Ocean Engineering Programs in the National Oceanic and Atmospheric Administration

March 31, 1980

U. S. DEPARTMENT OF COMMERCE
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Philip M. Klutznick, Secretary

National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator

I. INTRODUCTION

This report has been prepared in response to a letter of May 30, 1978, from the late Congressman John M. Slack, former Chairman of the Subcommittee on State, Justice, Commerce, the Judiciary and Related Agencies of the House Appropriations Committee, which requested the Department of Commerce (DOC) to respond to the following question:

> What are the NOAA plans for improving the engineering support for the NOAA science missions?

NOAA currently spends over $20 million per year and devotes about 154 full time personnel to ocean engineering activities. Although these activities take place in five NOAA units, the major responsibility for ocean engineering is delegated to two Major Program Elements, the Office of Ocean Engineering and the Office of Marine Technology. Ocean engineering activities in NOAA range from investigations of airborne and surface remote sensing techniques to detect fish stocks, to installation of oceanographic, charting and research instrumentation, and maintenance of software for survey and map processing techniques. Most of the current ocean engineering work conducted in NOAA is in the form of engineering

development and basic engineering support to NOAA's science mission. Little work is done on research and development for advancing general ocean technologies.

There are indications that available resources could be used in a more effective manner. NOAA's current organization is the product of a series of reorganizations that have not been accompanied by a full redefinition of internal roles and responsibilities. As a result, there has not been a clear division of roles between the Office of Ocean Engineering and the Office of Marine Technology. Ocean engineering activities have also lacked integrated budgeting and long-term planning.

Upon publication of the Stratton Commission Report in 1969, many in the ocean community believed a new Federal government fundamental technology program was needed to advance ocean engineering. However, in the ten years since, no consensus has developed within the Federal government as to appropriate roles of government and private industry in the advancement of civilian marine engineering and technolgy. This lack of consensus about an appropriate federal role has resulted in a lack of support both in the Executive Branch and Congress for a national fundamental technology program such as that recommended by the Stratton Commission.

In order to define a clear and realistic mission for its ocean engineering activities, NOAA made the policy decision to adopt an ocean engineering role that will stress support of NOAA missions. Although NOAA will continue to examine the need for the creation of a broad national civilian ocean engineering program, its current ocean engineering efforts must remain focussed on its statutory responsibilities. It will continue basic support activities directly connected with its own missions, and will evaluate appropriate authorities and resource requirements to conduct engineering development activities that relate to other national objectives only in a limited number of carefully selected areas.

NOAA is proposing organizational changes designed to implement this policy decision because the existing organizational framework is not designed to address systematically all of NOAA's ocean engineering needs. The proposal includes the establishment of a new Major Program Element (MPE) in the Office of Oceanic and Atmospheric Services to provide ocean engineering and development services to all NOAA Main Line Components. The new MPE, when approved, will assume through transfer the functions of the Office of Ocean Engineering and the Office of Marine Technology. In addition, an Ocean Engineering and Technology Council to provide oversight for all NOAA ocean engineering activities will be established. Integrated planning and budgeting for all ocean engineering activities will be provided. The reorganized ocean engineering program will further assess the adequacy of

engineering support in NOAA and will develop long-range plans. In this manner, NOAA will continue to analyze the reliability and quality of its ocean engineering activities.

This report outlines the new direction in NOAA's ocean engineering activities. It is based on the work of a NOAA task force headed by Deputy Administrator James P. Walsh which reviewed NOAA's current ocean engineering activities, and incorporates material from a Department of Commerce internal working document, "An Evaluation of NOAA's Engineering Support Capability". The report summarizes and evaluates current ocean engineering activities, discusses the recent policy decision to focus on support to NOAA's missions, and describes NOAA's planned organizational response to the new ocean engineering policy.

II. CURRENT OCEAN ENGINEERING ACTIVITIES IN NOAA

"Ocean engineering" has not yet been defined with the same degree of precision or acceptability as other engineering disciplines. Opinions vary as to whether ocean engineering should be defined as a "discipline" at all, or if it is simply the application of all other recognized engineering disciplines to ocean activities.

In a broad sense, most of NOAA's marine activities involve ocean engineering. For example, surveying and mapping is a field of civil engineering aimed at enhancing the utilization of the ocean. In 1972, the National Academy of Engineering stated: "Central to our nation's advancement in marine affairs is a systematic review of our marine resources and the means available to extract, preserve, manage, expand, and enhance them for the maximum long term benefit to all our citizens - a process that is the basis of engineering in its broadest professional sense: the utilization of resources and the development of equipment and systems for the advancement of the quality of life."

As the term "ocean engineering" has been used in public debates over the last decade regarding the appropriate role of the Federal government, however, it refers to a narrower spectrum of engineering functions, ranging in size and complexity from simple small-scale repair and maintenance activities to design and construction of large ships, offshore structures or artificial islands.

This review of NOAA's ocean engineering activities uses the following descriptions of three broad categories of ocean engineering activities:

1. Basic engineering support. Basic engineering support is simple day-to-day repair, maintenance and minor modification of oceanographic instruments and systems. This type of activity provides the scientist or data gatherer with instruments and systems that work, and includes assistance concerning availability of systems to make desired measurements and advice on the expected quality of the data observed. This support is normally considered a function of operational units and, in most cases, is provided at the field level by both technicians and engineers.

2. Engineering development. Engineering development covers the span of engineering activities between basic research and the operational use of new equipment and systems. It includes applied research, prototype or pilot model development, and demonstration of new capabilities. This type of activity provides the scientist

with new systems or techniques for acquiring information, or with the equipment or systems required to meet new responsibilities. The Marine Board of the National Academy of Engineering, in a forthcoming report on ocean engineering, terms these kinds of activities "product improvement" and "new product development." Applied to NOAA, engineering development activities would include matters such as development of laser technology for hydrographic measurements, development of long-range underwater acoustics for determining fish species, and development of new instruments and systems for long-term monitoring of the ocean environment.

3. Research and development for advancing technology.

This area is similar to engineering development in the sense that it covers the entire range of activities from basic research through operational systems. It differs because the primary emphasis is on advancing technology in general rather than focusing on specific engineering applications to meet existing or new responsibilities. This kind of work is often characterized as least likely to be duplicated in the private sector, either because it lacks immediate foreseeable application or involves high risks for which there may be little immediate payoff. Examples are development of methods of acoustic control of underwater vehicles, investigation of the properties of the seafloor and of metals in the marine environment, and development of portable underwater power supplies.

For purposes of this report, NOAA's ocean engineering activities are described on a functional basis. NOAA currently spends over $20 million per year and devotes about 150 full time personnel (FTP), including about 90 engineers, to ocean engineering activities in its Offices of Research and Development (RD), Fisheries (F), and Oceanic and Atmospheric Services (OA). The monetary and personnel resources of the various activities are shown in Table 1. A description of other federal and private ocean engineering and development activities is included as an Appendix.

According to the Department of Commerce working document, in FY 1978 NOAA's professional and technical staff could be classified in the following occupational categories:

- Scientists - 4,544 (32.5% of total NOAA employees)
- Engineers - 341 (2.4%)
- Science Technicians - 3,106 (21.6%)
- Engineering Technicians -1,056 (7.5%)

There are an additional 122 NOAA Corps officers with engineering degrees. This distribution has remained similar through FY 1980.

Table I

Unit	Current FTP Personnel	FY 1980 Engineering Budget
RD-Office of Ocean Engineering	26 engineers	$13.5 million
RD-Sea Grant	--	$ 3.2 million
F-National Fisheries Eng. Lab	4 engineers	$ 0.8 million
OA-Office of Marine Technology	46 engineers 22 technicians	$ 2.2 million
OA-Atlantic & Pacific Marine Centers	13 engineers 41 technicians	$ 1.0 million
Total	152 engineers and technicians	$20.7 million

The five units in NOAA which undertake major efforts in ocean engineering are:

1. RD - Office of Ocean Engineering

The Office of Ocean Engineering (OOE) was formed in 1976 by combining three existing NOAA programs -- the NOAA Data Buoy Office (NDBO), a portion of the National Ocean Instrumentation Center (then a part of the Office of Marine Technology), and the Manned Undersea Science and Technology Office (MUS&T). In FY 1980 OOE has a total of 68 FTP and a budget of $13,484,000. In addition, the office has 15 U.S. Coast Guard and 4 IPA personnel assigned to it, and uses 57 employee-years of support contractor services annually.

OOE has been assigned three basic functions:

- To exercise functional review over and recommend policy and plans for all of NOAA's ocean engineering and instrumentation programs;
- To conduct an integrated program of research, technology development, and services related to ocean engineering and undersea operations;
- To serve as a national focal point for knowledge related to civil ocean engineering, a catalyst for industrial ocean development, and a mechanism for technology transfer from the military and space fields.

OOE's activities can be broken down into the three categories of ocean engineering as follows:

	Personnel	Funding ($000)
Basic Engineering Support	4 (plus 5 USCG)	4,233
Engineering Development	21 (plus 5 USCG)	4,148
R&D for Advancing Technology	14 (plus 4 IPA)	2,861
Total	39	11,242

The remaining OOE personnel and funding resources are devoted to management, administration, and support services (e.g. facilities) activities, with involvement in all three of the ocean engineering categories. These activities account for 29 personnel (plus 5 USCG) and $2.28 million.

2. RD-Sea Grant

The Sea Grant Program is not a primary ocean engineering organizational component; however, some of its activities fit in the category of research and development for advancing ocean technologies. The portion of the FY 1980 Sea Grant budget identified with ocean engineering research and development is about $3.2 million.

3. F-National Fisheries Engineering Laboratory

Overall technology coordination responsibility for the National Marine Fisheries Service (NMFS) is assigned to the Office of Science and Environment in NMFS headquarters. The formal "fishery engineering" effort in NMFS is found primarily in the National Fisheries Engineering Laboratory (NFEL) in Bay St. Louis, Mississippi.

NFEL has the responsibility for monitoring and applying technological advancements, developing new methods, and increasing the accuracy and efficiency of old methods for assessment and utilization of living marine resources. This responsibility is implemented through the development of sampling, monitoring and tracking systems to increase data return, coverage and accuracy; and the development of data management systems and techniques for efficient data storage, retrieval, display and analysis. Current activities include: (1) satellite investigations to use measurable oceanographic parameters to predict distribution and abundance of fish species; (2) investigations of airborne, surface and subsurface remote sensing techniques to detect, identify and quantify fish stocks; (3) development of sampling and analysis systems; (4) development of data systems capable of assimilating, integrating, analyzing and displaying vast amounts of information; and (5) program planning and analysis.

In addition to this formal organizational aggregation of engineering responsibility, engineering support and minor engineering development functions are conducted throughout NMFS. Each regional fisheries center has its own engineering programs. Engineering support is also performed by technicians at the various NMFS labs and by scientists who maintain and modify their own equipment.

NFEL has 13 personnel engaged in the current activities described above. FY 1980 funding, for personnel salaries and support costs only, is $546,200. Funding to undertake specific projects is transferred to NFEL on a case-by-case basis from both NMFS and non-NMFS activities. For FY 1980, total project funds of $350,000-$400,000 are expected.

The total NMFS ocean engineering effort for FY 1980, including engineering development programs is $1.6 million and 29 person years.

4. OA-Office of Marine Technology

The Office of Marine Technology (OMT) was created within the National Ocean Survey (NOS), in 1971 and charged in part with providing NOAA with marine systems, including data buoy development and some ocean instrumentation development. When the data buoy and certain instrumentation development functions

were removed to help form OOE in 1976, OMT continued in existence with an informal understanding that its functions would be limited to support of NOS missions, but there was no formal change in its broad ocean engineering mission.

OMT acts as the focal point for NOAA technology in the development testing, evaluation, and calibration of ocean sensing systems. It enhances the quality of these systems by disseminating operational results and technical information to the national oceanographic community.

OMT has three primary organizational components: the Engineering Development Laboratory (EDL); the Systems Analysis Division (SAD); and the Test and Evaluation Laboratory (T&EL). In FY 1980 OMT consists of 89 personnel and has a budget of $2,206,000.

OMT activities, in terms of the three categories of ocean engineering, can be broken down as follows:

	Personnel	Funding ($000)
Basic Engineering Support	10	225
Engineering Development	36	1,332
R&D for Advancing Technology-EDL	2	20
Total	48	1,577

The remaining OMT personnel and funding resources, 41 personnel and $629,000, fall in the management, administration, and support services categories.

5. OA-Atlantic and Pacific Marine Centers (AMC and PMC)

The Atlantic and Pacific Marine Centers each have a Marine Engineering Division and an Electronics Engineering Division supporting the NOAA Atlantic and Pacific fleets. AMC and PMC also have a secondary mission of providing "technical support for...other assigned field data acquisition, transmission, processing, recording, and general electric equipment used for land, sea, and air investigations."

The personnel (13 engineers and 41 technicians) and funding (approximately $1 million annually) resources are devoted to activities in the "basic engineering support" category such as management of vessel repairs and modifications, installation of oceanograhic, charting, and research instrumentation, equipment and systems, and maintaining software for survey and map processing techniques.

To summarize NOAA's activities in terms of the three categories of ocean engineering, it is evident that most of the ocean engineering work currently done in NOAA falls in the engineering support and engineering development categories.

Basic engineering support work in NOAA is conducted primarily in the field, at locations such as the Atlantic and Pacific Marine Centers, the four Fisheries Centers, and at various laboratories. Some centralized engineering support projects are carried out by OMT (for NOS operations) and by OOE in direct support of buoy operations.

Ocean engineering development efforts in NOAA are conducted primarily in NOS (OMT), in the Fisheries Engineering Lab and at the Fisheries Centers, and in OOE. OOE's 1977 Report on NOAA's Ocean Engineering Baseline study identified nearly 79 separate development projects throughout NOAA in FY 1977. They varied from specific applications (such as design of new shrimp trawl equipment and techniques or bathymetric swath sonar development) to general applications of new technologies (such as acoustic fish stock assessments and underway sampling systems). Although much of this work is done in-house, the majority is contracted to industrial companies, universities, and the laboratories of other government agencies.

Research and development for advancing ocean technologies is currently a small part of the total NOAA ocean engineering effort. Some Sea Grant Program activities would fit in this category: design of manipulators for manned and unmanned underwater vehicles and underwater welding and cutting techniques at MIT; materials research at Florida Atlantic University, MIT, and LSU; and seafloor sampling techniques at Texas A&M, and Oregon State University. Other activities are of a "special project" nature, such as the Ocean Thermal Energy Conversion (OTEC) work for the Department of Energy and NOAA's undersea research program.

III. EVALUATION OF CURRENT OCEAN ENGINEERING ACTIVITIES

There are indications that NOAA's present ocean engineering structure does not utilize existing resources as effectively as possible. For a variety of reasons, the existing organizational components have not always been able to fulfill their stated missions. Consequently, improvements need to be made to the organization of the ocean engineering programs.

NOAA's current ocean engineering organization is the product of a series of reorganizations that have not been accompanied by a full redefinition of internal roles and responsibilities. The Stratton Commission's 1969 recommendation for the creation of a new federal "fundamental technology" program resulted in the creation of the Office of Marine Technology (OMT) within NOS in 1971, charged in part with providing NOAA with marine systems. However, rather than assuming a broad national role, OMT instead provided data buoy engineering, some ocean instrumentation work, and engineering development for NOS. The Office of Ocean Engineering (OOE), reporting directly to the Administrator, was formed in 1976 by combining three existing units with a stated mission of performing broader ocean engineering functions. OMT continued in existence without any formal

change in its equally broad statement of ocean engineering mission, but with an informal understanding that its functions would be limited to support of NOS missions, primarily of a near-term nature.

OOE has not assumed the broad role envisioned for it at the time of its creation. OOE was to review functionally all of NOAA's ocean engineering and instrumentation programs. However, it does not have clear authority with respect to engineering programs in other NOAA elements, and suffers from a lack of clear division from OMT. In addition, it does not have the legislative authority to concentrate on advancing ocean technology.

As a result, OOE's activities have continued to reflect the variety of initial elements from which it was assembled, rather than the "fundamental technology" activities envisioned by the Stratton Commission or the engineering oversight program envisioned at its creation. Because the buoy programs and manned undersea activities were established and recognized programs with some legislative support, adequate resources to carry them out have been justified and received. Specialized instrument activities tailored to NOAA programs were received in FY 1980 ($300,000) and are proposed in FY 1981 ($900,000).

The failure to accompany past internal ocean engineering reorganizations with a full redefinition of roles and responsiblities within NOAA has resulted in misunderstandings and disagreements at all levels in NOAA and confusion outside of NOAA. This confusion about organizational roles has created communications difficulties, lack of understanding of organizational goals and of the reasons for success and failure of budget initiatives, and attendant feelings of isolation at lower levels in the organization. In light of these problems, NOAA is proposing a new direction for ocean engineering implemented through the reorganization of existing programs.

IV. PROPOSED CHANGES IN OCEAN ENGINEERING PROGRAMS

A. Recent NOAA Ocean Engineering Policy Decision

On November 15, 1979, NOAA Administrator Richard A. Frank announced the policy decision to adopt an ocean engineering role that will stress support of NOAA missions in order to strengthen NOAA's ocean engineering activities and correct existing problems. The policy decision can be summarized in these major points:

- NOAA will continue the basic engineering support and engineering development activities necessary to maintain and improve NOAA's capability to provide products and services directly connected with its own missions, including development of advanced technologies where required.

- NOAA will attempt to obtain appropriate authorities, funding and personnel to conduct engineering development activities in a limited number of areas, carefully selected by its senior management and approved by DOC and the Administration, that relate to other national objectives. In this regard, NOAA will continue to engage in ocean engineering development work for other Federal agencies where it is consistent with NOAA's overall plans and would strengthen NOAA expertise, and where sufficient financial reimbursement and personnel ceilings are made available for NOAA to do so.

- o NOAA's ocean engineering efforts, while stressing NOAA mission support, will continue to evaluate the need and support for an expanded Federal role in ocean engineering.

The policy decision is based on the consideration of two factors: recent public expressions of concern about NOAA ocean engineering activities; and a lack of consensus within the federal government about the role government should play in ocean engineering.

1. Public Expressions of Concern about NOAA's Ocean Engineering Activities

NOAA's ocean engineering activities have been the subject of a series of studies and reviews over the last decade. After completing its internal review and evaluating the information compiled in the DOC working document, NOAA concluded that a number of the concerns expressed about its programs were valid and could begin to be remedied through administrative means.

Public interest in federal civilian ocean engineering and technology development had its early beginnings in the 1969 report of the Stratton Commission, Our Nation and the Sea.

The Commission urged the Federal government to "initiate a dynamic and comprehensive fundamental technology program" in order to advance marine technology and to house this program in the newly-created NOAA. Public interest in ocean engineering has continued, fueled by the publicity that attended the establishment of the Office of Ocean Engineering. Recently, several additional advisory reports have been published or proposed:

- The 1978 Department of Commerce (DOC) Ocean Policy Study covered ocean engineering in the Federal Government in general, and noted the lack of a central Federal civilian focus.

- The DOC working document reviewed the size and distribution of NOAA staff with engineering backgrounds and analyzed current activities, recommending several general steps that might be taken to improve NOAA's engineering support.

- The Marine Board of the National Academy of Engineering is preparing a study of the role of ocean engineering in NOAA and the broader Federal role. In its deliberations, the study panel concluded that the kind of "fundamental technology" role envisioned by the Stratton Commission is still needed and has not yet been accomplished within NOAA.

- NACOA has proposed a study of the Federal and private roles in ocean engineering.

- The Committee on Atmosphere and Oceans is surveying current Federal ocean engineering capabilities and assessing the advantages of increased interagency coordination in the area.

- The Office of Technology Assessment recently initiated a study of the future needs for platforms to conduct oceanographic research and of new platform technologies.

Several major areas of concern have emerged in the public commentary. First, there is concern about the absence of a lead federal civilian ocean engineering agency. Several groups perceive the potential for an important federal role in research and development for advancing technology. They are disappointed that the role has not materialized within NOAA.

Second, a lack of adequate funds and personnel within NOAA has been cited both by those commentators who perceive NOAA's role as covering the entire spectrum of ocean engineering activities, and by those with a narrower focus on the basic engineering support and development requirements of NOAA's current programs.

Finally, reviewers also have noted deficiencies in the existing organization of engineering activities in NOAA, which NOAA's review and the DOC working document have confirmed.

2. Lack of Consensus about the Federal Role in Ocean Engineering

Despite the long-standing interest of the ocean community, no consensus has developed within the federal government as to the appropriate roles of government and private industry in the advancement of civilian marine engineering and technology. The expansion of the offshore oil and gas industry and the plans of the ocean mining industry have demonstrated the ability and willingness of private enterprise to advance ocean technology where a profit potential exists. Consequently, the wisdom of federal expenditures on some technology such as nuclear power plants on the continental shelf or large ocean platforms, as the Stratton Commision recommended, is being questioned. This lack of consensus about an appropriate role translates into lack of adequate support both in the Executive Branch and Congress for a program such as that suggested by the Stratton Commission. Historically NOAA has had little success in funding engineering programs that are not directly related to NOAA's statutory missions. Until a consensus is reached, NOAA has determined that its ocean engineering efforts should be primarily directed to carrying out effectively its missions.

In light of these factors, NOAA will concentrate on improving its own mission - related ocean engineering programs. However, in other limited cases NOAA will seek support for programs of applied research, prototype or pilot model development, and demonstration of ocean engineering products that relate to other agreed Federal objectives. In proposing such areas, NOAA will consider several factors: whether the area coincides with existing agency technical strengths; whether the work duplicates other agencies' programs; and whether it would compete with private industry. NOAA will work closely with other agencies in their ocean technology efforts, where financial reimbursement and personnel availability allow it to do so.

B. Organizational Response to the Ocean Engineering Policy Decision

The policy decision on the focus of NOAA's ocean engineering activities has organizational implications. Based on the evaluation of current ocean engineering activities, it is evident that the existing organizational structure will not adequately serve the re-directed ocean engineering effort, and that new structures are needed. Although any reorganization will have some negative impacts on affected NOAA elements, the benefits of some further program centralization will outweigh the costs. Integrated ocean engineering planning and budgeting will be required as well.

After a review of various organizational alternatives, a reorganization plan and recommendations aimed at strengthening NOAA's ocean engineering activities have been proposed. Specific recommendations are now being prepared for the approval of the Secretary of Commerce.

The recommendations include:

- The Establishment of a new Major Program Element (MPE) in the Office of Oceanic and Atmospheric Services to provide ocean engineering and development services to all NOAA Main Line Components. The new MPE would also be responsible for planning and budget integration for all NOAA ocean engineering activities, including the development of a long-range ocean engineering program to achieve NOAA priority needs and the evaluation of the reliability and quality of information gathering systems.
- The new MPE would assume, through transfer, the functions of the Research and Development Office of Ocean Engineering (other than those functions which are research-oriented), and the functions of the Office of Marine Technology of the National Ocean Survey.
- The establishment of an Ocean Engineering and Technology Council, to provide oversight for all NOAA ocean engineering activities, to review the long-range ocean engineering program developed by the new MPE, and to establish NOAA priority needs.

With the concurrence of the Secretary of Commerce, OMB, and the Congress, these changes will be implemented as soon as possible. The new MPE, if approved, would initially consist of up to 160 personnel and an annual budget of approximately $12 million from existing resources.

V. CONCLUSION

The proposed changes in NOAA's ocean engineering activities, if approved, will strengthen NOAA's mission-related ocean engineering programs by consolidating resources from two ocean offices which had similar functions and programs, and by establishing a formal planning and budgeting process. These changes will improve engineering support for NOAA's science missions, and will provide a basis for implementation of programs with broad national objectives if such a Federal role is established.

APPENDIX

OCEAN ENGINEERING IN OTHER FEDERAL AGENCIES AND THE PRIVATE SECTOR

The two major organizations involved in ocean engineering activities (other than simple support engineering) are the U.S. Navy and the oil industry. In their recent plan for the study of the Federal role in civil ocean engineering, NACOA credits the Navy for laying "the foundation for U.S. ocean engineering and ocean technology in general," and indicates that oil and gas exploration by the private sector "led to advances in offshore technology of marine construction and operation and to the establishment of U.S. leadership in offshore technology." The Navy and the oil industry are still the major, but not the only, organizations involved.

1. Ocean Engineering in the Federal Government. The most recent compilation of information about Federal ocean engineering programs is the 1978 DOC Ocean Policy Study. The Study indicates that "Federal ocean engineering and technology programs encompass a wide gamut of activities as diverse as the missions of the sponsoring agencies." The major programs are summarized as follows:

- Department of Defense. The Navy program is the largest and most diversified, although directed to the development of weapons and systems in support of naval operations. The Navy lists 15 laboratory facilities for ocean engineering and related technology. The U.S. Army Corps of Engineers has three lab facilities directed toward improvement of coastal waterways and harbors and the protection of beaches and seashore.

- Department of Commerce. In addition to NOAA programs, the Maritime Administration has a program designed to develop advanced technology to rebuild the U.S. merchant fleet so that it can compete effectively with foreign shipping.

- Department of the Interior. The U.S. Geological Survey has substantial programs to assist its regulatory mission. R&D programs are directed toward improving technology for detecting problems in offshore oil production systems; including the development of underwater vehicles to be used for inspection.

- Department of Transportation. The U.S. Coast Guard programs in ocean engineering are primarily in the areas of search and rescue, marine environmental protection, aids to navigation, and regulating the construction and operation of deepwater ports.

- Department of Energy. DOE's ocean engineering and technology efforts are directed toward development of alternate energy systems, such as OTEC, for commercial applications. DOE also has responsibilities for disposal of radioactive waste and is conducting a long-term investigation of the feasibility of seabed disposal. Three laboratory facilities are involved in the ocean energy and nuclear waste disposal programs.

- Environmental Protection Agency. EPA programs are developing the technology necessary to determine marine water quality standards, including the development of criteria for the packaging of nuclear waste materials. Most of the EPA ocean engineering activities are accomplished by contract.

- National Aeronautics and Space Administration. NASA's "ocean applications program" engineering efforts revolve mainly around the development and use of remote sensing systems to observe ocean phenomena from aircraft and satellites. NASA has recently become involved in the development of undersea vehicles and long-term, deep ocean monitoring systems.

The last Federal Ocean Program Report, issued in 1975, indicated a total estimated FY 1976 budget for "general purpose ocean engineering" of $52 million, of which DOC programs accounted for $15.5 million.

Despite the apparent heavy activity in ocean engineering and technology development, the DOC Ocean Policy Study and NACOA have concluded that most current programs are narrowly focused and mission-oriented. As NACOA stated, "Federal support for the development of the foundations of ocean engineering and ocean technology, which traditionally had been carried out by the U.S. Navy, has declined substantially. The many Government agencies dealing with control and regulation of ocean activities undertake very restricted and often narrow research and development programs in ocean engineering and technology. These programs are in many cases marginal for their intended purposes."

2. Ocean Engineering in the Private Sector. The vast majority of ocean engineering and technology development is carried out by the oil industry or in response to oil industry requirements. Large platform design, construction, operation and maintenance activities have provided significant advances in engineering and technology. At the same time, the move further offshore has created a demand for newer technologies and engineering techniques -- site surveys for both exploratory and regulatory purposes, manned and unmanned vehicles for underwater inspection and maintenance, and safety related equipment

and techniques. Because of proprietary or patent rights, technological advances produced by industry are not always available to other industries or to scientists and engineers in government and academia.

Other "industries" in which there are ocean engineering and technology development activities are offshore mining, transportation, deep-water ports development, and aquaculture. General industrial activity has slowed, however, due to uncertanties of Federal regulations, particularly environmental protection regulations, and international negotiations such as the Law of the Sea discussions on ocean mining and the London Ocean Dumping Convention.

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