautics industries have many similarities, OTA suspected that this conclusion might apply to maritime R&D as well. The OTA survey, however, did not support this view. In the few cases where respondents indicated that patent law does influence investment, it was generally regarded as an inducement.

Phase-out of Subsidies

Two maritime industry subsidy programs—the Construction Differential Subsidy (CDS) and the Operating Differential Subsidy (ODS)—are being phased out by the Reagan Administration, although debate over the need for subsidies continues. The CDS provisions in the Merchant Marine Act of *1936* as amended in 1970 have not been repealed by Congress, but, for the past two years, the Administration has requested, and has been granted, no funding. Funding for existing ODS contracts has continued but the Administration has announced plans to abandon ODS when those contracts expire.

Since the industry itself has been publicly divided on whether the phase-out is a positive or negative step for the maritime industry as a whole, OTA asked the survey respondents whether the phase-out encourages, discourages, or has little or no effect on their R&D investment. Again, the ship operators and shipbuilders responding to the question revealed different views. More than half of the shipbuilders viewed the phase-out as discouraging investment, and about one-third considered it to have little or no effect. Half of the ship operators felt the phase-out would have little or no effect.

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[13] Office of Science and Technology Policy, *Aeronautical Research and Technology Policy, vol. 2,* final report, 1982, pp. VII-17.

Anticipating some industry concern over the phase-out, OTA asked the respondents what alternative Federal incentives might help to revitalize the industry. One of the most common responses to this question from both shipbuilders and ship operators, with shipbuilders somewhat more enthusiastic, was the institution of cargo preference for U.S. shipping. One shipyard wrote:

> A Federal assurance of adequate cargoes for U.S.-flag and U.S.-built ship owners is the only means of ensuring a large, stable and continuing demand for new building from the U.S. shipbuilding industry. Sufficient demand and stability of demand will by itself enable private industry to invest sufficient funds in R&D of new capital equipment to significantly improve efficiency and match foreign shipbuilders' productivity levels.

A suggestion to employ tax credits as an alternative to direct subsidies also was made frequently. One shipyard, for example, suggested that to "offset the higher cost of using U.S. ships, " tax credits should be granted to "companies that use U.S. ships to haul their cargoes." A bill sponsored in 1984 by Congressman Herbert H. Bateman of Virginia and Congresswoman Lindy Boggs of Louisiana, the Competitive Shipping and Shipbuilding Act, would provide tax breaks resulting in estimated credits of $800 million per year. One respondent emphasized that such a program would create the stable market environment necessary to carry out R&D. Both operators and shipyards suggested tax credits as an alternative to direct subsidies.

A number of other suggestions were made by the respondents. For instance, several shipyards recommended providing incentives for productivity increases. While the ManTech Program already does this for shipyards that build Navy ships, it was recommended that similar incentives could be extended to non-Navy construction. It was further suggested that modernization incentives could be offered to the ship operations industry. Finally, a number of respondents referred to the Jones Act. One shipyard advocated an "extension of the Jones Act and closing of loopholes, " while an operator called for "Jones Act" shipowners to be permitted to build abroad without restriction.

Federal Incentives

The OTA survey questioned operators and shipbuilders about possible future Federal policies that might increase incentives to invest in R&D. Such policy suggestions ranged from increasing direct Federal R&D funding to establishing a joint government/industry research facility. The survey also contained two open questions. One asked respondents to suggest other organizational or institutional changes within the Federal Government that might improve the effectiveness of Federal sponsored research; and the other asked for suggestions other than R&D options which might be beneficial to the revitalization of the U.S. industry.

Responses to the specific R&D policy options are given in tables 14 and 15. Responses to the open questions are listed in appendix E. While a number of the respondents thought that policies such as cargo preference, direct subsidies, or forms

Table 14.–U.S. Ship Operators R&D
Firms Reporting Factors Affecting Incentive to Invest in R&D

	Significant incentive		Slight incentive		Negative incentive	
Factor	Number	Percent	Number	Percent	Number	Percent
Extend CCF* to R&D.	4	21	14	74	1	5
Availability of Federal loan guarantees . . .	3	17	13	72	2	11
Amend antitrust laws permitting joint ventures	1	5	16	84	2	11
Expand R&D tax credits	8	40	10	50	2	10
Increase direct Federal support of R&D. . .	8	42	9	47	2	11

"Capital Construction Fund.

Firms Reporting Whether They Would Support New Government/Industry Maritime Research Facility

	Number	Percent
1. Strongly endorse and would participate and provide funding	3	13
2. Endorse but would not participate or fund	15	65
3. Do not endorse*	5	22
	23	100

*One firm said they did not endorse because they were in a specialized field which would probably not be covered in such a facility

Table 15.–U.S. Shipyard R&D
Firms Reporting Factors Affecting Incentive to Invest in R&D

	Significant incentive		Slight incentive		Negative incentive	
Factor	Number	Percent	Number	Percent	Number	Percent
Extend CCF* to R&D.	10	45	11	50	1	5
Availability of Federal loan guarantees . . .	8	38	12	57	1	5
Amend antitrust laws permitting joint ventures	6	27	14	64	2	9
Expand R&D tax credits	18	82	4	18	0	0
Increase direct Federal support of R&D. . .	13	57	9	39	1	4

"Capital Construction Fund

Firms Reporting Whether They Would Support New Government/Industry Maritime Research Facility

	Number	Percent
1. Strongly endorse and would participate and provide funding , , ..., , , , , , , ., , , , , , , , ., ...	5	22
2. Endorse but would not* participate or fund	11	48
3. Do not endorse*	7	30

"Two firms reported they may participate after established if work **was** relevant to their needs,

NOTE: Percentages are rounded, and may not add up to 100 in some tables, Percentages in each row are calculated using the total number of firms responding to the item in that row.

of capital investment assistance would offer more for the industry than any R&D initiative, most of the R&D policies suggested were considered to offer some incentive.

The proposals can be considered in three categories: 1) direct Federal R&D support, 2) encouraging industry R&D, and 3) devising government/industry cooperative approaches. Under "direct Federal R&D support" 42 percent of the operators and 57 percent of the shipyards responding to the question reported this to offer a significant incentive to R&D investment. Under "encouraging industry R& D," the most operators (40 percent) and shipyards (82 percent) reported that a significant incentive would result from expanding R&D tax credits. Other tax or financing incentives for R&D were rated favorably but higher by the shipyards than by the operators.

Direct Federal R&D Support

Survey respondents were asked whether an increase in direct Federal support would be a significant, slight, or negative incentive for investment in R&D. For the most part, both operators and shipbuilders who responded to the question said that increasing Federal support would not discourage their own investment, but rather would provide a positive incentive. Each sector of the maritime industry, however, was divided as to whether increased Federal support would provide a slight or significant incentive. By a slight margin, more shipyards felt Federal support would provide a significant incentive; whereas ship operators also, by a slight margin, tended to think such an action would provide only a slight incentive for R&D investment.

The OTA survey respondents were also asked to suggest changes which might be made to improve existing institutions. While many of these suggestions were very narrowly focused, a few were of a scope that would bear congressional interest. In particular, one frequent request was that a means be found to deal with current institutional arrangements which cause decentralization of research activities. For example, the U.S. Navy has research related to shipbuilding located under three commands: the Assistant Secretary of the Navy Research, Engineering and Systems, the Chief of Naval Operations, and the Chief of Naval Material. One shipyard wrote:

> This highly fragmented R&D organizational structure . . . would not appear to result in the effective and efficient utilization of R&D dollars. Some effort may be made to simplify the organization and consolidate the R&D program.

This respondent recommended that:

> . . . there should be more extensive use of joint efforts in higher cost technology developments and in technology demonstrations.

When questioned about this comment, a U.S. Navy spokesman responded:

> The preceding is a misconception of the Navy R&D organization. There is only one Navy R&D program. All of the above organizations plus others participate in the planning, review, approval and execution as appropriate for the program. For instance the Commander, Naval Sea Systems Command, plans, programs, budgets and implements its portion of shipbuilding R&D projects. The Chief of Naval Material integrates across commands and submits the program to the Chief of Naval Operations, for review and approval, and forwarding through the Assistant Secretary of Navy (RE&S) submission to the Department of Defense.

In general, however, it may be useful to explore a number of alternatives to strengthen and integrate common elements of U.S. Navy, MarAd, and U.S. Coast Guard R&D programs.

Some of the specific recommendations made by the respondents are listed below:

1. Establish a fund for unspecified R&D projects administered by an agency such as MarAd's Office of Advanced Ship Development and Technology for funding those "target of opportunity" projects meeting predefine criteria and limits.
2. Change contract approval procedures to decrease proposal lead time for R&D projects by eliminating red tape delays that, while necessary for normal procurement items, are an impediment to R&D projects (e.g., source approval, advertising), In general, streamline contracting procedures to make R&D efforts time effective.
3. Coordinate all specialized R&D areas (e.g., computer integrated manufacturing systems) through one government agency.
4. Improve control over research funds by uti-

lizing the ship operating and shipbuilding firms themselves as primary contractors.

Several respondents supported the recommendations of a recent National Research Council (NRC) study which reviewed ship operations R&D and found that an arrangement similar to the National Shipbuilding Research Program is needed to improve the efficacy of ship operations research. One of the NRC's primary findings was that the ship operations R&D program of MarAd "has not achieved wide acceptance of its project results, principally because of insufficient industry participation in the direction and management of research." NRC further concluded that "cooperative ship operation R&D should be coordinated and managed not by a government agency but by the private sector."[14]

Encouraging Industry R&D

Extending CCF.—In 1970, Congress adopted a tax measure for the U.S.-flag fleet that instituted the Capital Construction Fund (CCF). This program generally allows U.S. shipping companies to enter into agreements with MarAd to establish CCF for the replacement or addition of vessels for use in the U.S.-flag merchant marine. Earnings from the operation of U.S. merchant vessels can be deposited in the CCF. Federal income taxes on these earnings are then deferred until the funds are withdrawn from the CCF for a purpose not permitted under the agreement with MarAd. Theoretically, the tax deferral can continue on income deposited in the CCF as long as the fundholder continues to acquire U.S.-built ships or to construct, or reconstruct qualified vessels in a U.S. shipyard.

The OTA survey asked ship operators and builders whether extending the CCF concept to R&D expenditures would represent a significant, slight or negative incentive for investing in R&D. A large majority of operators responding to the question reported that this option would be a slight incentive for future R&D investment. Only four operating firms said that this extension of the fund would be a significant incentive, and only one firm indicated that it would be a negative incentive. The shipyards, on the other hand, endorsed this option more enthusiastically. * Ten yards indicated that this would be a significant incentive, while 11 yards reported that extension of the fund would only represent only a slight incentive. Only one yard felt this option would be a negative incentive for R&D investment.

Make Federal Loan Guarantees Available for R&D Expenditures.—The Federal Ship Financing Guarantee program was established in 1938 pursuant to Title XI of the Merchant Marine Act of 1936. It provides for a full faith and credit loan guarantee by the U.S. Government. The program was overhauled in 1972 and is now a financing guarantee program, rather than a mortgage insurance program under which the government guarantees shipbuilding obligations sold to investors.

OTA asked survey respondents whether similarly guaranteeing loans for R&D expenditures would represent a significant, slight, or negative incentive for R&D investment. A majority of both operators and shipbuilders answered that loan guarantees for R&D would create a slight incentive to invest. Relatively more of the shipyards felt that such an option would create a significant incentive (eight yards) than did the ship operators. Only one shipyard and two ship operators reported that this option would create a negative incentive for investment.

Expand Existing Tax Credits for R&D Expenditures.—The OTA survey asked respondents to indicate whether an expansion of tax credits for R&D expenditures would have a significant, slight or negative incentive for R&D investment. Shipbuilders as a whole were more enthusiastic about the positive effects of an expanded tax credit than were ship operators. A large majority of the shipyards indicated that an expanded tax credit would have a significant incentive, while only four yards indicated that it would represent a slight incentive. None of the yards indicated that such a tax credit would have negative effects. In contrast to the shipbuilders, the operators were more equally divided on whether an expansion of tax credits

[14] National Research Council, "Ship Operation Research and Development —A Program for Industry," 1983, p. 39.

* This would, of course, require changes in the law to allow shipyards to establish Capital Construction Funds similar to those now allowed for operators.

would have a slight or significant effect on the incentive to invest in R&D.

The Economic Recovery Tax Act of 1981 instituted major changes in the Nation's tax system. One of the most important changes introduced was the incremental R&D tax credit, which amounts to 25 percent of "qualified" R&D expenditures in excess of outlays in a preceding base period .15 Because of its incremental character, the 25 percent tax credit is designed to be especially cost effective, since it targets changes in a firm's behavior. Whereas a nonincremental credit would reward firms for their existing level of R&D expenditures, an incremental credit encourages increased R&D since only the increase over the base qualifies for credit. The relevant issue in evaluating the incremental credit concerns the relationship between the Federal tax revenue losses it generates and the additional R&D it encourages. Estimates of the benefits of the incremental tax credit—namely, the additional R&D it encourages—tend to be lower than the estimated Treasury Department losses. One study, for instance, suggests that the additional R&D generated by the incremental credit lies somewhere between $227 million and $638 million for 1983, compared to estimated Treasury losses of $645 million. Analyses of similar tax incentives in other countries suggest the same result. Tax credits for R&D do not appear to be a particularly cost-effective mechanism for increasing R&D activity.

The R&D credit is scheduled to terminate at the end of 1985. Such a sunset provision, even with periodic extensions, undermines the credit's effectiveness. From a business planning standpoint, there must be certainty that the credit will be available when the research is performed.

In conclusion, for most of the American economy, the incremental R&D tax credit does provide some incentive for increased R&D. For firms in more extreme circumstances—those that have no tax liabilities in a given year and those that are rapidly increasing R&D spending—the impact of this program may be limited.

[15] The discussion of the incremental tax credits is based on a Congressional Budget Office report, entitled "Federal Support for R&D Innovation," 1984, pp. 72-83.

Devising Cooperative Approaches

Reduce the Risk of Antitrust Violation Associated With Research Joint Ventures.—While the survey respondents indicated that antitrust laws do not have much effect on their investment in R&D, most reported that amending antitrust laws to permit joint research ventures would represent a slight incentive for them to conduct more R&D. Only two operators and two shipyards indicated that such an option would act as a negative incentive for investment. Relatively more shipyards than ship operators reported that revision of antitrust statutes would have a significant effect on investment. Recently, a number of measures have been adopted to encourage joint research, including the Research and Development Joint Venture Act of 1984.

Several other approaches have also been suggested for eliminating the real or perceived antitrust barriers to joint research ventures. It is beyond the scope of this discussion to analyze the pros and cons of these various approaches. However, some approaches are discussed in the next section on R&D approaches in other industries.

Establish a Central Research Facility to be Sponsored Jointly by Industry and Government for Conducting Maritime Research.—The OTA survey asked ship operators and shipyards whether they would endorse the formation of a government/industry sponsored maritime research facility for the purposes of conducting long-term basic and applied research and for serving as a clearinghouse for Navy, foreign, and domestic civilian R&D advances. Specifically, the respondents were asked whether they would: strongly endorse such a facility and be willing to participate and provide funding for cooperative research projects; endorse the facility but not necessarily become actively involved with its research projects; or not endorse such a facility.

The responses are shown on tables 14 and 15. Seventy-eight percent of the operators responded that they would endorse such a facility but only 13 percent indicated strong endorsement including participation and funding. For shipyards, the response was similar, 70 percent endorsement and 22 percent strong endorsement with participation.

Some firms qualified their responses saying they would or might participate if the facility was designed to be relevant to their specific needs.

A comment by one of the shipyards is representative: "Our company would be interested in participating in a *Government sponsored* maritime research facility but is not willing to commit any funding until a charter is firmly established." Only three operators indicated that they would strongly endorse a central facility and actively participate, financially or otherwise. Five operators did not endorse such a facility at all.

The shipyard responses were more equally divided than the operators. Eleven yards endorsed this option, but did not anticipate that they would actively participate. Five yards strongly endorsed the idea of a central facility, seven yards rejected the idea. It appears from these responses that the maritime industry as a whole would have difficulty taking the lead in establishing a joint government/industry institution but that a properly designed institution with competent leadership may be able to attract substantial industry support after it is established.

Section III

Models of Other R&D Institutions

Section III

Models of Other R&D Institutions

FOREIGN APPROACHES

A variety of foreign approaches to encouraging R&D possibly could serve as models for considering support of U.S. maritime research:

In Germany, the Wagnisfinanzierungs Gesellschaft program under the Ministry of Research and Technology is an independent corporation formed by seven banks. The consortium purchases equity shares in new companies undertaking innovative projects. The government underwrites up to 75 percent of any losses incurred by this corporation for the first 12 years of its existence, thus considerably reducing investment risk. In return, the government retains a seat on the corporation's board of directors. Another program, the "First Innovations" program of the Ministry of Economic Affairs, advances interest-free loans of up to 50 percent of the cost for commercial development of a new technology. If the effort fails, the loan is canceled. The Japanese Ministry of Trade and Industry provides similar R&D support in the form of long-term notes or low-interest loans. The loans are repayable only if the program is successful.

In France, a Letter of Agreement program insures a company against loss for large projects involving high initial production costs and serves as a method for obtaining low-interest capital. An Aid to Development program pays 50 percent of the total cost of prototype development and provides for reimbursement in the case of success.[16]

In Norway, an industry government research institute, The Ship Research Institute of Norway, was chartered by Norwegian ship owners, the Royal Norwegian Council for Scientific and Industrial Research, and Det norske Veritas.[17] Most of the Institute's projects are started with grants from the Royal Norwegian Council for Scientific and Industrial Research or through a commission from a government directorate or a business company. Government funding of the Institute, however, has declined and is now approximately 8 percent of the total funding. Projects are normally conducted by Institute researchers but almost always in close contact with a customer or steering committee. The steering committee can be established for a single project, but is typically organized around programs composed of a number of similar projects. It will typically have resources of more than $250,000.

The Ship Research Institute of Norway sponsors a number of associated facilities. The Marine Technology Center (MTC) is one of the world's most comprehensive and well-equipped research facilities. Some of its laboratories are unique, and the center represents a considerable potential for Norwegian companies in their development of new products and services. A computer-aided design/computer-aided manufacturing (CAD/CAM) center, for instance, was recently established at the MTC. Its aim is to build up competence and to accumulate a library of CAD/CAM programs. In addition to laboratories and model testing facilities, The Ship Research Institute provides information and training services. Management seminars are organized to teach modern managerial concepts, skills, and techniques for managers in the shipping industry. The Institute has standard library services and access to domestic and foreign data bases. It participates in a European cooperative on-line information service called Ship Abstracts, which abstracts information on ship technology, ship operation and ocean engineering from approximately 450 periodicals, reports series and papers from all over the world.

The Institute experienced a high rate of activity in 1983 despite a sharp drop in Norwegian shipbuilding, a set-back for traditional shipping, and limited research grants in the public sector. The

[16] Testimony of Daniel DeSimone, Office of Technology Assessment to the Subcommittee on Transportation, Aviation and Communications of the Subcommittee on Transportation, Aviation and Communications of the Committee on Science and Technology, U.S. House of Representatives, May 1979.

[17] Personal communication with Mr. Egil Wulff, Research Coordinator, The Ship Research Institute of Norway and the 1983 annual report of The Ship Research Institute of Norway.

1983 turnover was $15.9 million compared with $14.2 million in 1982 (calculated in 1984 dollars). The shipowners' share of the Institute's revenues increased from 14.3 percent in 1982 to 21.4 percent in 1983. In 1983, the Institute had a total staff of over 300 people.

In the Far East, the Shipbuilding Research Association of Japan was established over 20 years ago by eight major Japanese shipbuilding companies, suppliers, and shipping industries. It is authorized by the Japanese Government as a nonprofit organization. A planning committee, composed of representatives of member organizations and scholars, selects priority "R&D themes, " which are then approved by a Board of Directors. Committees composed of the member organizations with relevant expertise are then organized to implement these "R&D themes. " The Association receives financial support from its membership and through grants from private financial bodies. The average appropriation over the past five years has been about $4 million a year.[18]

[18] Personal communication with the Shipbuilding Research Association of Japan, Mr. H. Haga, Managing Director, August 22, 1984; and with Mr. Katayama of the Japanese consulate in New York, June 5, 1984.

U.S. APPROACHES

A variety of models of proposed or existing R&D institutions can be found in other U.S. industries. In fact—especially in basic industries—recent reports have urged new attention to R&D as a means of improving world competitiveness. The January 1985 report of the President's Commission on Industrial Competitiveness concluded that technological innovation is fueled by R&D which is vital to America's future, being the key to productivity advances. That report recommended initiatives in the areas of R&D partnerships and cooperation between industry, government, and academic institutions .19

In one important U.S. industrial sector, OTA has recently published an assessment of Information Technology R&D. Among other topics, that report discusses Federal patent policies, technology transfer, tax credits, R&D limited partnerships, and antitrust policy. It also provides information about industry R&D in areas of industry-university links and jointly funded research. It concludes that cooperative industry research could have long-run policy implications for the level and focus of Federal R&D programs.[20]

"Report of the President's Commission on Industrial Competitiveness, "Global Competition–The New Reality, " Washington, DC, January *1985.*

[20] "Off ice of Technology Assessment, U.S. Congress, *Information Technolog, and R&D: Critical Trends and issues, OTA-CIT-268* (Washington, DC: U.S. Government Printing Office, February 1985).

The following discusses two joint industry R&D approaches that may have relevance to the maritime industry, one Federal program from another agency (NASA) and some existing maritime institutions that have potential for modification.

Research Joint Venture

R&D joint ventures and R&D limited partnerships have both been suggested by a few of OTA's respondents as a model for certain maritime R&D. Both approaches probably have limited applications (as other advisors to OTA have commented) but their characteristics are of interest because other industries have found useful applications.

For the joint venture approach, antitrust immunity is often a concern. In a new project, the applicability of the 1984 R&D Joint Venture Act would need to be examined, Further antitrust immunity might be sought for a specific industry sector, area of research, or qualifying institution.

Actually, at least two major research joint ventures have already been established—the Microelectronics and Computer Technology Corporation (MCC) and the Semiconductor Research Cooperative (SRC). MCC is a research and development venture owned by a number of major U.S. corporations in the computer, electronic, and semiconductor industries. Participating so far are Advanced Micro Devices, Allied Corporation,

Control Data, Digital Equipment Corporation, Harris, Honeywell, Martin Marietta, Mostek, Motorola, National Semiconductor, NCR, RCA, and Sperry. [21]

Projects to be undertaken by MCC are aimed beyond the state-of-the-art. Initially, four projects have been identified, lasting from 5 to 10 years. All shareholders are not required to participate in each project, but each is required to participate in at least one. MCC projects will be staffed to a considerable extent by personnel from shareholder companies. At the completion of a project, these borrowed experts will return to their respective companies. This flow of talent to and from shareholder companies is a key to the success of MCC projects. In addition, such a process greatly facilitates the transfer of technologies to participating companies. For convenience, MCC will hold title to all know-how and patents. Although participating companies will have initial rights to the resulting technology and to receive preferential treatment, technology will be licensed to other companies on reasonable terms.[22]

In 1980, the association that represents the semiconductor industry, the SIA, focused on self-help action by the industry to counter increasing competition from abroad by forming the Semiconductor Research Cooperative (SRC). The objectives of SRC are: to plan and to promote, conduct and sponsor research; to improve the understanding of semiconductor material, devices, and phenomena; and to develop new design and manufacturing technologies. The program operates on a contract basis, primarily with universities. About 50 projects have been funded so far.[23] Three university research centers have been established under the aegis of the SRC—computer-aided design centers at Carnegie-Mellon and Berkeley, and a microstructure center at Cornell. SRC is negotiating with MIT on a materials contract, with North Carolina on manufacturing research, and with Rensselaer Polytechnic Institute on beam technology. Thirty-eight other contracts of a smaller nature have been negotiated with other universities.

Z] Edward M. Kaitz & Associates, Inc., "The Profitability of the U.S. Shipbuilding Industry (1947-1976)," 1978, p. 7, statement of Admiral B. R. Inman.

*'U.S. Department of Commerce, 1983. The New Climate for Joint Research, Conference Proceedings held May 13, 1983, pp. 17-18.

[23]Kaitz & Associates, op. cit., note 10, pp. **45-46,** statement of Erich Bloch.

R&D Limited Partnerships

In some very special cases of high risk product development R&D limited partnerships may be useful to consider. Several basic concepts are common to all forms of R&D partnerships. Generally, limited partner investors receive a tax deduction for a substantial part of their initial investments. In addition, if the deal is properly structured, investors receive favorable capital gain treatment on their royalty or equity payback. A sponsoring corporation performs research on a particular project on behalf of the partnership, which owns the developed technology. The corporation controls the commercial exploitation of the product that results from the research and has an option to buy the technology from the partnership. If the corporation exercises its option, its payment to the partnership may take the form of royalties, stock, or a combination of royalties and equity, depending on the structure of the particular deal .24

The R&D limited partnership is an alternative to the joint research venture. It is based on a 1954 law that was not used until it was tested and validated by the Supreme Court in 1974. The Economic Recovery Tax Act of 1981 and a reduction of capital gains tax to a maximum of 20 percent have combined with this law to stimulate the creation of new venture capital businesses in recent years.

R&D partnerships have been evolving as a financial alternative since 1974. The early partnerships were formed to provide seed money to start-up ventures. These partnerships raised money to carry very early-stage companies through often protracted development periods before venture capital could be raised from more traditional sources. Later, early-stage operating companies began to consider R&D partnerships as a means to finance new or second generation products that faced either a high technical risk, a long development period, or both.

Finally, mature companies are now using R&D partnerships to raise substantial amounts of money. To these companies, the R&D partnerships offer a way to shift the development risk to outside investors—to avoid betting the company on

[24]Kaitz & Associates, op. cit., p. 57.

a speculative new technology. To the private investors, a joint investment like this with a well-established company may be less risky than one with an early-stage company. A number of regional and national investment banking firms are now involved in funding offerings such as these.

In spite of the numerous advantages of R&D partnerships, they are not right for all companies. First, the use of the funds raised will be strictly limited to research and development activities, except to the extent that the company generates profit on the contract. Second, only high margin products are appropriate for royalty partnerships, since generous royalties directly reduce profit margins. Depending on the particular structure, the company's cost of capital may be relatively high. Third, the company must be prepared to give up potential tax loss carry forwards and R&D tax credits, since the investors, rather than the company, would take the deductions for research expenses. Finally, the formation and structuring of R&D partnerships could have high transaction costs, and may dilute the use of management's time.

Investors in R&D limited partnerships face particular uncertainty with respect to long-term capital gains treatment. Recent changes in the tax law, under the Tax Equity and Fiscal Responsibility Act of *1982,* have been designed to discourage individual investments in R&D. It is too early to assess the impact of the recent change to include research and development expense deductions as a tax preference item for the minimum tax, but it is likely to reduce the attractiveness of R&D partnerships to a great number of potential investors .[25]

NASA Industrial Applications Center

The U.S. Navy conducts a great deal of research and development that has significant applicability to the commercial maritime industry. While the results of unclassified R&D are generally available to the commercial sector, the institutional aspects and quantity of completed **and ongoing work preclude easy access to** these **products.**

An effort to facilitate the flow of information from the U.S. Navy to the private sector might be modeled on the industrial application centers set up by NASA. As one shipyard responded to the OTA survey: "1 would suggest the establishment of a maritime industry (applications center) equivalent to NASA with responsibility for collection and industry-wide dissemination of maritime related basic research, design, and construction technology. " Eight nonprofit industrial application centers were organized under an original grant from NASA to transfer NASA technology to commercial industrial applications. These centers enter into agreements with individual firms or groups of companies to develop solutions to industry technical problems. The fees from private firms help to support these activities.

The first Aerospace Research Applications Center (ARAC) was created by NASA in 1963 as a private not-for-profit technical information and assistance center operated by the Indianapolis Center for Advanced Research. ARAC maintains a staff of scientists and engineers and a system of computerized data bases of world-wide scientific and technical literature to aid industry, business, and government. It was first designed to help NASA find industrial uses for space research. However, ARAC's literature and data resources have now extended into the full range of modern, industrial science and technology chemistry, materials, reliability and quality control, and computer science.

ARAC provides two primary services to industrial clients. One is through engineering background studies, essentially extensive literature searches. The other is a current awareness search, which provides access to the new literature that is continuously added to the ARAC data bases. The current awareness search contains abstracts of new literature on a monthly basis in an attempt to keep clients abreast of new research and developments taking place in industrial science and technology.

[25]Kaitz & Associates, op. cit., p. *59.*

EXISTING MARITIME INSTITUTIONS

The David Taylor Naval Ship Research and Development Center

The David Taylor Naval Ship Research and Development Center is the U.S. Navy's principal research, development, test, and evaluation center for naval vehicles.[26] It was established March 31, 1967, with the merger of the David Taylor Model Basin at Carderock, Maryland, and the Marine Engineering Laboratory at Annapolis, Maryland. The Carderock laboratory is the largest facility of its kind in the Western World with about 1,000 people employed in its seven major research departments. The Annapolis facility employs another *500* people. Research areas addressed at these two facilities include hull-form structures, propulsion, silencing, maneuvering and control, auxiliary machinery, environmental effects, pollution abatement, logistics, computer techniques, and software for analysis and design.

The enabling legislation for a model experiment tank at the Washington Navy Yard, the precursor to the Carderock facility, specified that upon the authorization of the Secretary of the Navy, experiments could be conducted for private shipbuilders provided that they defray the costs of material and of labor for such experiments. This authority continues to prevail today but is seldom used.

The Kings Point, New York, Facility

At present, a national maritime research center exists at the U.S. Merchant Marine Academy at Kings Point, New York, but it provides few services and lacks the focus for R&D projects that this option might envision. The National Maritime Research Center was created in response to conclusions drawn at a maritime R&D conference held at Wood's Hole, Massachusetts, in 1969 to attempt to identify a long-range maritime research program. One final recommendation called for establishing field centers to conduct maritime research. In response, centers were set up in Galveston, Texas, and at Kings Point, New York. Originally, the intent was to establish laboratory and model testing facilities at both centers, but neither materialized. The Computer-aided Operations Research Facility was the only facility actually established; it now dominates the budget and agenda of the Kings Point operation. The Galveston center was closed a few years ago.

In January 1982, MarAd completed a study that assessed the level of industry interest in supporting a shipping management center designed to disseminate management techniques to individual companies. As a result of this effort, an exchange center, which would rely on industry for most of its support, was proposed. At least on paper, it was established and a few symposia were sponsored under its auspices. However, progress towards full realization of its stated objectives has stalled. Through congressional oversight activities, full-scale realization of such a center might be encouraged.

The Maritime Research Information Service

The Transportation Research Information Service (TRIS) is a computer-based research information storage and retrieval system maintained and operated by the Transportation Research Board of the National Research Council. TRIS consists of more than 185,000 abstracts of published works and summaries of research in progress. This data base is made up of four principal subfiles on highway, urban mass transportation, highway safety, and railroad research.

The Railroad Research Information Service (RRIS), for example, which receives its financial support from the Federal Railroad Administration, began abstracting technical papers, journal articles, research reports, statistical sources, computer programs, and data sets in 1973. The service collects information from a number of U.S. Government and industry sources and has a formal exchange agreement with the International Union of Railways, which allows it to obtain foreign railroad research information. In addition, RRIS provides dissemination services such as the semiannual Railroad Research Bulletin which lists

[26] Brochure of the David Taylor Naval Ship R&D Center and legislation establishing the Washington Navy Yard's model experiment tank, 54th Cong., 1st sess., June 10, 1896.

all new references placed on its magnetic tape files during the preceding six months. File searches are also conducted on request.

A maritime research data base, similar to the RRIS, was formerly available as part of the Transportation Research Information Service. The Maritime Research Information Service (MRIS) had information exchange agreements with Norwegian and British maritime research institutes. The data base was financially supported by MarAd until 1981. Abstracts from this data base, however, are still filed on the TRIS computers and operations could be resumed if funding were reinstated. Alternatively, MRIS could be integrated with the information services already available at the Merchant Marine Academy. This alternative was, in fact, proposed after MRIS was discontinued, but it was never acted on.

Section IV

Summary of Issues

Section IV

Summary of Issues

The major issue highlighted by the OTA survey and the foregoing analysis is whether the Federal role in maritime R&D is adequate or whether it should be enhanced for the benefit of both the maritime industry and the Nation as a whole. If it is to be enhanced, then one or more of a range of suggestions for new or modified institutions could be put in place. Since some of the existing institutions are valuable and productive, it is also important to preserve the successful elements as a part of any future institutions.

If the present Federal system is considered adequate, then perhaps no changes are desirable and existing programs should be continued much as they are.

A majority of the respondents to the OTA survey are among those advocating some change. Those advocates, however, do not agree on any one specific alternative. Also, if made, any changes should offer clear benefits to the Nation as a whole as well as to the maritime industry.

It appears from the OTA analysis that, while aspects of the Federal maritime R&D effort are useful and productive, a number of problems limit the benefits to the U.S. industry and hinder the pursuit of such national goals as technological preeminence.

Problems identified with existing Federal maritime R&D are in the following categories: 1) government contracting, 2) disseminating R&D results, 3) outreach, 4) cooperative R&D, and 5) promoting application of new technology.

Government Contracting.—Research and development, by its very nature, requires experimentation, risk-taking and somewhat open-ended exploration of new ideas. The most important criteria for selecting a good project, and someone to perform it, are the potential of the idea and the expertise of the people who will work on the project. The government's contracting process is not designed to be sensitive to such selection criteria. It was developed mainly for the purchase of materials at the lowest prices. Consequently, many R&D contracts take years to execute, are given to the lowest bidder, and are not selected to meet long-range technology goals. This has discouraged some of the best innovators and stifled some of the best ideas.

One participant at the OTA workshop stressed that, if a more effective shipbuilding R&D program is to be achieved, then the Navy (i.e., the Naval Sea Systems Command) must understand the problem better and institute much needed changes. The Navy is currently almost the exclusive customer for the U.S. shipbuilding industry. Therefore, "the U.S. Navy will be the principal beneficiary of the (shipbuilding R&D) program for years to come and must join the industry in fully understanding and making the changes in the ship design, procurement, and contracting processes that are necessary to exploit the full potential of these improved methods. "

If government-supported maritime R&D is to be enhanced or expanded, improved contracting procedures should be a major consideration.

Disseminating R&D Results.—The OTA survey indicates that in the past many private firms have not received the results and/or the benefits of much of the R&D efforts sponsored by Federal agencies. At least two problems have been described. One is that reports and abstracts are not always published in the proper format and journals, with complete data and results of R&D work. The other is that relevant information on new technologies is not always disseminated to a wide group of those who will be able to make the best use of it. Information and technology transfer systems of the past have had a number of problems, but, if an R&D project is worthy of Federal support, there should be an equal effort to make the results as useful as possible to as broad a group as possible. Any new institution for R&D should be developed with careful attention to procedures for disseminating the end product.

Outreach.—The OTA survey indicates that a majority of the number of firms in the industry

do not participate in the ongoing Federal R&D effort. Many feel that much of the work is not relevant to their needs. Some other recent studies of ship operations R&D indicate that a number of operators have not participated in federally sponsored R&D efforts and consequently the results have not been widely accepted.

Future R&D work and institutions would benefit from wider participation and acceptance from the industry. While it is difficult to achieve such participation, there have been recent examples of excellent participation and acceptance in some specific cases (e.g., the NAS Ship Structures Committee work and the MarAd National Shipbuilding Research Program and Cargo Handling Program).

Cooperative R&D.—Since the U.S. maritime industry itself is made up of diverse sectors, the opportunities for cooperative R&D may be limited to special cases where groups of firms have the clear interest and need. In other cases R&D by individual firms may be the best approach; in still other cases, direct Federal support of basic and long-range research may be the best.

The OTA survey indicates that some firms are eager to participate in a government/industry cooperative R&D venture; others are cautious but would support some versions of cooperative ventures; and still others do not see the need nor the benefit of such approaches. Under these circumstances, it appears important to provide enough flexibility within any new R&D institution both to sponsor cooperative ventures where they make sense and to sponsor independent R&D where it makes sense.

Promoting Application of New Technology.—A persistent problem in the U.S. maritime industry appears to be the application of certain advanced technologies or the pursuit of innovations seeking such goals as increased productivity or improved competitiveness. Several studies have identified a need for encouraging new maritime ventures, new products, or the adoption of new technologies. If a new R&D institution were developed, attention also should be given to the application of useful new technologies in business ventures. One participant in OTA's workshop suggested that a Government role in R&D should be to assist and encourage the innovator or new venture entrepreneur through the creation and support of maritime venture capital funds. Whatever approach to future Federal R&D programs may be followed, the application of advanced technologies developed to enhance U.S. maritime enterprises is an important consideration.

Appendixes

Appendix A

Summary of the R&D Program of the Maritime Administration (MarAd), Department of Transportation

Overview*

MarAd's research program grew out of the program office for the nuclear ship SAVANNAH of the late 1950s and early 1960s. The program pursued a variety of small projects and worked with the Navy on surface effect ships until **1970** when it was enlarged and redirected. The emphasis then shifted to cooperative work with industry to solve the near-term problems that plagued shipbuilders and operators,

In the past year or two emphasis is once again shifting. Administration policy is to have industry assume more responsibility for its near-term problems while government concentrates its efforts on the longer term basic research. Corresponding to this policy, MarAd's research budget gradually has been reduced. In the 1970s, funding peaked at $25 million per year, after which budget cutting took its toll. The FY 1984 and 1985 budget are $11.4 million and $9.9 million respectively. Accordingly, MarAd has been trimming some of its programs. Work will continue in certain applied research areas but it will involve broad-based projects which apply to many or all companies, and these areas will be turned over to industry whenever that becomes possible.

With the limited funds available, high priority projects will be undertaken in shipbuilding, ship operations, and port technology. First priority will be policy or defense-related issues. Second priority will be fundamental research. Third priority will be applied research that can be useful to a broad range of shipyards, operators, or ports.

Government/industry cost sharing is a key element in certain of the MarAd R&D programs. During fiscal year 1982, MarAd committed $9.6 million to R&D projects. Industry contributed an additional $4.5 million (FY **82** Annual Report, chapter **6)**. Joseph A. Seelinger, assistant to MarAd's Research Advisor, estimates that the industry contributed **$5** million to **$7** million in 1983. The actual amount the industry contributed, however, is difficult to estimate because industry often makes in-kind contributions of labor, facilities, or technical assistance rather than cash.

MarAd also has cost-sharing and cost-reimbursed arrangements with the U.S. Navy and the U.S. Coast Guard. In 1983, MarAd obligated $25 million of research and development funds. Of this amount, $15.5 million, including a one-time amount of $5.3 million for funding of USCG icebreaker operations, was directly appropriated to MarAd, while $9.5 million was contributed or reimbursed by other agencies, primarily the Navy.

The MarAd R&D program was recently reorganized. Formerly, an Associate Administrator had sole responsibility for research and development. The Associate Administrator's supervisory responsibilities encompassed: 1) the Office of Advanced Ship Development, which included the shipbuilding and ship machinery programs; 2) the Office of Advanced Ship Operations, which included the programs of fleet management, cargo handling, and ship performance and safety; and 3) the Office of Maritime Technology, which included the hydrodynamics, university research, marine science, advanced ship systems, and ship structures programs.

With the recent reorganization, the R&D office was merged with the MarAd Operations office and is now under the Associate Administrator for Shipbuilding Operations and Research. The major organizational change was to combine the Offices of Advanced Ship Development and the Office of Maritime Technology in the Office of Advanced Ship Development and Technology.

Within MarAd, the managers at the program level (e.g., shipbuilding, ship machinery, etc.) are largely responsible for the organization and the conduct of individual programs. This results in a great deal of variation in how these various programs are operated and how they interact with the industry. In a few programs, such as the Shipbuilding, Fleet Management and Cargo-Handling Programs, formal relationships have been established between the programs and the industry. These arrangements may dictate specific procedures for soliciting input from the industry and for carrying out joint research projects. Other programs have less formal mechanisms for coordinating with the

*The material in this appendix was taken from various published and unpublished MarAd sources then reviewed by Dr Zelvin Levine, Senior Advisor for R&D, February 1 985

industry but still have an active relationship with the private sector. Overall, it is a policy of MarAd to conduct most projects on a cost-sharing basis; projects that are not conducted on this basis are required to justify their actions.

Current MarAd Program Elements

Shipbuilding Research

A large percentage of MarAd R&D funds are devoted to the National Shipbuilding Research Program (NSRP). The projects conducted under this program are jointly sponsored by MarAd and industry; this joint participation is widely thought to be the primary reason this program has been so successful. J. E. DeMartini of the Bath Shipyard writes: "The National Shipbuilding Research Program has grown into an effective vehicle for the conduct of industry-wide research and development programs that have made substantial contributions to increasing the productivity of our industry. " (DeMartini, 1982.)

NSRP coordinates R&D activities through the Society of Naval Architects and Marine Engineers (SNAME). SNAME helps to disseminate the results of R&D projects to their members. In addition, the Ship Production Committee of SNAME has formulated a five-year R&D plan. According to M. Lee Rice, President of the Shipbuilders Council of America, the shipbuilding industry generally views NSRP as a successful program.

Ship Machinery

Before the oil embargo of **1973,** the Ship Machinery Program concentrated on lower cost engines and lower manning. After the embargo, fuel efficiency became its main thrust although work continues on lowering capital and maintenance costs. All work in coming years will be on longer range projects: fundamental work will be conducted on the diesel engines, alternate fuels, and fluidized bed combustion. The near-term work on energy conservation and steamship retrofits will be left to industry.

In FY **1985** the first phase of a project on ceramic coatings for diesel components will be completed. These coatings, which were originally developed for gas turbine blades, can be applied to diesel internals and allow higher operating temperatures, and thereby attain greater efficiency and raise tolerance to lower grades of fuel. In cooperation with the U.S. Coast Guard, the problem of spontaneous combustion of coal aboard ship will be studied.

In FY 1986, further work on diesel efficiency will be conducted including the application of the Navy's RACER system (Rankine Cycle Energy Recovery) to diesel waste heat recovery. In both 1985 and 1986, work will continue on the use of alternate fuels, such as coal-in-water slurries, and on a cooperative project with industry to adapt the new concept of fluidized bed combustion to ships.

Cargo Handling

The Cargo-Handling Cooperative Program (CHCP) is an arrangement between MarAd and six U.S. carriers for conducting cooperative R&D on cargo handling. The program was initiated in 1981, with projects actually beginning in 1983. The program operates through an executive committee composed of representatives of the carriers and MarAd. The committee meets two to four times a year to discuss common interests and to plan future projects. These projects are then conducted by contractors recommended by the MarAd program administrator and approved by the executive committee. The carriers themselves do not conduct R&D projects as do the shipyards associated with the Ship Production Committee; however, one of the member carriers takes the lead in monitoring each of the projects. Results of the projects are disseminated through monthly reports written and distributed by the MarAd program administrator. The CHCP was budgeted at **$500,000** for FY 1984. Additionally, the CHCP is being funded by the Navy to conduct research relevant to both military and civilian needs.

In 1985, work on a computerized simulation model of container terminal operations will continue. The carriers use this model to determine the impacts of changes in operational methods and vessel scheduling. Another project is determining how changes in cargo handling might capture some additional cargo for container carriers. Bar code identification equipment is being tested to determine its ability to function in the marine environment. There is a continuing effort to assess the technologies used in other industries for their application to marine cargo handling.

Future projects will include a test of low frequency microwave identification systems, improved communications between yard equipment and a central control station, automatic storage and retrieval of containers in the container yard, automated interchange transactions, testing of automated guided vehicles, and laser disc storage of documentation.

Computer-Assisted Operations Research Facility (CAORF)

This facility simulates a ship's bridge as well as ports or channels and their associated traffic and is used to investigate and test alternative operating procedures.

Cost-shared projects are carried out with U.S. Coast Guard, U.S. Navy, Corps of Engineers, port authorities, and shipping companies to test the effect of variables in their operations—changes in turning basins, positioning of buoys, changes in training procedures, etc.

In FY 1985 and 1986, CAORF will continue to work on a wide variety of navigational problems, many for other parties on a reimbursable basis. One project which will continue into FY 1985 is a reimbursable project for the Panama Canal Commission. The Corps of Engineers will continue to be a heavy user of CAORF in connection with several dredging projects, including Hampton Roads, Mobile, and New York. Individual port authorities will also be funding projects at the facility. MarAd will conduct its own work at CAORF on safety-related projects such as improved navigational and training procedures.

Fleet Management

The Fleet Management Program has established a formal mechanism—the Cooperative Industry Research Program—for soliciting ideas and establishing cost-shared projects with the industry. Under this program, a Request for Proposal is issued annually to over 800 firms. The program then funds the best proposals among those submitted.

MarAd has been working with the ship operating industry on information technology since the early **1970s.** Various computer modules were developed but problems arose on the transferability y of these modules from one company to the next. A new approach is to work with groups of companies through trade associations and to structure the output so that it is as widely usable as possible. This work has been merged with a former program on ship communications. Work on near-term computer/communications applications is being phased out as recently developed modules are being implemented, and as industry takes a larger role in developing new ones that may be required. A new generation of technology is being investigated to see how it can be applied profitably to ships and shipping.

Emphasis in 1985 and 1986 will be on long-term, high-risk projects which will be formulated during a technology forecasting project initiated in FY 1984. These projects will use technologies that are not yet fully developed, but are currently in the basic research phase of R&D. Projects will be undertaken to provide a useful product within 5 to 10 years. Although of a lesser priority, work will continue in the Cooperative Industry Research Program, which provides for 50/50 cost sharing with industry on near-term projects to implement existing state-of-the-art technology. Continuation of these near-term projects is thought by MarAd to be essential to maintaining a spirit of cooperation with industry.

Ship Performance and Safety

This program addresses several areas of ship operations not covered elsewhere. Among these are effective manning, maintenance and repair, and hull and propeller coatings. Projects are usually conducted in cooperation with industry and/or labor. They are aimed at reducing fuel consumption, reducing the hazards aboard ship, or analyzing motivational aspects of seafaring to improve productivity and retain skilled seafarers in the work force. There has been an increasing emphasis in this program on making better use of the human resources of the industry. The biggest effort in coming years will be on effective manning of ships. In cooperation with shipowners and unions, shipboard experiments will determine the safest and most economical crew levels. Hull and propeller coatings will continue to be an important area of research in an effort to increase propulsive efficiency and reduce maintenance.

Advanced Ship Systems

This program is designed as the industry's bridge to tomorrow's shipping systems. The maritime industry is not organizationally or financially equipped to do long-range research and development. Under present circumstances limited resources are directed at near-term survival. The probability of success in any given Advanced Ship Project is small compared to that of the other programs, and the successes may come in directions other than those originally intended.

For FY 1985 and FY 1986, an initiative is planned on "competitive ships of the future. " This would be an R&D joint venture, involving both government and industry, to develop prototype ship designs which incorporate the latest technology. The goal would be a series of ships which could be competitive in many world freight markets. While this project has been approved in the budget, the project has not yet been given the go-ahead to begin.

In addition, technology development for ice transiting ships will continue, Also, the study of powering needs in various ice conditions will continue. This will require additional full-scale tests of polar class icebreakers in cooperation with the U.S. Coast Guard.

Marine Science

Just as there is very little work on advanced concepts by the industry, there is little or no fundamen-

tal research on hydrodynamics, structures, and propellers. In addition, because of the nature of this research, relatively few projects are cost-shared by industry. Other government agencies such as the U.S. Navy and U.S. Coast Guard as well as the American Bureau of Shipping share in this work, especially through the Ship Structures Committee. Wherever possible, the agencies work together to solve common problems. MarAd, however, must take the sole initiative in problems peculiar to the merchant fleet, such as the maneuvering of tankers in shallow water or the resistance of vessels with very high block coefficients. Research will continue in the following areas: 1) improving ship maneuvering performance, **2)** propulsion efficiency, and 3) ship structural safety through the interagency Ship Structure Committee.

Market Analysis

The small amount of research conducted by this program is directed at a number of areas. Specific market opportunities are assessed, such as heavy lift cargo, perishable cargo, or shipments to developing nations. Market information is produced, such as monthly performance printouts and Canadian diversion reports. Planning is carried out on new market strategy models and forecasts of trade. In addition, U.S. and international policies are evaluated for their affect on U. S.-flag carriage. Industry has taken part in this program by recommending research projects.

In FY 1985 and 1986, this program will emphasize research on possible barriers to U.S.-flag vessels in world markets. The impact of international maritime policies also will be assessed and responses will be recommended.

Table A-1 .—MarAd R&D Program Funding, Fiscal Years 1969-76
(dollars in thousands)

	Contract awards by final year							
	1969	1970	1971	1972	1973	1974	1975	1976
Prior year carryover					$ 900.6	$ 492.4	$ 1930	$ 7680
Appropriation					24,000.0	24,000.0	22,432.0	19,768,0
Total available					24,900.6	24,492.4	22,625.0	20,5360
Obligations:	$9,471.0	$11,584.0	$23,435.0	$22,864.4	24,408.2	24,2994	22,138,9	19,164.1
Advanced ship development	$ 129.0	$ 1,319.0	$ 5911.8	$ 4,193.2	$ 7,018.7	$9,314.7	$6,572.2	$ 7,4331
Advanced ship operations	217.0	4,293.0	7,521.0	9,021.6	10,623.3	8,434.4	9,677.3	3,272.8
Maritime technology	500.0	385.0	2,190.2	6,120.6	2,361.2	1,626.6	2,343,3	3,6566
NMRC/CAORF	0.0	0.0	0.0	1,936.6	3,595.8	3,3846	2,221.9	3,1279
NS Savannah/nuclear	3,973.0	3,389.0	5,334.0	0.0	0.0	6668	882.9	5682
JSESPO	3,332.0	1,500.0	500.0	0.0	0.0	00	0.0	0.0
Agency support	369.0	698.0	310.0	1,068.5	809.2	872.3	525.0	318.5
Market development	0.0	0.0	481.0	[a]	[a]	[a]	39.3	3006
Port & intermodal	0.0	0.0	308.0	[b]	[b]	[b]	[b]	4864
Other	951.0	0.0	879.0	523.9	0.0	00	(123 O)	00

[a]Included in advanced ship development
[b]Included in advanced ship operations
NOTE Numbers are ballpark since recoupments from prior years are not entered in a consistent fashion

Table A-2.—MarAd R&D Program Funding, Fiscal Years 1976-85
(dollars in thousands)

	Contract awards by fiscal year									
	Transfer quarter	1977	1978	1979	1980	1981	1982	1983	1984	1985 (estimated)
Prior year carryover	$1,371,8	**$2,270.4**	**$2,595.7**	**$1,910.0 2,670.4**	**$2,701.0**	**$1,102.5**	**$1,507.0**	**$ 636.0**	**$ 908.0**	**$2,919.0**
Appropriation	4,000,0	**18,500,0**	**18,325.0**	**17,500,0**	**16,300.0**	**13,800.0**	**8,481.0**	**15,300.0**	**11,385.0**	9,900.0
Total available	5,371.8	20,770.4	20,920.7	22,080.4	19,001.0	14,902.5	9,988.0	15,936.0	12,293.0	12,819,0
Obligations:	$3,101.3	$18,174.6	$19,030.2	$19,362.8	$18,007.0	$13,738.0	$9,668.0	$15,330.0	$10,500.0	$13,790.0
Advanced ship development	574.0	5,973.6	5,735.7	4,860,7	5,179.0	4,409.0	2,808.0	3,670.0	2,666.0	3,365.0
Advanced ship operations	774,6	1,882,2	1,922,3	2,476.0	2,673.0	2,274.0	1,569.0	2,1660	1,332,0	4,164,0
Maritime technology	742.1	3,624.3	4,889,7	5,111.3	4,159,0	2,852.0	1,181.0	1,244.0	2,731,0	1,818.0
NMRC/CAORF	8370	5,080.5	4,850,6	6,568.4	5,802,0	3,534.0	3,666.0	2,933.0	3,478.0	3,547.0
NS Savannah/nuclear	870	107,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
J S E S P O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agency support.	8.6	2055	175,6	346.4	194,0	669.0	444.0	617.0	2930	0.0
Market development	[a]	[a]	[a]	[a]	[a]	[b]	[b]	[b]	[b]	450,0
Port & intermodal	780	1,301.2	1,4563	[c]	[c]	[b]	[b]	[b]	[b]	446,0
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,7000	0.0	0.0

[a] Included in advanced ship development
[b] Included in agency support
[c] Included in advanced ship operations

VOTE Numbers are ballpark since recoupments from prior years are not entered in a consistent fashion

Appendix B
The Navy's ManTech Program

The U.S. Navy's Manufacturing Technology Program (ManTech)

The U.S. Navy's ManTech Program was established in 1977. Its objective is to encourage the adoption of advanced production equipment and processes to reduce the cost and delivery time of Navy systems, improve the quality of fleet hardware, improve the mobilization readiness of the Navy's industrial base, and reduce dependency on strategic and critical materials. It provides funding and other incentives for the adoption of production technologies where industry cannot provide for such advances in a timely manner.

The ManTech Program directs its efforts towards all industrial sectors that manufacture products for naval use. However, a major effort in shipbuilding technology was initiated in FY **1984,** with the goal of a reduction of 10 percent in the cost of Navy ships and **25** percent in delivery time by 1990. This effort is a joint undertaking between Navy, MarAd, and the industry as represented by SNAME's Ships Production Committee. The shipbuilding technology program of ManTech will be a priority program of the Navy's for at least the next five years. The program's budget in FY 1983 and FY 1984 was $10.27 million and $19.12 million respectively. The projected budgets for FY 1985 and FY 1986 are $21,37 million and $24.70 million.

The U.S. Navy's ManTech Program is an Advanced Development Program (identified as Navy Program Element 78011N, Project Z1050). Funding in the amount of $2.0 million per year is provided to the NSRP-SPC from the ManTech Program as the Navy's share. In addition to conducting development within the SPC, the SPC provides oversight review of the Navy's ManTech Program applicable to ship production. Criteria for selecting ManTech projects is specified in NAVMATINST **4800** and emphasizes "Return on Investment" to the Navy.

The portion of the ManTech Program supporting shipbuilding or ship performance technology development is managed by NAVSEA. The NAVSE (ships) project funding for FY 1977 through FY 1985, representing the Navy's efforts in this area over the past nine years, is as follows:

Fiscal year	*Funding ($-millions)*
1977	*8.9*
1978	*7.5*
1979	*8.2*
1980	*5.1*
1981	*2.1*
1982	*11.8*
1983	*10.3*
1984	*19.1*
1985	*21.4*

Table B-1.— Navy's ManTech Program Funding, Fiscal Years 1983-86 (dollars in millions)

	FY 1983	Percent	FY 1984	Percent	FY 1985	Percent	FY 1986	Percent	4-year total	Percent
Ships	10.27	32	19.12	34	21.37	31	24.70	31	75.46	32
(MarAd)[a]	(2.2)		(2.2)		(2.2)		(3.0)		(9.6)	
Aircraft	7,89	25	15,639	28	16.03	23	18.58	23	58.14	25
Electronics	6.96	22	8.147	15	10.69	16	12.37	16	38.17	16
Logistics	.30	1	1,1	2	5.34	8	6.20	8	12.94	6
Manufacturing science	3.34	11	7.92	14	10.27	15	11.90	15	33.43	14
Administration and planning	2.96	9	4,202	7	4.79	7	5.65	7	17.6	7
Total	31.72	100	56.13	100	68.49	100	79.4	100	235.74	100

[a]Included in ships line
NOTE Percentages are rounded and may not add up to 100 m some tables

Table B-2.—U.S. Navy ManTech Program (Shipbuilding Portion) Funding by Category, Fiscal Years 1983-85 (dollars in millions)

Category (subject)	FY 1983		FY 1984		FY 1985	
	Amount	Percent	Amount	Percent	Amount	Percent
Hull structure—automatic welding	0.0	0	1.4	7	1.1	5
Propulsion—propeller manufacturing, reduction gear measure	2.4	24	2.4	12	3.2	15
Electrical	0.0	0	0.0	0	3.2	15
Auxiliary-piping automation flexible machining	1.8	18	4.8	25	3.2	15
Outfit—robotic preparation and coating	0.2	2	3.7	19	3.2	15
Armament—laser metalworking	3.6	35	4.6	24	4.3	20
Integration—computer scheduling	0.0	0	0.2	1	1.0	5
National shipbuilding R&D—MarAd	2.2	21	2.2	12	2.2	10
Total	10.3	100	19.1	100	21.4	100

NOTE Percentages are rounded, and may not add up to 100 in some tables

Samples of Survey Forms

CONGRESS OF THE UNITED STATES
OFFICE OF TECHNOLOGY ASSESSMENT

Survey of R & D activities in the
SHIPBUILDING INDUSTRY

July 1984

1) Please indicate the approximate percentage of your firm's operating budget spent on R & D activities (not including Federal funds for R & D):

a) in the past 5 years? _____ % b) in the current year? _____ %

2) **Of the total spent on R & D indicated in question 1, estimate the percentage spent for each of the categories below.**

a. Ship design and performance _____ %
b. Ship subsystem design — _____ %
(e.g., propulsion system, navigational equipment, etc.)

c. Shipbuilding research _____ %
(e.g., CAD/CAM, ship production technology, shipyard management, etc.)
d. Other (please specify below) _____ %

3) **If your firm received any Federal R & D funds, please indicate what percentage of your total R & D expenditures (Federal** + private) the Federal monies represented?

a) in the past 5 years? _____ % b) in the current year _____ %

4) If any Federal funds were received for R & D activities, which agency and program contributed them? In addition, indicate the approximate percentage of the total contribution that each agency/program contributed.

Agency	Program	070 of Total Contribution
		07₀
		%
		07₀
		07₀

5) Please indicate the relative influence that the following factors have on your firm's investment in R & D.

	Very Influential	Somewhat Influential	Not Influential
Interest rates			
Availability of finance Capital			
Government policies and programs			
Market demand			
Competitive pressure			
Other (please specify)			

6) **How do the following Federal laws, regulations and policies affect your firm's investment in R & D?**

	Encourages Investment	Discourages Investment	Little or No Et'feet
Antitrust statutes			
Patent law			
U.S. tax code			
OSHA safety regulations			
Phase out of ODS/CDS			

7) **Please rank order the laws and regulations from question 6 according to the relative degree that they encourage or discourage R & D investment.**

Encourages Investment	Discourages Investment
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____
5. _____	5. _____
6. _____	6. _____
7. _____	7. _____

8) **Does your firm have access to the technological advances resulting from:**

	Yes	***No***
a. U.S. Navy R & D activities	_____	_____
b. Foreign R & D activities	_____	_____

9) **Could you suggest ways the Federal government might make this information more accessible?**

10) How would the following options affect your firm's incentive to invest in R & D?

	Significant Incentive	Slight Incentive	Negative Incentive
a. Extension of the Capital Construction Fund to R & D expenditures (allowing tax deferment).	_____	_____	_____
b. Availability of Federal loan guarantees for R & D expenditures (e.g., Title XI)	_____	_____	_____
c. Amendment of antitrust laws to permit research joint ventures	_____	_____	_____
d. Expansion of tax credits for R & D expenditures	_____	_____	_____
e. Increase in direct Federal support for R & D	_____	_____	_____

11) Would you support the formation of a government-industry sponsored maritime research facility for the purposes of conducting long-term basic and applied research and for serving as a clearinghouse for Navy, foreign, and domestic civilian R & D advances?

_____ Strongly endorse such a research facility and would be willing to participate and provide funding for cooperative research projects.

_____ Endorse such a facility but do not anticipate that my organization would actively participate or provide funding.

_____ Do not endorse the concept of such a facility.

12) Do you have any suggestions for any other organizational or institutional changes within the Federal government that might improve the effectiveness of government-sponsored research?

13) Would you advocate increasing direct Federal expenditures on maritime R & D? If so, please indicate through which Federal agency or program.

14) **In addition to the R & D options suggested on questions 10-13, and in light of the recent phase out of Federal construction and operating subsidies, can you suggest other Federal maritime incentives that might help revitalize the industry? Which of these, if any, would be significantly more beneficial than** R & D **incentives?**

Classification Questions

Answers to the following questions will be used to classify the survey responses and will assist OTA in drawing conclusions from the data collected.

1. Is your firma participant in the Active Shipbuilding Industrial Base (ASIB)? (yes or no) _____
2. What is the average (past three years) annual gross tonnage constructed in your shipyard? _____gross tons
3. Please indicate the approximate percentage of your work that is:
   For the U.S. Navy_____% For commercial clients % **New** construction— % Repair_____%
4. Title of survey respondent _____
5. Name of respondent (optional) _____
6. Affiliation (optional) _____

Thank you for your cooperation.

Appendix D

Firms Responding to the OTA R&D Survey*

Ship Operators

Alcoa Steamship Co.
Amerada Hess Corp.
American Automar, Inc.
American Global Lines
American President Lines
American Trading Transportation Co.
AMOCO Transport Co.
Arco Marine, Inc.
Bulkfleet Marine Corp.
Central Gulf Lines, Inc.
Charter Marine Transportation Co.
Chevron Shipping Co.
Cosmopolitan Shipping Co.
Crowley Maritime Corp.
Diamond Shamrock
Dixie Carriers, Inc.
Dow Chemical Co.
Energy Transportation Corp.
Falcon Grove
Farrell Lines
Getty Marine
Gulf Oil Products
Hvide Shipping
Ingram Barge Co.
Lykes Bros. Steamship Co.
Marathon International Petroleum
Marine Transport Lines
Mobil Oil
National Marine Service, Inc.
Navieras de Puerto Rico
Ogden Corp.
Overseas Shipholding Group
Pacific-Gulf Marine, Inc.
Phillips Petroleum Co.
Reomar, Inc.
Shell Oil Co.
Standard Fruit & Steamship Co.
Stolt-Nielsen, Inc.
Sun Transport, Inc.
Texaco, Inc.
The Lubrizol Corp.
Trinidad Corp.
Tropical Shipping Co.
Union Oil Co. of California
Unnamed Operators-Two (2)
U.S. Lines
Western Hemisphere Corp.

Shipyards

Alabama Dry Dock & Shipbuilding Corp.
Avondale Shipyards
Bath Iron Works Corp.
Bay Shipbuilding
Bethlehem Steel Corp.
Campbell Industries
Dillingham Ship Repair
Dravo Marine Equipment Co.
FMC Corp.
General Dry Dock & Repair Corp.
General Ship Corp.
HBC Barge
Hoboken Shipyards, Inc.
Ingalls Shipbuilding
Leevac Shipyards
Lockheed Shipbuilding Co.
Marco Seattle
Marinette Marine Corp.
McDermott, Inc.
NABRICO
National Marine Service, Inc.
National Steel & Shipbuilding Co.
Newport News Shipbuilding
Newport Shipyard, Inc.
Norfolk Shipbuilding & Drydock
Pennsylvania Shipbuilding Co.
Peterson Builders
Service Machine Group
Southern Shipbuilding Corp.
Southwest Marine
St. Louis Ship
Steiner Shipyard, Inc.
Todd Shipyards
Tracer Marine, Inc.
Twin City Shipyard, Inc.

● Not all the firms listed here completed the survey; a number of them indicated that they did not conduct any R&D and were unable to respond in full.

Appendix E

Compilation of Responses to Open Questions

A Compilation of Specific Suggestions of Survey Respondents

1. Question #9—Could you suggest ways the Federal Government might make (R&D) information more accessible?

Operators

- MarAd could screen this information on behalf of U.S.-flag operators and distribute free abstracts of applicable material very much as many trade association libraries make industry information available to their members.
- Regular publications issued to the Federation of American Controlled Shipping Organization.
- The Federal Government could make information regarding USN and foreign R&D activities into a single source, single catalog, available to U.S. liner companies through a single agency such as MarAd.
- Allow government contractors greater freedom to use their government work in civilian applications.
- The Freedom of Information Act has been very helpful in accruing information. The response time or turnaround time needs to be greatly reduced if information is to be utilized properly.
- There is no need for Federal Government involvement in this area.
- It could be summarized for publication through an industry trade association.
- Microfiche Titles. Supply to our national organization in Washington-American Waterways Association (AWA). Run articles in our publications, such as, Waterways Journal, Work Boat, etc.
- They should be presented (including translation) in a form that is understandable to the merchant fleet and shipbuilders in general.
- Provide an industry-related catalog listing and describing R&D programs in progress or completed for the past 2 or 3 years.
- Greater information exchange between U.S. Navy and organizations such as MarAd, SNAME, and Naval Architectural schools in areas which affect cost savings and shipbuilding techniques. For example, MarAd could periodically update commercial S.B. specifications, say, yearly reflecting current state of the art. Also, R&D should be targeted at the practical aspects of S.B. and operations.
- The National Technical Information Service periodically makes available lists of technical publications collected from various sources, which may be ordered. The number of items included in this listing could be expanded to make more technical information available.

Shipyards

- Establish a government/industry sponsored maritime research facility as described in question #11 with the provision that overall management control be exercised by industry.
- A how-to-help access catalog might help. Seminars have been successful, such as IREAPS-SPC show and tell programs, such as have been held at University of Michigan. Education training programs could be improved with more funds. They have a good start on library information but need to be advertised more and put on technology updates.
- Conduct annual symposiums. Distribute via GPO both domestic and foreign R&D updates.
- Navy R&D should be shared on a periodic basis with all shipyards. Meetings should be convened to present and update the results of MarAd R&D projects with particular emphasis on ship system and productivity developments. Item 9 addresses a *significant* shortfall in Navy R&D, specifically the timely accessibility of Navy generated R&D data. It is recommended that the Navy sponsor periodic reviews during the year organized by NRL or DTNSRDC to present to invited shipyards the results of recent projects. Emphasis should be placed on those projects which enhance shipyard productivity or describe ship system developments. These meetings would not only encourage a dialog between the Navy R&D community and the shipbuilding industry, but also better enable the shipyards to plan their own R&D programs.
- Assuming R&D activity results in hardware designs, and those designs are utilized to produce hardware, "technological advances" could be accessible via design information included with Federal bid requests for the hardware involved. The point is that the firm conducting the R&D work should not necessarily} have control of the R&D output.
- Publish through the Society of Naval Architects and Marine Engineers.

- Publish a catalog of U.S. Navy R&D reports and available R&D reports of foreign governments.
- Offer seminars where shipyards are invited. Send out information indicating the scope and objectives of ongoing R&D.
- Use industry technical groups.
- Establishment of maritime industry equivalent to NASA with responsibility for collection and industry-wide dissemination of maritime-related basic research, design, and construction technology.
- Accessibility appears adequate in the Shipbuilding Industry. However, direct access to a U.S. Government controlled technical library would enhance and broaden the application of advanced techniques. Publication on a quarterly basis of the documents registered at the library would also assist.
- Acquisition and distribution: cost of printing only.
- Seminars, meetings, publications, etc.
- It is suggested that a recommendation be made to establish a joint Navy/industry study group to address this issue. The group should be tasked to identify the specific problems, identify and evaluate alternative solutions, and develop specific recommendations. Specific possibilities include establishment of a formal technology transfer program similar to NASA's with its many and varied mechanisms.
- Publish a quarterly compendium of R&D efforts with progress reports on each project.

2. **Question #12–Could you suggest other organizational or institutional changes within the Federal Government that might improve the effectiveness of government-sponsored research?**

Operators

- **Adopt** the Peter Grace Commission Report.
- As a passenger operator, it is not understood that we are more in the vacation business than in the steamship industry. Accordingly, the organizational institutional changes within the Federal Government that would most improve effectiveness, would be proper funding and market research conducted by the office of tourism. Where we could most use the help would be in development of international markets for our operations in the State of Hawaii. This is an area where it is very difficult for a company of our size to develop an adequate international presence, and the continuing cutbacks in funds for the office of tourism has significantly hampered our ability to attract foreign passengers This, of course, affects the balance of payments of the United States, as well as putting us at the mercy of our foreign competitors in the cruise industry who generally have easy access of foreign markets because of their ownership structures.
- Those areas chosen for government-sponsored research should be established with strong participation and input from the end users of any expected R&D results.
- In general, it is important for the government to encourage improved industry contact (shipyards-owners-consultants-operators-navy-education institutes). The feeling of' unity through the marine industry gives an enormous boost, which both are required in the U.S. Research should be done within all the marine groups and preferably with the participation of more than one group in each program. The government can help to coordinate and pay for this or leave the coordination to someone else.
- Under present arrangements, results of research tend to be too narrow and too late. Administration of research should be directed more to the timeliness and practical applicability of the results.
- The U.S. Department of Transportation should take direct responsibility for government-sponsored research, and also the direct responsibility for the communication of this information to shipowners.
- Rather than making payments to secondary contractors, payments if made to U.S. liner companies would ensure better control over R&D activity performed by the subcontractors.
- We recommend that the Federal Government shift its support of marine R&D to a role of primarily being a source of funding. The marine industry should participate to a greater extent in the selection of R&D projects and their administration. This would help to make the funded work relevant to real industry problems, thereby providing the most efficient use of government R&D funds. Under this scenario an industry-wide research information facility would be most desirable.
- Government-sponsored research has been ineffective in the commercial marine area. It makes little sense to spend $4 million in one day on commercial shipbuilding research when no ships are being built or contemplated.
- Focus on things we'd all use—such as better barge fastening systems, better navigation aides for Mississippi River, river pilot simulator/trainer development, shorter range radar enhancement, etc.

Shipyards

- Establish a fund for unspecified R&D projects administered by an agency such as the Maritime Administration's Office of Advanced Ship Develop-

ment and Technology for funding those "target of opportunity" projects meeting predefine criteria and limits. Change contract approval procedures (F. A. R.) to decrease proposal lead time for R&D projects by eliminating "red tape" delays that, while necessary for normal procurement items, are an impediment to R&D projects (e.g., source approval, advertising). Coordinate all R&D specialized areas (e.g., Computer Integrated Manufacturing Systems) through one government agency (e.g., National Bureau of Standards). Designate and fund a central control agency to administer all major R&D projects with authority to mandate implementation of the results of those projects as a condition of continuing/obtaining government contracts (e.g., ship acquisition and repair organizations implement the advances made by some of the industry in the use of group technology).

- Make the results more readily available to private industry.
- The effectiveness of government-sponsored maritime research could be improved by centralizing the administration of research projects in one agency, specifically the U.S. Navy.
- Research is only effective when it can be applied. Without U.S. commercial ship and offshore construction U.S. maritime research will always be ineffective. The Federal Government must establish a positive maritime policy to decrease dependence on foreign vessels. Establish a positive maritime policy which will cause vessels to be built in the United States. Commit to build and maintain an adequate military sealift capability with an adequate sustaining domestic industrial shipbuilding base.
- Strengthen integration of common elements of U.S. Navy, MarAd, and U.S. Coast Guard research programs. Suggest detailed investigation of role and effectiveness of the British Shipbuilders Research Association (BSRA).
- Streamline contracting procedures to make R&D efforts time effective. Broaden the concept of IR&D such as to create greater acceptance of cost allowability for efforts undertaken independent of government sponsorship.
- Force existing agencies (i.e., Coast Guard, MarAd) to be more sensitive to industry needs and requirements and become more aggressive in pursuing programs to benefit the marine industry (inland and offshore).
- At the present time, three government organizations are directly involved in maritime research: the Navy, the Coast Guard, and the Maritime Administration. While the focus of these research efforts is not the same it would appear that there should be more extensive use of joint efforts in higher cost technology developments and in technology demonstrations. The research activities accomplished by the Navy are not centralized under a single command as illustrated in the following:

  Assistant Secretary of Navy Research, Engineering and Systems:
  - –Director RDT&E
  - —Director of Navy Laboratories
  - —Chief of Naval Research
  - —Chief of Naval Development
  - –Deputy Chief of Staff Marine Corps RD&S

  Chief of Naval Operations:
  - —Director RDT&E

  Chief of Naval Material:
  - —Deputy Chief of Naval Material (Laboratories)
  - —Deputy Chief of Naval Material (Technology)

  This highly fragmented R&D organizational structure when coupled with the R&D activities accomplished under the Under Secretary of Defense Research and Engineering would not appear to result in effective and efficient utilization of the R&D dollars. Some effort **may** be made to simplify the organization and consolidate the R&D program. A major detriment to R&D effectiveness is the slow pace at which new technology is introduced. A major reason for this is the absence of R&D platforms (ships, submarines) on which to demonstrate this technology in an operational environment as is done in aerospace programs.
- Clarify Jones Act to include icebreaking and ice management in the OCS as an absolute requirement of the U.S.-flag built and manned vessels.

3. **Question #13—Would you advocate increasing direct Federal expenditures on maritime R&D? If so, please indicate through which Federal agency or program.**

Operators

- No, I would recommend curtailing such programs, particularly those of the Maritime Administration.
- Through universities—we have best interface there.
- No, if this means an all government-controlled activity. Yes, if it means channeled through government agencies and including nongovernment participants.
- Yes. Maritime Administration.
- Yes, through Maritime Administration support of educational and pure research institutions, not through industry.

- All expenditures on maritime R&D should be beneficial and should be administered through the U.S. Department of Transportation.
- Yes. MarAd.
- Yes, increasing Federal expenditures on maritime R&D would be helpful. Again, selection of the proper agency could be based on experience of R&D administration such as MarAd.
- Yes—The Maritime Administration Fleet Management Technology Research and Development Program.
- Increased Federal support might be useful if industry participated in selection and administration of projects.
- As presently constituted now. Again we can only comment with respect to the American flag passenger industry. The most important Federal policy or incentive change which could affect the passenger ship industry, would be a recognition that the present body of law governing passenger vessels was written and devised at the time when the purpose of passenger vessels was to transport somebody from point A to point B. People don't do that anymore, with the exception of small ferries. People get on passenger ships to take a vacation, not to travel from point A to point B. The laws as presently constituted place a great handicap on American operators. A proper body of law recognizing that the passenger business has changed from transportation to vacation industry could perhaps promote the American industry more than any other single change. As you can see, the classification questions indicate that the survey is designed for other than a passenger operation and we again caution you against using the results incorporating our percentage results and our responses into your main survey.
- Yes. Navy and MarAd.
- Yes—through a program of funding research by academic institutions.

Shipyards

Yes, but with some modifications: a) The current Manufacturing Technology program is an excellent vehicle if modified to reduce funding time from proposal to contract award and to expand its **definition to include total manufacturing** systems in addition to production machinery and supporting systems. b) Recognize the National Shipbuilding Research Program, which has momentum and is successful (described in a **1976** Rand Corporation report as being one of the five most effective government-funded research programs in terms of development and implementation achieved), as a de facto research consortium that should be continued and supported with increased funding.

- Yes, Maritime Administration and U.S. Navy via the National Shipbuilding Research Programs which have done a lot to educate all levels of shipyard people. Keep them talking as to how to be more competitive. This program has sharpened up. A lot of shipbuilders and I believe the Navy has benefited most as they are currently the ones having ships built in U.S. shipyards.
- Yes, by increasing Navy, MSC, and USCG design/construction programs; fund through MarAd for conversion of steam turbine vessels to diesel.
- Yes, MarAd.
- Yes, U.S. Navy.
- Current funding levels are adequate but should be used and appropriated in a more timely efficient manner.
- Yes: 1) Navy ManTech Program; **2)** MarAd NSRP; 3) Combine the above.
- Yes—MarAd ship production committee panels.
- Only as necessary to recover/maintain parity with competing modes of transportation.
- The Federal funding of maritime R&D should be increased at least to the extent necessary to permit the funding of demonstration projects to expedite the introduction of new technology. This could best be done through a Navy program.
- MarAd.
- Yes, MarAd.
- Yes, through the U.S. Navy. With regard to items 12 and 13, we believe Federal expenditures on maritime R&D should be increased, and more importantly, this funding of private industry should be administered through one agency, specifically an agency of the U.S. Navy, This would have the effect of eliminating redundancy and improving the overall effectiveness of the Federal research dollar.
- Yes. Through a Maritime Administration, firmly instructed and dedicated to a new maritime policy to maintain a viable shipbuilding industry. Present policies are leading to the rapid demise of commercial shipbuilding and no research can be effective or stem that tide without a change in policy.
- Not particularly, all published R&D in the United States is readily available to foreign competitors. There is very little way of the U.S. maritime industry taking exclusive advantage of this R&D.
- Strongly advocate Government financial support of existing industry-wide R&D efforts conducted by SNAME ship production committee.
- No, use tax incentives for privately funded R&D programs.
- Focus entire research budget on labor productivi-

ty—skills assessment and training, production planning and organization, productivity measurement and control.

4. **Question #14—In addition to the R&D options suggested on questions 10-13, and in light of the recent phase-out of Federal construction and operating subsidies, can you suggest other Federal maritime incentives that might help revitalize the industry? Which of these, if any, would be significantly more beneficial than R&D incentives?**

Operators

- Stop changing laws and regulations. Apply cargo preference. Prevent CDS payback. Halt the export and re-import of petroleum products.
- Cargo preference.
- Significant tax incentives for investment in vessels. Greater freedom to purchase abroad where U.S. suppliers are not competitive. Particularly critical in making slow-speed diesel equipment available.
- Let's form a real export selling team for our bulk commodities (grain and coal in particular, but also timber products, finished steel, containers, etc.) with a focus on barters and exchanges.
- Avocation of foreign technological advances to be incorporated in U.S. hull construction.
- In my opinion, the U.S. Government needs some good basic *Maritime Shipper* input for the entire business. Most input today comes from the Maritime Unions and ship operators. How about doing a study of shippers (those who pay the bills)? Some research on what shippers really want and need could be worthwhile. Most people in the business today know what can and cannot be accomplished in ship construction and overhaul areas. The limitations and restraints are the laws and regulations limiting the flexibility of using foreign equipment and facilities. U.S. shippers cannot continue to compete in the world market place using U.S. equipment and U.S. crews.
- Permit "Jones Act" Coastwise shipowners to build abroad without restriction.
- Consider U.S. Government review of the current impact on operating costs of U.S. union pension fund cost / unfunded liability. Union membership crew significantly as a result of U.S. Government requirements for supply capability connected with the Korean / Viet Nam conflicts result being that today and in foreseeable future a "declining" industry is saddled with an excess of manpower.
- Greater proportion of U.S. generated cargoes reserved for U.S. flag (cargo preference) with competition *among* carriers for the cargo, and subsidy if necessary to the shipper so that he does not suffer competitive disadvantage.
- No. Federal maritime incentives would currently "revitalize" the tanker industry which is experiencing a long sustained recession.
- An increase of monies for wharfage improvement and less trade route regulations would be areas that could be looked into. The areas that reduce port time would be more beneficial than R&D incentives, at least for the near outlook.
- Development of a positive Federal Maritime Policy.
- Income tax exemptions for the merchant marine while abroad.
- Non-union labor. MarAd—increase their budget.
- Improve direct tax credit(s) deductions to encourage expansion.
- Direct orders, under Defense appropriations, for ships designed to meet Defense requirements. Development of joint effort by shipyards and shipowners and U.S. Government of realistic national program (based only on need) to support and maintain required national shipbuilding ban. (Both would be more beneficial than R&D incentives.)
- Elimination of Federal Duty (50 percent) on foreign replacement and repairs on vessels. Also, provide greater operational flexibility for deployment of fleet.

Shipyards

- **a) Recognition of the U.S. commercial fleet as the "Merchant Navy" with formal integration into the defense plan. b) Identify the required geographically dispersed mobilization base needed to support the combatant and merchant navies and devise an effective allocation system for construction and repair of both merchant and combatant ships. c) Establish a cargo preference act with modernization incentive similar** to the DOD Industrial Modernization Incentives Program (IMIP) as an integral part of those shipyards identified and allocated in part b). d) Establish a program of Government aid for U.S. shipyards to secure construction work of any kind, contingent upon their being part of the mobilization base and which are demonstrably adopting analytical means for constantly improving their manufacturing systems. e) A modified version of the DOD Industrial Modernization Incentives Program (IMIP which would permit shipyards without significant

major *Navy* ship construction contracts to participate (e.g., average annual Navy ship overhauls, etc.).

- We build ships usually too small to get involved in subsidies. The tuna vessels had no help. Tuna people did well up until the market fell apart two years ago. The Naval vessels and tugs and ferries also get no outside help so we can't really comment.
- Reinstate ODS / CDS. Limit small business set aside. Preference Act percentage of American cargoes carried by American bottoms. Ad Valorum Tax.
- There are two areas where the Federal Government might have an appropriate role in revitalizing the maritime industry: 1) adopting a Federal policy which implements a contingency strategy to be followed in case of conventional war, i.e., guaranteed maintenance of shipbuilding facilities; and 2) incentives, laws, etc., which increase the volume and profits of U.S. ship and barge owners (effectively creating an investment "fund").
- Enact cargo preference legislation. Reserve to U.S. built, U.S. flag all temporary and permanent marine construction, including vessels, rigs, stationary and underwater construction, involved in the exploration, development, and production of nonliving resources with the U.S. 200-mile Exclusive Economic Zone. Preserve the Jones Act. These three measures involve no direct Federal expenditures and would have a far greater benefit than any R&D incentives in revitalizing the industry and preserving a viable industrial base for national defense.
- The largest help would be in low-cost, long-term credit facilities. the two major ship costs are interest and fuel; interest is the greater of the two.
- A Federal assurance of adequate cargoes for U. S.-flag and U.S.-built ship owners is the only means of ensuring a large, stable, and continuing demand for new building from the U.S. shipbuilding industry. Sufficient demand and stability of demand will itself enable private industry to invest sufficient funds in R&D or new capital equipment to significantly improve efficiency and match foreign shipbuilder's productivity levels.
- Tax incentives for shipping U.S. goods on U.S. bottoms. Tax incentives for foreign imports shipped on U.S. bottoms.
- Bring more ships under U.S. flag by making it an economic advantage to do so.
- No, R&D incentives outlined should be adequate.
- A shipbuilding subsidy which provides incentives for increases in productivity.
- 1) A Title VII shipbuilding program. 2) Shift of emphasis in naval shipbuilding from combatant to auxiliaries and sealift. 3) Bulk and neobulk cargo preference. 4) Tax credits for shipbuilders, shipowners, ship operators, and shippers. 5) Extention of Jones Act and closing of loopholes. *6)* 100 percent cargo preference for government-impelled cargoes.*7)* Etc., etc.
- Maintenance of inland waterways, removing obstructions to navigation. Funding for facilities and equipment to maintain minimum mobilization capability.
- The greatest incentive for revitalizing the U.S. Merchant Marine is a program which makes oceangoing cargoes available to U.S.-flag ships. Because of the prevalence of foreign government supports for the national maritime fleets, a "free trade" environment has not existed for many years, and U.S.-flag carriage of U.S. export and import cargoes has decreased to less than 4 percent. Because of this unhealthy market environment, many ship owning / operating and shipbuilding companies are unprofitable. This lack of profit, together with the low level of cargo carried, results in virtually no tax revenues derived by the Federal Government from this industry. The U.S. is in danger of being held hostage for the carriage of cargoes not only to support the national economy, but also to support one or several major military contingents involved in sustained operations in overseas trouble spots. The realistic solution to this potentially dangerous situation is to develop and implement a national program which reserves a reasonable amount of U.S. import and export cargo for carriage in U.S.-built, U.S.-crewed, U.S.-flag merchant vessels having defense utility. Without government support, the freight rates required to be charged by the owners / operators of these vessels will be much higher than rates charged by foreign ships. This will make U.S. exporters less competitive in world markets, and will increase the consumer cost of imports. To offset the higher costs of suing U.S. ships, tax credits should be allowed. These tax credits should not go to the shipbuilder or the ship operator, but to the companies that use the U.S. ships to haul their cargoes. The Competitive Shipping and Shipbuilding Act, as redrafted by Congressman Herb Bateman of Virginia, does all of the above. The passage of this bill would result in the construction of an overage of **20** ships a year for 1.5 years. The bill requires that shipbuilding and ship operating costs for a 10-ship series in any single

yard to be reduced by 20 percent from the current level for a one-ship project. If the bill is passed and signed into law, and if the 20 percent cost reduction is achieved, the resulting long-term program would establish a stable market for the commercial part of the maritime industry. Such a stable market environment invariably creates a strong incentive for R&D as more efficient building and operating methods are sought. Program costs to the Federal Government would be nil, and the total tax credits would be about **$800** million per year. This $800 million in tax credits would not be a revenue reduction to the Federal Treasury. For, without the tax credits there will be no market.

- Clarify Jones Act to include icebreaking and ice management in the OCS as an absolute requirement of U.S.-flag built and manned vehicles.
- Accelerate the decisionmaking process at MarAd.

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