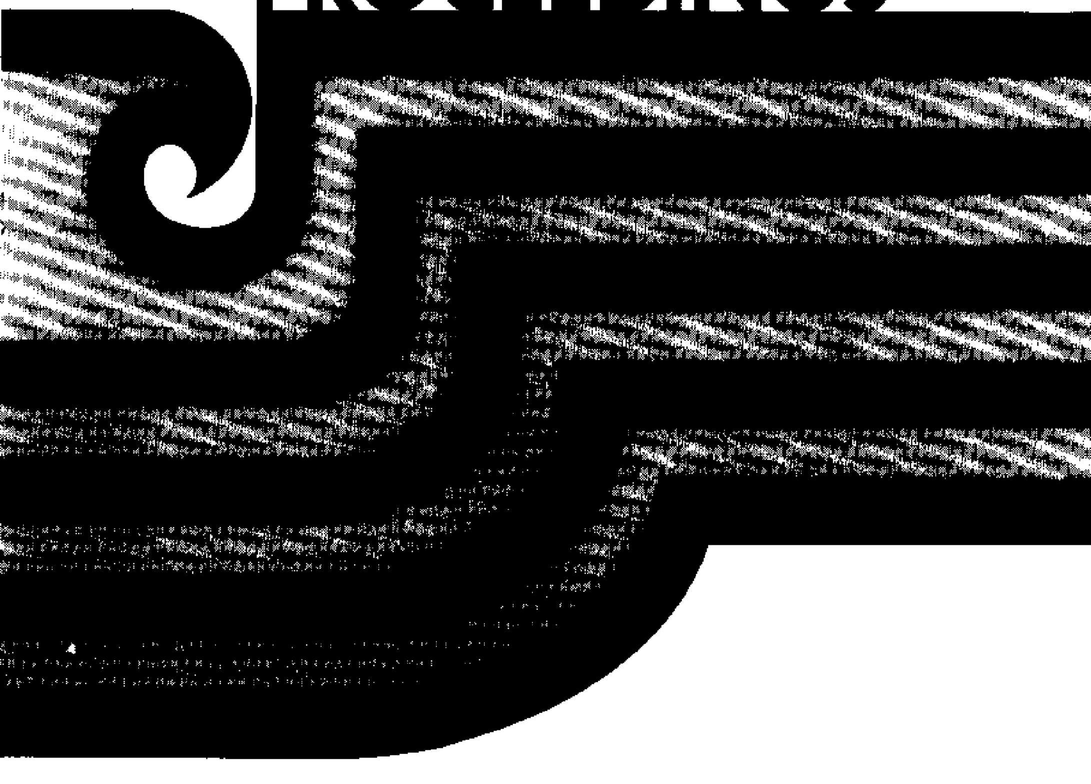
NATIONAL SEA GRANT CONFERENCE

5TH NATIONAL SEA GRANT CONFERENCE

PROCEEDINGS



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The Association of Sea Grant Program Institutions

The Association of Sea Grant Program Institutions was formed on November 19, 1970 in Washington, D.C. as an organization of colleges, universities and other institutions concerned with the broad objectives of the National Sea Grant Program.

The Association's objectives are:

1. To further the optimal development, use and conservation of marine and coastal resources (including those of the Great Lakes), and to encourage increased accomplishment and initiative in related areas.

2. To increase the effectiveness of member institutions in their work on marine and coastal resources (including those of the Great Lakes).

3. To stimulate cooperation and unity of effort among members.

Fifth National Sea Grant Conference

Hosts:	Dr. Jack K. Williams, President Texas A&M University
	Dr. John C. Calhoun, Director Texas A&M University Center for Marine Resources and Sea Grant College Program Texas A&M University
Association President:	Dr. Herbert Frolander, Director Sea Grant Program Oregon State University
General Conference Chairmen:	Willis H. Clark and Leatha F. Miloy Texas A&M University
Proceedings Editors:	Exa Ellis Kathi Jensen Len Faseler
Artist:	Donna Defenbaugh

Acknowledgements

The annual meeting of the Association of Sea Grant Program Institutions provides a forum for reviewing events and accomplishments within the program and for exchanging information on projects and planning among Sea Grant personnel and representatives of government, industry and the public. Conceived in 1970, the Association represents 51 member institutions throughout the nation, individually and collectively dedicated to the task of understanding and enhancing the wise use of the resources of our coastal regions and marine waters. This conference, actually the fifth in a series dating back to 1965 but only the second since formation of the Association, had as its theme "A Year of Achievement." Befitting the occasion was the presentation of the annual National Sea Grant Award to Dr. Athelstan Spilhaus, the "father of Sea Grant."

Texas A&M University served as host institution for the annual meeting, held at the Astroworld Hotel in Houston, Texas. Many hours of labor were devoted to planning a program to fit the theme, to the arrangement and coordination of the comprehensive set of presentations and to the administration of the three-day conference. This report is the final step in these activities. It contains the written versions of the statements presented. In a few instances, final papers were not prepared. Since no transcriptions of the oral presentations were attempted, these speakers' remarks are not included here. The open discussions that were a part of each session are also not included. Consequently the Table of Contents only reflects those speakers whose presentations were available when these proceedings went to press.

The officers and the board of the Association and the host institution express special thanks to the following session chairmen for their help in planning and conducting the conference: Jack R. Davidson, Ira Dyer, Sidney D. Upham, Willis H. Clark, Niels Rorholm, William S. Gaither, William Q. Wick, John M. Armstrong and Stanley R. Murphy.

Special appreciation is also expressed to the guest speakers: Dr. Ralph K. Huitt, Executive Director, National Association of State Universities and Land Grant Colleges; Dr. Howard W. Pollock, Deputy Administrator, National Oceanic and Atmospheric Administration; and Dr. Robert MacVicar, President, Oregon State University.

Herbert F. Frolander
President of the Association
1971-72

Presentation of the National Sea Grant College Award

Dr. Athelstan Spilhaus, "father" of the Sea Grant concept, was honored by presentation of the second National Sea Grant Award at the Sea Grant Association meeting in Houston. Urging that "the United States take steps to make a lasting commitment to the sea," Dr. Spilhaus first suggested the establishment of a Sea Grant program in 1963. The concept by the noted engineer and science writer became reality in 1966 with the passage of the National Sea Grant College and Program Act -- legislation similar to the 1862 Morrill Act that created the historic Land Grant College System.

The Sea Grant Award, an engraved silver tray and $500 honorarium, was presented to Dr. Spilhaus by 1971-72 Association President Herbert Frolander of Oregon State University.

The esteem for Dr. Spilhaus held by fellow members of the marine-associated community was demonstrated most significantly in the following congratulatory letter from the President of the United States, Richard M. Nixon.

THE WHITE HOUSE

WASHINGTON

October 5, 1972

Dear Dr. Spilhaus:

The Concept of Sea Grant Colleges which you described nearly a decade ago has resulted in the development over the past five years of one of the most productive and innovative programs in recent Federal history. Sea Grant colleges and institutions are today making a substantial contribution to solving the ecological and economic problems of the marine environment in two-thirds of our coastal states, and their programs are rapidly being extended to others.

It is most fitting that the Sea Grant Association has chosen to recognize you as the originator and continuing supporter of Sea Grant development. I join in expressing my personal admiration for you on this occasion, and my very best wishes to you for the years ahead.

Sincerely,

Richard Nixon

Dr. Athelstan Spilhaus
c/o Dr. Herbert Frolander
President, Association of Sea Grant
Program Institutions
Astroworld Hotel
Houston, Texas 77001

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The National Association: Some Facts of Life

Ralph K. Huitt
National Association of State Universities
and Land Grant Colleges

I am delighted to be here because we represent the old and the new brought together -- I am representing the Land Grant Colleges that stem from the Morrill Act of 1862 and you represent the relatively new Sea Grant Act of 1966. This is an historic confrontation, and I hope that it can lead to many good things.

We are unlike in some ways. The Land Grant College System started with a land grant to each of the states for building of a college. I do not assume that the Sea Grant Colleges have been given a grant of sea water. We are also unlike in the sense that the Land Grant Colleges were organized to provide a new kind of education. The old private schools had been frankly elitist; they trained people for teaching, preaching, law and ministry. Young people were not expected to go to college; in fact, most never went to high school. When the Land Grant Colleges were organized, it was often necessary for the college to be a state high school before it could become a state college. The University of Minnesota, for instance, was in existence eight years before it could offer a baccalaureate degree.

But we are much alike in many other ways, certainly in the emphasis on improving the material aspects of life, the emphasis on the practical and the emphasis on producing something better. Yesterday I read some information that the Sea Grant Program is just getting out. It said, 'To qualify as Sea Grant research, the project must be related to a clear possibility of culturing a commercially valuable organism." That sounds like the Land Grant College Act. In a day in which the country could produce a rapidly expanding industrial labor class but could not provide leadership for industry, it was necessary to import from Europe technicians, foremen and scientists to run industry. The Morrill Act provided for the training of people, the so-called industrial classes, in all practical aspects of life. From that effort came agriculture as a science and not as a folklore; then came home economics and engineering as disciplines -- all kinds of things that have made this nation the great industrial producer it is with perhaps half the world's industrial activity.

I am sure that Sea Grant institutions will succeed. I am sure that, in the years ahead, from the oceans will come such new produce that perhaps in a hundred years people will be fed by the ocean and not by the land. Nevertheless, I predict that a hundred years from now someone will write a book called Hard Fish, Hard Times and criticize you for putting small fishermen out of business!

The association today is a characteristic form of intra-political action. Because it is so marvelously flexible, an association can be as narrow or as broad as desired. Associations have proliferated in this country so that they are impossible to count. Indeed, it is almost impossible to count the ones in Washington; it is characteristic of our times that associations increasingly have moved their headquarters to Washington.

I'm told that when the eight-story building in Washington that houses the higher education associations was first constructed, it was believed that only about one-third of that building would take care of all the higher education associations. The other floors were to be rented out until the associations expanded enough to fill the building. When the building was opened for leasing, however, the higher education associations flocked in. We now have the building completely filled and at least three-quarters of the higher education associations are not in it. This is because almost every day someone decides that some special interest exists within an association that needs individual representation.

What can an association do? One thing is "horseback research" -- survey research, the business of collecting available information to support the association in programs. This activity is similar to the Sea Grant advisory function, as I understand it.

The association also performs an important intelligence function so that member institutions know what is going on among other members. The production of newsletters and other communications mechanisms is one of the most effective and useful functions of an association. It is important also to let people know about activities in Washington. The intensity of political life in Washington is such that no one away from there really can keep up with it. Congress, for instance, may call a hearing with only a day or two of notice so that the person who depends on a member of Congress to inform him when hearings will be held is simply going to miss it. Having somebody on the spot, then, to pass the word, is another function of an association.

The greatest function is representational -- representation for the public by someone who understands the media. This is the best money that an association can spend -- to find somebody from the media. When you buy such a person, you buy contacts -- just as when you buy a lobbyist, you buy his contacts. What a media-man can do in telling the world about his association is something wonderful to see.

There is also a representational function where the government is concerned. People still have some of the funniest misconceptions about lobbying. Friends will come to Washington and ask me, "How do you like the cocktail circuit?" This reflects the old notion that much lobbying takes place at social affairs. The truth is that members of Congress and public officials are sensible people. One of the hardest things in the world is to get a member of Congress to a cocktail party unless his friends are giving it. Again, the old notion that lobbying consists of arm-twisting is one of the worst misconceptions. In the first place, if a Congressman or government official has enough power and status in town to be worth contacting, he is somebody who cannot be pressured into anything. A member of Congress likes to be bullied as much as anybody else likes it. If somebody successfully forces a member to do something he does not want to do, somewhere down the line the "bully" is going to run into that member waiting around the corner, and some other piece of action will go awry. The notion that there is a lot of financial corruption in politics is an interesting one, and it may be true in some cases. But the very fact that the politics of most interest groups is associational means that it must be clean. An association's reputation is worth so much that the association cannot possibly endanger it with a scandal. When you read about a Washington scandal in the paper, you will see that it is some small outfit or some individual -- not an association. If you are the AFL-CIO or the Land Grant Association, which dates back to the latter part of the nineteenth century, prestige and reputation are much too important to endanger.

Just what does an association do to influence the government? First, of course, is the recognition and assessment of its own resources. Labor unions, for example, begin with the important fact that they have a very large membership. If these unions can mobilize their own members, they can accomplish almost anything. Some of the unions are able to spend money, and this is an enormous asset. Business can utilize its public relations skills, enormous prestige and money that is available when necessary. Higher education's primary asset is public acceptance. Perhaps you have heard how much ground we lost in the last four or five years because of the periods of unrest and trouble. But this year the U.S. Congress passed a bill authorizing approximately $18 billion for that four-year period. The bill unanimously passed the Senate subcommittee, the full committee and the Senate. There was no opposition; the only question was the bill's composition. The acceptance of higher education, the prestige of the presidents of our institutions, is definitely our greatest asset -- not large membership, not money, but the fact that the American people support higher education. Protection of that prestige and proper application of it is the most successful kind of lobbying we can do.

The most effective things accomplished by the association I represent often come about without the knowledge of our office. Our member institutions' presidents come to town when there is no bill hanging in the balance and meet informally with their delegations. They talk to their delegations about higher education needs -- in terms of the institution and of the delegate's own state. That is far more effective than anything the association office is able to do.

This effectiveness has a number of dimensions. One is cohesiveness. An association that is relatively coherent in its interest can obviously act more effectively as a whole than as one that is not unified. The American Council on Education, for instance, represents 1400 institutions and associations, while we represent 120 very similar institutions. The fact that we are public and that our institutions are very much alike is a great asset for us.

Those people who urge an association to be morally courageous and to take a stand on an issue that divides the membership are actually heading into making two associations out of one. What is necessary (and the Sea Grant Association will have to face this) is to avoid divisive issues. The former Land Grant College Association could push for legislation that designated the Land Grant Colleges to carry it out. When that association merged with the State University Association, however, designation became impossible. We now say the governor or the legislature should designate or that the legislation should apply to the best qualified institution.

Knowledge also counts. Government officials and congressional members pay attention to a group speaking in their own field of expertise. You will find that when you talk to congressional committees about oceanography and marine-related research they will listen. However, they will not care what you think about the Vietnam war; that is not the area in which you have expertise.

Depth of feeling also matters a great deal. I read in the papers that the National Rifle Association is a great, overpowering lobby that prevents Congress from passing antigun laws. There is nothing that the National Rifle Association does that our association does not do regularly. The difference is that National Rifle Association members feel threatened and that they respond. If we were presenting a bill to abolish public universities, we could get our people to Washington without difficulty. Congress pays attention to how much people care about something. I have observed our association to see what agitates our people. Ever so often we ask that all college and university presidents respond with a letter, telegram or call to their delegations. Anything that immediately affects money gets almost 100 per cent response. A few years ago, for instance, Congress abolished the tax exempt status of colleges and universities for transportation. I watched the response to the letter we sent; it was almost 100 per cent. The Bankhead-Jones funds, which amount to only $12 million for support of Land Grant Colleges, is something that will arouse our people like tigers because this is money that they may spend as they please.

I know some educational lobbyists who like to get lists of how representatives voted and send these rosters to their memberships. When the House met as a committee of the whole and voted on issues simply by walking past tellers, these lobbyists tried to remember who voted which way so they could inform their memberships. I asked, "Why are you doing that?" The lobbyists answered that they wanted their members to know who voted for and against them. "What are you going to ask your members to do? Are you going to ask them to defeat a Congressman?" No teachers' organization in the country can defeat a sitting Congressman.

But we do not want to threaten because that is not our kind of activity -- the notion of threatening something that is not going to be done is silly. Sometimes Congressmen will pay attention to a little group simply because it is a nuisance group, but they are more likely to pay attention to support on the kind of position they expect from a group.

Associations in their representational functions cannot do much about the distribution of grants. Any institution that has to have representation to obtain grants is too small to qualify for Sea Grant support. In our own institutions, for instance, so many people come to town and take care of their own grants that our presidents probably have difficulty keeping up with what their people are committing the university to do. When Fred Harrington took over the University of Wisconsin, he first tried to find who was committing the university to new buildings, new schools, etc. "Grantsmanship" belongs to the experts.

There is something, however, that an association can and should do -- monitor the activities of executive agencies in terms of guidelines and rules. If Congress passes a law for a certain amount of money for a specific purpose, somebody has to write rules and guidelines for qualification for that money. Our members have been more concerned in the last three or four months about the guidelines coming out of the Department of Housing, Education and Welfare concerning affirmative action programs than they have been about the higher education act -- and I can see why. Now that the act has been passed, the six, seven or eight internal task forces in the Office of Education that interpret the law are probably doing as significant a legislative job as anything that Congress did.

I have been discussing associations that have headquarters, professional staffs and offices. The question I am sure you are concerned about is "What can an association do without headquarters or without a professional staff?" The answer is "A lot more than you think." Much can be done about legislation. For one thing, your member institutions are already members of other associations. Our association, for instance, is interested in legislation on mineral resources, water resources and environmental centers. Why? Because some of the institutions in the association are interested in them, too. We are not confined to higher education legislation, per se. The six Sea Grant Colleges are all members of our association, and they have every right to call on us for help.

Moreover, what can be done through committees organized around a common interest is amazing. Within our association are some groups set up by the association's constitution. A great amount of energy goes into trying to activate those groups. Yet when an ad hoc committee is appointed on some subject in which committee members are interested, nobody has to ask or tell them when to meet. What you have to do is try to keep up with them because they move. I am convinced that there must be groups within an association to follow legislation -- groups that can perform nearly all the functions of professional offices.

We have in our association something called the Division of Agriculture, which is almost Byzantine in its organization. This division has committees on everything -- it is the only group in our association that I know of with a formal presentation on the Agriculture Department's appropriations requests to the Office of Management and Budget every year. What unpaid people can do, if they want to do, is very great indeed. As a matter of fact, I will make the generalization that the Washington office that of necessity must be small is probably too expensive. Almost every three or four months some specialized interest group within our association will come in with a little committee and say, "We believe that we ought to be represented in Washington. Now what will that entail?" The answer is a minimum of about $100,000 a year for one person, a secretary and an office. This money can be spent much better by augmenting the resources of an existing association. The larger an office becomes, the more effective it becomes; the specialized people on the staff support each other. The notion of simply getting somebody in Washington is pretty much nonsense.

Let me conclude by welcoming you to the great American pastime -- trying to get money from the federal government. I think that you will succeed. An appropriation of $10 million for federal programs is almost a gift of eternal life. There will be Sea Grants, even if the seas dry up. But, what will the amount be? This political system is more representative of the American people than most Americans realize. The public mood swings, and Congress swings with it. I can remember that, back in 1958 when the country was scared because of Sputnik, Congress encouraged universities to expand graduate programs in that most expensive field of education. Now all over the country these institutions are scrounging for money to support what the federal government started. Just to give you an indication of how quickly these moods can swing, the higher education bill was passed in May of this year. Its main thrust was aiding disadvantaged students, and that was all the committees talked about for about two years. When that bill was finally debated in the House of Representatives, I heard every word that was said; nobody used the word "disadvantaged" once. What they were talking about was the middle-income student. Some members of Congress have been following the primaries!

I would say that consorting with the federal government is not unlike sleeping with an elephant. There are certain risks that have to be run. I leave you by wishing you luck and by extending you sympathy, both of which you will need from time to time.

Achievement and Assessment: A View from Washington

Howard W. Pollock
National Oceanic and Atmospheric Administration

It is always with greatest pleasure that I attend a Sea Grant event or meet and interact with people in the Sea Grant program, from your energetic and candid National Sea Grant Director Bob Abel to the stimulating participants in university-based programs.

It is especially fitting that the theme of this meeting is "A Year of Achievement." Sea Grant is beginning to capture the attention and support that it so richly deserves, including the personal recognition of the Secretary of Commerce.

One year has elapsed since Dr. Bob White spoke at your last meeting, held at a great university then destined to be named a Sea Grant College. This year's meeting is hosted by another great university which has held that proud title for a year.

This is the fourth Sea Grant event that I have had the honor of addressing, and all have been different and stimulating. They ranged from a conference on coastal zone management sponsored by the Michigan Sea Grant program, to a meeting that marked the inception of a Sea Grant institutional program at the University of Delaware, to the ceremony three weeks ago establishing the first bi-state Sea Grant compact, between Mississippi and Alabama, for cooperation in organizing their approach to coastal and marine management activities. Those three diverse meetings shared one characteristic -- all were concerned with forward progress, with planning for the future, with tackling problems and solving them. This is indeed the spirit of Sea Grant.

However, I believe we all realize that from time to time we should stop, take a deep breath, examine our accomplishments and study the direction of our efforts. It is appropriate that this conference has selected a somewhat different theme, looking to see how far Sea Grant has come, what its accomplishments have been and where it has suffered disappointments or set-backs that need to be overcome.

It has also been a year of considerable achievement for NOAA. I think you will be interested in some of the areas where we have made progress and in some of the directions we are now taking that relate to the interests of Sea Grant.

In the past year, we have reviewed the organization and programs in NOAA, seeking to crystallize our thoughts about the directions that organization should take and modifying our concepts to best meet the needs of the people we serve. In general, we are now seeking to emphasize four major areas of effort. We are strengthening our present programs in ways that support these four areas of effort, and in a few cases we plan to create new programs to further their aims.

Two of these I will just touch upon briefly, because they are not of direct interest to Sea Grant.

The first is in disaster warning systems. We have carried on work both in ESSA and now in NOAA to track and to give early warning of hurricanes, to warn people of tornado-spawning weather and to establish watch and warning systems for floods and winter storms. These services will be strengthened. Flash floods are hard to predict, but we are trying. This past year, for example, NOAA began the installation of devices that automatically alert local officials when stream waters reach certain levels. We intend to continue such efforts.

A second area of emphasis is chiefly internal, though its effects should be felt on all our service programs and research. This is the area of increasing the effectiveness of the NOAA work force and operations. One step taken in this direction may be of particular interest to you. All NOAA ships, both those of the National Ocean Survey and those of the National Marine Fisheries Service, have been brought together under a single-manager system. Another step is the integration of marine-oriented staff and services throughout the NOAA organization.

The other two major areas of emphasis are directly involved with Sea Grant interests, and we look to Sea Grant for leadership in many ways.

One of these areas is the establishment of a government-industry partnership in programs and projects leading to the establishment of new industries or to an increase in the effectiveness of existing industries. Of course, a major activity within this area of emphasis is aquaculture, which so many of you are pursuing with great imagination and energy. The National Marine Fisheries Service is also working in this area where technology and nature are being successfully combined and where the prospects for a new and important industry appear very encouraging. Secretary Peterson, incidentally, has expressed a personal interest in and support of our aquaculture efforts. We wish to continue our strong support of those aquaculture areas that appear to be feasible and heading toward commercial application.

In this connection, of course, we must mention the work with salmon and trout in Washington, which won Dr. Lauren Donaldson last year's Sea Grant and Marine Technology Society awards, and the pan-size salmon success that is on its way to becoming a classic case of successful cooperative effort. This effort involved participation by an academic institution -- in this case, the University of Washington -- by state agencies of the state of Washington; by Domsea, a private industry; and by the federal government, working through the National Marine Fisheries Service and Sea Grant.

Here in Texas, the commercial shrimp aquaculture history appears to be another success story with Texas A&M Sea Grant taking the lead, interested private industries actively participating and Dr. Al Sparks' NMFS Galveston laboratory contributing research knowledge. The University of Miami has published the first handbook forshrimp aquaculture; the Oceanic Institute has succeeded in breeding mullet. Dr. Oswald Roels' artificial upwelling project in the Virgin Islands has produced unprecedented growth rates for two species of oysters and one of clams, feeding on the phytoplankton bloom in his ponds -- and there are more signs of progress throughout the Sea Grant circuit.

Another example of this major NOAA emphasis on government-industry partnership -- and an example of immense importance to NOAA and to Sea Grant -- is the NOAA Marine Advisory Service. Dr. White attaches the highest priority to this service, which we are determined to make really helpful to users. We will be following the trail blazed by Oregon State University, by Rhode Island with its NEMRIP service and, of course, by PASGAP on the West Coast. We expect that the NOAA Marine Advisory Service will continue to help existing industries become more efficient, that it will also be of great assistance in establishing new industry. Again, aquaculture is the example that leaps immediately to mind.

Utilization of so-called waste products is another example. It has been said that a waste product is a useful compound that man, in his ignorance, has not yet discovered how to use. For example, crab and shrimp shells are made of chitin, the same composition as your fingernails. What on earth do you do with a warehouse full of fingernail clippings? -- Or in this case, of shrimp shells? At the University of Washington, Sea Grant scientists have discovered uses for chitin and also for chitosan, a polymer that can be made from chitin. One investigator has found that the two materials can be converted into wet-strength paper, but even more exciting is the discovery that the chitin molecule makes a remarkable substrate to which molecules of pesticides and herbicides will attach. The molecules then leach out into the soil at a designed rate instead of running off during heavy rains and causing non-point-source pollution of streams and estuaries.

If these kinds of development come to the stages of fruition and commercial application, then the NOAA Marine Advisory Service will be most concerned in getting them into the hands of industry, of users who can put the waste to work.

I wish to make two additional points about the NOAA Marine Advisory Service.

First, it will be designed for rendering service to all who seek livelihood or recreation from the sea and to those who have responsibility for planning the uses of the seashore. Too often, marine advisory is taken to mean only commercial fishermen and perhaps the food processors who purchase their products. These will continue to be highly important groups, but -- as with several Sea Grant advisory programs already established -- we shall also be interested in helping marina operators, recreational boaters, state and local planning organizations and others.

Second, responsiveness to user needs is paramount. This means a system of user feedback and, more than that, of actively seeking user problems that need solutions, then getting these task requirements to the investigators.

I want to tell you briefly about the other area of current NOAA emphasis that is also integrally involved with Sea Grant. This program area comprises activities looking toward ways to resolve the impending energy shortage in this country or, more broadly stated, to resolve the difficult problems of conservation versus development, particularly in the coastal areas. About three weeks ago Dr. Athelstan Spilhaus spoke at a ceremony inaugurating the institutional Sea Grant program at the Massachusetts Institute of Technology. At M.I.T. he spoke of the need for moving toward what he calls an "eco-librium" position -- balancing the desired ecology with the necessary economy. That sums up very neatly what this area of NOAA emphasis is all about.

And may I add, sir, that perhaps some of the more fervid proponents of some scheme or another in this context might better understand the eco if they first took a librium!

One of the activities that NOAA is planning to expand is mapping of the continental shelf. The President's energy message to Congress on June 4, 1971, noted the need for accelerated offshore petroleum development, with government providing assistance in resource evaluation and industry undertaking developmental activities. Sand and gravel resources on land are becoming depleted, so offshore mining must be considered. Recovery of seafloor manganese nodules -- with the valuable copper, nickel and cobalt that they contain -- is becoming technologically feasible and economically desirable. To accelerate the development of these mineral and energy resources, NOAA has initiated a program of accurate, detailed geophysical and resource mapping and assessment. The program will provide 1:250,000 scale reconnaissance maps of bathymetry, with overlays of geophysical properties. From this information, the Department of Interior will prepare geologic maps and detailed studies in areas of high economic potential for use in lease bids and for managing resource development. This mapping program will also help to alleviate disasters, such as the one resulting from inadequate knowledge of subsurface conditions in Santa Barbara Channel.

Another basic fact-finding program that NOAA hopes to emphasize is that of geodetic control and tidal data in the wetlands. Texas and Louisiana, among other states, are having problems determining waterlines and boundaries in wetlands. This is important for a number of reasons. Insurance, for example, ordinarily covers the area down to one foot above the waterline; if you don't know where the waterline is, the insurance may be no good. The mean low waterline is usually the dividing line between federal and state ownership; and the mean high waterline, the dividing line between state and private ownership. Texas is different -- according to state law, state jurisdiction extends three leagues out to sea.

These dividing lines are meaningful in a legal sense only if they are known, but often they are not. In addition, they are frequently changing. Along the entire Gulf Coast there is real concern with the occurring subsidence. The Houston-Galveston area is sinking about three inches per year -- it has subsided five feet in 20 years, and we have reason to believe that some sections are sinking much faster. This is due primarily to withdrawal of water from underground but may also be caused by normal movements of the earth's crust.

NOAA has been trying -- so far, without too much success -- to gather together the appropriate federal, state, local and private interests in this area to repeat the basic surveys made in 1964.

The National Ocean Survey is the only agency that has measured tides with the accuracy necessary for precise mapping and charting. Their work was developed and carried out to meet hydrographic responsibilities. More and more, however, states and localities have found out about these measurements and are asking help in determining their boundaries. The Survey is now, under contract, assisting the Gulf states and the U.S. Geological Survey to the extent possible but does not at this time have funds available to carry the work throughout the Gulf Coast.

We are, however, able to extend our geodetic control in wetland areas. This is underway and will give the precise positioning needed for ownership determination.

Another basic NOAA function that we are expanding in order to increase service to the user is environmental data storage and dissemination. Environmental data are essential to assess the quality of the environment, to document its long-term trends and to conserve its resources for future generations. Contamination of air and water must be minimized as development proceeds, and specific decisions must be made rationally on the basis of documentation of the problem. You are aware of the scope and function of our Environmental Data Service. We are trying to make it even more useful. In February of this year, for example, EDS established a special unit to meet the needs of multidiscipline data users in the Great Lakes drainage basin. This unit is collecting an inventory of project records from the International Field Year for the Great Lakes, containing about 3,000 computerized records of data collected this year from Lake Ontario. The inventory is available to any interested user.

In addition to the expansion of relevant ongoing activities, NOAA hopes to begin shortly a new and important program to deal with this basic area of program emphasis, the balancing of resource development and environmental improvement. Called MESA -- for Marine Eco-Systems Analysis -- the new program will be devoted to making baseline studies, carrying out continuing monitoring programs and analyzing results of changes -- either manmade or natural -- in selected ecosystems. It is planned that MESA will also develop predictive models when sufficient information has been obtained, so that proposed changes in an ecosystem can be evaluated from the standpoint of different, perhaps unfavorable, results that may occur from such changes.

During the past year one of the new NOAA programs has shown much promise and a great deal of accomplishment. The Manned Undersea Science and Technology program -- MUS&T, as it is called -- has worked with and benefitted from its Sea Grant colleagues on numerous occasions. Perhaps the most significant was Project FLARE -- the Florida Aquanaut Research Expedition -- that took place along the coast from Miami southward earlier this year. The National Sea Grant Office took the lead in organizing FLARE more than a year ago when the MUS&T office was just organizing. The participation of Sea Grant programs of the University of New Hampshire and the University of Miami was obtained early in the project by the national Sea Grant office, as was the involvement of the Woods Hole Oceanographic Institution and other academic and research organizations. FLARE could not have been mounted so quickly, nor succeeded so well, had it not been for the active interest and encouragement of Sea Grant.

Sea Grant scientist-divers have been able to carry on their research through MUS&T support, so the partnership is viable and is working well. Sea Grant scientists from the University of Alaska, for example, participated in an investigation of the productivity of the ice-covered northern part of the Bering Sea, under the aegis of the International Biological Program and with a submersible made available through MUS&T. Numerous Sea Grant scientists from the University of Michigan, Texas A&M University and other institutions have had the opportunity to pursue research at Hydro-Lab in the Bahamas, with the aid of the same program.

Sea Grant-trained technicians from Maine, North Carolina and elsewhere have contributed to a number of NOAA-sponsored exercises, including FLARE and the International Field Year for the Great Lakes, where they work aboard the Advance II and in the U.S. data center at Rochester field headquarters. Advance II was made available to the Field Year through Sea Grant and is the second largest research vessel participating in the study, the largest being the NOAA ship Researcher.

At the laboratories and in the field around the country, there are more examples of day-to-day working relationships that produce results. On the Pacific coast especially noteworthy is the long history of close-working relationships between the National Marine Fisheries Service staff in Seattle and the University of Washington fishery scientists. The participation of NMFS in PASGAP is a reflection of this. On the East and Gulf Coasts other items come to mind. There is the interchange of information, ideas and assistance between Texas A&M Sea Grant and the NMFS Galveston laboratory. In New England the National Marine Fisheries Service developed a fish separator that appears to be both effective and, for some uses, quite economical. NMFS technicians from Gloucester, Massachusetts, traveled to Gloucester Point, Virginia, to demonstrate the separator to VIMS. The VIMS Marine Resource Information Bulletin, part of its Sea Grant Advisory Service, disseminated this important information to Virginia seafood processors for their possible use.

We can discern a great deal of progress and considerable amount of achievement within Sea Grant and in the Sea Grant-NOAA relationship. As always, there is still room for improvement. Last year when Dr. White addressed you, he concluded his remarks with a long series of questions, which he introduced by saying:

"This seems a good time to look back upon Sea Grant's efforts to assess their results, to review their procedures, to ask what, if any, changes are desirable.

"I am asking the Sea Grant staff, the Sea Grant directors and their colleagues to focus upon such an assessment over the coming year."

Through the efforts of the national Sea Grant office, an assessment of this nature has continued. Answers to many of the questions are not completely clear or subject to generalization for the Sea Grant circuit as a whole. But, from our standpoint at the center of the Sea Grant network, a few trends may be discerned, a few words of help and guidance may be appropriate -- and perhaps a few more questions may be in order. The following are general remarks prompted by this continuing assessment:

Sea Grant as a whole is in a very good position to compete for additional government funds because it is an excellent example of two important areas of emphasis. It is a revenue-sharing program, with its matching requirement and the return of federal funds to the localities; it is devoted to the useful and the relevant -- to the payoff. But competition within Sea Grant is increasing, just as competition for federal funds at all levels is increasing. Proposals will need to be better written, better planned; you must show that programs are tightly knit. In particular, you will need even clearer exposition of the relevance of your programs, in terms that are clear to non-marine people.

One of the areas where you are certainly to be commended is in interesting your state legislatures in Sea Grant activities. I suspect that in these activities you emphasize the same things that I urge you to emphasize in your proposals -- economic value, relevance, usefulness. Continue this good work -- don't let down.

Another important thought is the critical importance of an overall approach to problems -- a systems approach, a holistic approach. It is not enough to develop a better method of harvesting a species -- you must also know about the stock and work toward its conservation, protection and better management. You must know the economics of marketing and -- as in the excellent example I previously mentioned with respect to chitin and chitosan -- look into the uses of waste material.

Another example -- it does little good to develop aquaculture in a state where laws inhibit aquaculture, unless you also cooperate in activities designed to obtain more favorable interpretation of those laws. In my own state of Alaska, a provision of the state constitution stipulates that there shall be no right of private fisheries. This has been interpreted in such a way that it would handicap mariculture and efforts to control the numbers of fishermen through limited entry. The Chairman of the Senate Resource Committee consulted with the Alaska Sea Grant program, among others, in developing legislation that, if it passes the referendum this November, will permit both. This is the kind of service that Sea Grant can perform in carrying out a systems approach.

Make sure that success in one field does not lead to greater problems in another field. This is where the systems approach is essential. It cannot be applied in single project grants, but in the coherent area and institutionals it must be. Indeed, the idea of coherent area and institutional grants was to provide continuity so that teams could be structured to attack all essential elements of a problem, whether biological, economical, technological, legal or whatever.

Faraday once succintly defined the three elements of research when he said that you have to begin it, end it and report it. The question is, what are you in Sea Grant doing about the latter two? And what are you doing about the element that Faraday omitted -- the element of "apply it"?

Both Sea Grant directors and the national Sea Grant office have been engaged in a conscious effort to identify products and determine which activities are beginning to pay off or hold great promise for doing so. The national office now has two interns from Texas A&M with them for that purpose. The efforts in Washington and at the universities are vitally necessary, and I urge you to continue.

Another area where we see progress is communications. As the Sea Grant network grows, there are an increasing number of activities that are scattered around the country and relate to each other -- for example, nutrition studies. Nutritionists are working on various aspects of this at perhaps a dozen institutions. The national Sea Grant office is encouraging conscious communication and coordination among them.

Communications within a single university are not always the best. Only two weeks ago the national Sea Grant office received a letter from a scientist asking for information about Sea Grant -- although his university has had a Sea Grant program for three years, right in his own department!

I hasten to add that I am not pointing a special finger of blame at the universities. We all have our problems in this area, as you are well aware. But it is an area that requires vigilance and imagination.

Finally, involvement with user communities is most important, indeed critical. This ties in closely with NOAA's overall interests in assisting industry and with the forthcoming advisory service. Within Sea Grant the flow of task requirements from industry to university needs improvement; there are still too many proposals that fail to relate the interest of the scientist or engineer to the genuine needs of the marine community. The time and effort might better be spent on more productive proposals.

Those are a few criticisms, a few words of caution. They are not intended to be adverse criticisms of the overall job you are doing. Sea Grant is one of the most stimulating, creative and, we think, productive efforts that the federal science structure encompasses. We are very proud of the quality of our Sea Grant participants and of the vigor and intelligence with which you carry out your science and public service responsibilities. I am confident that you will continue in the splendid tradition that you have begun, and I congratulate you on your achievements.

Sea Water — Solvent for Reaction

Robert MacVicar
Oregon State University

Scholars of higher education believe that the record of United States history will show two significant social contributions to the field of higher education. One of these is the community college; the other, the Land Grant state university.

Originating in Scotland during the late 18th Century, the latter contribution resulted from a growing concern for broader and more practical education, especially for what the Morrill Act of 1862 called "the industrial classes." Within two decades after passage of this act, almost every state in the union had created a practically oriented institution of higher education. The newly developed profession of engineering found a natural site for formal preparation in these institutions, and the Scottish progenitors of the movement placed high priority on agriculture as well. Indeed, the language of the Morrill Act lent itself to the issue by requiring instruction in "agriculture and the mechanic arts."

From the early days of the Land Grant colleges, the tradition of providing practical information to farmers and to others involved in agricultural enterprises was part of the developing programs. Farmers, institutes and similar activities that had occurred earlier naturally become attached to the newly developing schools and colleges of agriculture in the Land Grant institutions.

Agricultural scholars and scientists realized that the importation of scientific information from Europe was not necessarily applicable to the development of agriculture on the American continent. Hence, in the late 1880's the federal Congress took a second step in creating the complex that is now the Land Grant College System; legislation was passed to provide support to several states for agricultural research -- again, particularly aimed at the solution of practical problems. Thus, a second leg was attached to the platform from which advice, counsel and assistance could be provided to users of scientific and technical information. Thirty years later the third leg of the platform was affixed by creation of the Cooperative Extension Service. This entity is a unique government institution, combining state, federal and local support and management in a comprehensive enterprise that places a local representative in each county and parish of the United States.

Careful students of agricultural enterprise in the United States attribute the enormous increases in productivity-per-man, which occurred during the late 19th and early 20th Centuries, to the combination of American industrial capability and the Land Grant College System. The development of mechanized farming also flowed perhaps as much from research and studies in the schools and colleges of agriculture and in their associated agricultural experimental stations as it did from American industry itself. Indeed, a partnership evolved in which the university and the farm-related industry shared research and development that expanded the capability of producer and procerssor to make more effective use of advancing technology as it was evolving.

Therefore, with the increased concern about the marine environment in the 1950's and 60's, the pattern that had been previously developed became the subject of discussion. Dr. Athelstan Spilhaus, using the analogy of a federal "Land Grant," began to talk about a federal "Sea Grant" that would create analogous institutions with federal, state and local support. These institutions would serve the needs of those concerned about the marine environment, its protection and full utilization. Federal legislation created the Sea Grant program in the mid-60's, and we are here today to testify to the extraordinarily rapid development of an additional complement to the federal-state relationships that have characterized this aspect of American higher education. Not all institutions involved in the Sea Grant program are of the Land Grant family. Of the first four formally designated Sea Grant colleges, one has no traditional Land Grant affiliation. Nonetheless, the pattern of the Land Grant program has continued in a new setting. Resident instruction at the undergraduate and graduate levels is combined with research and public service; and the transfer of new knowledge and technology to the user, particularly the small entrepreneur, is emphasized.

One might ask what are the future implications of this rapidly developing new agency for both the university and the more effective use of our marine resources.

Certainly one of the things that has been characteristic at Oregon State University and, I suspect, true elsewhere is that salt water of the sea has become a "universal solvent." Sea water has dissolved some of the traditional barriers that have hampered research and the utilization of research information in traditional non-Land Grant institutions as well as in those segments of Land Grant institutions that have not been directly involved in agriculture and home economics programs of research and extension. Problems of the marine environment are complex, and almost every one of them requires a team of experts to extract useful information and to appropriately utilize it. At Oregon State University the Sea Grant program has created a series of team efforts that would not have taken place without stimulation from new resources that became available and from demands of the problem being studied.

In our case, team effort has gone beyond the boundaries of the university to include cooperation with two community colleges located in seacoast regions and with the neighboring University of Oregon, which houses the only tate-supported law school. Teams provide instruction at the community college in technical fields related to the marine environment, and the sister university is strengthened in its capabilities to provide instruction and to do research in the field of maritime law and other related legal aspects that are critical to the fullest utilization of our marine resources.

One additional aspect that has become obvious at Oregon State University and, I believe, can be observed elsewhere is the growing realization that, although we have long recognized the team effort frequently required by applied research to achieve prompt and satisfactory resolutions of problems, the same approach must now be employed in seeking the answers to a more fundamental, basic question. The "lone-wolf" research scientist is no longer really capable of understanding many complex problems. The instrumentation that he must use is beyond his capability of setting up and monitoring. Analysis of the mass of data required is something accomplished satisfactorily only with the assistance of statisticians and computer experts. All we now know about research on complex problems of the marine environment suggest that the basic fundamental research, so critical to the continued viability of our practical research and development, must also be done by teams of individuals working together to permit the fullest understanding of the phenomena.

Just as salt water has become a solvent to erase some of the departmental and disciplinary barriers in the field of research, so has it also become a means of bringing closer together various aspects of public service and continuing education. The problems of the marine environment are so complex that it is not as feasible to achieve a scientific specialization comparable to that developed in the field of agriculture for nearly a century. It is necessary for the marine extension agent to be more of a generalist, and it is necessary for him to be able to contact on the home campus a wide spectrum of basic and applied scientists and engineers who can deal with specific problems when they arise. Perhaps over a long period of time the same degree of specialization that characterized the agricultural extension aspects of the Cooperative Extension program will develop, but I doubt it. I believe the complexity of the marine situation and the rapidly developing, changing economic situation will continue to require a generalist at the interface between the university and the user of information. This generalist needs to be more adept and skillful than his agricultural counterparts in marshaling the total university resources in the presentation of alternatives, in the development of public policy and in all other ways relating to the fuller and more adequate utilization of marine resources. At the same time he must achieve a satisfactory protection against misuse.

The medieval alchemist sought the philosopher stone that would turn lead into gold and the universal solvent. He was, of course, unable to achieve either of these objectives; and, interestingly enough, apparently he never stopped to ask what kind of container would hold the universal solvent when he found it. However, as president of a major Sea Grant university, I think I have found a universal solvent to erase some of the artificial barriers within my institution -- it is a 3.5 per cent solution of salt in water.

NATIONAL MARINE PROGRAMS

Total Utilization Concepts in Fish Processing

George M. Pigott
University of Washington

The food industry, largest in the world and the most important to mankind, has been the last to modernize. Often history and tradition, rather than efficiency, have been the driving forces behind growth. Unfortunately, management in our business of harvesting, processing and marketing seafoods has probably been the worst offender in not effectively utilizing available technology. On the other hand, scientists and engineers commonly orient research and development projects toward fragmented parts of a process rather than efficiently integrate new applications of basic principles into an entire process.

The seafood industry must rapidly reorient efforts to support the accelerated requirements for mass production of wholesome fabricated foods. At the same time it must help to maintain and to improve the environmental factors often overlooked by an industry that discharges part of its raw materials as waste.

Many phases of our "now" industry are not compatible with the requirements of today's world and, more particularly, tomorrow's future. What is the "now" industry? It is an industry that sees the majority of its world catch (70 million metric tons) reduced to low-grade animal feed or returned to the sea as a waste and pollutant. The "now" industry allows this practice to continue despite an ever-expanding, protein-hungry world that needs the nutritional components contained in these solid and soluble wastes. In many countries, our own in particular, industry is under tremendous pressures from regulatory agencies that decree "no wastes" as a goal.

The much-maligned scientists and engineers, blamed by many self-proclaimed environmental experts for creating wastes, inefficiencies and pollution, are the only ones who can solve these problems. We must take a systems approach look at the entire industry -- not the gold-plated systems engineering developed by the aerospace industry, but a common sense analysis of our industry and of the processing techniques from harvesting raw materials to marketing finished products.

Harvesting fisheries products can be divided into two broad classifications, those that involve catching large masses in a single effort and those that concern catching or harvesting individual specimens. Mass catching ordinarily requires expensive and sophisticated equipment as compared to catching individuals. Hence, mass catching techniques, particularly when applied to high seas fisheries, are limited to countries that can afford the expensive vessels and gear required. On the other hand, many fisheries do not adopt mass catching techniques since the fish are not concentrated in accessible locations. Processing and marketing are certainly related to the harvesting manner. Mass catching necessitates large-scale processing operations and many times limits preservation methods. For example, the only available economic technique for handling large tonnages of fish such as anchovy, menhaden and herring without undue loss from spoilage is reducing to meal and oil for animal feed. The best potential improvement of these "industrial" fish processing methods is to upgrade technology so that the product will be an acceptable concentrated protein for human food supplements.

Procedures for preserving these large amounts of raw material in more desirable forms are not currently available, nor does the immediate future promise to upgrade more than a small portion of the total world catch of industrial fish. Even marketing highly desirable seasonal fish such as salmon is often restricted by the gluts of raw material available during a small portion of the year. Although market demand and profit are often greater for frozen salmon, much of the pack must continue to be canned due to unavailable freezing facilities. By unavailable I mean an unfavorable balance between capital investment and profit, not unavailable market facilities.

To overcome these problems, we see companies that handle seasonal fish make extensive efforts to diversify into other fisheries in order to justify capital investment. This means that differing types and quantities of waste will become an increasing problem to the processor.

Companies that process and market seafoods caught in small quantities sometimes face the problem of labor costs being more important than capital investment, particularly in the United States. Unfortunately for the consuming public, many of the most salable and desirable products such as prawns, crabs, oysters, clams, trawl-caught and many line-caught fish are in this category. These products, under pressures of dwindling resources, will be commercially farmed in the near future, thus creating other specific localized waste disposal problems. What is the solution to this dilemma?

Under Sea Grant at the University of Washington, we have tried to implement a practical research and development program that is attempting to relieve several facets of our industry that need immediate help. From the small processor with extremely variable production rates to the large processor with greater loads of varying raw materials, from industrial and edible fish to shellfish, sometimes in the same plant at the same time, a common problem of waste disposal and of polluting effluents plagues the industry.

Thus, in the TUC (Total Utilization Concept) program we are trying to achieve the following:

1. Close the processing cycle in all fish or shellfish operations so that water acceptable for reuse or return to the environment will replace the current effluent that contains not only high pollution loads but also valuable by-products.

2. Develop practical aqueous extraction techniques that greatly reduce capital investment and operating cost of processing industrial fish or fish waste into concentrated proteins for humans or animals.

3. Develop a process for producing high quality, functional proteins from edible fish or fish waste.

4. Coordinate our program with an industrial proprietary process for extracting valuable chemical products from shellfish waste.

This is a big order. Where do we stand today, and where are we going tomorrow?

Figure 1 shows a flow sheet of our brine-acid process, in which protein is extracted from whole fish or fish waste. This work has been described in a Ph.D. thesis [Chung-ling Chu. Total Utilization of Hake (Merluccius productus Ayres) by Method of Brine-Acid Extraction. 1971. Ph.D. Thesis, University of Washington]. Although this aqueous extraction process has many advantages, there remains a problem of high fat content in the final product. High fat causes product instability through rancidity and nutritional loss through destruction of essential amino acids. Our current research in this area concentrates on determining how residual fats are bound to proteins. Although the high fat content limits the present product from the aqueous extraction to an animal feed supplement, our present research should result in techniques of breaking the protein-lipid complex so that the concentrated protein will meet the requirements for a human food supplement.

A modified enzymatic hydrolysis technique, shown in Figure 2, was reported at the May 1972 National Institute of Food Technologies meeting and shows good promise for producing relatively inexpensive functional proteins from fish.

Current research in this area is directed toward removing or reducing the high salt content caused by controlling pH during hydrolysis and subsequent acid neutralization. Ultrafiltration, Sephadex-molecular exclusion chromatography and slight alterations in enzyme systems and in hydrolysis control methods bring the greatest promise for finalizing this technique into a commercially viable process.

Since a large portion of the waste from fish plants is shellfish, no program attempting to develop techniques applicable to the entire industry is complete without considering shellfish waste. In conjunction with Food Chemical & Research Laboratories, Inc. in Seattle, Washington, we are studying techniques of further processing the protein recovered from the proprietary chitin process. The general schematic for the process, shown in Figure 3, consists of 1) grinding the shellfish waste; 2) extracting protein (from 25-40 per cent) with sodium hydroxide; 3) removing calcium salts with a hydrochloric acid treatment that results in insoluble chitin and a calcium chloride brine; 4) deacetylating the chitin with sodium hydroxide, thus yielding sodium acetate and the final product, chitosan.

Through a Sea Grant-supported program, chitin and chitosan are available to anyone interested in research applications directed toward the utilization of chitin or chitosan. Information on obtaining samples of these products may be obtained from the Oceanographic Institute of Washington, 312 First Avenue North, Seattle, Washington 98109.

We are excited about this cooperative venture since it represents a pioneering effort in the field of government, university and private research involving a proprietary process. We feel that, by expanding the applications and uses of shellfish byproducts, both industry as a whole and the company that has spent much money in developing the process will benefit.

A major part of the University of Washington program is the processing of effluents from the above processes. Serious limitations on water supply and stringent demands on effluent control are giving new impetus to this total utilization concept. This concept involves recovering usable products from solid or liquid wastes with a closed-loop operation that allows reuse of the extracted water. Liquid effluents from the various processes have been collected and analyzed for different components. For example, Figure 4 shows the general analysis of the four effluent streams from the brine-effluent process (Figure 1). Proteinaceous components are recovered by precipitation (with hexametaphosphate), and fat is separated by centrifugation. This leaves the effluent free of salable by-products but heavily laden with nonprotein nitrogen and other organic pollutants. Reduction of the chemical and biological oxygen demands caused by these materials is accomplished by various combinations of coagulation and flocculation, ultrafiltration techniques, biological trickling filters, ion exchange and activated carbon adsorption.

The present status of our work indicates that, depending upon the effluent, these techniques can be sequenced in such a manner as to economically reduce BOD and COD well within the limits prescribed by regulatory agencies.

In the laboratory and pilot plant at the University of Washington, we are making good progress toward total utilization of marine food resources. We hope that this work will not only be applicable to present commercial operations but will also stimulate others to drop the word "waste" from their vocabulary and to think of these portions of the fish processing sequence as secondary raw materials.

Future requirements will not allow disposal of products to adversely affect environmental conditions. Let us therefore develop, through applied research and development programs, the procedures for "closing the loop" in anticipation of regulations rather than as a result of legislative pressures.

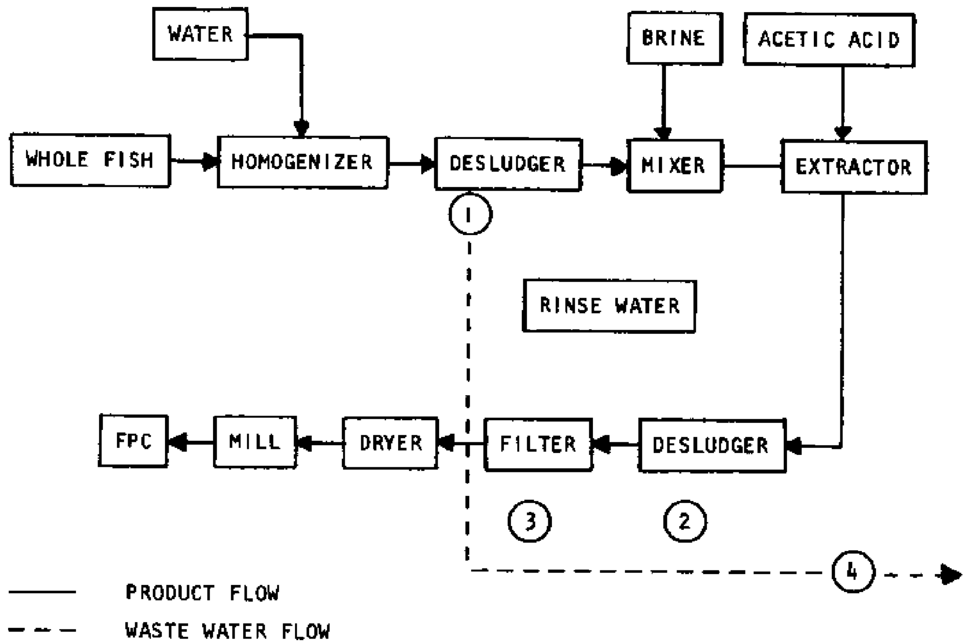


Figure 1. Brine-Acid Protein Extraction Process Flow Diagram

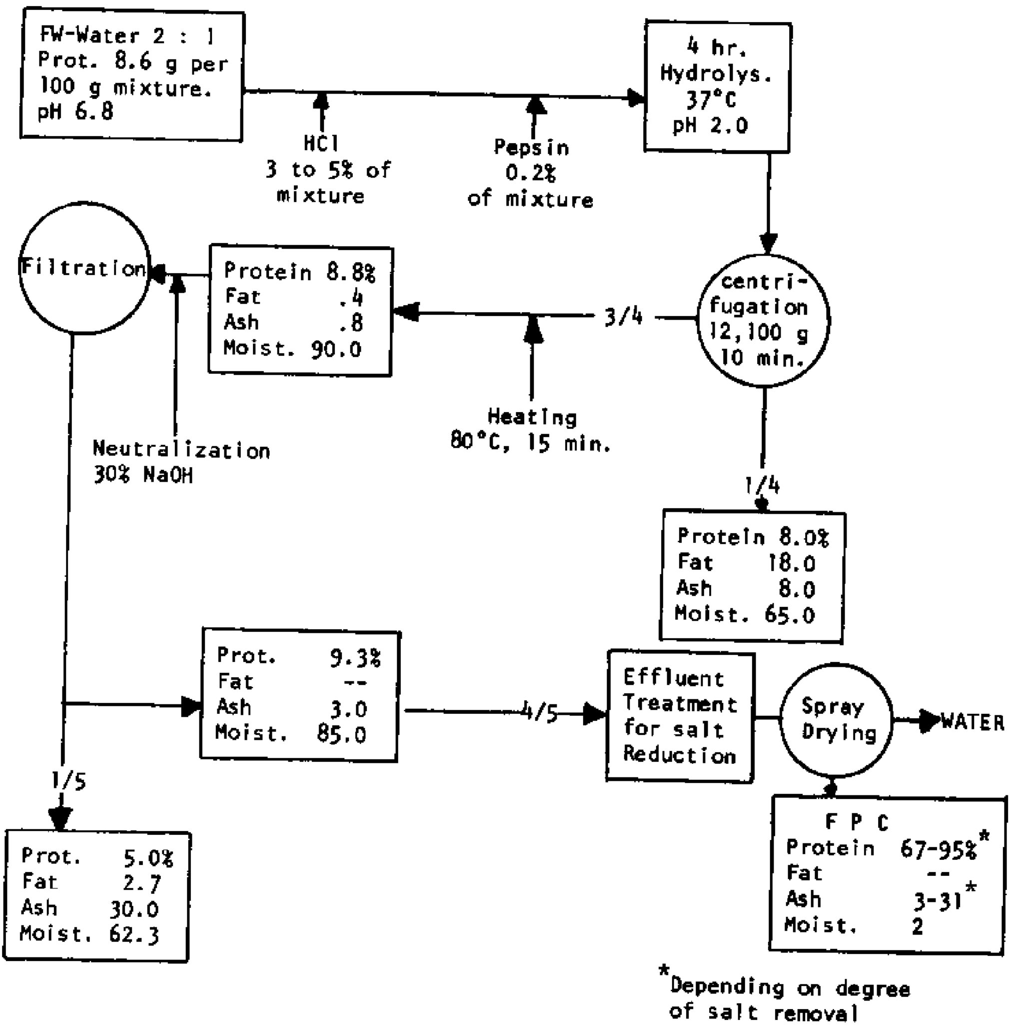
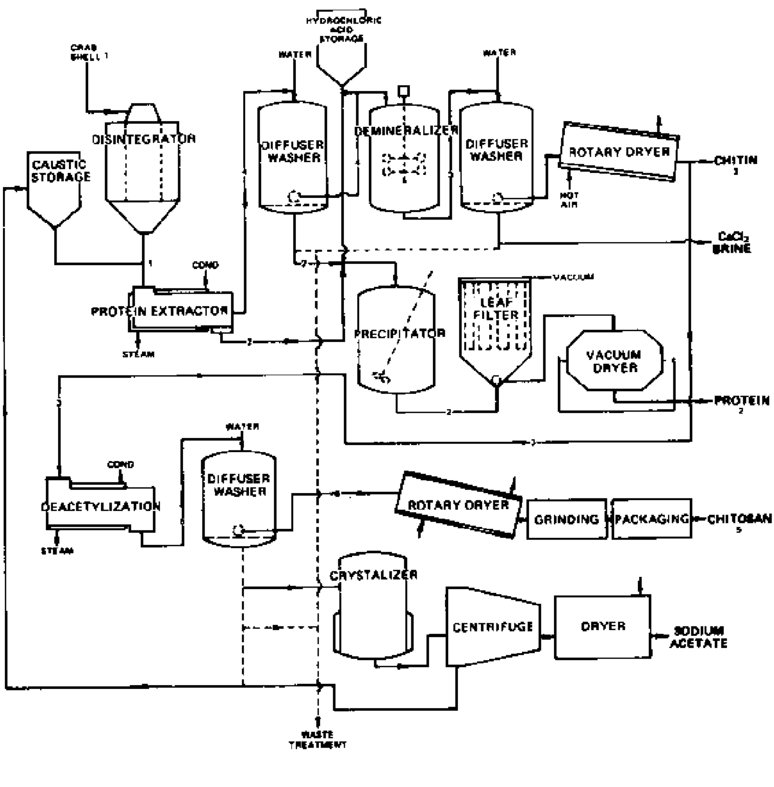


Figure 2. Enzymatic Hydrolysis Flow Diagram

CHITOSAN PROCESS
FLOW DIAGRAM



Waste Streams	1	2	3	4
TR, mg/l	41,400	77,300	28,900	48,125
NF-R, mg/l	40,400	25,800	6,500	21,300
TN, mg/l	3,065	2,660	838	1,420
OIL, mg/l	14,250	8,680	440	6,100
COD, mg/l	71,350	60,800	15,750	47,300
BOD, mg/l	26,300	25,800	9,390	16,380
pH	7.30	4.5	4.50	5.0

Figure 4. Analysis of Effluent Streams from Brine-Acid Process

The Mardela Aquaculture Report

V. L. Giannini
Mardela Corporation

Over the last eight months, Mardela Corporation has conducted 12 aquaculture workshops, supported through the University of Hawaii Sea Grant Program, across the United States on behalf of the National Oceanic and Atmospheric Administration. The objective of these workshops was to identify research priorities in order to move aquaculture from the laboratory to commercially viable operations at the earliest possible date. The program scope was limited to marine and brackish water species with commercial potential in the United States.

The workshops were attended by approximately 180 representatives of universities, private companies, NMFS and other federal, state and local entities. Participants included economists, lawyers and other nontechnical persons as well as technical authorities.

Prior to each meeting, participants were asked to complete detailed questionnaires on research priorities and to prepare work statements for programs that they felt should receive priority attention. In addition, several position papers and letters amplifying individual opinions pertinent to the overall objective were submitted.

At the meetings each participant completed a feasibility evaluation sheet to delineate his position on the present state of various aquacultural facets in his specialty area. This compilation was intended to complement the research priority questionnaire by defining our accomplishments today and contrasting them with our future needs.

It should be noted that these statistical summaries are an approximation and should not be rigidly interpreted. They do not, for instance, take into account differences among subspecies or regions and are not weighted according to individual respondent's qualifications. The data compiled are, nonetheless, extremely valuable and will be extensively analyzed.

The meetings were conducted according to a structured agenda. At the outset each participant was given the floor for approximately

10 uninterrupted minutes to present his "testimony" on the obstacles, priorities and plan for action required in the field. After the individual presentations, the chair conducted ad hoc discussions of specific subject areas pertinent to the group and region, ranging from reproduction technology and disease to legal and pollution problems.

In addition to accomplishing the overall objective, we believe that the workshop program had two beneficial side effects: (a) NOAA acquired detailed information on individual feelings underlying field requirements: (b) the participants had a forum in which to express their views directly to NOAA management.

At the end of September, we presented our findings to NOAA top management, including Dr. White. We are currently compiling the vast amount of data received into a final report, which will be distributed to all participants.

Coast Guard: New Research Opportunities

Dr. Charles C. Bates
Office of Research and Development
U. S. Coast Guard

On September 22, 1972, the U. S. Department of Transportation (DOT) announced a "University Research Program" at a day-long conference in Washington, D. C. Funded at the $4 million level this year, the program is designed to increase the involvement of the nation's universities in solving intermediate and long range transportation problems. Some important objectives of this program are:

- To stimulate relevant high-quality and innovative transportation research at universities for the creation of new concepts, techniques and knowledge; to develop highly skilled professionals in transportation.

- To increase university effectiveness in helping to solve local, state and national transportation problems.

- To encourage the modern use of analysis, of planning and management, of new technology and of professionally trained people by state and local transportation agencies.

- To stimulate industry and state and local agency sponsorship of university-based transportation research.

- To assess the demand for professional manpower in transportation; to project future training requirements.

Contracts will be awarded on a competitive basis to educational institutions that qualify according to professional merit and relevance of the proposed research and to qualifications of the investigators. A detailed program description including objectives, generic areas of interest and procedures for preparing proposals will be made available upon request by the Office of University Program (TST-4), U. S. Department of Transportation, Washington, D. C. 20590.

Contracts awarded under this program will provide for:

- Major research activities involving critical-sized interdisciplinary teams.
- Research on specific projects.
- Innovative research by individual faculty members.
- University-based seminars for industry and state and local governments.

Proposals received for this program will be evaluated competitively within their common categories twice a year. The first closing date for receiving proposals is December 1, 1972; second closing date is March 1, 1973.

This program is coordinated with those of other agencies within and without the Department. For example, the program will match those of the National Science Foundation, particularly the Research Applied to National Needs (RANN) program. Program of University Research is strictly devoted to transportation research and complements research activities of the DOT operating administrations and general interest programs. In a sense, the new program can act as a halfway house for the broad exploratory application-oriented research of RANN and the specific modal research in the DOT. This may also be regarded as a trade-off opportunity between the two federal agencies.

The second university research program described on September 22, 1972, was that of the United States Coast Guard, the agency handling marine transportation for the DOT. This contract research program with universities is designed to provide an opportunity for faculty members and students to become thoroughly familiar with the technical challenges facing the Coast Guard, to assist in solving those challenges by a direct technical approach or by supporting research and to serve as catalytic agents for creating new ideas, approaches and manpower for man's safe, economic, efficient use of the oceans and other navigable waters.

The Coast Guard is particularly interested in receiving proposals for applied research in the following interest areas: search and rescue, aids to navigation, recreational boating safety, merchant marine safety, port security, marine environmental protection, domestic ice navigation, polar operations and marine law enforcement. However, as in the case of the DOT University Research Program, available funding will be relatively modest for the immediate future.

A 20-page brochure describing the Coast Guard's university research program can be obtained by contacting one of the following:

Office of Research and Development (GDS/62)
U. S. Coast Guard Headquarters
400 Seventh Street, S. W.
Washington, D. C. 20590
(Telephone 202/426-1037 or 1038)

Commanding Officer
U. S. Coast Guard Research and Development Center
Avery Point
Groton, Connecticut 06340
(Telephone 203/445-8501 or 8502)

In summary, university researchers interested in working in marine transportation and related technologies may wish to familiarize themselves with these two new, although modest, governmental research programs. The programs are specifically directed toward utilizing the academic community as a partner in the continuous effort to achieve man's goal of an ever-improving transportation system.

Concepts and Ways of Assessing Accomplishments

Virgil Norton*
University of Rhode Island

In attempting to evaluate effectiveness of Sea Grant projects we run into some particularly difficult problems. These, in large part, relate to the wide diversity of Sea Grant projects and programs. The problems range from hardware development to education programs and advisory services.

Thus, with a superficial examination, it might be quite difficult to determine the product to evaluate.

Sea Grant programs are further complicated, however, because of various funding sources. We cannot forget that in addition to federal Sea Grant funds there are matching state funds and direct university contributions involved in Sea Grant programs and projects. Therefore, the payoff at each level must be appropriately considered.

Considering that at any of these levels -- i.e., federal, state or university -- there are many other uses of these funds, it is not surprising that we are asked to justify our projects and programs in terms of output or benefits and relative costs.

If we have confidence in what we are doing, we should be not only willing but also anxious to provide "appropriate evaluations." The words "appropriate evaluations" are in quotes because, to me, the real question is not whether Sea Grant projects or programs should be evaluated but what evaluation techniques are appropriate. I believe Sea Grant projects, as well as other activities undertaken with funds from federal, state or university levels, should be evaluated. The primary problem, however, is finding the appropriate techniques.

No one technique can provide the necessary information for evaluating projects at all levels. However, evaluations at all levels have one common characteristic -- with more meaningful quantitative and qualitative information comes better evaluation.

There is a necessary preliminary step to developing appropriate techniques. This is specific identification of goals or objectives toward which we want to strive with our Sea Grant program. It seems to me that each level of funding -- federal, state, university -- must have a specified goal(s) or set of objectives.

At the federal level these objectives must surely relate to the wording of the bill that established the Sea Grant program, but this is not specific enough. Through the Office of Management and Budget (OMB), the Department of Commerce, NOAA, and the Sea Grant office (hopefully) in cooperation with Sea Grant universities, the federal government must more clearly identify the accomplishments of the Sea Grant program on a national basis.

Only when national goals of the Sea Grant program are clearly defined is it possible to discuss more than a general approach to measurement techniques. Certainly, no university should be expected to try to guess the goals of the National Sea Grant program.

Until we clearly specify these goals and determine our progress by appropriate techniques to measure benefits and costs (keeping in mind that benefits and costs are not measured solely in dollars), I believe that we are going to have more and more difficulty competing with other demands for federal dollars at the OMB, congressional or presidential level.

Beyond the specification of goals, things are still not easy. We recognize the difficult, and in some cases almost impossible, task of measuring -- especially in dollars and cents -- either all costs or all benefits associated with a given Sea Grant project or program.

However, although the job may seem almost impossible, many government agencies and activities are increasingly evaluated on this basis. Considerable effort in many agencies is devoted specifically to determining how to measure benefits and costs. Thus, if we simply say at this point that it is not possible to measure benefits or costs of our Sea Grant programs, we are going to be at a disadvantage in a few years when competing for money against programs and projects in which considerable effort has been made to determine appropriate benefit and cost measures.

For this reason, I think it is critical that individual Sea Grant universities do not take a light-handed approach with information provided to the Sea Grant office.

As an example, if we are developing sand and gravel mining possibilities, we should be prepared to evaluate the environmental costs of our projects. In addition, we should lead the way in establishing the institutional framework through which sand and gravel companies will pay the costs to those affected by increased beach erosion or loss of fisheries.

We should ask ourselves: what are the real benefits of geared research in a commercial fishery that is already overfished? What is the appropriate measured output of an educational program or advisory service? Is it the number of students trained or the number of people contacted through the advisory service? Maybe a clue to these questions is another query: what benefits would result if we were dealing with another type of program but still needing to turn out a few hundred nuclear physicists or aeronautical engineers?

This problem, to me, implies a need to identify where our students are expected to go, what their general type of output will be and, more specifically, how this output should be calculated as a program benefit.

One further point that we at the university level must recognize is the importance of identifying the regional aims of our projects. Otherwise, the evaluation approach will become weighted too heavily toward the national level. We and those at the federal level must recognize the legitimacy of regional or state goals and objectives as long as state matching funds are involved. These state or regional goals might be economic development, preservation of public areas along the coast or attempts to redistribute income regionally by providing more opportunities for low income families to experience marine recreation.

Recognizing that we must consider benefits and costs at federal and state levels and that it is extremely difficult to quantify many of these benefits and costs, we must search for approaches that will allow us to move in the right direction.

Something we should all be aware of is the Water Resources Council Proposal for evaluating federal water and related land projects,[1] which recognizes the following points:

1. Contributions at the federal and regional (or state) levels are important.

2. Many benefits or costs cannot be specified in money terms. The proposal provides four accounts of national, regional, environmental and social efficiency or development.

The environmental and social accounts provide for some very desirable considerations. Let me give you an example.

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[1] Federal Register. Vol. 36, Number 245, Part II. Washington, D.C., December 21, 1971.

Over the past few years there has been substantial effort in evaluating recreational experiences. Through analysis of travel expenditures and certain other associate expenses, techniques have been developed to identify individual willingness to pay for recreational facilities. By this technique some researchers have shown that is is possible to estimate the demand curve for a "product" such as sport fishing where a market price does not even exist. From this estimated curve, researchers can identify what economists might call consumer surplus, which is simply an indication of how much individuals are willing to pay for sport fishing experiences. This amount can run into millions of dollars for certain sport fish resources.

Just as important, however, is another finding by research in this area. The value of a sport fishery resource that can be measured is not solely the value associated with the users (present sport fishermen). There are certain individuals who, although they do not use this fishing resource now for reasons, such as lack of income or time, would be willing to pay a small amount to preserve that resource. This is termed option value.

For example, I may not fish for striped bass along the coast of Rhode Island right now. However, since I hope that I will have more time next year, I am willing to pay the few dollars to help preserve the fish and my fishing option for next year. This option value of nonusers can then be added to the value determined by the demand curve for users.

There is a third value that is termed preservation value. This value is represented by people who never intend to use a particular resource. There may be some individuals (for example, members of the Sierra Club living in New York City) who never intend to fish for striped bass or to look at Hell's Canyon but, in fact, gain some value or satisfaction in knowing that these resources exist. Therefore, they are willing to pay to maintain the resources (i.e., by helping to finance court cases against developing some of these natural areas). Clearly this attitude does exist with many people because membership in organizations such as the Sierra Club is increasing.

As another example, what is the true value of a commercial fishery? It is fairly easy to calculate the value of fish caught by the Point Judith fleet, to identify contributions to national economic development by improvements in this fleet and to recognize losses to national economic development if this fleet declines. It is certainly possible to identify through input-output analysis the contributions to regional income and employment. But there are other considerations that we do not want to overlook, and the Water Resources Council Proposal may give us some hints. To me, the proposal certainly allows inclusion of quantitative or qualitative measures such as the value, beyond the generated income and employment, of the existence of the Point Judith commercial fishing fleet in the sense of maintaining a small coastal port environment (i.e., the social account). How do I evaluate the fact that, when someone comes to Rhode Island to visit me, one of the more interesting sights I can show him is the Point Judith port (i.e., the environmental account) and vessels coming in, unloading, etc.? How do you evaluate the fact that these ports are aesthetically desirable, as indicated by the numerous paintings of such port scenes?

I am not suggesting that there is now a readily available, appropriate technique to quantify this type of benefit. I do suggest, however, that these benefits be considered along with favorable economic development measures resulting from a Sea Grant project that contributes to the maintenance or enhancement of such a fishing fleet and port.

Thus, I propose that Sea Grant establish an intensive short-term project to evaluate the Water Resources Council Proposal and to specify a research program for improving evaluation techniques.

The project should be conducted by an interdisciplinary team that represents the Office of Sea Grant and Sea Grant universities. The specific charges of this group would be:

1. To evaluate the Water Resources Committee proposals and to determine their applicability to Sea Grant projects.

2. To identify quantitative and qualitative measures of payoff and of benefits from Sea Grant projects that would be acceptable to all universities and to the federal government.

This is not to suggest that we should all have the same project goals or objectives and thus the same measures of benefits. Rather, this proposal would allow the identification of areas where common measures are appropriate and would allow research directions aimed at improving these measures. In turn, these allowances will promote the concept that, if we develop more universal measures of benefits, the sum of these benefits will be greater when they are all added together by the Sea Grant office.

Information Needs for Federal Decision-Making

Nancy Richards
United States Department of Commerce

It is a pleasure to be here and to discuss a topic with which I have interest. The title suggests a broad treatment of federal decision-making, but I am going to concentrate on one aspect of the decision process. The federal budget is the part I am most involved in, and it is most central to questions of evaluation and assessment.

In the past the budget process has been seen as a competition for scarce additional federal dollars -- a question of which deserving programs will receive the resources to expand. Due to uncontrollable increases in the federal budget and to a proliferation of programs competing for funds, the situation has changed. We now have to look at the process as a competition for continuing as well as for additional resources. No longer a choice between good and bad programs, decision-makers must select from good and better programs.

The administration's attitude on the budget has been made abundantly clear. President Nixon and his top advisors have stated on several occasions that further tax increases are unacceptable. Moreover, he has urged the Congress to enact a $250 billion limitation of federal spending. We have every indication that the fiscal 1974 budget requests submitted to the President will receive a more searching review by the Office of Management and Budget (OMB) than ever before.

The budget process thus imposes compelling requirements for evaluating programs. The first is simply one of accountability, reporting to the Department head, the President and Congress on the responsible use of funds from the public treasury. The second is one of justification for continuing or expanding programs by showing the accomplishment of past objectives and the resulting benefits.

The federal budget cycle begins each year in mid-January with the President in transmission to Congress of the annual budget request and of the budget message to the nation. The estimates cover the fiscal year beginning the following July. However, preparation of the proposed budget actually begins almost one year earlier. At that time heads of agencies like Dr. White for NOAA ask their program managers to draw up initial plans for the budget year.

These plans are summarized and submitted as a preview estimate in the spring. There is an informal dialogue within the Administration on the general shape of the budget under consideration. The Cabinet secretaries communicate their initial program requirements, and the President provides preliminary guidance on the overall budget level.

The result of this dialogue is usually guidance of a very general nature, with little resulting impact on the preparation of individual budget estimates. The estimates are formally presented to the Cabinet secretary for his review in July, 12 months before the period covered.

At the Cabinet level and within agencies the requests are subjected to a number of informal reviews and to more formal policy discussions. After a series of decisions and appeals, the budget estimates become the formal request of the Secretary to the President for his programs.

Agencies revise their requests and supporting documentation to reflect Secretarial decisions and submit them to the OMB in mid-September. The OMB imposes a number of formal requirements on the preparation of budget estimates. With emphasis, changing the concept of planning, programming, budgeting and spending has come and gone in the time that I have worked in Washington. However, the emphasis on relating future requests to past accomplishments has remained. Instructions call for identification and analysis of these important factors -- the national problem to which the program is directed; the magnitude of need; the extent to which the current program is meeting that need; and responsibility of the federal government in meeting the need. In summing up the Commerce Department's performance on the fiscal 1973 budget, and assistant director of OMB commented:

> One of the things we have stressed in previous discussions with the Department has been the need to identify and quantify objectives and outputs of the various programs. This is particularly important for programs, such as NOAA, that have experienced considerable increases over the last few budgets ... A reevaluation of performance criteria would help not only to insure that programs are doing what is desired, but also aid in the selection of future activities which will be consistent with stated goals and objectives ... These comments are illustrative of the kind of program evaluation we feel is

important, particularly in terms of identifying output from Federal investment.

The review conducted by OMB is stringent, based on a budget ceiling established by the President. Here, scarcity of resources to cover departmental requests becomes acute. After hearings within the departments and within OMB, recommendations are submitted to the President beginning in November. Interaction on the complex issues within the budget continues through December before Presidential decisions are formally transmitted to the Congress in January.

Congressional review of program and budget requests is more pragmatic and in many ways more stringent than those by the administration. The mysteries of cost-benefit analysis and other budgetary concepts were never very well received by Congress. Legislators' questions tend to be blunt and plain but equally difficult to answer -- "What did you do with the money we gave you last year? How do we know you'll be able to accomplish what you say you will with the funds you're requesting?" Congress is less interested in program philosophy than in plain facts. Commerce Department budget requests are heard by the State, Justice and Commerce subcommittees of the Appropriations committees of the House and Senate. In the last Congress, John Rooney of New York was head of the House Appropriations subcommittee, and John Pastore of Rhode Island was recently named to head that Senate subcommittee.

An optimistic schedule would call for House hearings in March and appeals to the Senate in April, with conference committee action completed by the end of June. Only a superhuman effort appears to allow such a schedule to be followed. In 1972 the House allowance was reported May 15, and the Senate completed floor action on the appeal June 15. Conference was not held until October 10, and we are still awaiting final enactment of the 1973 appropriations bill. In this, as in many other years, we have been conducting reviews on budget requests for next fiscal year without knowing what the program for the current fiscal year will be. While NOAA programs have fared well in the Senate, the House carries great weight in appropriations matters. It is certainly much easier to obtain funds if they are included within the initial allowance of the House.

Two facets of the budget process have been demonstrated -- the annual review of all programs; and the number of different decision points within each annual cycle. Each requires hard information on program accomplishments.

Turning specifically to Sea Grant, what kinds of questions are raised about Sea Grant through these reviews? What expectations have been raised in the minds of Congress and the public? What commitments has the Administration made for carrying out this program? Bob Abel initiated an internal evaluation process with a list of questions which Sea Grant officials have had to address in the past. They are excellent examples, and I would like to share some of them with you:

1. You found mineral deposits in state _y_ but what are the legal, economic, social and environmental implications of mining them? Is the state _y_ taking action based on your studies? Is there any real possibility of mining those deposits? What are you doing to get things moving?

2. Your lawyers did an analysis of state and federal regulations affecting marsh developments and offshore lands for aquaculture. Who is using this analysis? Is legislation being changed? Has the state paid any attention?

3. You've invested hundreds of thousands of dollars in modeling your coastal zone. Who uses the model? Who asked you to do this?

4. Your advisory service people have been working for three years. What results have they achieved? Can you demonstrate that the economy or sectors of the tax paying public are any better off as a result of their work?

5. What has this tremendous investment in aquaculture actually produced in terms of economic value? What companies have applied your research results? Who is producing your animals commercially? Are they surviving? Can you produce figures?

6. It appears that a good deal of what Sea Grant is doing contributes to the objectives of other NOAA programs. How are these efforts coordinated? Is there any duplication? How do the different efforts complement or support each other?

These questions were addressed primarily to individual projects. But they need to be answered in the aggregate, on the national scale, as well. Few of them call only for specific cost-benefit ratios. Certainly we are looking for dollar values where they are applicable and for quantifiable outputs wherever possible. But the principle thrust of the questions is toward hard accomplishments presented in systematic manner. The expectations of the Congress have been very clearly expressed in the National Sea Grant Act. The provisions of the act supply the basic criteria by which Sea Grant activities must be judged. The Declaration of Purpose provides that

-- marine resources ... constitute a far reaching and largely untapped asset of immense potential significance to the United States;

-- it is in the national interest of the United States to develop the skilled manpower ... and the facilities and equipment necessary for exploitation of these resources;

-- aquaculture and the gainful use of marine resources can substantially benefit the United States ... by providing greater economic opportunities ...; the enjoyment and use of our marine resources; new sources of food, and new means for development of marine resources;

-- in view of the importance of achieving the earliest possible institution of significant national activities related to the development of marine resources, it is the purpose of this title to provide for the establishment of a program of Sea Grant Colleges.

It has been stated in numerous Administration documents that the Act has three explicit objectives:

-- to accelerate training and education of specialized manpower, especially ocean engineers and technicians required by industry and government;

-- to initiate and support applied research, in predevelopment stages, particularly related to recovery and use of marine resources; and

-- to disseminate knowledge and information about marine resource development to all interested and concerned sectors of the nation through extension and advisory services.

These provisions have been cited to show what specific desires and objectives were expressed by the Congress and what results they therefore are expecting. While there are long-term implications in the program, there is also a sense of urgency which calls for a fair level of results in the short-term. "Achieving the earliest possible institution of significant national activities" does not indicate a willingness to wait a decade for accomplishments.

There are two areas that are particularly critical in this regard -- manpower training and advisory services. Much of the motivation for the act came from a recognition of the lack of skilled manpower. The first graduates could be expected within two to six years depending on the level of education. But this is a program that needs to be monitored carefully to insure that the proper mix of fields and that professional level is being produced. Specific objectives and accomplishments supported by statistics are called for. For the most part, Sea Grant has been very responsive in this regard.

The advisory services provide the vital link between Sea Grant universities and the community of users. Many of the solutions to marine development problems are still in the research stage. However, expectations are that a large body of technical knowledge already exists that simply needs to be put in the hands of industry and local officials. Clear objectives and systematic reporting of accomplishments are therefore looked for from advisory services as well as research efforts.

As mentioned earlier, the objectives of Sea Grant have been reiterated by a number of administration bodies, including the Council on Marine Resources and Engineering Development. These statements identify the Executive Branch firmly with carrying out the intent of the act. The Marine Council, NSF and now NOAA have made further commitments in setting policy for Sea Grant.

The need for programs to serve both national and regional needs has been made a criterion for awarding Sea Grant funds. Emphasis has been placed on pragmatic research programs with the support required to carry them through to economic opportunity. The coastal zone estuaries and the near-shore are identified as the principle focus of Sea Grant activities. All of these commitments present opportunities and requirements for evaluation.

One characteristic of the Sea Grant program seems to me to make evaluation and assessment doubly important. That is the commitment to continuity in individual programs, which has been developed carefully by Sea Grant officials. Recognizing the need for long-term development to produce many of the desired results, they have made the commitment to fund continuing programs at Sea Grant institutions, especially those which have been designated as colleges. However, this commitment only holds good if the activity at the institution maintains consistently high quality. One of the bases for receiving the continued level of funding necessary to develop long-range programs, then, is a clear record of past objectives achieved.

I hope that this discussion has demonstrated the general framework in which an evaluation of Sea Grant activities needs to take place. These are all areas in which federal decision-makers look for hard answers.

I would like to close with some general observations about how that evaluation might proceed. The first requirement is for a concrete statement of the needs -- regional as well as local -- that the programs seek to address. Second, objectives need to be formulated in terms that lend themselves to evaluation. If benefits or outputs cannot be quantified, then an end result can be identified with milestones against which to measure progress. Third, accomplishments against these objectives need to be reported.

Emphasis should be given to means of aggregating and summarizing these results. It is a measure of the success of Sea Grant that a listing of individual accomplishments is too long for a decision-maker to absorb.

If the accomplishments are intermediate steps, provision should be made to follow through and report on the final result, e.g., the establishment of commercial aquaculture. Finally, an attempt should be made to relate accomplishment of past and future objectives to specific levels of Sea Grant funding. Evaluations conducted along these lines would provide answers to the sorts of questions that Bob Abel identified.

But Sea Grant Is About People

William Q. Wick
Oregon State University

Those of us with agricultural college ties have recently found time to read an indictment of the failure of the Land Grant college complex entitled Hard Tomatoes, Hard Times[1]. Although I have difficulty agreeing with the book's apparent thesis that Land Grant is guilty of moving people off the farms so that corporate agribusiness could succeed them, some of the points about bigger, better, more mechanized, more complete, more efficient farming may support that position.

Since the title "Sea Grant" implies a kinship with Land Grant and since our discussion today seems to equate rampaging technology with cost/benefit ratios, perhaps we should take heed that Sea Grant is indeed about people. If not, I can visualize a sequel to the above-mentioned book, in 30 years or so, with a title of Frozen Albacore, Frozen Assets.

Sea Grant will succeed, despite our preoccupation with bigger and better gadgets, more and faster production, instant analysis of all ocean parameters and complex models of all flushing systems ... if we can develop a feeling among America's marine resource users that they belong to the human race. Our main mission is to work in the minds of men -- to improve their attitudes, perspectives and talents so that they may better contribute to their civic responsibilities, obtain a wiser understanding of the resources upon which they depend, utilize these sea resources more efficiently and productively and develop the knowledge and leadership capabilities required to fulfill these roles.

Whatever benefits accrue from Sea Grant efforts depend primarily on program philosophy and concept. If we at x university espouse Sea Grant as a people-oriented program to develop understanding and use of America's marine resources, then we are

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[1]Hard Tomatoes, Hard Times The Failure of the Land Grant College Complex Agribusiness Accountability Project, 1972, ix plus 308 p. 1000 Wisconsin Ave., N.W., Washington, D. C.

obliged to design the program to attack priority problems of x state based on (1) the combined judgment of citizens, affiliated government and the university and (2) the potentials of x university. Within this framework we can justify an emphasis in basic and applied research, in training students in advisory education or in a combination. Emphasis may change slightly from year to year, according to revised needs. Benefits may be more apparent once baseline data are gathered and implication of knowledge expands. This simply means that basic research is the foundation of the Sea Grant program or of any other multidisciplinary human and natural resource thrust.

Pragmatically it may be necessary to invent high profile emissions to give the illusion of quantifiable results early in a program's life. I prefer to do that rather than to permit a promising program to die without maturing to the point of solid accomplishment.

One of the best ways to develop action early in the program and to set the stage for the Sea Grant program is by involving many public-spirited citizens in marine problem identification. This step can include organization or aid in forming marine special interest groups, as well as participation in resource planning with county and other local officials. These activities are visible results of Sea Grant. After one of these planning sessions, a marine recreation leader said, "This was the first time that any public body has asked for my advice and then used it."

Let's get back to the game of cost-versus-benefit and how it fits into a people-oriented Sea Grant program. To a noneconomist the cost/benefit game is both exciting and scary. For every dollar Sea Grant spends, ideally a dollar or more would be gained, preferably in the same year. But the chances are that a dollar spent on a promising project may return $10 during the decade rather than instantly. On the other hand, if we pay the dollar back 10 years from now, the chances are that it will be worth only 50 cents. If not, can someone in this room explain the federal debt to me? The point is that cost/benefit can be a dangerous game or a useful tool. I prefer something else.

The Oregon State University Sea Grant Marine Advisory Program has attempted to keep records of benefits to people since Sea Grant began. We probably do this in a fumbling way, but short-term and long-term patterns are emerging.

Examples

1. We keep records of every nonfederal (private citizen, industry, local or state government) contribution of cash,

equipment, travel and time. During 1970 and 1971, total contributions amounted to about $49,000. To support the Pacific Sea Grant Advisory Program, about $20,000 in travel costs, subsistence and time by citizens was given in 1971-72 to help plan for marine development on the Pacific Rim. Are these costs or benefits? I'm not sure, but it is important to keep records. The benefit to people may be in the opportunity to participate.

2. We provide news releases to major general trade and technical publications and publish bulletins, fact sheets, brochures, announcements, slide programs, television programs, etc., on the wide variety of subjects encompassing the OSU Sea Grant Program. We tabulate how many copies of bulletins are distributed and how they are used. Film usage is monitored. One bulletin, Crisis in Oregon Estuaries, has been reprinted up to a total of 25,000 copies, and quotations from it have been cited in regional, national and international publications. Port commissions have used this bulletin as a teaching tool. When Crisis in Oregon Estuaries was first published, estuaries were figuratively unknown. New laws have since been passed to protect Oregon estuaries, and in September 1972, our Governor McCall cited estuaries as Oregon's most precious natural resource. Did the bulletin and the hundreds of educational slide programs presented by MAP staff members help?

3. The marine science public educational program of MAP is based at OSU's Marine Science Center. More than one million visitors have used the public program since Sea Grant started. Some visitors came to look and to be entertained; some school children (about 15,000 per year) participated in programmed lessons on marine science; others (about 1,500 homemakers) have learned how to pick crab, to peel shrimp and to fillet fish through "hand-minded" learning sessions. Perhaps 25 elementary and secondary schools in Oregon now have marine science elements integrated into science, mathematics, art and other curricula. Marine science projects were prepared in 4-H activities and are being field tested in several states. Summer programs combining sea science with marine art have contributed more than 500 separate activities during summer 1972. Our university president estimated that public visitations to the Center are worth $2 million annually to Newport's economy.

4. Can we claim as a benefit the leadership role developing among our Marine Advisory Program staff? Agents and specialists serve a multilevel clientele from the individual to corporations and governments at city, county, state, regional, national and international levels. This leadership includes chairing international forums, serving on national committees and coaching basketball junior leagues.

5. We view cooperating agencies as clients for information and as information contributors. We were able to save a federal

agency x number of dollars by suggesting that a method of analyzing benefits to sport fishermen was in error. The letter acknowledging this suggestion said, "Your observation that the opportunity cost of the investment should not be deducted from gross revenue is obviously correct. The procedure has been modified accordingly." Similarly, money was saved through workshops teaching seafood processors how to understand and to file federal waste discharge permits. For an agency that may have difficulty in executing a specific job, what is the value in having MAP provide aid in understanding? We can sometimes be of service because the people know us from everyday contact.

At times it may be ethically appropriate to be opportunistic, ready to strike and to take credit for benefits that happened because we were in the right place at the right time -- or, more properly, because we anticipated an event and were prepared.

6. Last spring, a MAP staff member attended a four-hour meeting and then spent two hours that evening preparing a two-page report on flood damage destruction to an ecosystem. The report allegedly tipped the scale for a $150,000 flood damage renovation project -- instant action at a good cost/benefit ratio.

7. Our "town hall" meetings with fishermen have been exciting. Although meant to be thoughtful, dignified, unexciting discussions between fishermen and management agencies, there always seems to be a crisis in early December when we meet. Foreign fishermen, hatchery salmon or crab season squabbles erupt -- and attendance zooms.

8. The micro-environmental "albacore central" program of 1969 and 1970 gave us a chance to test cooperative system among fishermen, agencies and the university. Fishermen continually tell us that this system helped them understand the fish that they sought, as well as comprehend the pure economics of the catch. The program has led to activation of other larger-scale albacore projects. Fortunately the thermal envelope necessary for albacore developed during those years, or the project might have faltered. Timing, again, was to our benefit.

Undue concern over cost/benefit ratios can also cloud an understanding of genuine accomplishments of the Sea Grant program.

A fisherman who visited another coast of the United States said to me a few months ago, "Those people down there are asking the same dumb questions we were asking four years ago." Four years of Sea Grant Marine Advisory Program field effort has resulted in major changes in audience involvement, talent and sophistication. Fishermen are better businessmen; they view themselves as professionals, use more advanced fishing gear and have a better understanding of electronics, hydraulics, refrigeration and sanitation and care of the catch. Several of our closer cooperators are becoming leaders, involved in a broad spectrum of public policy questions on local and regional bases. One young man became president of a 9,000-member fishermen's association. Similarly, port commissioners, county commissioners and coastal citizens are becoming more involved and talented in developing and preserving coastal resources. This is crucial since an overall coastal development plan for the Oregon coast is to be finished by 1975.

You might want to ask, "What did Sea Grant have to do with all this?" In almost all cases, the results came from a planned program that utilized the research knowledge and advisory talent of the Sea Grant university attempting to solve a problem identified by Oregon's marine publics. This is as it should be.

Sea Grant is about PEOPLE -- their hopes, aspirations, dreams and ideals in using the ocean for economic, recreational, scientific and aesthetic purposes. The Sea Grant Act was designed to help people by harnessing the university through ocean research, training students and utilizing marine knowledge.

Program introspection to assess benefits-versus-costs can be a useful exercise, even in a people-oriented program, if kept in perspective. Major program benefits may take more than a few years to materialize. In the meantime, we should be recording obviously measurable activities -- meetings held and bulletins published, etc. We should be opportunistic in claiming appropriate credit for results that may or may not have been planned but for which we were prepared. Most importantly, we should gather evidence for the long-term success stories with and about people that will be the true measure of whether or not Sea Grant succeeds.

DEEPWATER TERMINALS

Ocean Technology Trends

Ernst G. Frankel
Massachusetts Institute of Technology

Transportation has undergone radical technological and operational changes in recent years. Ocean transportation, in particular, has been subject to a revolution in ship size, dimension and operational characteristics. At the same time, ship-to-shore transfer and inland-feeder transport technology has changed significantly in form and method. As a result, our concepts and definitions of port requirements must be reevaluated. In ocean transportation a large proportion of the development is tied to the availability of deepwater ports.

These ports are designed not only to handle the increasing draft of ships but also to provide improved navigational access and better control or prevention of pollution and of other detrimental factors. The large unit cost and unit capacity of deepwater ports induce the requirement for multiple user or multiuse of such facilities. Similarly, such facilities should be designed as part of an overall transportation system.

Deepwater port alternatives are numerous and will continue to increase as new concepts, novel material handling and transfer methods are developed to provide the required improved modal interfaces. Although most deepwater port concepts are concerned with the transfer of liquid bulk cargoes, primarily crude petroleum, large efforts are currently underway to utilize the economy of size of such terminals and thereby serve shipping systems in the transport of dry bulk cargoes. In many instances combined or interchangeable use of deepwater port facilities and of large ships for dry bulk and liquid bulk cargo is advantageous. Developments in slurry movement of dry bulk cargoes and various types of continuous mechanical conveyors introduce new opportunities for deepwater port developments. Similarly, unitized and other general cargoes increasingly demand deep-draft transfer facilities.

Trends in Demand and Supply of Ocean Transportation

In addition to changes in ship size and speed, recent years have brought increasing demands for more specialized ships. The general-purpose cargo ship has been largely replaced with ships distinguished by their specialized cargo handling and stowage functions. Similarly, dry and liquid bulk carriers cover a wide range of specialization. The amount of world deadweight ton (dwt) capacity has practically doubled since 1955 and is expected to double again by 1980. The largest capacity growth is in dry and liquid bulk carrier while general-cargo ship capacity has remained fairly constant. This is explained by the greater increase in bulk movement growth and by the larger improvement in unit productivity of unitized general cargo ships.

With larger tankers ton-miles per dwt introduce improvements by the effect of increased unit dwt on port time losses amounting to an increase in ton-miles/dwt capacity of less than two per cent for an average tanker dwt increase of 50 per cent. Container ships offer larger improvements in ton-miles/dwt as higher speeds and faster turnaround jointly affect transport capacity as multiplying factors. As a result, a container ship with a 50 per cent higher capacity (dwt or cubic) and 50 per cent higher speed than an average cargo ship on a transoceanic route will usually offer better than a 200 per cent increase in ton-miles/dwt (or measurement ton).

Tankers in 1971 comprised nearly 50 per cent of the world's dwt capacity but less than 25 per cent of the total number of oceangoing ships. Although container ships represent less than 1.4 per cent of the number and 2.5 per cent of the dwt capacity of the world's general cargo fleet, they produce more than 8 per cent of the ton-miles of general cargo movements and generally are at least three times as productive as general cargo ships.

The demand for bulk transportation is expected to increase from 2000 billion ton-miles in 1970 to 4000 billion ton-miles before 1980. The net supply available to meet this demand in 1970 was 2350 billion ton-miles or 18 per cent above transport demand, a situation producing a significant price rise. By 1975 the supply margin is expected to rise to about 50 per cent, a fact that seriously affects prices currently offered for shipping capacity. Thereafter, the gap can be expected to close again and may even achieve a smaller margin than during the 1967 and 1970 supply "shortage." World shipyard supply capacity, which only increased by about three per cent per year during the fifties, achieved an average growth rate of over seven per cent during the sixties. This capacity increase is expected to continue at least to 1975, when the last of the currently projected new shipyards becomes operational.

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[1]Productivity increase per dwt $= \frac{\text{Avg. \% tanker port time}}{\text{New avg. dwt/Old avg. dwt}}$

The continued controversy regarding the economies of very large crude carriers (VLCC) will be more affected in the future by operating considerations than by investment cost components. While the unit transport cost curve usually levels off at about 250,000 dwt and sometimes reaches a minimum at about that number now, increasing fuel and insurance costs, more extensive automation and greater availability of terminals for tankers of 350,000-800,000 dwt will tend to reduce costs of very large tankers relative to those of smaller VLCCs.

Increases in fuel and insurance costs will always affect smaller tankers to a much larger extent. As a result, it is expected that the most economical tankers for a typical 10,000-12,000 mile (one-way) route will be: 300,000 dwt, 1974; 350,000 dwt, 1976; 500,000 dwt, 1980; 800,000 dwt, 1985.

It is now generally assumed that more than 50 per cent of new tanker dwt delivered after 1975 and that 70 per cent after 1980 will have a unit capacity in excess of 250,000 dwt. The marginal unit transport cost differential between a 200,000 dwt and 300,000 dwt tanker that was marginal in 1971 is expected to be about 20 per cent by 1975 and over 30 per cent by 1980.

Ship Technology Trends

The number of ship types available today is diverse. At the same time, there exists a large number of propulsion and other subsystem alternatives that introduce a practically infinite number of combinations of ship type and subsystem selections. Similarly, ships with a particular function such as container ships can be considered in a large number of possible configurations.

The dimensions of oceangoing ships continue to increase for all types of vessels. Considering tankers and dry bulk carriers, note that the average tanker or dry bulk carrier under construction today already has a draft exceeding the depth provided by all but one U.S. port. It is expected that the draft of the average dry or liquid bulk carrier in the world fleet will continue to increase with the average size of vessel. Unless deepwater ports are provided, less than one-third of the world's bulk carrier tonnage will be able to serve the U.S. after 1976 if the present trend in tanker and dry bulk carrier development continues. The great advantage of tankers and dry bulk carrier displacement types over other types of hull forms will be noted. It could similarly be shown that the specific power requirement for large bulk carriers at low speeds offers increasing advantages for the large size of vessels of these types under consideration.

As noted earlier, container and other higher value dry breakbulk cargo ships will continue to associate an increase in ship size and throughput capacity with higher speed. In other words, it is not attractive to increase the size of a container ship on a transoceanic route without increasing its speed. The same is not true of short or medium container routes, and consequently a number of mini-container ships of comparatively low speed and capacity have been developed successfully. This trend to larger and higher-speed point-to-point container ships and to increasing use of container shipment may encourage the development of off-shore container terminals or transshipment centers.

Although many proposals for shallow draft VLCCs have been developed and some ships have been built to such specifications, there is an economic limit to the reduction in draft achievable without severely affecting payload or drag characteristics. As mentioned earlier, large tankers do not appreciably improve their ton-mile capacity with large unit deadweight tonnage, but over long distances the unit cost of carrying liquid cargoes in larger ships decreases appreciably with increasing size. A trend is expected to be amplified as fuel and insurance costs continue to rise. The new 530,000 dwt ton tanker ordered in France following the keel laying of 477,000 dwt tankers in Japan appears to have opened the door for the development of a half-million-ton standard tanker for certain trade routes. There are two or three existing routes capable of accommodating such tankers. The transport requirements on these routes projected to 1976 justify as many as 20 half-million-ton tankers. Therefore, construction of tankers of that size will continue. This trend can also be expected to have major effects on other trade routes.

Dry bulk carriers lag behind tankers, though 280,000 dwt ore carriers are presently in existence. The major constraint on rapid development of larger such carriers is the smaller cargo flow between loading and unloading terminals and the lower value of the cargo, which affects terminal investment incentives. As the economics of dry bulk carrier operations continue to favor increasing size, we may expect to see 350,000 ore carriers or combined carriers on the seas by 1978.

Major developments have also taken place in the area of ship propulsion. Although steam turbine and direct drive diesel machinery is still very much in use, medium speed geared diesels, gas turbines or combined plants increasingly provide alternatives. Steam turbine propulsion plants of 60,000 shaft horse power (shp) per shaft with specific fuel consumption of .44 pounds per shp-hour and direct drive diesel plants of up to 42,000 shp with specific fuel consumpsion of .36 pounds per shp-hour are operating. These steam turbine plants today can be provided with specific weights of less than 50 pounds per shp, while direct diesels usually weigh 80 pounds per shp or more. The large specific weight, comparatively high investment and installation cost of these traditional power plants have led to increasing consideration and use of marine-type gas turbine or geared medium-speed diesel plants. Although gas turbines still require appreciably higher specific fuel consumption than steam turbine plants, recent developments indicate the possibility of achieving fuel rates as low as .43 pounds per shp-hour by 1976. Geared medium-speed diesel plants can usually deliver power at the rate of .37 to .38 pounds per shp-hour with combined specific plant weights of less than 40 pounds per shp. For both medium-speed diesels and gas turbines, the problem of reversibility usually exists. The availability of reliable reversing gears and of propellers with outputs in excess of 30,000 shp provides the capability for effective use of these propulsion plants. Such combinations, furthermore, often provide additional operational efficiencies and maneuverability.

Additional trends in technology occur in the areas of ship control, navigation and cargo handling. Such developments include installation of preliminary anticollision devices and construction of fully automated ships with onboard computers for control of machinery and of navigational functions. The same computers are often used to provide inputs for cargo planning and for cargo systems operations, particularly on large dry and liquid bulk ships. Some of these are equipped with fully automated cargo loading and unloading systems. A large number of ships are in operation today without engine room watch and with only a skeleton engine staff for preventive maintenance and inspection functions. The increasing use of easily controlled and automated machinery plants such as gas turbines and medium-speed diesels is expected to lead to an acceleration of the adoption of full automation of marine propulsion plants. Similarly the light weight and compactness of these power plants make it increasingly attractive to perform major overhaul and repair functions ashore by replacing faulty units. This approach is expected to allow not only continued reduction of engine room crew but also more effective scheduling and higher utilization of ships.

Bulk cargo handling systems have developed capacity in line with ship growth. As a result, the bulk carriers loading and offloading rates are such that turnaround time is a marginal function of ship suze. New technology in handling fluidized dry bulk cargo in the form of slurries, etc., permits vast economies in the transfer and storage of many cargoes traditionally handled by mechanical conveyors or similar equipment. The resulting increase in handling speed and decrease in equipment and operating costs offer major new opportunities for dry bulk transportation. In parallel, many new developments in the handling of dry break-bulk cargo have occurred that permit vastly increased handling of cargo. As a consequence, modern break-bulk ships that carry cargo unitized in trailers, containers, barges or on pallets can often achieve less than 24 hours in turnaround time independent of the amount of cargo transferred. The impact of unitization is felt in improved ship and port utilization , and in packaging, insurance, handling and feeder costs. In general, ocean transportation is moving towards more capital intensity and labor extensity aboard ships and ashore.

Container ships and barge carriers with lengths in excess of 1000 feet and loaded drafts of more than 40 feet will be operating on major developed trade routes before 1980. This will result from increased density of unitizable cargo flows due to growth in demand for trade of industrial goods and to savings inherent in unitized movements. Economy of size will dictate the development of this new generation of carriers. It appears that speed of such ships will converge on the 27-29 knot range, which is attractive on both Atlantic and Pacific runs.

Deepwater terminals are now of primary concern for handling liquid bulk carriers, dry bulk ships, container ships and barge carriers. There may soon be a more intense demand for availability of deeper draft and for more accessible terminals than now provided by traditional ports. It is becoming increasingly obvious that ports within densely populated urban areas cannot effectively serve the intermodal function between ocean and inland transportation.

Technological Forecasting

The rapid change in technological developments requires continuous reevaluation of technology trends. The period between generations of a particular type of ship has been reduced to a fraction of the expected ship's lifetime. Therefore, we must forecast developments to assure effective incorporation of features that allow ship systems to remain competitive throughout their life. This is particularly important in planning new deepwater port facilities whose life expectancies will span several ships' lifetimes and a number of generations. Ship technology developments are increasingly dependent on interface developments and vice versa. As a result, analysis must be performed for the total system.

Scientific and technological advances from other areas have a pronounced effect today on ocean transportation technology and are often adopted for use before acceptance by other modes. This is a drastic change from the traditional unwilling reactions by ocean transportation and from the long time delays before acceptance of innovation and change.

Environmental aspects have become an important factor in the design of ocean transportation systems and in the development of new technology. They affect the design of ship structures, ship subdivision, utilization of cargo spaces, cargo handling systems, propulsion and navigational systems, automation control and operational procedures.

A large number of technological forecasts have been performed in recent years. Some of these were based on traditional trend analysis, while others used pooling methods such as the Delphi technique. The results of recent forecasting exercises performed in Japan, the United Kingdon and the United States are listed in Table I.

Technological Challenges for the Seventies

Although doubts may be raised concerning implementation of many technological and operational forecasts, all the developments mentioned:

1. Are theoretically feasible.

2. Solve known problems.

3. Offer economic and operational advantages.

4. Provide great opportunities for the risk-oriented ocean transportation investor.

5. Introduce the step increase in capability or capacity needed to meet future demand.

As an industry, ocean transportation is unique in many ways but at the same time is among the most traditional and progressive of human endeavors. This industry is labor intensive and extensive; it provides opportunities to the small operator and to the large corporation with equal chances of success. It is international yet highly nationalistic. Among the most essential of services, ocean transportation is basically an enigma to the average citizen, who maintains a romantic illusion about shipping. It is a highly capital-intensive industry, yet undercapitalization predominates. Though many of the great fortunes of the world have and are being made in shipping, this business remains a highly protected and/or subsidized industry. It is a major tool of economic warfare, particularly by nations jealously guarding freedom of the seas and free competition in ocean shipping. Supposedly a highly competitive, free enterprise industry, it is subject to more cartelization, rate fixing, conferences, discounts and other approaches designed to reduce free competition than most industries.

Notwithstanding, ocean shipping is cheaper in a relative sense than ever before, and the quality of service is generally better. It provides larger margins in capacity and greater flexibility, yet offers more specialization.

At the same time, many problems have arisen that require prompt action. Among these are the following:

1. Labor availability and skill; working and living conditions; labor relations; demands for elimination of ardous tasks without their replacement by monotonous tasks.

2. Environmental protection; prevention of air and water pollution; reduction of noise and vibration as well as control of temperature and humidity within vessels; containment of spills, etc.

3. Integration with other modes; terminal interface through documentation, billing and cargo consolidation; capacity balancing.

4. Physical form change of cargoes; packaging and resulting effects on ship form, operation, cargo transfer and storage.

5. Unit lot size of cargoes; ship size and inventory holding costs.

6. Navigation and traffic control on open sea lanes and in congested waters.

7. Fuel cost and availability; rising fossil fuel costs and shortages hasten development and adoption of more efficient energy conversion.

8. Port accessibility and availability; outmoded concepts of the urban port; replacement by efficient and independent port complexes with free access to open sea lanes and inland transportation routes; provision of ample storage and consolidation capacity.

9. High investment requirements in ocean transportation are at a level where private investors can no longer generate the capital or assume the risks; increasing involvement of large investment companies, banks, major corporations, governments, international agencies and other nonshipping interests; merger of shipping companies into fewer and larger entities; investment

in transportation systems instead of vessels; consideration of total movement control.

10. Increasing attacks on traditional maritime law, rate and operational regulations and ship classification; demands for "equal" opportunity or rate control by developing countries.

11. Complexity of transportation system management; science of transportation management lags behind developments in other industries.

At a lower level of detail we confront many operational deficiencies such as:

1. Insufficient maneuverability.

2. Excessive stopping distance of large ships.

3. Lack of training and commitment of crews.

4. Lag in development of efficient lightweight, low volume marine propulsion systems.

5. Efficient and reliable thrusters, particularly for higher speed.

6. Effective full power reversing devices for high powered unidirectional propulsion plants.

7. Obsolescent docking and mooring methods.

8. Lack of effective berth approaching methods independent of outside (tug) assistance.

9. Outdated ship supply and strikedown systems.

10. Ineffective maintenance and repair methods.

11. Cumbersome conversion of rotational energy into thrust; inefficient thrust transmission.

12. Fouling and corrosion of external surfaces; corrosion of internal surfaces.

13. Handling and stowage of general cargo.

14. Ship safety devices.

There are obviously many other areas where improvements are required. Although "safety of life at sea" is still a predominant concern, it is only one of many major concerns in new technology development for more effective and economical ocean transportation.

The technological challenges of the seventies are numerous but the means for solutions of many problems are at hand. Technological developments in ocean transportation are dynamic and affect all deepwater port developments and other related systems.

Conclusion

Ocean transportation trends are toward larger, safer and more efficient vehicles. Largely unmanned ships, with computer-controlled navigation, propulsion plant and cargo handling systems may well be in service before the end of this decade. Half-million-ton dwt capacity ships are on order. Transmissions without hull-penetrating shafts are offered by superconducting and hydraulic energy transmission devices under development now. Laser-controlled berth approach techniques and automated mooring devices are being designed. Cargo ships exceeding the speed of fast passenger liners ply the sea lanes now. Ocean traffice control systems could be implemented with international agreement. Anticollision and antigrounding devices could be developed shortly.

These and many more developments will invariably come into being. They will change the traditional approach to ship design, construction and operation. They will also affect port requirements and functions and justify or demand deepwater facilities different from any past port concept. These developments will change conventional concepts of interface requirements as transportation becomes a more efficient, continuous and systematic flow of goods from origin to destination.

Table 1.

Ocean Transportation Technology Forecasts

A. Predicted as Realizable in This Decade (by 1980)

1. Anticollison and antigrounding devices
2. Oil spillage containment and clean-up techniques
3. Oily water separator
4. Continuous and automated unitized cargo (pallet or container) loader/unloader
5. Detachable lifesaving bridge and/or deckhouse structure
6. Completely automated propulsion plants
7. Completely automated bulk cargo loading/unloading systems
8. Completion of oceangoing trimaran vessel
9. Completion of oceangoing surface effect ship
10. Completion of first 750,000 dwt tanker
11. Development of submerged tanker terminal with bottom loading/unloading system
12. Development of marine gas turbine with specific fuel consumption of 0.42 lbs/shp-hour
13. Development of effective smoke emission device for ships
14. Development of truly effective oceangoing, detachable tug-barge or barge-ship coupling system
15. Draft reducing device for mammoth tankers
16. Sea traffic system controls and automatic navigation system
17. Automatic ship mooring and docking systems
18. Catamaran containerships
19. Semisubmerged catamaran ships
20. Effective tanker safety (fire, explosion, etc.) system
21. Floating offshore container terminals
22. Superconducting ship power transmission system

B. Predicted as Realizable in the 1980's

1. One-million-ton tanker
2. Automatic port and harbor navigation and maneuvering system
3. Large oceangoing surface effect ship
4. Fuel cell ship propulsion system
5. Completion of first ship with batteries for propulsion
6. Completion of submarine tanker
7. Ships built with automatic 'cold' steel joining techniques
8. Completion of unmanned merchant ship
9. Completion of tanker loading/unloading system without hose connection
10. Economic nuclear marine propulsion
11. Overland ship transfer systems
12. Inflatable/deflatable ships

Who Should Operate the Offshore Terminals: What Are the Options?

Paul A. Amundsen

American Association of Port Authorities

We of the port authorities association have been watching the approach of a U. S. deepwater terminal with less wondrous enthusiasm than other groups. Our members, who manage the 80 public seaport administrations of the United States, have long known that such terminals would appear and approximately where. We have also known "when" -- about the same time long-voyage crude begins arriving on our shores in quantities that would bring the economics of superdraft ships to play.

At some point in the future, the line of domestic and near-Western Hemisphere production will cross the line of increasing domestic consumption, making deep-draft terminals for deep-draft ships from far places a feasible circumstance. When that point arrives, the terminals will be there because economic feasibility will be there.

Meanwhile, there have been thousands of recent speeches and articles citing the supertankers of increasing size being built by Ishikawajima Harima, among others, and citing the fact that the United States has few seaports that could serve these vessels. For a while it seemed that every new keel-laying in the "Universe" series brought a fresh restlessness about the "obsolete" U. S. port system; it seemed that only port authorities and the petroleum industry knew that the "Universe" tankers were locked into the Kuwait-Bantry Bay run and would not need the special facilities that we had the foresight not to build.

Today most of the hysteria is behind us, and there is a growing body of deepwater experience overseas as well as a growing shelf of domestic deepwater literature -- some of it sound. As we take a hard look at offshore terminals I would like to place into that literature some basics that I have not seen considered.

The first of these basics is the lack of competition between the public port authority and private industry in the United States. The public port authority does those things that private industry lacks the ability to do, or for which there is no private industry capacity in the port area. Since the rate of return on investment in general-cargo marine terminals is typically one per cent, private industry is absent from that endeavor by choice -- with a few isolated exceptions.

Because orderly harbor development and promotion in the U. S. are ventures in public finance requiring broad mandates by a local political authority or commission, we know that private industry lacks the ability to perform in such a climate. U. S. public port authorities are a unique combination of public administration and business enterprise. Typically, they are "public enterprise" in nature.

A third level of seaport endeavor consists of activity suited neither to private industry nor to local port authority. This is activity in the national interest, and this is rightly handled by the federal establishment. Customs, quarantine, coast guard, immigration and numerous other federal services function on the seaport scene. We have the Federal Maritime Administration (developmental) and the Federal Maritime Commission (regulatory). The U. S. Army Corps of Engineers is responsible for navigable waterways, harbor depths, breakwaters, jetties, channels, etc.

With this as background we can begin to discuss deepwater terminal operation and the various options.

Private Industry Operation

To think of private industry as the actual operator of the deepwater terminal seems natural. Private industry, which operates most deepwater transfer facilities in the world, certainly has the expertise to do so. Experience includes pile structures with loading arms in Kuwait, Iraq and Saudi Arabia for loading and in Bantry Bay, Okinawa and a number of Japanese ports for discharge. Multibuoy moorings are used at marketing, refining and crude-loading terminals in many places; numerous single point moorings are also in use throughout the world.

In a unique example at Bantry Bay, private industry has done it all. No Irish tax money has been invested, mainly because there are no public benefits. The oil company is prevented by law from storing or manufacturing petroleum products on the mainland. Transshipment is made to refining locations on the European continent. Bantry Bay is operated by and for a single company (Gulf Oil).

With the exception of Bantry and the Kiire operation of Nippon Oil in southern Japan (both purely private), the oil companies work jointly with port authorities in operating oil terminals. Usually the port authority provides the waterways, traffic control, etc., and the oil company conducts the actual terminal operation at a privately owned dock. France is an exception, having port authority-operated terminals.

The U. S. offshore tanker facility differs radically from most in its joint-facility aspect. Potential locations on the North Atlantic and Gulf Coasts are considered in terms of multiple use by several oil companies.

Various refineries in the New York-New Jersey area and in the Delaware River area would receive crude from an offshore terminal off Sandy Hook, in one proposed example. Ten major oil companies have substantial refining facilities in the area, the average distance being 69 miles from the proposed Sandy Hook site. The closest refinery to the proposed site is 19 miles, the most distant is 110 miles.

Louisiana and Texas proposals also contemplate multiple use of the offshore oil facility. This prospect gives immediate rise to one of the limitations of private industry as the potential operator of the deepwater port. Possibly a group of 10 oil companies could jointly operate a single marine terminal facility, just as most pipeline companies are organized for joint use. However, such an organization at once assumes public utility and common carrier aspects that are more in the realm of public enterprise than of private enterprise.

There is also the question of equitable port benefits. If the site selected is to serve the refineries in a specific region, theoretically all should benefit equally: the 110-mile refinery receives crude at the same transshipment rate as the 19-mile refinery. In other words, no port-oriented industry should be forced into economic decline because of a regional deepwater facility.

One approach would be some sort of control by tariffs and rates over transshipment operations. The concept is similar to the equalization of railroad export-import rates among a range of ports to and from a common inland freight territory. Such rates are equal despite variations in actual distances and in routings between ports and inland points.

This again seems to be an area in which private industry is not particularly well adapted. The considerations are public-interest oriented.

Another constraint to private industry operations is the possibility of using offshore facilities for dry bulk and other commodities, in addition to bulk liquids. Some federal studies point in this direction. If a multipurpose aspect is added to multi-use, the structure becomes even more complicated as an operating entity if it is in private hands.

This may become more of a theoretical than a real consideration. In its testimony for recent hearings on a North Atlantic site selection, Humble Oil & Refining Company said:

> Humble does not support the development of multi-use terminals. We believe the concept is inherently at odds with the principle of preventing spills by engineering out the opportunity for operating mistakes. Multi-use implies additional operating procedures, differing types of equipment, additional ships, and congestion. Each of these complexities adds unnecessarily to the risk of an accidental spill. In addition, it appears that there is little economic incentive for deep-draft general cargo vessels. Other than oil, the only significant interest in deep-draft ships is for the export of coal and the import of ores. These operations, like the receipt of crude oil, are specialized operations best performed through dedicated facilities. Therefore, it appears desirable to construct deepwater facilities for the receipt of petroleum only.

In July John Mascenik of Esso told the National Transportation Engineering meeting of the American Society of Civil Engineers:

> Offshore oil terminals, especially discharge terminals, are relatively simple systems. The mode of operation for each type of facility is the same for every vessel that uses it. Thus, the personnel are trained specifically to berth the vessel, to load/unload it, and to unberth it. Handling other than normal liquids (with the exception of such items as ore slurry) which utilize pipelines in delivery to shore storage located many miles away would result in more complicated designs, variations in mooring and unmooring procedures and practices, and greater congestion. It would also require storage at the discharge point necessitating the construction of expensive man-made islands and breakwaters. This would increase the danger of collision and decrease the reliability of designs and operations. Also, the use of shuttle vessels as suggested in several proposed multi-use facilities does not alleviate the problem of congestion in existing

> ports. It would only add to it and increase the possibility of catastrophic collisions and groundings. Thus, multi-use facilities should be avoided whenever possible.

I agree with these experts. The primary goal of the deepwater offshore facility is to get crude oil into the refinery via pumps and pipelines; there is no need to hold the crude offshore. As for dry bulk and transshipment, I cannot see bringing some of the small vessel traffic that is congesting the inner harbor out to the offshore terminal where the supertankers will operate. Other suggested uses for the offshore island concept such as aviation and waste disposal are also magnets to small craft traffic.

The Federal Operating Alternative

Assuming that there are certain built-in reasons why a multi-use deepwater terminal should not be privately operated, it will be valuable to take a look at the advantages and disadvantages of federal operation.

The U. S. government is not new to operations -- before World War II a federal barge line aimed at reestablishing waterway transportation was operating on the Mississippi River. Such enterprises as the St. Lawrence Seaway and the Alaska Railroad are also federally operated. Each of these enterprises is or was an operation to which private industry and local government were equally ill-suited. From the viewpoint of local government, these operations are regional in nature; to private industry and its balance sheet, they were not attractive to private capital.

The federal government has made fine terminal operation accomplishments in the field of military ports and should be credited accordingly although such operations follow budgets rather than balance sheets.

At first glance, one would suppose that a deepwater offshore terminal calls for a federalized operating approach because of its regional character, but that supposition may be too oversimplified. There will probably be a number of such terminals. In the testimony on North Atlantic locations we have the following:

> Humble believes that eventually more than one deepwater port may be needed to supply the East Coast's growing crude oil requirement. A terminal is needed convenient to each refining center in order to

achieve the maximum economic and environmental advantages.

The strong programs promoted by Louisiana and Texas indicate that there may be more than one deepwater terminal in the Gulf of Mexico as well. The 1972 Louisiana legislature created a "Deepdraft Harbor and Terminal Authority" in keeping with the established concept of port authority operation in the United States. In Texas the ports of Galveston, Freeport and Port Arthur funded a preliminary survey toward a Texas superport.

The currently discussed Sandy Hook location lies entirely within the jurisdiction of the Port Authority of New York and New Jersey, and one oil company official has said that his industry would not be averse to jointly operating a terminal with that highly regarded agency. The agency itself has not commented.

In the national interest the federal role is more logically one of site selection (already proceeding), regional research on commodity flows (already proceeding) and construction of the basic substructure, similar to handling a breakwater or jetty as a Federal Rivers and Harbors project. Maintenance of the substructure appears to be another logical federal function.

As we described in the Report of the Institute for Water Resources of the Corps of Engineers, federal governments involved in deepwater facilities elsewhere in the world function in the same fashion.

In the Netherlands, Rotterdam is a municipal port that receives national funds for maintenance dredging outside the harbor and two-thirds of initial deepening costs.

In British ports a system of government grants provides for 20 per cent of the cost of any new harbor works that benefit Great Britian's national and foreign trade.

In France Le Havre benefits from government aid in maritime approach channels, sea walls, the outer harbor and access locks from the sea.

Specifically for deepwater ports, Japanese subsidies are predicted to be in the neighborhood of 15-20 per cent in the near future. In other words, national governments subsidize in varying degrees but do not operate.

Port Authority Operation

Public port authorities have the great advantage of prior experience in operating a multi-use terminal. They are familiar with the public service nature of such a terminal, with the needs of private industry in the shipping business and with the various governmental agencies with which they deal daily on regulatory, safety, environmental and other matters.

It should be understood, however, that the public port authority does not look at bulk terminals as it looks at general cargo terminals. The latter have a certain flexibility, and there is a broad market for their use. As steamship lines, terminal operating companies and consortiums come and go, leases are signed, terminated and re-signed for the use of such facilities.

Bulk cargo facilities, on the other hand, are highly specialized. Some of them, like the single-user offshore oil terminals elsewhere in the world, are so specialized that the company can afford to construct them for its sole use because of an assured large and steady controlled volume. Such marine terminals are simply links in a processing cycle. There are many such private facilities within the U. S. port system for various bulk forms.

There are also a growing number of "public" bulk terminals owned and operated by port authorities. When a port authority goes into this type of highly specialized operation, it must have a long-term commitment of movement in volume because, as specialization is provided, flexibility is sacrificed.

Such a commitment is certainly present in a multi-use deepwater crude oil terminal. Long-term volume seems assured, and multi-use strengthens public investment by spreading the risk. It seems likely that a prudent public port authority would find it favorable to engage in this type of operation.

To operate the facility, such a port authority would calculate costs, direct and special, add overheads and divide by the amortization period to determine its annual cost of amortizing the facility. To this annual amortization cost would be added the yearly cost of maintenance, utilities, insurance, dredging, administration and operation. A total annual cost would then form the foundation for its rate base.

In keeping with our way of doing business in this country, there could be a certain federal input for the first costs and maintenance of the substructure. It can be assumed, then, that the port authority investment would relate to the superstructure, berths, service facilities and the like. The assumption that private industry would bring its pipelines to the terminal at its own cost or on a cost-sharing basis would complete the operating structure for practical purposes.

The New York-Philadelphia refining area has a capacity of more than one million barrels a day, and a consumption of four times that amount. One can assume that the traffic in that area would support, in terms of operating costs and amortization costs, a public terminal operation. It must be emphasized, again, that these two factors must be included in the rate base. That kind of facility has no alternative residual value as a long-term investment.

Nothing new or radical has been presented here. The port authority industry has been providing ship facilities for many decades. Most of the time, its people have invested vision, encouragement and leadership of the kind that enables the carrier to develop his service to the fullest.

In the early days of the container movement when there were frequent bankruptcies, this responsibility sometimes meant red ink on the public port books. But every port involved in that movement remained steadfast in its developmental interest and can be proud of that record.

Public port authorities have been supporting wholesale resumption of East-West trade for at least the last 10 years. Through the field offices of our members all over the world, worldwide trade has been generated for decades.

If a certain pragmatism is maintained about superports and superships, I hope that this view will not be considered as lack of vision. Indeed, this outlook should be taken as quite the opposite.

Who will actually operate the offshore oil terminal, private or public, local or federal? The decision-makers will have to take a look at the options, in much the same manner as they have been presented above, to choose the final route.

Deepwater Ports: How Do We Get There from Here?

Brigadier General K. B. Cooper
U. S. Army Corps of Engineers

Throughout the nation, concern is expressed whenever superships and superports are mentioned. This is not surprising since new ideas and new plans often produce uncertainty and unease. There is the fear that we will be trading old ports, familiar trade patterns and established institutions for new ones, greatly disrupting habits and lifestyles. There is also the fear of damage to the physical environment and the dangers of uncontrolled growth and/or decay to the social environment. And not least is an overwhelming fear of competition that cannot be met.

All these concerns are somehow intermingled with the excitement of challenges to be met and with the thought that we will, in responding to public needs, have the chance to improve our private and public lots. In some places the fears predominate, in others the spirits of adventure and optimism prevails. On closer look, these emotions are often found to be part of the same concern.

The Social Process

No one doubts that the United States has the scientific and management capability to develop deepwater ports in our coastal waters. After all, many deepwater terminals throughout the world were built by American engineers, often working for American companies.

It is the social or organizational questions -- such as how to manage our emerging port requirements -- that concern us. This is a very healthy sign, signifying that we are clearly a society in contrast to a mere economy. We see that there are important legal, financial, social, organizational and institutional problems to be solved. When speaking of the social process and how we may successfully go from where we are today to the safe and super harbor of tomorrow, I am willing to hazard stepping into the future on the basis of my belief that we are a socially imaginative people and that we will find ways to make changes successfully, with a keen sense of private and public values.

Private and Public Roles

For the foreseeable future superports in the United States will be principally concerned with crude oil arriving in deep-draft tankers from the Middle East and North Africa. By the year 2000 we may need to import one billion tons of crude petroleum annually. The specialized nature of the ports needed to receive these huge shipments makes it essential that oil refining companies involved have a major hand in planning and financing the superports required. I believe that it is safe to say that the oil companies want to undertake this task and stand ready to do so. In several instances the companies have already formed into groups with the intention of carrying out deepwater port developments. The aggressive interest of the private sector must be encouraged and supported if this job is to be done well.

There is likewise a need to clarify the public role in respect to superports. Efforts toward this end are underway in several federal departments and in the Executive Office of the President. The states are also actively studying the superport problem and are seeking to define their relationships to the needs of oil interests and to their own public responsibilities, as well as to programs and policies of the United States government. Several states have created, or are considering the creation, of superport authorities designed to act in the public interest when and where deep-draft facilities are developed.

In general the states and the federal governments have the same or very similar concerns. Their investigations seek to determine which political, legal, financial and managerial institutions need to be involved in the planning, development and management of ports for very large bulk oil concerns; to determine how these institutions would be used; to determine the policy issues likely to be raised by their involvement; to determine how current institutions might be modified; and to determine what management structures are best adapted to current and potentially modified institutions.

To speak less abstractly, the federal and state governments seek to guide port developments so that there can be an equitable treatment of all who need and wish to use port facilities. The land and sea environments will be protected, and public safety and well-being will be strengthened with the coordination of port developments by the state and nation.

Only with a clear recognition of both private and public aspects can superport development go speedily and successfully forward. It is in the defining of these aspects that the Sea Grant Program can render a distinguished public service -- a service that no other group is so well qualified and equipped to render.

Federal Efforts

Both the legislative and executive branches of the federal government are deeply concerned with development of sound policy and guidance for our deepwater port development, recognizing the close connection with our nation's energy problem.

Congress has asked the Corps of Engineers to investigate the potentials for accomodating deep-draft shipping on the Atlantic, Gulf of Mexico and Pacific Coasts. They recognize that site selection must be made with a knowledge of many factors. Truly strategic sites are limited and unique national resources and must be treated as such. The President also has a broadly based investigation underway with the help of numerous departments and agencies including the Corps of Engineers. Not yet complete, the work can be safely said to seek an outline of the private and public role in site selection. The objective is to develop an efficient plan of action that can be carried out at an early date.

The Step Toward a Federal Position on Superports

These steps will inevitably be complex, as the problem is many-faceted and casts long shadows over our economy and society. There is a familiarity with the long-established responsibilities of the Corps in respect to harbors and waterways of the United States and with the system of permits required when nonfederal alterations are made in harbor, inland and coastal waters.

The needs for deepwater ports and associated offshore installations have not altered procedures, nor have they resulted in any attempt to turn these practices into impossible hurdles.

Advice, Consent and Dissent. In carrying out its responsibilities, the Corps of Engineers has the assistance of numerous federal agencies, including the Department of Justice, Interior, Commerce and Transportation as well as such executive groups as the Council on Environmental Quality. Deepwater developments pose problems that fall in the field of interest and competence of each of these federal agencies.

For example, offshore locations may be in international waters with special legal and jurisdictional problems, conflicts between port development and other uses of the continental shelf such as oil drilling and fishing are of concern to the Interior and Commerce departments; the Coast Guard of the Department of Transportation is clearly concerned with safety regulations; and the Council on Environmental Quality is concerned with problems of prevention and control of oil spills and other pollution. Many additional problems could be mentioned that involve other federal agencies such as the Environmental Protection Agency, the Public Health Service and the Labor Department.

State, Local and Private Interests. The federal position on superports will be determined by the actions and attitudes of the states, local governmental authorities such as port authorities and by a broad range of private groups.

There is every reason to believe that presently operating port authorities will play an important role in the development and operation of new superports. For example, Louisiana's recently enacted Deep Draft Harbor and Terminal Authority will be governed by a board; two of its nine members are chosen from a list of nominees submitted jointly by the Boards of Commissioners of New Orleans, Baton Rouge and Lake Charles port authorities.

The new Louisiana legislation for deep-draft ports seeks to protect the established ports, stating in section 3110:

> A. To prevent impairment of the bonds of the Three Deepwater Ports which are backed by the full faith and credit of the State, and to recognize the existing authority of and functions performed by the established ports and harbors of Louisiana, it is hereby recognized that the function, power and authority of the various existing port authorities established pursuant to Article 14, Section 31 of the Louisiana Constitution, and others established by specific Constitutional provision are not to be diminished by the jurisdiction and powers exercised by the Deep Draft Harbor and Terminal Authority except as provided in this Act.

Parts C and D of the same section further state:

> C. The Authority, in establishing or enacting its rates and charges for bulk cargo shall consider the overall economic impact on the economy

of the Three Deepwater Ports, and its charges and rates shall be compensatory.

D. The Authority shall not engage in the handling of break bulk or general cargo without the prior written agreement of the Three Deepwater Ports, which agreement, among other provisions, may provide for use of existing port facilities, rates, wharfage fees and other matters of mutual interest.

These excerpts reflect the important connections between old and new institutions in the port field.

Federal Concern for the Secondary Effects of Deep Water Port Development. The secondary effects of major port development will be great. The federal government seeks to evaluate the response required to deal with the secondary effects induced by planning, design, construction and operation of U. S. harbor facilities for large bulk carriers. The anticipated effects involve (a) regional transportation, including pipelines; (b) regional and local economic changes; (c) demographic changes; and (d) regional and local environmental and ecological changes.

Identification of Policy Issues

An important element of the deepwater port research program in the Corps will lead to a better identification of the critical policy issues. We can anticipate that changes will be required in existing institutional arrangements for (a) continued participation in the planning, construction and operation by all interested parties; (b) regulation of facility planning, construction, operation and maintenance; (c) pollution control; (d) financial responsibility for polluting incidents; (e) facility management; (f) labor relations; (g) local sea and land area zoning; (h) regional transportation development; (i) antitrust regulations; (j) taxing arrangements; and (k) distribution and sharing of all costs and benefits, including those of a secondary nature. We will also seek to identify the federal, state or local levels at which the changes should be made and define the federal financial interest in harbor facilities for very large bulk cargo carriers.

In addition to these research studies our first phase reports on regional navigation studies mentioned earlier for the Gulf, North Atlantic and Pacific Coasts are planned for completion by the end of this fiscal year.

As these studies progress, specific site alternatives are being evaluated and hopefully will identify what is needed, when it is needed and where. The number and range of environmental considerations will be an integral part of these investigations. These studies will receive wide public review prior to any recommendation being made to the President and Congress. Coordination must be achieved between federal, state and industrial interests. The entire situation presents a difficult learning experience for the Corps and for all other parties presently involved or due to become involved, for we are grappling with an unprecedented problem.

Conclusions

The port problems are, of course, a small but vital part of our energy supply system. Fox example, U. S. refining capacity has not been increased greatly in recent years. There will have to be a tremendous refining expansion program to meet foreseen needs for petroleum products. Decisions on ports will determine to a substantial degree the location of new refining. It is important to every citizen that refining be located where it can operate efficiently, taking into account the market to be served.

Our port plans will have an import on and will be influenced by public investments in other fields such as inland waterway systems on rivers and the Great Lakes.

Finally, the way must be found to mobilize the vast talents of the scientific community to get its help in viewing the port problem as a part of the total system of energy movement. This mobilization will look to the oil companies for the talent and expertise held by their personnel.

United States Imports: The Challenge of the 70's — A Shipper's Perspective

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If we accept as fact that the United States has no future recourse other than to import substantial volumes of crude oil and that the only environmentally safe, economically viable method for importing this foreign oil is by deep-draft Very Large Crude Carrier (VLCC) facilities in coastal zones of the United States, then for what are prospective shippers of these large volumes of crude oil looking?

The key items that such shippers will be seeking include:

1. Low cost marine transportation and unloading terminal facilities with a relatively modest rate of return. The capital commitment for a domestic facility is substantially greater than for offshore transshipment through the Caribbean or Canada. Savings from this alternative are relatively modest; therefore, local interests should not expect a bonanza from a domestic facility.

2. An adequate number of deepwater oil ports to ensure smooth and continuous operation. These ports should not be incompatible with dry cargo handling at some point in the future, but the clear and urgent need is for oil facilities.

3. Adequate lead times to permit proper accomplishment of objectives.

4. Cooperative agency approach.

5. Industry-built, industry-operated and industry-financed facilities. The petroleum industry is willing and able to raise the requisite capital; government funding for this enterprise is not needed. We have the expertise to build and to operate these facilities as has been demonstrated in other parts of the world.

6. Freedom from unrealistic controls by county, state and federal agencies.

All these items in concert will provide industry with the environment in which it can work and plan the facilities so desperately needed by the United States. We must get started now. Any major upset in this environment will only hamper, delay and, in some cases, prohibit the construction of these facilities. Such obstacles could result in national security and balance of payment problems as well as in higher oil-related costs for the American consumer.

Changing patterns in crude oil supply for consuming nations, renewed emphasis on VLCC ships and increasing environmental considerations all point to a needed joint reappraisal of United States ports by governmental, industrial and environmental groups in order to assure that our nation remains competitive and to protect the American consumer from excessively higher costs for petroleum products. The shipper is a key element in this process.

Low Transportation Cost

Based on the accepted fact that the United States will be importing large volumes of crude oil, primarily from the Persian Gulf area, the most economical transportation mode is obviously via VLCCs.

A particular advantage of the VLCC is that its use achieves a major reduction in ship intensity, compared to small ships carrying the same volume. More than five small tankers of 45,000 dwt (satisfying most U.S. port draft limits of 40 feet) are required to equal the transport capability of one 250,000 dwt VLCC. Accordingly, with deepwater-receiving facilities the average number of crude-carrying vessels arriving each day in 1985 can be reduced from about 45 to 10 (approximately 18 million barrels). This reduction in port congestion should materially enhance prospects of minimizing the possibility of pollution from vessels unloading oil and thus should give added protection to the environment.

On the basis of transportation cost, obviously the cost per deadweight ton decreases as size increases up to a point (economy of scale). As an example, we can compare new bulding cost per deadweight ton. With a base cost of 100 per cent for a 25,000 dwt ship, comparable costs are 70 per cent for 50,000 dwt, 48 per cent for 100,000 dwt, 33 per cent for 250,000 dwt and 26 per cent for 500,000 dwt. Obviously the VLCC is the most practical solution, considering harbor congestion and potential transportation savings.

The expected arrival of VLCCs into U.S. ports puts the nation into a rather poor situation because there are no domestic facilities capable of receiving the jumbo ships. Draft requirements range from 62-90 feet, but existing developed port facilities were not designed or built for such ship size and have only a maximum draft limitation of 40-45 feet.

United States industry will need cheaper energy if we wish to remain competitive with Western Europe and Japan in the world market of the 70's.

Deepwater Ports -- General

It is sometimes argued that vessels have increased in size to such an extent that the costs of berthing structures become too high to be justified. However, in reality the cost of operating a large vessel is such that the most efficient terminal facility is essential. Demurrage can be as much as $30,000-35,000 per day. In an integrated industry that produces, stores, ships, refines and markets its products, economy of operation must be considered as a whole. Therefore, ports are considered as parts of the overall economics.

Deepwater ports for the United States could be of various systems, dependent upon the particular location under consideration. Such systems include the following:

Fixed berth. In a protected area this is the most preferred system from an operational viewpoint. Two advantages to the fixed berth are that cargo and bunkers may be loaded at the same time and that the entire operation is under strict control. Also, there is no hindrance from poor communication, inefficient lighting or difficult personnel access for documentation. With good lighting and communication, night berthing is also much easier than at a buoy berth. Additional advantages of a fixed structure are minimum pipeline and service links as well as ease of shore ballast discharge for vessels.

The fixed structure may have some apparent disadvantages compared with a sea berth. The capital cost is likely to be higher, and it is usually necessary to provide tugs. Such disadvantages are usually small compared with the benefits obtained by far more efficient operation. This results in fewer required berths for a given annual throughput of oil. However, in an unprotected area extensive downtimes lessen the economic attractiveness of a fixed berth.

Single buoy mooring (SBM). History shows that by the late 1950's the large ships brought into operation at that time imposed severe loads on the fixed heading buoy moorings in use around the world. By the early 1960's there seemed to be a general conclusion that a 100,000 dwt ship was about the maximum size that could be reasonably handled at fixed heading buoy moorings in areas open to dangerous sea conditions. For ships of larger size it would be necessary to reduce strain by allowing the ship to swing freely according to prevailing weather conditions such as wind, current and waves. This general contention seems to have been borne out; where berthage is provided outside harbor works or natural shelter, single buoy moorings must be used. The downtime comparison on a SBM versus a fixed berth varies with the particular geographical area under consideration. As an example, a study was made for an area approximately 20 miles offshore Louisiana. According to the study, fixed sea islands with a 3.5-foot surf limit would be out of service 58 per cent of the time on an average annual basis. However, a sea island is completely inappropriate because of the anticipated outage of 70 per cent during average winter months and because of the possibility of a 100 per cent outage for a full month every five years. With monobuoys the maximum full port outage expected to recur every five years in any one month would be around eight per cent. However, in this same month an outage of 35 per cent would be expected in terms of ability to conduct mooring operations with current technology.

Dredging of existing channels. In the Corpus Christi proposal and in a suggested Baltimore bulk terminal, dredging could be the solution. However, there is a point where dredging and maintenance costs become prohibitive so in most cases this solution is not a viable alternative. In addition, dredging can have a substantial effect upon the environment. Of particular concern are spoils and their disposition -- especially spoils so contaminated that they affect the natural environment if not disposed of correctly.

Offshore islands. The concept of artificial offshore island creates many problems, among them too high construction costs, concentration of high volumes of oil within a small area that would create a national security danger if destroyed by weather or other crisis and congestion by small vessels if adequate pipelines to refineries are lacking.

Regardless of the system chosen, from an environmental and economic viewpoint these systems must be tied to an onshore tank farm via submarine pipeline and a network of onshore pipelines to refining centers.

Such a system decreases the number of oil transfers and increases environmental protection. Small vessels cannot compete economically with pipeline, and they permit smooth, efficient operation.

Location of U.S. Deepwater Ports

Where should the deepwater ports be developed in the United States? In 1970, there were 262 domestic refineries with daily capacities averaging 49,000 barrels per day. On the basis of forecast demands, it is estimated that 58 new refineries averaging 160,000 barrels per day will be required by 1980.

Much of the needed additional refining capacity should be built along the East Coast where 40 per cent of the demand but just 12 per cent of the refining capacity is located. Based on assessment of site availability and limitations from environmental pressures, it is now anticipated that at least five major refineries that would have built in the eastern United States will be constructed in the Gulf of Mexico region or elsewhere. Therefore, we see a need for at least one deepwater port on the East Coast and two or more in the Gulf.

Alternative to U.S. Deepwater Ports

If deepwater ports are not developed domestically, there are several alternatives available to shippers. Shippers can continue with existing systems utilizing 60,000-80,000 dwt vessels. Although this choice is not physically or economically feasible and should not be considered. There are not enough of these vessels today to move our requirements to a forecasted import of 12 million barrels per day in 1980. New construction is not economically possible.

Shippers can lighter VLCCs to bring them as near to the demand point as possible. This operation is efficient if kept small. However, the chances for spills are increased by the more numerous oil transfers. From a physical viewpoint, aside from economics, lightening could not manage the imports forecast for 1980 and subsequent years.

A newly-designed fleet of shallow-draft vessels could supply U.S. ports. The economics of this type operation are less attractive than those for several other solutions. In addition, it is impractical from an economic standpoint to build ships of the capacity needed with drafts sufficiently shallow to enter U.S. ports. Studies have shown that unit costs for this type vessel would have 50-60 per cent higher costs than conventional VLCCs. Steel weight is two times as great, and fuel consumption is approximately one and two-thirds times as great due to the hydrodynamic vessel shape.

Transshipment through Canada, the Bahamas or the Caribbean Islands would be the most economically viable because of 80 per cent VLCC savings. However, transshipment would have a substantial effect upon national security and national balance of payments. Congestion at the receiving points would continue, and the exportation of refining capacity would be encouraged. To shippers, this system would be the most expeditious interim step prior to the development of U.S. deepwater facilities.

In conclusion, we must support the development of deepwater facilities in the United States. The immediate emphasis must be on the provision of facilities for recieving foreign oil. Facilities for handling dry bulk cargoes, perhaps necessary in the long run, are not of comparable immediacy to the energy problem. In order to satisfy forecast demand for imported oil (12 million barrels per day in 1980, 18 million in 1985), at least one major facility will be required on the East Coast, at least two or more in the Gulf and perhaps one on the West Coast.

There is already evidence that development of foreign transshipment facilities is being encouraged in the Bahamas, in the Caribbean and in the Canadian maritime provinces. When such ports are established outside the United States, movements in VLCCs will go there; later transshipment of oil in smaller, less economical tankers will come to the U.S.

We believe that the U.S. must determine to establish its own port facilities soon and must make that determination known. In the interim, we acknowledge that the use of foreign facilities may be necessary because of delays in establishing domestic ports. However, we do not believe that total long-term reliance on foreign ports is in the national interest.

We think that failure to establish oil-receiving facilities for VLCCs will have an adverse effect on both our balance of payments and national security. Payments made by consumers for the services provided by foreign transshipment will result in exported dollars, thus increasing the dollar outflow without providing a corresponding inflow. Moreover, construction of foreign facilities will mean that nations other than the U.S. will provide jobs and materials for building and operating such facilities, which would not be under U.S. controls.

If the North American deepwater port facilities upon which we will depend are in U.S. waters, this country will benefit not only from the availability of the facilities, but also from the probable growth of associated refinery capacity. Establishment of such port facilities and refineries will also permit the orderly development of logistic facilities required for support: pipelines, marine terminals, tank farms and the like to optimize benefits of the entire system.

We recognize that both government and industry have an interest in the creation of sufficient capacity in deepwater port facilities. Nevertheless, we believe that government's role in establishing these facilities can be limited to three areas.

First, our citizens require assurance that establishment of deepwater port facilities will not have undesirable ecological consequences. We therefore believe that industry and government should cooperate in ensuring that there will not be any adverse ecological impact from any facility considered.

Second, in view of the federal interest in port traffic and navigational safety, the federal government should provide lighthouses, navigational aids and traffic control in conjunction with the port facility.

Third, such facilities will have to be established in waters over which the state and federal governments both exercise jurisdiction. These governments will need to establish procedures by which the granting of rights to locate and to operate deepwater ports will be facilitated.

We recognize that formulating the problems of U.S. deepwater port facilities and making decisions to establish them may require some time. Meanwhile, the industry is likely to adopt interim measures for receiving VLCC traffic at foreign ports. We strongly urge that this country should announce plans for development of long-term policies creating domestic deepwater port facilities to minimize the proliferation and long-range impact of these interim measures.

Environmental Vulnerability of the Delaware Bay Area to Deepwater Ports

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This study was conducted to evaluate the environmental vulnerability of deepwater port facilities at proposed sites in the Delaware Bay area. To accomplish this goal, it was necessary to describe the environmental setting of the area prior to construction and operation (Maurer and Wang 1973). The area was then hypothetically exposed to a series of activities (construction, operation, major oil spills, minor oil spills) related to deepwater ports. The probable effect of these activities was described in a hypothetical scenario. Based on the scenario, sites were rated in order of environmental vulnerability. The purpose of this paper is to briefly outline probable environmental effects and problems involved in rating and comparing environmental vulnerability.

Background

Huge energy needs have recently been projected (Soros 1972, Winger et al. 1972). Since other sources of energy are not presently available in sufficient quantities (Hammond 1972), these needs will probably be met by imported petroleum products in the next decade or two. The unit cost of petroleum transportation by ocean tankers decreases as vessel draft size increases. As a result, there has been a rapid shift to supertankers (300,000 - 500,000 dwt). At present there are no ports along the Middle Atlantic Bight to berth vessels even as large as 100,000 dwt. To accommodate supertankers as large as 500,000 dwt (100-foot draft), deepwater port facilities will have to be constructed. Depending on the site, construction, maintenance and operation of these terminals (Rounsefell 1972), together with massive oil spills and regular low level spills, may cause immediate serious damage and in some cases long-term environmental damage.

To minimize damage from port-related activities, the Council on Environmental Quality (CEQ) and other federal agencies were charged with developing a broad-based study that included a report on the environmental vulnerability of prospective port sites to supertanker accommodation. The Council enlisted the aid of the Sea Grant Program (SGP) because of its close relationship with academic institutions. In turn, SGP contacted specialists from respective areas to participate in the study.

Several points concerning the objective, scope and approach to the study were agreed upon in joint session with CEQ, SGP and participants. The study objective was to collate existing data in order to develop informed scientific opinions on environmental effects of the construction and operation of supertanker port facilities. The result will attempt to rank alternative facilities in terms of their relative environmental effects.

Emphasis was placed on analysis and formulation of scientific opinions from existing data rather than on acquisition of new data. This effort involved description of the environmental setting (biological, chemical, engineering, geological, meteorological and physical). Although all disciplines interface in this problem, biological aspects received the most attention. Identification and description of marine biota, the basic food chain including important ecological and commercial species, location of spawning grounds and assessment of sensitivity to stress of individual species were among principal aspects.

Determination of stress sensitivity zones, areas particularly subject to harmful effects due to oil spills, sedimentation, currents, as well as locations and movements of stress-sensitive organisms were indicated. Changes in physical characteristics due to terminal construction and to supertanker operations were also included.

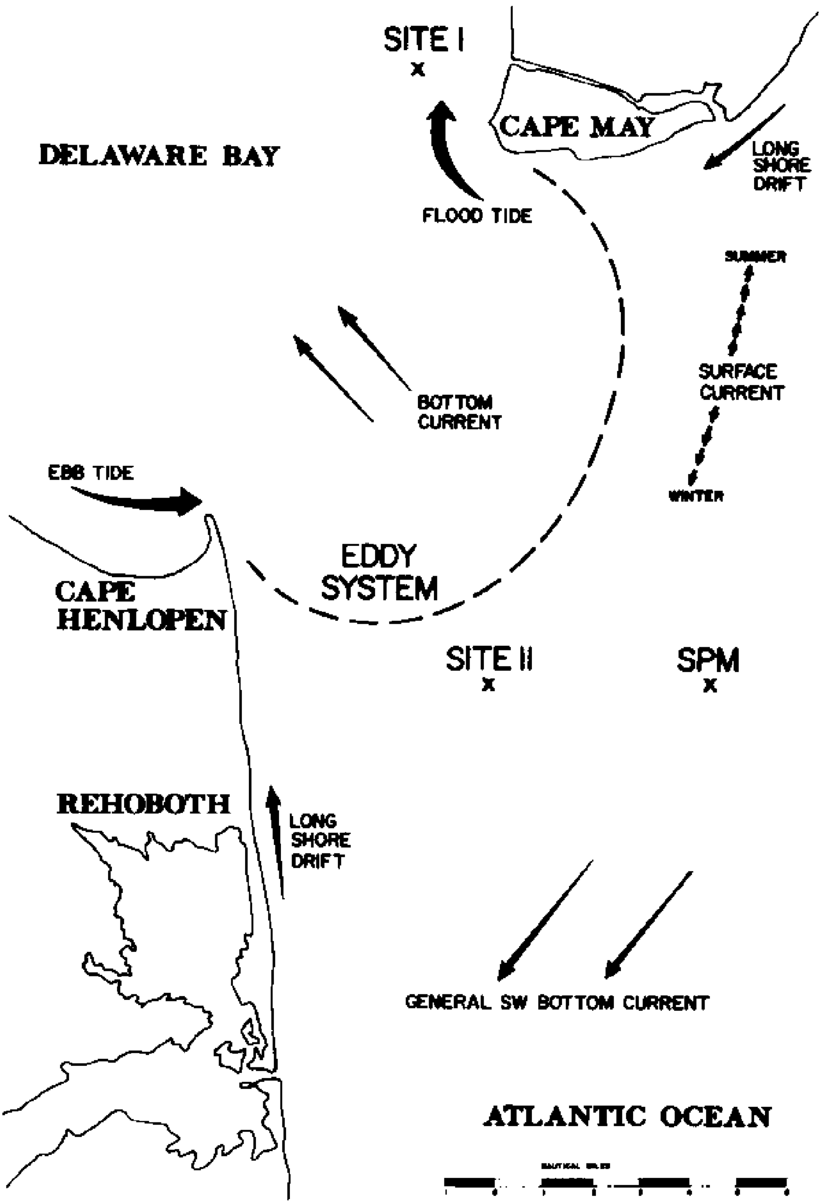
A description of the spread and the fate of oil spills using a simplified model of oil dispersion was proposed. This included short- and long-term effects of one major spill and continual low level spills. Construction and operation effects of the terminal sites on environmental vulnerability was also covered.

Recommendations for future studies to increase the confidence level of educated guesses were also included. These objectives were discussed in detail by Maurer and Wang (1973).

Several other ground rules were established. Based on its studies, the Council also provided locations of proposed deepwater ports together with general configurations of port facilities for each geographic area. In addition, the Council stipulated amount and frequency of major and minor spills and general composition of oil in the spill.

Proposed Deepwater Port Sites

A potential site for Delaware Bay facilities would be three and a half miles west of Cape May Canal inside the bay (Figure 1).



LOCATION OF PROPOSED DEEPWATER PORT SITE IN THE DELAWARE BAY AREA & SCHEMATIC OF HYDROGRAPHIC CIRCULATION

FIGURE I

The site lies in 50 feet of water; and the substrate consists of coarse sand, shelly sand and gravel. An island would be built from the rather extensive dredging operations required for this site. The dredging would include two square miles of berthing and turning area and an access channel 1000 feet wide, six and a half nautical miles long.

Approximately 150-200 million cubic yards of bottom material would have to be dredged to provide the necessary 90-foot draft. (The excess dredge material could be disposed of on land, close to the island site or at sea, depending on possible toxicity of sediments and on sediment requirements for onshore projects.)

The alternative of a platform with a shore-based tank farm was also considered. Platform facilities would be similar to the island except that the platform would be smaller (200 feet by 250 feet). This platform would be in addition to the platform included with the berthing facility.

One supertanker site offshore would be located eight miles east of the coast, halfway between Cape Henlopen and the northern bank of Rehoboth Bay, in the case of the platform or island. This site, which takes advantage of a natural deepwater trench for supertanker berths, locates the island (or platform) and breakwater (11,000 feet long) on the shelf. Dredging would include a 1000-foot wide channel for a distance of about three nautical miles and two square miles of berthing area dredged from a 65-foot to 100-foot depth.

Another supertanker site offshore would involve a five-nested single point mooring (SPM) with central platform located 20 miles directly east of Rehoboth. No dredging would be required here.

Effect of Construction and Maintenance

An outline of possible environmental effects of offshore construction was proposed by Rounsefell (1972). All the categories in his outline were not appropriate for each proposed site, and the selection of specific ones (Table I) for discussion was based on personal experience and on other references (Cronin et al. 1970, 1971; Sherk 1971). Since construction and maintenance effects on the biota were described in considerable detail (Maurer and Wang 1972), only a brief summary will be presented here.

The matrix represented by Table II offers one means of summarizing these environmental effects. By ranking the positive and negative effects on a scale of zero (nonapplicable) to four (large), one can obtain some idea of the relative magnitude of damage per site and port configuration.

TABLE I. Outline of Possible Environmental Effects from Construction

I. Direct Effects of Structure Itself

   A. Permanent loss of occupied habitat (chiefly by islands)

   B. Thigmotropic effect of submerged structures

   C. Attachment or shelter for marine organisms

II. Changes in Water Mass Exchange (Applicable to Structures Within an Estuary)

   A. Changes in existing currents

      1. Velocity changes affecting areas of scouring and of sedimentation

         a) Effect on settling areas of larvae

III. Changes in Salinity, Turbidity and Oxygen

   A. Changes in primary productivity

      1. Through increase or decrease in turbidity affecting photosynthesis both in water column and in benthic flora

   B. Changes in trophic structure through changes in total plankton consumption by filter feeders caused by changes in total net water movement.

   C. Shift in areas in which certain oyster predators are controlled by intermittent periods of salinity below the predators' tolerance level

IV. Changes in Substrate

   A. Loss and gain of areas of habitat types by shifts in areas of scouring and sedimentation

   B. Loss of established benthic communities

(ADAPTED FROM ROUNSEFELL 1972)

TABLE II. Probable Effect of Construction and Maintenance Operations on the Ecology of Marine Biota at Proposed Terminal Sites

	SITE I Inbay		SITE II Offshore		
	Island	Platform	Island	Platform	SPM
ADVERSE (-POINTS)					
Permanent Loss of Habitat					
Community Disruption					
Mortality & Gross Effects					
Effect on Pumping & Feeding					
Effect on Larval Settling					
Shift of Predators					
SUBTOTAL					
BENEFICIAL (+POINTS)					
Thigmotropic Effect					
Attachment					
Gain of Sheltered Habitat					
Gain of Habitat by Deposition					
Increase of Nutrients					
Increase of Primary Productivity					
SUBTOTAL					
TOTAL					

LEGEND:

0 = Nonapplicable
1 = Negligible
2 = Small
3 = Moderate
4 = Large

For example, permanent loss of habitat and community disruption from dredging would be more extensive at the island/platform inbay site than at the SPM offshore site that requires no dredging. Consequently these two damage factors would receive minus threes or fours, whereas the SPM site would receive a zero.

Mortality, gross effects and problems with pumping and feeding would vary from site to site. The effect on larval (oyster in particular) setting and on shift of predators (oyster drills) from increased water velocity and from salinity, respectively, would be serious due to heavy inbay dredging off Cape May but not serious at the offshore island/platform or SPM sites. Their rankings would reflect these anticipated differences.

In terms of positive or beneficial points, thigmotropic and attachment effects would tend to be more significant offshore at the island/platform site than inbay because of the large breakwater. At the same time the SPM site size compared to the island/platform with breakwater would have relatively little value for these categories. The remaining categories received similar treatment until the matrix was filled. The ranks were totaled, and tentative conclusions on environmental vulnerability were presented in Maurer and Wang (1973).

Selection of categories and their relative weight are subjective and open to question. Selection of criteria in assigning weights will vary with training and experience. Nevertheless, the authors believe that most of these categories are important ones commonly cited in the literature. Furthermore, weight assignment to extreme conditions (inbay compared to SPM) would probably receive general agreement. On the other hand, weight assignment to marginal conditions (offshore island compared to offshore platform) would definitely be arbitrary.

The Effect of Oil Spills

In contrast to the inbay site (Cape May) where oil spread would be primarily controlled by tides, a spill at sea would be influenced to a greater extent by prevailing winds and current (Smith 1968, Schwartzberg 1971, Straughan 1971). In turn, oil toxicity would be related to oil type and to duration of weathering (Smith and MacIntyre 1971). Presumably longer periods at sea, which promote weathering (evaporation, dissolution, microbial and chemical oxidation and suspended sediment formation), would reduce toxicity (Moore, personal communication). Thus it is more difficult to evaluate the effect of oil at sea and its subsequent effect on the shoreline than an oil spill near shore. Effects of the latter spill may be observed within a tidal cycle, whereas it may require days or weeks to observe effects onshore from an offshore accident.

A brief review of the local hydrographic circulation would be useful (Figure 1). A strong littoral drift moves northward toward Cape Henlopen (Kraft 1971) and southward toward Cape May (Raney et al. 1971). Moreover, there is evidence that a bottom current is moving directly towards the bay mouth (Oostdam 1971, DuPont 1972). Off the bay mouth approximately 10-15 miles, a definite rotary current occurs (Miller 1952, Ketchum 1953, Bumpus and Lauzier 1965). A reversal of surface current drift to the northwest occurs during late spring and summer. Estimates of maximum net drift velocity range from 8.7 nautical miles/day (DuPont 1972) to 12 nautical miles (CEQ). Prevailing winds must be added to this picture; their velocity, direction and duration vary seasonally (Brower et al. 1972). In many cases oil dispersion at sea is almost totally dependent on winds (Schwartzberg 1971).

A number of models for predicting oil spill flow have been proposed (Kinney et al. 1969, Fay 1971, Schwartzberg 1971, Mikolaj 1972). Any model that attempts to predict an oil spread must account for seasonal variations. The model developed for this study by Wang is presented in detail in Maurer and Wang (1973). The model accounts for current, tidal and nontidal effects but is even more sensitive to seasonal wind patterns. Based on extensive weather data, Wang was able to estimate the probability of the direction and velocity of a hypothetical oil spread after 3 hours, 12 hours, 48 hours and 72 hours on a bimonthly schedule.

According to Wang's model, there is greater probability that the oil would move north-northeast toward the New Jersey coast in the summer and south-southwest toward the Delaware-Maryland coast in the winter. Because of the distance from shore for the island/platform site (eight miles) and the SPM site (20 miles), predictions from the model indicate that the oil probably would not come directly ashore in Delaware. More likely, the oil would come ashore in southern New Jersey or dissipate out to sea in the summer and come ashore in Maryland and Virginia in the winter. A storm or strong unseasonable onshore wind that is likely but unpredictable here could move a large mass of oil onshore in one or two days. If the oil did reach Delaware's coast, the strong littoral current would assure rapid spread over its beaches and enclosed bays.

A complete discussion of the oil scenario was presented that included a description of probable effects of oil on specific habitats and habitat groups (Maurer and Wang 1973). Based on data from CEQ, an initial matrix was developed to indicate possible interactions of oil spills on the biota. The matrix totaled 416 unique events or effects that might be considered for discussion. This task was prohibitive within the time frame for the study. Furthermore, there was insufficient information to discuss the effects even if time permitted.

As a result, a series of assumptions was made and a simple matrix constructed (Table III). Ranking followed the same procedure used with Table II except that only adverse points were assigned. For example, the oyster and its associated fauna that are locally restricted to the bay and to estuaries would suffer serious damage from a massive spill or from gradual oil accumulation at the inbay site, whereas similar circumstances at the SPM site would probably not affect them. The inbay site would receive minus threes or fours and the SPM site minus one. An accident or oil accumulation at the offshore island-platform site would harm the surf clam that is essentially restricted to the ocean. Moreover, an accident in the bay would also have some effect on the surf clam because the surf clam and its associated fauna are relatively close (three to five miles) to the mouth of Delaware Bay. These relative differences would receive intermediate values between 0-4.

There are a number of problems associated with evaluating environmental vulnerability. Certainly insufficient data is one of the most significant. In our study area there was a great deal of information known about finfish, and we pursued this in some detail.

In contrast, almost nothing was known about phytoplankton. As a result, the detrimental effects of port activities on the important biological process of photosynthesis and on primary productivity received little attention. Moreover, tolerance limits of the biota to immediate toxic oil effects are known under experimental conditions for only a few species. Even less is known about long-term and sublethal effects that may prove to be the most serious of all. The state-of-the-art in describing movement and spread of oil spills and reduction of toxic effects due to weathering is still in early developmental stages.

In addition to insufficient data, other problems involve lack of agreement on what constitutes environmental vulnerability and criteria for comparing environmental vulnerability from site to site. For my purposes environmental vulnerability is the degree (number or per cent) of reduction in a local ecosystem in terms of species survivorship, distribution, abundance, diversity and reproduction in the face of environmental factors. Other definitions may be equally defensible.

If agreement on the definition of environmental vulnerability is hard to obtain, criteria for comparing sites is even more difficult. Such aspects as commercial fisheries might be determined for each site and then compared site-to-site. In that case, a low fishery area would be less vulnerable than an area with high fisheries, and the former would be the preferred site for a deepwater port. On the other hand, an area with low commercial fisheries might still have great value for recreation purposes

TABLE III. Probable Effect of Oil Spills on Selected Biota and Habitats at Proposed Terminal Sites

	ISLAND-PLATFORM				SPM	
	Inbay		Offshore		Offshore	
	Single Massive Spill	Long Term Spills	Single Massive Spill	Long Term Spills	Single Massive Spill	Long Term Spills
Oyster						
Oyster Fauna						
Benthos						
Phytoplankton						
Nekton						
Beach-bay						
Beach-ocean						
Marshes						
Dunes						
Small bays						
Surf clam						
Surf clam fauna						

LEGEND:

0 = Nonapplicable
1 = Negligible
2 = Small
3 = Moderate
4 = Large

while the high fishery area might be surrounded by habitats essentially inhospitable to recreation activities. Based on this, the low-use recreation area would be the preferred site for the deepwater port.

Another consideration might involve the present condition of the environment prior to port activities. Both areas might have similar recreation and fishery profiles, but one area might be demonstrably more polluted than another. Confronted with the anticipated environmental effects of the port facilities, the polluted site would be less vulnerable than the unpolluted site. As a result, the former would be the preferred deepwater port site.

Despite the foregoing considerations, the authors believe that areas can be compared and propose the following tentative outline. Each geographic area would be categorized as to the major habitat types present. For example, Delaware Bay area has marshes, exposed beaches, bay beaches, jetties and tidal flats. In turn, each major habitat type would be rated in terms of its biological productivity. Locally this would be 1) marsh, 2) tidal flats, 3) jetties, 4) bay beaches and 5) exposed beaches.

This scheme would differ geographically in that the New England states would have rocky intertidal areas or perhaps extensive mud flats. The Gulf Coast would have extensive marshes and no rocky intertidal areas exclusive of manmade jetties. Still each site would be characterized by a maximum biological contribution from a major habitat type. Perhaps a recovery factor from oil pollution could also be incorporated into the method.

For example, ocean beaches and open rocky intertidal areas have recovered from an oil spill in one year (Straughan 1970, Chan 1972), whereas more enclosed situations (North 1967, Blumer and Sass 1972) have required two-ten years. A marsh may require only one year to recover from a single low level spill but may never recover from regular low level spills (Cowell 1971).

The final step would involve determining the area percentage of major habitat type for each geographic area. By comparing the percentage of major habitat area in proximity to proposed deepwater port sites, the relative environmental vulnerability could be assessed. For example, one area containing 70 per cent of its major habitat in proximity to a proposed site would be more vulnerable than an area of 40 per cent. Factors such as recovery rate and degree of existing pollution might also be included in the decision process. Finally, the limitations of our present knowledge may urge us to develop more analytical and objective means to evaluate environmental problems.

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Some Aspects of Deepwater Terminal Site Selection in Northern New England Coastal Areas

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The realities of the energy supply and of the demand situation in the United States require that methods of importing large amounts of foreign oil be considered and be evaluated. Currently, one of the most attractive methods is the development of port facilities capable of receiving oil tankers of at least 250,000 deadweight tonnage (dwt) in the coastal waters of the U.S. However, such vessels require at least 60 feet of water and may need depths of 80-120 feet. In the past dredging has been an acceptable solution to provide adequate depths. However, there are both economic and environmental limitations to this approach.

An alternative is to locate port facilities in areas with naturally occurring deep water either near shore or off shore. Along the Atlantic and Gulf Coasts the northern New England coastline provides the only naturally occurring deepwater harbors. For this reason, there has been considerable interest in determining the feasibility of developing a supertanker port in the New England region, especially at Machias Bay, Maine.

In addition to environmental impacts, there are serious questions regarding oil spill impacts due to construction of the physical system. In the Machias Bay region, oil spillage is the most serious environmental problem.

The research reported here is part of a study in which the primary objective is to assess the environmental vulnerability of the Machias Bay region to a hypothetical supertanker terminal. Specific projection of biological populations, water quality and other environmental parameters are not a major goal, although any quantitative models that can assist in this assessment are desirable. The study is based on currently available data bolstered by informed scientific opinion.

This paper reports preliminary results regarding an extensive review of the biological impacts of oil, an attempt to include the effects of oil weathering in the impact assessment and tentative conclusions regarding the selection of a deepwater terminal site in the coastal waters of northern New England.

1. The Northern New England Coast

Physical Environment

The northern New England coastline is irregular, rocky and bold with numerous islands, bays, rivers and coves. The intertidal zones are characterized by lack of sediment. Where beaches are present, the particle size is large, ranging from pebbles to small eroded boulders. Sand and mud flats exist only in embayments and in estuaries far from the frequently violent surf. Shores often drop off to deep water steeply, at angles of 30 to 40 degrees, further inhibiting sediment deposition. Estuaries are a particularly important landform because of the crucial role they play in life cycles and in food webs of coastal ecosystems.

Graham (1970) has described the New England coastal currents. The most prominent feature of coastal circulation is upwelling; water is carried parallel to or offshore from the coast at the surface with compensatory movement inshore along the bottom. However, significant exceptions occur, bringing surface water shoreward, due to wind and dynamic pressure gradients influenced by temperature and river discharge. Spring tides range from 11 to 21 feet along the coast. The current velocity is often as high as two knots and in constricted areas as swift as six knots. The greatest storm surges result from offshore passage of extratropical cyclones. Surges over five feet above mean high water have been experienced.

The weather in the region experiences frequent and rapid changes, especially in the cooler seasons, due to the extratropical cyclones (Nor'easters) that enter the area from the west or southwest. The prevailing westerly winds have a northerly component from November to March, with a southerly component from April to October. Wind speeds are typically 15-20 knots; however, speeds greater than 100 knots have been recorded. Air temperatures range from the 70s(°F) in the summer to as low as 0°F in the winter. Sea temperatures typically fall between freezing (32°F) and 60°F.

Biological Characteristics

Two major biological zones are of interest: the exposed rocky intertidal and subtidal areas and the highly productive estuary/marsh complex. The rocky intertidal organisms are particularly important due to the extensive tidal range along the coast. Typical of the biota are numerous blue-green algae and lichens (*Verrucaria*), the periwinkles (*Littorina littorea*), barnacles (*Balanus balanoids*) and blue mussel (*Mytilus edulis*). In the transition zone from intertidal to subtidal, the sea moss *Chrondus crispus* and the laminarian sea weeds are important inhabitants.

The subtidal zone contains diverse invertebrate fauna including animals of the barnacle-mussel level, dog whelks (Nucella lapilla), limpets (Acmaea) and many small copepods and mites. Where sediments allow, amphipods and worms are plentiful. In the deeper waters are found many larger animals including lobsters, crabs (Cancer and Carcinus), brittle stars and star fish, as well as numerous small copepods, sponges and other forms.

Salinity, temperature, sediment distribution and water circulation are the primary factors determining the distribution of organisms within an estuary or salt marsh. The biota in the estuary/marsh complex are typical including many shellfish (soft-shelled clams and blue mussel), marine worms (Nereis), crabs and primary producers [Zosteira, known as eel grass and marsh grass (Spartina)]. Hard-shelled clams (Mercenaria) are rarely found due to cold temperature and heavy predation by green crabs. Most importantly, the estuaries and marshes act as nursery grounds for larval and juvenile stages of many shellfish and finfish.

2. Possible Ecological Impacts

Possible impacts of a deepwater terminal may be categorized as nonoil spill or oil spill. The nonoil spill effects result from construction activities, existence of a facility and operation of tankers. Oil spill impacts may result from either low level, nearly continuous discharges (chronic) or a single major spill (catastrophic).

Rounsefell (1972) has recently reviewed the potential ecological effects of offshore construction activities and the installation of physical structures. He concludes that there is slight danger from most construction programs. The major threat is the placement of artificial islands too close to estuaries, which could affect water circulation. Island facilities have not been proposed for the northern New England area; but, should such a proposal be made, then the potential impacts must be assessed.

Tanker operation can result in environmental changes due to scouring, turbulent mixing and wave generation. However, the traffic intensity probably must be relatively high to pose a serious threat. In addition, the primary problem of sediment scouring is not likely to occur at most sites along the northern New England coast.

The most serious potential ecologic impacts along the New England coast are the results of oil spills. These potential problems are treated in detail in the next section.

3. Ecological Impacts of Oil Spills

Oil spills are classified above as chronic or catastrophic. The potential effects of oil from either source may be categorized as: 1) immediate lethal toxicity; 2) sublethal inhibition of behaviorial activities, especially during feeding and reproduction; 3) lethal or sublethal effects by direct coating of animals by oil substances (this is not the same as toxic effects); 4) incorporation of high boiling point polycyclic aromatic hydrocarbons (PAH), especially carcinogens, in the food chain; and 5) changes in habitat, especially for attached (sessile) organisms, due to deposition of oil on rocks, sediments or other substrates.

Lethal toxicity refers to the direct interference by hydrocarbons with cellular and subcellular processes, especially membrane activities, leading to organism death. Sublethal disruption also refers to interference with cellular level processes but does not include death-causing effects. The most important effects in this category are disruption of behavior -- especially feeding and reproduction. The effects of direct coating are the result of smothering an entire organism with oil. The response (lethal or sublethal) does not result from biochemical interference of cellular activities.

The incorporation of hydrocarbons in the food chain is interesting because of potential accumulation of PAHs, especially carcinogens, in various marine organisms. Lethal or sublethal responses exhibited by the organisms are included in the previous categories. Habitat changes, which include effects from both oil spill and nonoil spill events, consist of physical or chemical environmental changes that result in significant shifts of species distribution within the region of concern.

A group of investigators at M.I.T. are currently carrying out an extensive review of the specific biological responses that have been recorded from experimental and field studies. The objective is to sort out the various responses and to clarify some of the current confusion that exists regarding the effects of oil on organisms. The complete results will be published in the future.

However, some preliminary conclusions are that: 1) the low boiling aromatic constituents of petroleum substances are the only serious toxic threat; 2) concentrations of soluble aromatic fractions as low as .1 parts per million (ppm) may be lethal to certain larval stages, but many adult organisms are insensitive to soluble aromatic fraction concentrations as high as 10-100 ppm; 3) investigation of sublethal effects of very low concentrations [parts per billion (ppb) range] on behavioral characteristics of organisms should be a high research priority; 4) effects of direct coating of organisms are minimal in most cases; 5) one of the most serious threats is the buildup of relatively low concentrations, which are lethal to larval stages but not to adults; and 6) questions regarding the buildup of high-boiling PAHs in the food chain also remain unanswered.

However, the relative importance of effects listed above and the ultimate impact of oil in a particular situation is dependent upon several additional factors (Straughan 1972) including: the composition and amount of oil; physiography, hydrography and weather in the spill region; biota in the spill region; season of the year; and previous exposure to oil.

The composition and amount of oil determines the nature of the materials introduced into the environment. The physiography, hydrography and weather determine the spread, trajectory and dispersion of oil in the environment. Because the sensitivity of organisms exposed to the oil varies over a wide range, the specific biota of the region must be considered. This sensitivity is strongly influenced by the time of year (spawning seasons, migration, etc.) and previous exposure to oil. The overriding factor is the dynamic nature of this problem.

Oil weathering results in changes in composition and characteristics of the oil through time (Blumer and Sass 1972). Wind and currents transport spilled oil over large areas in the environment (Fay 1971; Ichiye, personal communication). Stages in the life cycle of most organisms have different sensitivities to oil (Hepple 1971; Cowell 1971; Nelson-Smith 1970). Previous history of spills may determine susceptibility and adaptations of organisms (Kanter et al. 1971). All of these factors are dynamic, changing through time and must enter into the analysis.

Because biological responses are dependent on specific fractions of oil, the weathering process is particularly important. Oil constituents are affected at different rates by weathering forces; therefore, the relative composition and biological effects of spilled oil changes over time. A simple model is proposed below to assist in assessing the significance of weathering.

4. Oil Weathering

The characteristics of spilled oil are altered significantly by evaporation, dissolution, microbial and chemical oxidation and suspended sediment formation (Dean 1968). Blumer and Sass (1972) and Blumer et al. (1972) have reported data that clearly demonstrate the extent of these various degradation processes.

Two approaches may be taken to develop a model of the weathering process. The first is to develop equations using a mass balance, accounting for mass fluxes of each oil component due to weathering mechanisms outlined above. Various assumptions can be incorporated to simplify the model according to the user's needs. An alternative is to make an a priori assumption about the overall process, to compare the resulting model with available data and, if acceptable, to estimate necessary parameters in the model. The latter approach is utilized here.

Assuming that weathering may be approximated by first order decay, then:

1. $\frac{dC_i}{dt} = R_i C_i$ where C_i = concentration of component i, R_i = overall weathering rate for component i ($time^{-1}$) and t = time.

The overall weathering rate is composed of several specific rates:

2. $R_i = r_i^E + r_i^D + r_i^M + r^S$ where r_i^E = specific rate of evaporation for component i ($time^{-1}$), r_i^D = specific rate of dissolution for component i ($time^{-1}$), r_i^M = specific rate of microbial degradation for i ($time^{-1}$) and r^S = specific rate of suspended oil formation ($time^{-1}$).

The weathering rates in equation 2 are functions of environmental conditions, especially wind, temperature and currents. However, over short-time periods (Δt), the rates can be considered constant and:

3. $C_i(t + \Delta t) = C_i(t)e^{-R_{i\,t}\Delta t}$ where $R_{i\,t} = R_i$ evaluated at time t.

If the original first order decay assumption is valid, then the time history of the slick composition can be estimated by equation 3 when given appropriate relationships between the rates and environmental inputs.

The large number of individual compounds in crude oil precludes the consideration of each one explicitly in the model. Alternatively, compounds are grouped according to number of carbons and hydrocarbon type. Table I summarizes one possible grouping and the range of physical/chemical constants for each fraction. The six fractions selected provide adequate flexibility in characterizing oil, especially with respect to biological effects, both short- and long-term. However, more detailed breakdowns are possible and may be warranted in some cases.

Before estimating the weathering rates for each of the six fractions, it is desirable to have some idea of the validity of the first order decay approximation. Figure 1 shows a plot of changes in concentration of the normal paraffin (undecane), (C_{11})[1], in a short-term weathering experiment reported by Kinney et al. (1969) in which evaporation and dissolution were the primary weathering forces. Because a semilog plot of first order decay is linear, Figure 1 provides some credence for accepting the first order decay assumption. Figure 3 demonstrates further evidence for the validity of the assumption. Gas chromatogram peak heights reported by Blummer and Sass (1972) are plotted and show an approximate first order decay for the ratio of the normal paraffin, heptadecane (C_{17}), to the isoprenoid, pristane (C_{19}). Changes in this ratio indicate microbial degradation because hydrocarbon is subject neither to significant evaporation nor to dissolution, but normal paraffins are degraded noticeably by bacteria and isoprenoids are not.

The final step in model development is to determine the rates r_i^E, r_i^D, r_i^M and r^S. Blumer et al. (1972) demonstrate the use of gas chromatograms not only for determining the presence of petroleum-derived hydrocarbons but also for assessing environmental weathering of oil. In particular, certain characteristic chromatogram parameters, such as the ratio C_{17}:pristane, can be used to estimate various degradation rates. The reader is referred to Blumer, et al. (1972) for a detailed discussion of gas chromatograms and their use. Table II summarizes estimates of weathering rates for the fractions given in Table I based on data reported by Blumer and Sass (1972), Blumer et al. (1972), Kinney et al. (1969), Smith and MacIntyre (1971) and the physical/chemical constants listed in Table I. (Note: r_s is not a function of fraction type and is not included in Table II.)

As an example of arriving at the rates in Table II, consider fraction I$(C_6 - C_{14}$, normal and iso-paraffins). Data reported by Kinney et al. (1969) and by Smith and MacIntyre (1971) indicate that this fraction is completely lost by evaporation and dissolution in less than 12 hours. Therefore, microbial degradation can be ignored. Semilog plots of some data given in Kinney, et al. and in Smith and MacIntyre are shown in Figure 1. Interpretation is confused by lack of information on temperature and on variation in winds. However, as a first approximation temperature effects for this fraction can be ignored due to high

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[1]The notation C_n indicates a hydrocarbon containing <u>n</u> carbon atoms.

TABLE I.

BASIC DATA FOR OIL

SPILL WEATHERING MODEL

Fraction	Description[a]	% by weight[a] in Crude Oil	Density[b] (gm/ml)	Boiling Point[b] (°C)	Molecular Weight[b]	Vapor Pressure[b] @ 20°C (mm)	Solubility ($gm/10^6 gm$ Distilled H_2O)
1	Paraffin C_6-C_{14}	0^+ -25	.66-.77	69-253	86-198	110-.01	9.5-.00
2	Paraffin C_{15}-C_{22}	0^+ -10	.77-.78	270-368	212-290	.01-0	.007-.003
3	Cyclo-Par Paraffin C_5-C_{11}	1-25	.75-.9	49-200	70-152	230- 1.	156. - 1.
4	Aromatic (Mono-Cyclic) C_6-C_{18}	0-5	.88-.90	80-204	78-136	72-.34	.780.-50.
5	Aromatic (Poly-Cyclic) C_{10}-C_{18}	0^+ -5	1.1-1.2	218-350^+	128-234	.1-0	12.5-0
6	Residual	30-70	1.-1.1	> 350	200-900	0	0

TABLE II

Estimated Weathering Rates for Oil Fractions as Listed in Table I (Day^{-1})

Fraction	r_i^E [a]	r_i^D [a]	r_i^M
1	$-.8e^{-2S_w}$	-.1	___ [b]
2	-.002	0	-.03 @ 12°C (Q_{10}= 3.)
3	$-.8e^{.2S_w}$	-.5	___ [b]
4	$-.8e^{.2S_w}$	-1.0	___ [b]
5	-.02	-.001	? [c]
6	0	0	? [c]

a -- temperature dependence could be included by considering vapor pressure and/or solubility dependence on temperature.

b -- assumed insignificant relative to r_i^E and r_i^D.

c -- these rates might be of the order 10^{-5}.

TABLE III.

Estimated Weathering of Oil Fractions

	% Of Fraction Remaining					
	24 hours		48 hours		96 hours	
Fraction	0 Knots	10 Knots	0 Knots	10 Knots	0 Knots	10 Knots
1	.41	.001	.17	--	.03	--
2	.99	.99	.99	.99	.99	.99
3	.27	.001	.07	--	.005	--
4	.16	.001	.03	--	.001	--
5	.98	.98	.96	.96	.92	.96
6	--	--	--	--	--	--

volatility even at low temperatures. The data is replotted in Figure 2 to show the effect of wind. Evaporation and dissolution are not readily separable from this data. However, most of the increase in total loss rate by wind can be attributed to wind effects on evaporation. Therefore, dissolution is certainly less than the minimum total loss rate.

Furthermore, the large difference between gas and liquid diffusivity rates (gas diffusivities are typically one or two orders of magnitude greater than liquid diffusivities) indicate that dissolution is considerably less than the minimum total loss rate. Using these considerations and the slope of the plots in Figures 1 and 2, the rates are estimated and given in Table II. The other rates can be estimated similarly and by considering the differences in vapor pressure and solubility as given in Table I.

Estimates of r_s are equally tenuous. The mechanisms of suspended oil formation and deposition are not well understood. Berridge, Thew and Loriston-Clarke (1968) report investigations of water-in-oil emulsion formation, but the sea occurrence of these emulsions, which were typical following the Torrey Canyon spill, appear to be closely linked to the application of emulsifiers. Oil-in-water emulsions did not occur significantly, if at all, following the Santa Barbara (Straughan 1971), San Francisco (Chan 1972) or Tanker Arrow (Forrester 1971) spills.

A more important process appears to be the formation of suspended oil particles in the water column. The suspended oil may be deposited in sediments if it forms negatively buoyant particles by loss of low boiling fractions or by contact with other suspended material. Contact with other particulate matter may result from either physical processes of mixing or biological contact via injection and defecation by organisms (Conover 1972).

Rate estimates of suspended oil particle formation suggested herein are based solely on empirical evidence. Forrester (1971) estimates that, following the tanker Arrow spill, the production rate of suspended oil particles with a characteristic length between 10μ and 1000μ averaged between 1-6 m^3/day. The Arrow spill consisted of about 10^4 m^3 of oil, so the specific rate of suspended oil formation is 10^{-4} - 10^{-3} days $^{-1}$ as a first approximation. This rate is strongly dependent on sea and surf conditions. For winds less than 10 knots (i.e., no white caps), the rate of suspension formation is probably close to zero.

Hartung and Klinger (1968) and Poirier and Thiel (1941) have investigated oil deposition by sediments. Their results indicate that the grams of oil sedimented per gram sediment (diatomaceous earth) is in the range of .4-.8. The lower value would apply to lower boiling fractions, the higher value to residual material.

Conover (1972) estimates that zooplankton ingestion and defecation could lead to sedimentation of suspended oil per unit of zooplankton biomass per day equivalent to 1.5 per cent of the suspended oil concentration.

Using the rates given in Table II, the changing composition of spilled oil can be estimated.

Table III shows a simple example for short-time periods and two different wind conditions. The actual percentages are not particularly important. Rather, the fact that in a relatively short time (24-48 hours) the highly toxic fractions (3 and 4) are reduced to very low concentrations. However, the potentially undesirable high boiling fractions remain either to be ultimately dispersed in the oceans or to be incorporated in sediments where they could remain for years.

The weathering rates estimated above are first approximations at best. They should be used cautiously and with a clear understanding of the assumptions and limitations involved. Effects of temperature and wind are difficult to include yet play a major role. In all cases, it is desirable to double check the estimates with alternative, independent determinations.

5. Site Selection Considerations

The foregoing discussion of ecologic impacts and weathering provide some insights into certain aspects of site selection. Most important is the rapid loss of low boiling aromatics. Because these are the most toxic, it is desirable to select a site such that spills could weather for 24-28 hours before impinging highly productive shore areas. Secondly, locations should be avoided that are semienclosed and allow the concentration of soluble fractions to build to dangerous levels. The importance of these two considerations has been illustrated by differences in effects of the West Falmouth oil spill (Blumer et al. 1972) and the Santa Barbara spill (Straughan 1972).

A third consideration, which is important for the northern New England coast and is related to weathering time, is the coastal currents. In general, it can be expected that any oil spilled in the near-coastal region would soon find its way onto shore over a large part of the coastline south of the spillage point.

A final consideration, especially important in northern areas, is temperature. Weathering rates are slower and to some extent recovery rates would also be slower because of the shorter growing season.

Conclusions

Several tentative conclusions can be drawn at this time from this work:

1. Potential nonoil spill-related impacts are minimal in the northern New England area.

2. The environmental vulnerability to oil spills is relatively high along the northern New England coast.

3. Deepwater terminals should be located in areas where buildup of materials from oil spills is minimized.

4. Significant reductions in oil spill impacts are likely if the spilled oil is able to weather before impinging on productive areas.

5. One of the most serious long-term threats is effects on populations due to repeated killing of larval stages by low level chronic spillage.

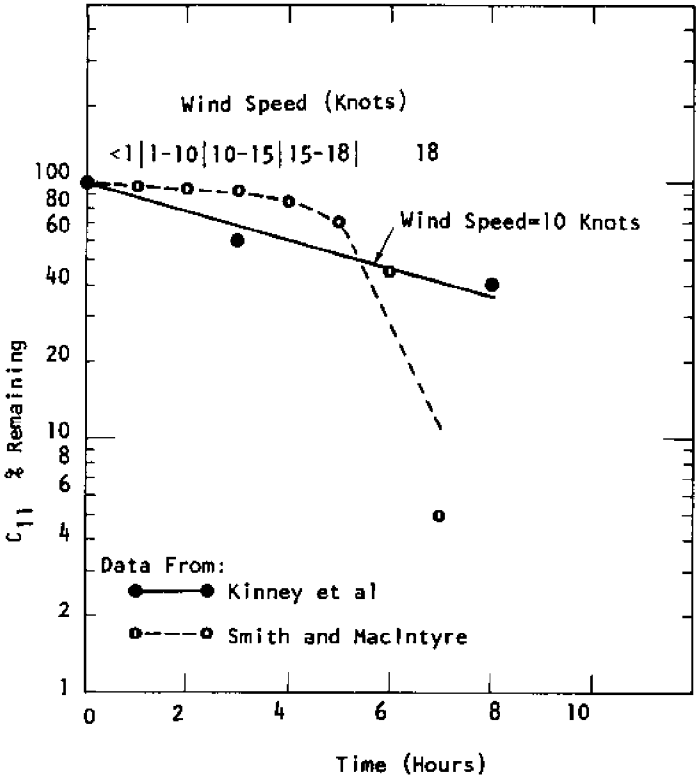

FIGURE 1. Loss of Undecane (C_{11}) By Evaporation and Dissolution

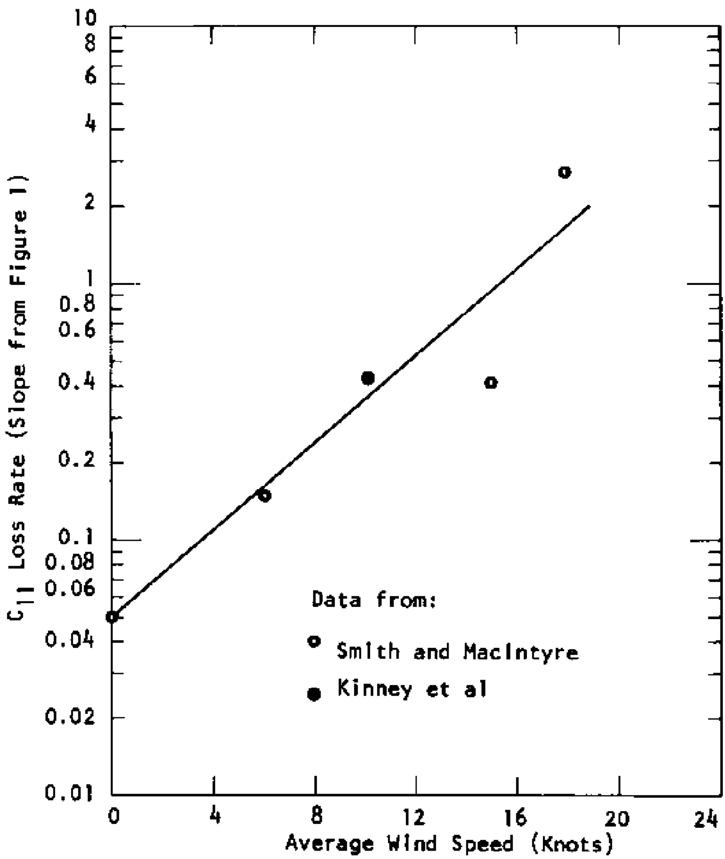

FIGURE 2. Effect of Wind Speed on Weathering

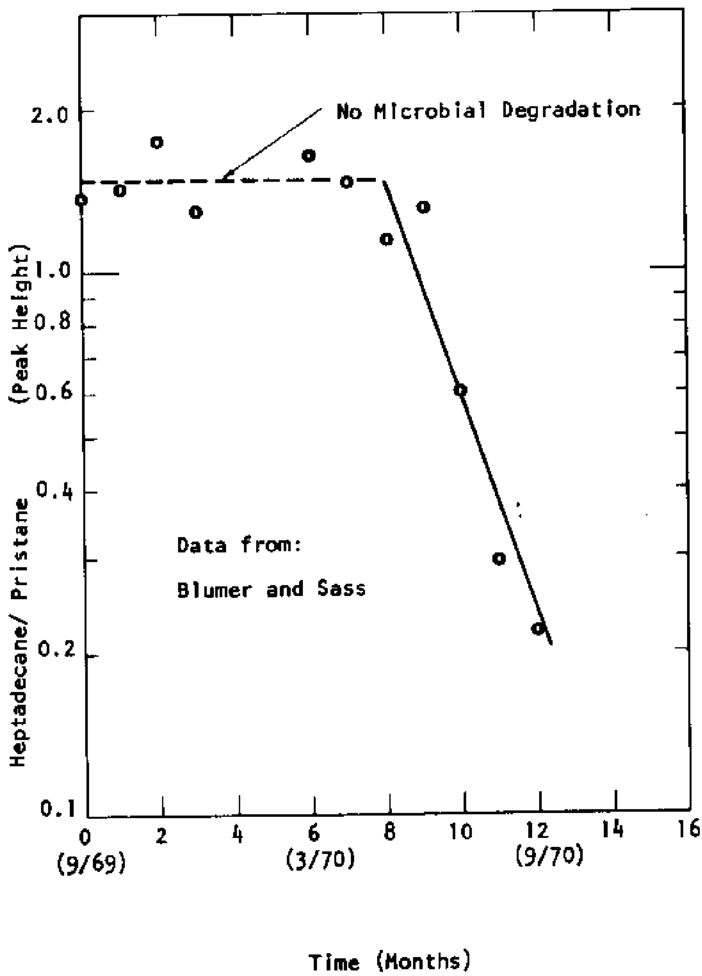

FIGURE 3. Microbial Degradation of Hydrocarbons

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Environmental Aspects of a Texas Superport

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Problem

The objective of this study is to evaluate the environmental impact of a superport off the Texas coast. Both the nonoil spill impact of construction and of operation and the oil spill impact on the coastal environment are included in this project.

Two port locations are considered. Site number one is located southeast of Freeport about 25 statute miles offshore in 95 feet of water. Site number two is located south of Freeport, 11 statute miles offshore in 60 feet of water.

A five-nested single point mooring with a central platform is being considered for the port facilities at site number one. The central platform includes pumping equipment with pipelines extending to a shore-based tank farm. This site in 95 feet of water would not require any dredging.

The nearshore site located in 60 feet of water requires dredging a 1,000-foot wide channel, 13 miles long and 90 feet deep. Port facilities for this site include a 6,000-foot breakwater, a 200-acre artificial island and a pipeline for transfer of oil to the tank farm on shore.

For the purpose of this study, three different oil spills were evaluated. The spills considered were a nearly instantaneous release of 30,000 tons due to a tanker mishap, a continuous spill of four barrels per day caused by the normal operation of the port and an accidental spill of 500 tons.

Procedures

Although this study concerned only two specific port sites, the procedures and data developed by this project are applicable to any site off the Texas coast. The general approach followed is listed below:

1. Identify those activities associated with the offshore port that might affect the environment.

2. Identify and inventory environmental elements that may be impacted by the various supertanker activities.

3. Analyze the interaction between supertanker activities and environmental elements.

4. Evaluate and summarize the environmental impact of the deep sea port on the environment.

Time and financial constraints limited the study to existing onhand knowledge. The expertise of ocean engineering, physical oceanography, petroleum engineering, industrial economics, marine biology, parks and recreation and environmental engineering utilized to accomplish various task items of the project.

Movement Of Oil

Oil on the sea surface forms a relatively thin film that will eventually disappear. The rate at which the fractions evaporate is of special concern since these compounds are generally the most toxic. The fractions that are water-soluble will have a direct effect on aquatic life. Moore, in an unpublished paper in 1972 at MIT, presented a first order decay model to approximate the rates of evaporation, dissolution and biological degradation for the various fractions of the oil. This model was utilized to predict the rate of decay and transfer of the various oil fractions between phases.

Accurate prediction of the spread and the transport of oil at sea is essential for the realistic evaluation of the environmental impact. Ichiye (1972) demonstrated that the initial bore from an instantaneous spill would dissipate within a matter of minutes after the spill. Viscosity will limit the gravity spread, and in a few hours the average oil thickness will be of the order 1 mm. Horizontal diffusion then becomes the dominant driving force spreading the oil.

The volume and area for the 500 ton spill and the 30,000 ton spill are listed in the following table for an average thickness of 1.0 mm.

Table I. Initial Area of Oil Spills

Spill	Volume	Diameter	Area of Oil 1.0 mm	Thickness
Tons	m^3	km	$(km)^2$	$(nm)^{2*}$
500	500	0.85	0.55	0.16
30,000	33,000	6.5	33	9.6

* square nautical miles

The oil slick will remain thicker in the center than at the edges for some time after the spill. Diffusion will tend to break the slick into patches and also reduce the oil thickness.

The rate at which oil is spread by horizontal diffusion depends upon both the sea state and the size of the oil slick. A modified form of the Fickian diffusion equation is presented here to account for the transport, spreading and decay of the oil slick.

$$\frac{\partial d_o}{dt} = -\frac{U\partial d_o}{\partial X} + \frac{D_x \partial^2 d_o}{\partial X^2} + \frac{D_y \partial^2 d_o}{\partial Y^2} - Kd_o \qquad (1)$$

where d_o is the oil thickness, U is the unidirectional velocity of the slick in X direction and is the vector summation of the wind and current components, D_x is the longitudinal spreading coefficient, D_y is the transverse spreading coefficient and K is the decay coefficient. K includes losses due to the water by solution and to the air by evaporation. The effects of biological degradation are considered to be very small in relationship to solution and evaporation terms.

Spreading coefficients that were used in the study to estimate the oil slick size are listed in Table II. These values were based on observations of several existing spills and are influenced both by the wind velocity and the spill size.

Table II. Spreading Coefficients for Three Oil Spills

Wind Speed	Continuous Spill D_x	Continuous Spill D_y	500 Ton Spill D_x	500 Ton Spill D_y	30,000 Ton Spill D_x	30,000 Ton Spill D_y
2.5-5	0.7	0.5	1.5	1.0	3.0	2.0
5-10	1.5	1.0	3.0	2.0	6.0	4.0
10-20	3.0	2.0	6.0	4.0	12.0	8.0

Utilizing the model given by equation 1 and the diffusion coefficients listed in Table II, the dimension of the oil slick can be estimated at any time after the spill. An example of slick dimensions estimated for the 30,000 ton spill with 10-20 knot winds are listed in Table III. When losses due to evaporation are included in the model, the thickness of the oil film is reduced at a faster rate. After the oil slick has been at sea for two days, approximately 95 per cent of the volatile fractions in the oil will have evaporated. The most toxic fractions will have been lost from the oil slick.

Table III. Oil Slick Size, 30,000-Ton (34,000 m^3) Spill, 10-20 Knot Wind*

Time	Major Axis	Minor Axis	Area	Average Thickness No Loss	Average Thickness With Loss
hrs.	km	km	$(km)^2$	mm	mm
2	6.5	6.5	33	1.00	1.00
8	7.6	7.2	43	0.77	0.49
14	8.5	7.9	52	0.63	0.33
20	9.4	8.5	62	0.53	0.26
26	10.1	9.1	72	0.46	0.23
32	10.9	9.6	82	0.40	0.20
38	11.5	10.1	91	0.36	0.18
44	12.2	10.6	101	0.33	0.16
50	12.8	11.1	111	0.30	0.15
56	13.4	11.5	121	0.27	0.14
62	13.9	12.0	131	0.25	0.13

*Spreading Coefficients from Table II.

If winds are from the southeast, the oil slick will travel toward the coast at a rate of about 3.1 per cent of the wind speed. The slick will require at least two days in travel time to reach the coastal area.

Environmental Inventory

The inventory of environmental elements that might be affected by an oil spill has been in progress since the start of the project. This task has been nearly impossible and would require several years of field studies to adequately complete. However, for the purpose of this study, on-hand data was compiled for the following general areas: 1) offshore, 2) nearshore, 3) surf zone, 4) beach, 5) estuaries and 6) uplands to the hurricane high-water elevation. Those environmental elements within areas 1 and 2 above were indexed on a three-mile grid system. The coastal elements within areas 3 through 6 above were indexed according to three-mile beach sections that were numbered beginning at the Rio Grande River and ending at the Sabine River. NASA's high altitude infrared color photography was used to delineate marsh areas and to locate water gaps in the barrier beach where oil might enter.

Evaluation

Evaluation of an oil spill impact includes the probability of the oil reaching each environmental element plus the effect of the oil after it comes in contact with the element. Wind and current data are lacking off the Texas coast. A model was developed using average wind and current values. This model estimates the probability of the oil slick reaching each grid square offshore and each beach section along the coast.

In the offshore area the fractions of oil soluble in water are of major concern. Once these fractions enter the water column, they move with the water currents and not with the surface oil slick. The lower limit of vertical mixing of the soluble fractions of oil is indicated by the thermocline that occurs 10 to 20 meters below the sea surface. In the offshore waters an oil spill would have little effect on the bottom organisms.

In the nearshore zone the soluble fractions of oil in the water column are expected to extend to the bottom. As the oil slick approaches the surf zone, it will begin to pick up silt and clay particles from the turbid water. Combined with the loss of volatile fractions, this action will cause the specific gravity to increase, and some sinking of oil can occur in the surf zone. By the time the oil reaches the environmental elements on shore or within the estuaries, most of the toxic compounds will have been lost. Major damage will result from smothering.

Summary

Evaluation of the impact of a superport will require the summation of the construction, operation and accidental oil spill effects on the environment. For the offshore site the effects of construction and operation, including the continuous low-level oil spills, will have minimal impact on the environment.

The biological productivity of the marine environment is lowest in the open ocean, increases towards the coast and reaches a maximum in the estuaries. The toxicity of an offshore oil spill decreases as it approaches the coast. If an oil spill is to occur, it will have minimum impact if it occurs offshore and approaches the coast rather than occurring in the coastal area and moving offshore.

Associated with the offshore port is the risk of a major oil spill. Over a period of time this spill is very likely to occur. Once the spill occurs, the oil is no longer considered a valuable resource but is an undesirable and potentially hazardous material. Efforts must be devoted toward minimizing the impact of this material on the environment. Control by containment at sea and by physical removal of the oil would have the least impact on the area.

The ocean has a capacity to utilize certain waste materials including oil. Ocean outfalls have been an accepted method of waste disposal for dissolved biodegradable materials. This reasoning has not been an accepted solution for toxic or slowly degradable materials. Letting the oil drift uncontrolled, eventually to spread over such a large area that the environmental effects are no longer measurable, does not appear to be a good solution. When summed over this large area, the total damage to the environment might be much larger than if the impact is confined to a small coastal area.

It appears from our study that prevailing winds and currents on the Texas coast will generally (about 60 per cent of the time) bring a major oil spill to the coast where the oil spill will have a better chance of being controlled. The Gulf beach will act as a barrier that will aid in removing the oil from the sea. Floating sorbent material added to the oil slick will be required to prevent sinking in the turbid coastal waters and will aid in oil pick-up along the beach.

Of the two sites studied off the Texas coast, the offshore site appears to be the most desirable from an environmental standpoint. The offshore site will allow a greater time to organize cleanup and to control operations in addition to allowing greater time for evaporation of lighter oil compounds. Because of the 11-mile narrow-dredged channel, the nearshore site would have the greater dangers of grounding and of the occurrence of accidental spills. The dredging required for the channel and turning basin for the nearshore site will affect the benthic organisms in the immediate area.

The construction of a supertanker port off the Texas coast will undoubtedly increase the potential for oil spills to occur in the area near the site. The estuaries have been described as the most biologically productive areas of the marine environment. Thus, by sifting the potential impact from the estuary to the coastal beach areas, the supertanker port facility may not increase the potential damage to the environment. Because of barrier islands, major oil spills most likely will create short-term problems on beaches, which appear to be preferable to long-term effects that might occur in bays and estuaries if the oil were shipped there instead.

This project is being sponsored by the Council on Environmental Quality through Sea Grant. The study is still in progress, and final conclusions and recommendations will be given in the final project report.

Current Status of Alternative Deepwater Terminal Feasibility Studies

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The need for deepwater terminals on our North Atlantic and Gulf Coasts to handle United States foreign trade in petroleum and in dry bulk commodities is a frequently discussed domestic issue. At this time the total picture is difficult to present because many important studies are not yet published or are just beginning. An overview of the current status of certain deepwater terminal studies and their conclusions would be helpful; however, because the issue is one with impact on public interest and on large private investments, misconceptions tend to grow when all facts are not yet known. Events happen so quickly that conclusions reached after careful analysis may become obsolete by the time they are published.

Yet from the standpoint of national economic interest, there is little disagreement that an ability to import crude oil from the Mideast and Africa in large deep-draft ships is essential in coping with the growing energy shortage that this nation faces. There is considerable disagreement, however, concerning the cost of alternative types of deepwater terminals to handle such vessels and also concerning the degree of potential threat to our coastal environments.

A previously released part of a Maritime Administration project to evaluate offshore terminal concepts will be used as a basis for discussion. This "executive paper" deals primarily with a North Atlantic deepwater oil terminal located east of Cape Henlopen and outside of Delaware Bay. The project findings emphasize the impact of such factors as ship size, route length, terminal location, coastwise distribution and pollution protection on the economics and engineering feasibility of deepwater terminals.

Background

An explanation of certain other related projects will preface discussion of the above study so that the significance of various findings can be placed in perspective.

The interest of the Maritime Administration in deepwater terminals stems from the limitation on ship size imposed by channel depths of U.S. ports on the North Atlantic and Gulf Coasts. Because of the limitation, this nation cannot develop or utilize the very large tankers and bulk carriers of 250,000 or more dwt that foreign experience has shown can produce major transportation savings. Since the Corps of Engineers has determined that it is not economically feasible or environmentally safe to dredge the ports in question from their present 35- to 45-foot depths to the 72-foot depth needed by ships of 250,000 dwt, this agency in 1971 issued a nation-wide solicitation for proposals to evaluate offshore deepwater terminal concepts.

Soros, Associates, Inc., consulting engineers of New York, started this study and provided a catalyst that helped to spur activities in private industry as well as in state and federal agencies. The study was intended primarily to place within the public domain engineering estimates of capital and operating costs required to provide offshore terminals in very deep water. Few precedents exist from which to obtain cost data, and this lack has been a constraint to serious consideration of offshore terminals as a dredging alternative. It was hoped that this study would encourage public and private bodies to undertake their own studies and would lead to construction of at least one deepwater terminal. The study, which covered the three coasts but concentrated on the North Atlantic and Gulf, included movement forecasts and analyses of environmental protection and shipping costs for both liquid and dry bulk commodities. Its principal contribution, however, was in engineering costs and conceptual arrangements for five sites.

During 1971 the Corps of Engineers initiated a related study by Robert Nathan, Inc. That went into greater economic analysis and covered a wider range of alternatives on the three coasts but treated engineering for each coast in less depth. In addition the Corps was directed by Congress to undertake a regional study of deepwater port requirements and of alternative designs for the North Atlantic Coast from Norfolk to Maine and for the entire Gulf Coast.

To ensure that environmental factors would be considered at the outset of developing national policy, the President in his message on the environment of February 8, 1971, directed the Council on Environmental Quality, in conjunction with the Department of Transportation (Coast Guard) and the Environmental Protection Agency, to review measures that deal with oil pollution risks that might result from development of alternative deepwater terminal proposals. This interagency study involved, in addition to the above, the Department of Commerce (MarAd, NOAA) and the Department of Defense (Corps of Engineers).

In August of this year, the Executive Office of the White House initiated an overall in-depth study to pool the resources of the various agencies and the data already gathered to develop a coordinated administration position. This multiple agency program, referred to as the "Domestic Council Superport Study," is to investigate such factors as economics, legislation, environmental protection, regional planning, U.S. shipping and U.S. ports. The principal agencies involved are the Department of Interior, Corps of Engineers, Maritime Administration, Environmental Protection Agency, Council on Environmental Quality and Department of Transportation.

All studies highlighted the importance of knowing where and to what degree the refinery capacity of this nation is most likely to develop. The National Petroleum Council has just recently begun a study of this key issue, and its findings will do much to clarify some differences in opinion that are discussed below.

While these federal efforts were in the planning process, certain significant projects were begun at state and municipal levels and in private industry. The Sea Grant program of the National Oceanographic and Atmospheric Administration helped launch a major effort in the western Gulf region by contracting with Texas A&M University to publish a "Work plan for the study of the feasibility of an offshore terminal in the Texas Gulf Coast Region." This publication formed a rallying point from which private and municipal bodies could plan the development of a superport.

The Texas A&M plan indirectly provided an example that stimulated a state-oriented effort in Louisiana to investigate requirements, sites and costs, and to develop a plan of action for a superport in the Mississippi Delta vicinity.

A significant state study is underway in Delaware where, at present, further development of heavy industry and deepwater terminals is not permitted. A special task force is now reexamining the feasibility of creating a terminal that would be beneficial to the state economy and yet not degrade the Delaware coastal environment. In the private sector it is more difficult to know all efforts that are in progress and how near to fruition each plan is; however, three examples will cover the areas pertinent to this discussion.

In the Delaware Bay a consortium of major oil companies, the Delaware Bay Transportation Company, has plans well advanced for the construction of a three-berth fixed pier in calm waters inside the mouth of Delaware Bay, five miles off Big Stone Beach. This project is now in abeyance because of the ban on such development by the Delaware State Coastal Zoning Act.

In the Mississippi Delta another consortium has formed the "Loop Project" to establish monomooring systems that serve Louisiana refineries; in Texas a group of oil companies, under the name of Texas Seadock Project, are actively planning a similar monomooring system in the Freeport area.

Effect of Ship Size and Route Length

The importance of ship size in reducing ocean freight costs can be seen in Figure 1. For the 24,000-mile round trip between the Persian Gulf and the U.S. North Atlantic Coast, a tanker of 326,000 dwt should be able to transport oil at about $6.15 per ton as compared to $9.63 per ton for a ship of 65,000 dwt. The latter ship is about the largest size that can deliver oil directly to the major U.S. East Coast refineries in the fully loaded condition. This $3.48-per-ton savings if over 36 per cent of the conventional direct shipment cost. From this savings must be subtracted the cost of transshipment, including the terminal charge. The approximate cost of transshipment by either barges or coastal tankers is shown in Figure 2. Relatively little can be done to change these costs significantly, but in the case of the terminal charge there is wide variation, depending upon the type of terminal selected.

Terminal Type and Location

The type and cost of a transshipment terminal is affected largely by location. To be consistent with our objective of minimizing any environmental threat, it was concluded that a site outside the mouth of Delaware refineries and freedom from collision or grounding hazards. The design criteria used are summarized in Figure 3. At this site the wave conditions are such that a breakwater is needed to maintain an efficient berth availability. The general layout of the terminal type can be seen in Figure 4. This shows two stages of operation, an interim stage consisting of two supertanker berths and six feeder berths for a 100 million ton per year throughput and a subsequent stage for 200 million tons per year throughput doubling the berth capacity.

The economic impact of alternative terminal concepts is illustrated in Figure 5, for a throughput of 100 million tons per year of petroleum moving from the Persian Gulf to Delaware Region refineries. This compares direct shipment in a 65,000 dwt tanker with three types of U.S. offshore terminals and with the alternative of transshipping oil via a foreign terminal located in the Bahama Islands. The U.S. alternatives in Figure 5 have certain distinguishing characteristics.

Alternative 3 is the Delaware Bay Transportation Co. design, referred to above, and is located halfway up Delaware Bay about five miles offshore, near Big Stone Beach. This site is favorable because it is at the head of a natural trench that minimizes dredging costs, but the channel length of over 20 miles limits ship size to 250,000 dwt. The shallow water that is adjacent to the trench, as well as the proximity to major refineries, minimizes pipeline costs.

Alternatives 4 and 5 are the hypothetical site chosen by Soros, Associates after careful examination of bottom contours and the evaluation of wave dissipation from shallow water southwest of Cape May. The site is about four and one half miles southwest of the Cape May tip and is considered to be the closest location to the ocean that does not require breakwater protection and that can receive a ship of 326,000 dwt. Alternative 4 represents transshipment by barge, and Alternative 5 is connected to the refineries by pipeline.

Alternatives 6 and 7 concern the site designated NADOT (North Atlantic Deepwater Oil Terminal), which is farthest offshore. The specific site was chosen because it is a 50-foot shoal on the seaward side of a natural trench over 100 feet deep. Although dredging is required to form its turning basin at the side of the trench and although the outer end of the trench must be dredged in places, the site is suitable for ships of 326,000 dwt; and, if it became desirable in the future, the site could be dredged to accommodate ships of 500,000 dwt. Alternative 6 assumes transshipment by barge, and Alternative 7 is connected to the refineries by pipeline.

Considering the pipeline alternatives we find total transportation costs generally comparable and fully competitive with the foreign transshipment alternative. The lowest cost is $.98 per barrel as compared to $1.07 for the Bahamas and $1.33 for direct shipment. Transshipment by tug barge would be four to five cents more per barrel. Despite its higher cost, the barge alternative was included since this would provide system flexibility at the outset and would avoid the possibility of right-of-way acquisition frustrating early project implementation.

Looking at the component cost in Figure 5, it is interesting to note that, even though these alternatives are generally competitive with regard to overall transportation cost, the capital cost component for the site in the open ocean is about 14 per cent higher than the site just inside the bay and is 160 per cent higher than the Delaware Bay Transportation Co. site, which is halfway up the bay. The reason for the cost difference is that the $182 million breakwater for the site outside the bay is offset by $188 million of dredging, which was the least costly alternative for accepting ships of 326,000 dwt inside the bay. The lower capital cost of the DBTC site at Big Stone Beach is balanced by that terminal being designed to handle ships of only 250,000 dwt, which according to Figure 1 has a voyage cost about $.56-per-ton higher than the 326,000 dwt ships that the two sites nearer the sea can handle. In the case of the Bahamas alternative, its low capital and operating costs are offset by a high cost of transshipment.

These numerical figures indicate that the deepwater alternatives serve the same overall functions with roughly equal effectiveness; however, each is designed to serve particular needs that make it more desirable to the sponsor, and at the same time each has a limiting factor that requires more study to select the final choice.

From the standpoint of the Delaware Bay Transportation Co., Alternative 3 (the terminal at Big Stone Beach) is the most desirable solution -- largely because it offers the least risk and could be implemented soonest. The drawback is that, since the terminal is on the Delaware shore, no permit can be granted under Delaware's coastal zoning laws. If the current Delaware study does not change that restriction, oil industry representatives in the Delaware Bay region have expressed a preference for Alternative 2 (a terminal in the Bahamas) because it also involves little risk and could be implemented without delay. The drawback in this case is that, if a change in environmental protection requirements should occur in the long run, a terminal located within Delaware Bay and closer to the market could undercut the foreign investment.

From the standpoint of the Maritime Adminstration, Alternative 7 (a terminal outside Delaware Bay connected by pipeline to the Delaware refineries) would be most desirable. This selection would remove much of the present tanker traffic from Delaware Bay, thereby limiting its future growth, and would present the least environmental threat. Therefore, Alternative 7 is considered most likely to meet the requirements of the Environmental Policy Act and related legislation. The drawback is that, because it has no close precedent on which cost estimates can be based and from which operational questions can be evaluated, Alternative 7 requires more study and its construction period would be longer than that of the alternatives preferred by the oil industry. The alternative, using feeder vessels in lieu of pipeline at this terminal, would ensure that an inability to obtain a pipeline right-of-way would not delay terminal construction; but recognizably this would not support our objective of reducing tanker traffic in Delaware Bay. However, the development of a new efficient tug-barge fleet to move this oil to major refineries between New York and Hampton Roads would be a unique opportunity and challenge for the U.S. shipbuilding industry. The technology exists by which we could produce more maneuverable vessels with special spill-control features now lacking on foreign flag tankers that enter the bay in great numbers. In this way Alternative 7 can be consistent with our responsibility to make this terminal less of an environmental threat than that which now exists without any deepwater terminal on the North Atlantic Coast.

Coastwise Distribution

The above discussion gives a rough comparison of alternative terminal concepts on a common level of 100 million tons-per-year petroleum throughput to the U.S. North Atlantic Coast; this comparison is intended to demonstrate that an offshore terminal for ships of around 326,000 dwt is feasible and could be financed by ocean transportation savings. A larger question exists as to the interaction between deepwater terminal construction and future changes in commodity flows and in refining capacity.

Although commodity flow data and forecasts in the reports discussed above support the development of U.S. deepwater ports, there are differences in opinion as to how high the predicted rise in import volume will go and as to where the new refinery capacity that is required will be located.

The requirement, as seen by Soros, Associates, was based on National Petroleum Council estimates that predicted a steady rise in ship-borne imports from 3.3 million barrels per day in 1971 to about 12.9 million barrels per day in 1985, a nearly four-fold increase. However, the study conservatively assumes that, after that period, there may be a restraint on this trend because of possible rising costs within the Mideast and because of price competition from other forms of energy. Basically this report presents for the year 2000 an upper limit of nearly 23 million barrels per day and a lower limit of about 15 million per day.

The question of coastwise distribution is a knotty one. Until the National Petroleum Council study establishes a clearer picture of the most likely locations for new refinery capacity, the split of foreign crude oil imports between North Atlantic and Gulf areas will be debatable. The rationale of the Soros study is based on the assumption that it is not economically possible to supply one coastal region with oil imported through another region. To supply the North Atlantic region by bringing oil from the Mideast into the Gulf Coast, by refining it there and by transshipping the refined products to the North Atlantic market would add approximately 30 per cent to the total coast when compared to supplying the North Atlantic directly by deep-draft tankers.

It was assumed that this cost difference would be enough incentive to cause a major expansion of refinery capacity in the Delaware region although higher land costs and possibly greater public opposition exist there than in the Gulf region.

The significance of the question can be seen from the fact that, in the coastal region to be served by a North Atlantic deepwater oil terminal, the present refining capacity is 70 million tons per year while the first-stage throughput for the 1980 terminal envisioned by the study is 100 million tons per year, which is increased in three stages to 300 million tons per year.

From discussion with various engineers in the oil industry, two conclusions were made: 1) through modern plant design involving reallocation of space within existing plant boundaries, the refining capacity of the Delaware region could be at least doubled without requiring new land; and 2) with modern technology and careful analysis of land use, ways could be found in the future to establish new refineries in the North Atlantic region. The most economical alternative is to place refinery capacity as close as is practicable to the market area; the 30 per cent cost differential noted above is a powerful incentive to do this.

In the event that East Coast refining capacity is unable to cope with demand, the most likely alternative is building additional capacity at a foreign transshipment point such as the Bahamas, which is on the direct delivery line.

In either event, this report concludes that as the volume of Mideastern oil imports increases the oil will be refined in the North Atlantic region, gradually supplanting domestic oil refining in that area. This supplantation would eventually lead to refining most domestic oils in the Gulf region to serve the rapidly growing market in the South and Southwest. This would delay but not eliminate the time when large volumes of foreign oil would be needed to supply Gulf Coast refineries.

The report indicates that this possibility should not detract from prospects of building a superport in the Gulf because there are features of the Mississippi delta coastline that would enable a terminal, equivalent in capacity to the outside-Delaware Bay alternative discussed above, to be built at much less cost. This cost is lower, in the judgment of Soros, Associates, because a breakwater would not be necessary and because placement of storage tanks on land appears to be feasible.

Environmental Protection

Environmental protection has a deep impact on engineering and economics of deepwater oil terminals. In the Maritime

Administration study the $499 million capital cost for the terminal outside Delaware Bay included an allowance of $50 million to ensure that no accidental spillage could escape from the terminal before being retrieved and disposed of in the terminal's oily-waste disposal system. The protection system exceeds the protective measures used today; but the Maritime Administration recognizes that, even though this terminal is outside of state waters and is located where wind and current would help to dissipate a spill before it could reach shore, there is still an obligation to leave no stone unturned to make this terminal as spill proof as possible. If this fact leads to early approval of the environmental impact statement that will have to be filed and if it reassures the local shoreline residents that the terminal poses no threat to their area, the cost is justified. A list of protective features follows:

Item	Cost $ millions
Oily waste water treatment	11.3
Ship traffic control	3.7
Spill containment barriers at berths	16.0
Standby spill containment for channels	4.3
Spill containment on the island	5.2
Mooring safety features	3.5
Miscellaneous	6.0
	50.0

The oily waste treatment system not only handles oily ballast and tank washing wastes, but it is also designed so that any spillage on the island will drain by gravity into a sump tank. The ultimate sludge disposal, after reusable oil has been retrieved, is through a fluid bed-type furnace. The cost figure is derived from data gathered in a recent study by Lockheed Shipbuilding and Drydock Co. for the Maritime Administration for floating oily waste treatment systems for port areas. Of the $11.3 million total, $4.6 million is for holding tanks.

The traffic control system envisions a 30-mile radius control zone around the terminal and a precision position-location system within a five-mile radius. By the time this terminal is built it, is assumed that positive centralized control as it exists in major airports will be administratively feasible.

Although the spill containment system at the berths is untried, it is a concept which ensures that a barrier can be placed around each tanker and feeder vessel before any hoses are connected, regardless of weather conditions. This "vertical rising" barrier would be permanently stowed on the sea bottom around each berth. By changes in bouyancy and by release of down-haul cables, a barrier suited to waves of up to eight feet in height could be raised around a ship in a matter of minutes. Because each berth is protected individually, a spill at one berth would not hinder operations at adjacent berths.

Although the centralized radar control systems would minimize the chance of collision, a conventional mobile spill barrier and oil retrieval system is provided for use in any emergency that could occur to ships going to or coming from the berths.

Spill control on the island covers many features but primarily concerns the cost of building the island up to a level flush with the tank tops so that no tank collaps or leakage is possible. This control makes it possible to place the entire oil piping system in trenches capable of draining by gravity any oil from a leaking pipe, faulty valve, flange, etc., to a central sump.

Mooring safeguard covers an allowance for future design concepts by which an error in the approach speed might be offset by fendering or a flexible dock structure, thus avoiding any possible rupture of the ship's shell or oil piping. While this safeguard is incorporated to a degree at present terminals, it warrants further examination.

The miscellaneous category covers such items as advanced leak detection devices for submarine pipelines, including improvements in underwater inspection and general maintenance.

While these features have not been individually designed at this time, it is important to note that the cost allowance we have arbitrarily assigned to each could be borne by the earning power of this terminal while still being competitive with other alternatives. This does not lead to a least-cost solution, but it might lead to the only acceptable solution in the long run under ntional and local environmental protection policy.

Environmental protection is a key issue because it creates areas of uncertainty that discourage investment in a deepwater oil terminal in any U.S. coastal region until all legal and administrative questions have been settled. The time needed to obtain clearance cannot be estimated because many issues must be settled in court.

Looking now at oil industry views, we see a strong interest in single point moorings for creating a deepwater terminal in the shortest time length and at the least cost. In developing the Maritime Administration report this alternative was considered carefully, but no way could be found to assure environmental protection that would be fully convincing. This conclusion was bolstered by the fact that two offshore mooring proposals off the New Jersey coast have been rejected because they posed spill threats.

This conclusion warrants explanation. It is true that, because it can be placed far offshore, an SPM can minimize the danger of collision as a major oil spill source. It is also true that a mooring is not capable of rupturing a ship's shell plating as readily as a fixed pier or a breakwater. The spill potential most often cited comes from the possibility of hose lines rupturing because of constant flexing caused by ship motion. The whole operation of retrieving a floating hose and making or breaking flanged connections is more difficult under far offshore wave and wind conditions. On the other hand, through proper installation of remotely operated cutoff valves, a break can spill only the amount of oil retained in a relatively short length of hose. One of the deciding factors is that weather conditions can limit berth occup^ncy more severely than if a terminal has protected berths.

Although due consideration was given to the work by private industry to improve operational procedures and the design of SPMs, this alternative was not considered as likely to gain public confidence or to be as adaptable to high throughput conditions as the terminal type identified as NADOT in the Soros "executive paper." NADOT is illustrated in Figure 7, which is presented here as an example of one answer to environmental objections against building a deepwater oil terminal in the Delaware region.

Conclusions

The conclusions of this Maritime Administration report provide a significant indication of the engineering and economic feasibility of building a deepwater oil terminal to serve the North Atlantic Coast of the United States. Furthermore, from this report specific protective features have subsequently been proposed to meet each significant type of oil spill hazard. This cost, which is roughly 10 per cent of the capital cost, does not make this type of terminal noncompetitive with alternative terminal concepts being considered by the oil industry.

By coordinating this report with ideas from representatives of the Delaware Bay Transportation Company, a work plan to refine details and to explore alternatives has been developed.

Looking at these conclusion in the light of other feasibility studies in progress we can see more than one way to view the situation. A major unknown is the effect on cargo movements and refinery development that would occur from actual development rather than from a theoretical feasibility study of a U.S. deepwater port on either the North Atlantic or Gulf coasts.

The Maritime Administration started with the end objective that deepwater terminal capability is essential to more efficient importation of crude oil from the Mideast. MarAd then worked back step-by-step to delineate a type of terminal that was the most practical combination of economic feasibility and environmental acceptability; this administration has also delineated four other candidate concepts, all to stimulate constructive action on both the Atlantic and Gulf Coasts in ways believed to be consistent with environmental protection policy.

The Corps of Engineers, under congressional mandate by the 1969 Environmental Policy Act, is conducting a series of studies to evaluate the significant proposals made to date, as well as all other alternative courses of action. The Corps studies are a technical basis for comparing the private industry studies now in progress; the studies will also be used to evaluate the Maritime Administration concepts.

We now see all these efforts brought into focus with national objectives and national economic policy under the broad umbrella of the "Industrial Council Superport Study," which is intended as a basis for establishing policy within this fiscal year. This policy will draw from these existing reports and will add aspects that are now missing in order to present an objective, comprehensive picture of the whole.

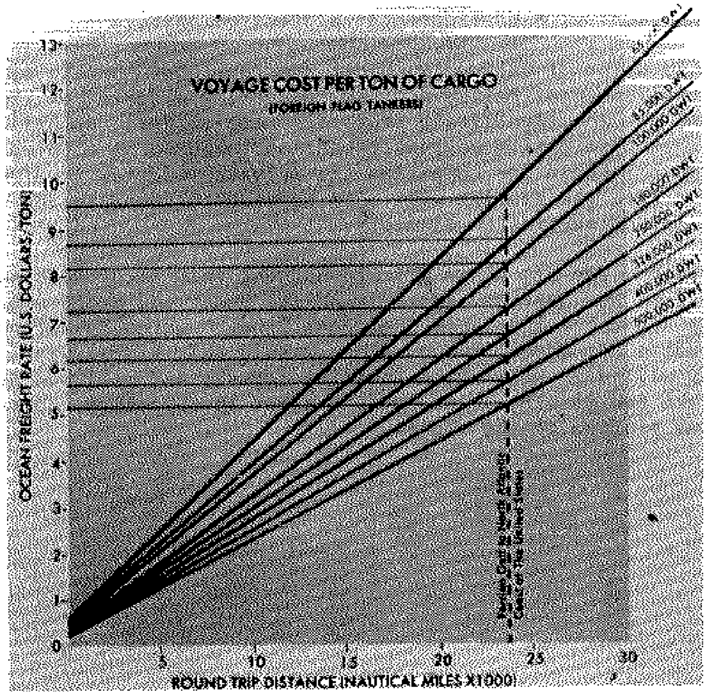

Figure 1. Ocean Shipping Costs

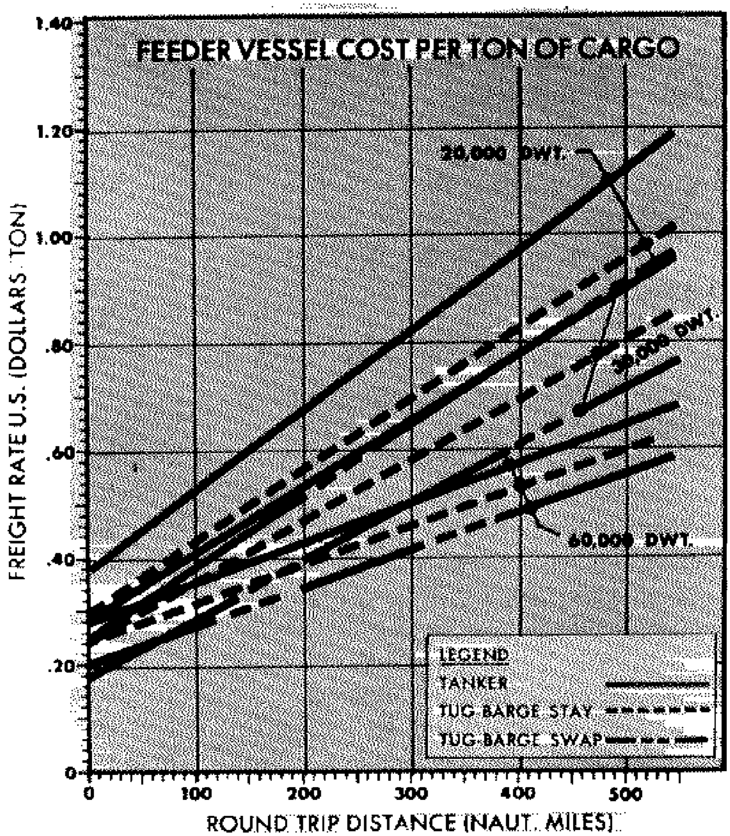

Figure 2. Feeder Costs

Basic design criteria used in planning NADOT include the following:

Ship Size	350,000 dwt
Water Depth Required at MLW for Loaded Ship	100 ft.
Water Depth Required at MLW for Ballast Ship	70 ft.
Maximum Water Height Above MLW Datum	58 ft.
Breakwater Design Wave Height	64 ft.
(Single Ampl.)	32 ft.
Breakwater Top above MLW Datum	40 ft.
Maximum Operational Wave Height for Marine Terminal	8 ft.
Maximum Survival Wave Height for Storage Island and Berthing Facilities	20 ft.
Maximum Current	3.1 knots
Maximum 1 Hour Sustained Wind	70 knots
Maximum 5 sec. Gust	104 knots
Throughput Design: Interim Stage—Crude Oil	100 MTY
Stage 1—Crude Oil	200 MTY
Stage 2—Crude Oil	300 MTY
Coal	20 MTY
Iron Ore	10 to 15 MTY

Figure 3. Design Criteria

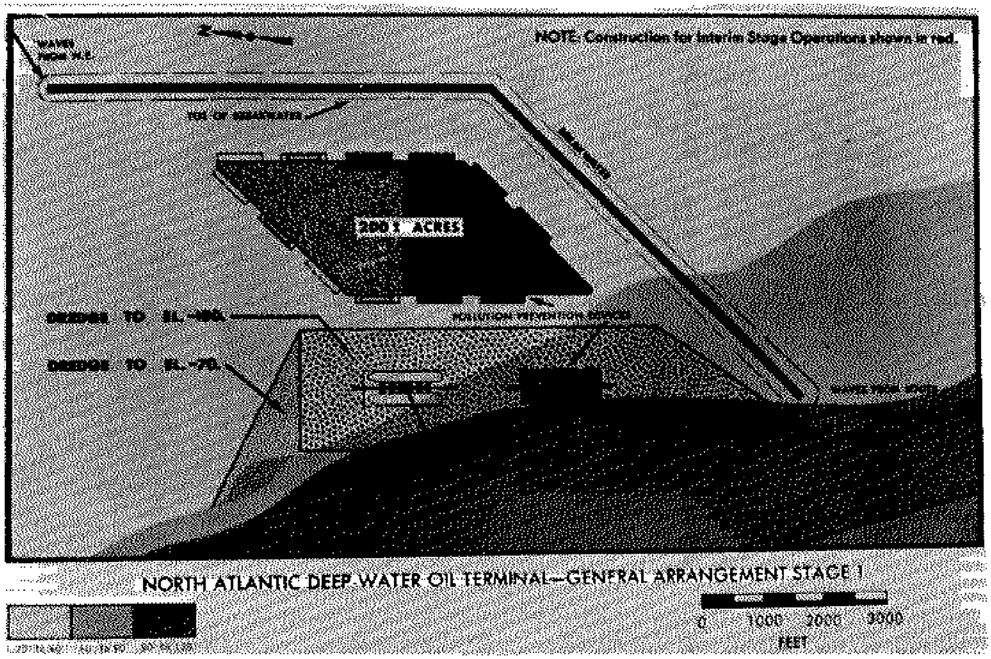

Figure 4. NADOT Plan View

TRANSPORTATION COSTS

Interim Stage-100 Million Tons Per Year

U.S. Dollars per Long Ton

Alternative No.	1 Direct to Existing Ports	2 Bahama Trans-ship	3 DBTC With Pipeline	4 In Del. Bay Tug-Barge	5 In Del. Bay With Pipeline	6 NADOT Tug-Barge	7 NADOT With Pipeline
Maximum Ship Size	65,000dwt	326,000 dwt	250,000 dwt	326,000 dwt	326,000 dwt	326,000 dwt	326,000 dwt
Ocean Freight	$9.63	$6.04	$6.71	$6.15	$6.15	$6.15	$6.15
Transfer charge, Excl. capital recovery	-	0.25	0.25	0.30	0.30	0.30	0.30
Transport to refinery	-	1.16	0.23	0.38	0.31	0.41	0.39
Unload at refinery incl. pollution control	0.30	0.30	-	0.30	-	0.30	-
Total, exclusive of transfer terminal capital recovery	9.93	7.75	7.19	7.13	6.76	7.16	6.84
Est. transfer terminal capital cost ($ million)	-	190	190	440	440	499	499
Capital recovery per ton 8% @ 15 yrs.	-	0.22	0.22	0.51	0.51	0.58	0.58
Total transportation Cost per ton	$9.93	$7.97	$7.41	$7.64	$7.27	$7.74	$7.42
Per barrel	$1.33	$1.07	$1.00	$1.03	$0.98	$1.04	$1.00

Figure 5. Transportation Costs

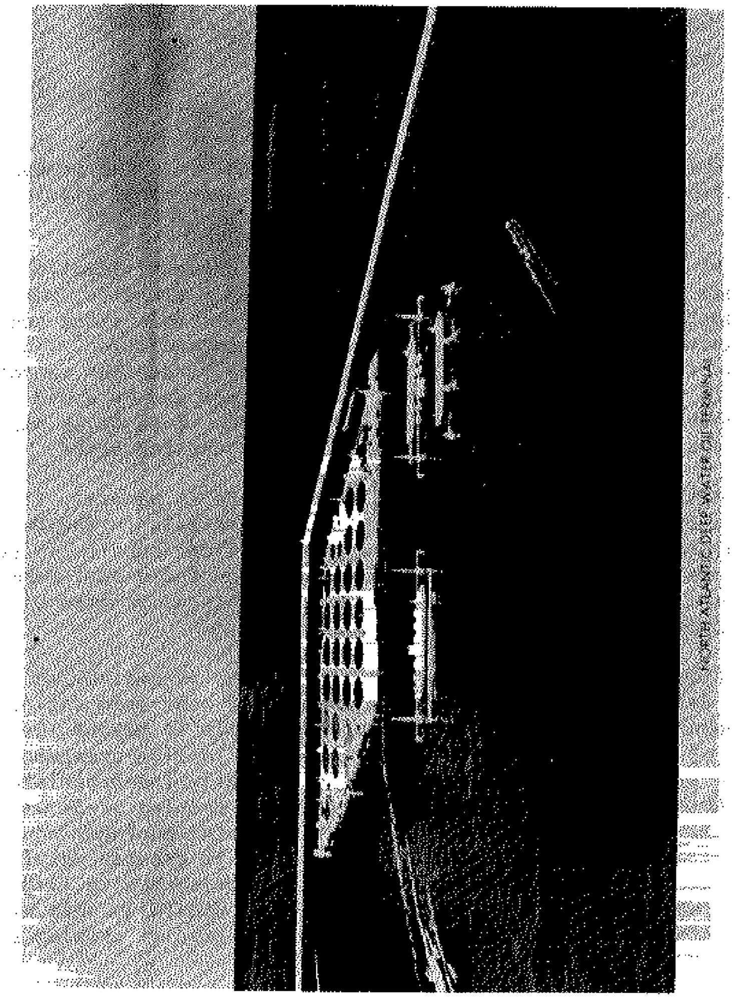

Figure 6. NADOT Terminal

What's Next in Super-Terminals?

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This paper attempts to give some insight into the probable directions of engineering development for super-terminals in the near-term future.

It is relatively easy to evaluate the present situation because there is no unknown element involved. Likewise, making prognostications for the long-term future is simple since such forecasts can be made with little fear of contradiction. To make a near-term forecast is most difficult. The forecaster cannot hope to know all that others are planning, nor can he avoid encountering contrary opinions. Furthermore, since he is dealing with the near-term future, he has little excuse for error.

Although the subject matter covered here is general, it refers to development of deepwater super-terminals in the United States and deals only with oil terminals. Since apparently centralized regional terminals and decentralized individual terminals are considered, problems and developments associated with both types are covered.

Inasmuch as the super-terminal is a complex system, an in-depth definitive treatment of all aspects of near-term engineering development associated with such terminals is beyond the scope of this paper. On the other hand, definitive treatment of only a single system component would be equally inappropriate. Therefore, a number of the more interesting problem areas will be considered briefly. Near-term developmental engineering that is considered most likely will be discussed in greater detail. Finally, some preliminary concepts will be presented to illustrate areas requiring developmental engineering. Hopefully this will stimulate additional ideas for dealing with crucial problem areas.

Problem Areas

The problems associated with the deepwater super-terminal concept can be categorized as ecological, sociological, political and technical. To completely isolate one area from the others is not possible since all are interrelated in a complex way. In the final analysis, however, the engineer must solve the technical problems in order to produce a facility that satisfies all requirements and meets all criteria associated with the other problem areas.

The technical problem areas associated with a deepwater super-terminal correspond with the various subsystems that comprise the total terminal system. A brief discussion of some of the more significant or apparent problems follows:

> Vessel. Although tankers using the terminal are not truly part of the terminal complex, they are a part of that system during the time that they approach the terminal, reside there and depart from that location. A number of terminal subsystems have problems related to vessel construction or operation; these problems are discussed under the appropriate heading. Additionally, there is the general problem of how to reduce vulnerability to damage and to increase safety through improved design and vessel operation.
>
> Vessel-Terminal Interface. The vessel-terminal interface has problems associated with bringing the vessels expeditiously into the terminal and taking them out efficiently and safely.
>
> Harbor Development. Numerous problems are encountered in creating a deep-draft harbor either inshore or offshore. Problems related to dredging and breakwater construction are among the most significant.
>
> Berthing. The goal is to provide safe berthing for the very large ships that must be served by the super-terminal.
>
> Cargo Transfer. The problem in cargo transfer is how to facilitate the safe discharge or loading of a vessel in the shortest possible time period.
>
> Storage. Onshore and offshore storage tanks are an integral part of any super-terminal. Problems encountered are related to safety, which is the prime concern in the design and operation of these facilities.
>
> Transshipment. Most super-terminal concepts include transshipment activity. Transshipment by

small tanker or barge has the same problems associated with the super-terminal; transshipment by submarine pipeline involves special design and operating problems.

Ballast Water. The problem is to provide for ballasting and, in the case of transshipment, deballasting of tankers without risking sea contamination.

Oil Spill. While environmental protection is an important consideration in the design and engineering of every component or subsystem of the super-terminal, oil spills represent a special problem. Spill prevention is the foremost consideration, but the problems of containment and cleanup in the event of an oil spill are also extremely important.

Approach

The so-called traditional "engineering approach" requires that the engineer consider function, safety and cost in preparing his designs. In the past the engineer has been a pragmatic problem-solver whose objective was to provide a safe facility that performed the desired functions at minimum cost.

The advent of recent grass-roots concern for preservation of the quality of the human environment has required a departure from the traditional "engineering approach." Now the engineer must consider not only traditional function, safety and cost aspects, but he must also take into account the environmental impact of his designs. The priority order of these considerations may vary from one project to another and can be expected to do so with time. However, presently environmental impact must be the engineer's primary concern.

Coastal and offshore engineers have always considered the environment. However, their concern was primarily with the effect of the environment on the function and safety of their designs. Now they must develop a new perspective, considering the effects of their designs on the environment. Admittedly, the coastal and offshore engineers are not the only engineers who must adopt this new perspective. However, they are working on one of the most important frontiers where the interface between man and his environment is extremely significant and controversial.

This new attitude toward man's effect on the environment is here to stay. It dictates that engineers find new solutions to old problems and solve numerous problems that were previously overlooked.

Need for Development Engineering

Current studies indicate that large amounts of imported crude oil will be required to meet future energy demands in the United States. These studies also show that annual savings amounting to hundreds of millions of dollars are possible if crude oil can be shipped in VLCCs (Very Large Crude Carriers). To realize these savings, however, it will be necessary to build deepwater super-terminals since existing U.S. ports do not have the capability to serve these very large tankers.

At the present time there is widespread fear of significant, permanent and irreversible damage to our marine and estuarian ecology because of petroleum shipping operations. As a result, the answer to the question "What is next in super-terminals?" may be that there will not be any super-terminals if engineers cannot convince all parties concerned that terminal designs will provide adequate protection against threats of environmental damage. The social and political pressures are presently so great that the only way to keep moving is to provide acceptable technical solutions to the environmental protection problems.

In order to make correct choices the decision-makers in the socio-economic and political sectors must have a thorough understanding of the capabilities of engineering technology to deal with the threat to the environment.

This is not as easy as it sounds. At the present time the lack of adequate knowledge and of data relative to the environment and to the ecology makes it difficult to accurately forecast the environmental effects of super-terminal construction and operation. Until we progress further along the learning curve, it may be necessary to devise interim solutions for environmental problems that involve overdesign and effort devoted to solving problems of little real significance.

Priorities

A number of engineering developments related to super-terminals, especially in each of the problem areas previously discussed, appear feasible in the near-term future. Some of these developments will be the simple evolutionary types that result from general technological progress. Other developments will be undertaken to provide solutions to specific problems; there will be both the improvement of existing concepts and the development of entirely new concepts.

Some items for near-term development are listed in Table I. The priority assigned to each item is based only on personal

Table 1. Super-Terminal Engineering Development --

Likely Items for the Near-Term Future

Engineering Development Item	Priority
Vessel	
Reduced Cargo Hold Size	N.A.
Clean Ballast Systems	N.A.
Shipboard Oily Waste Treatment	N.A.
Improved Maneuverability	N.A.
Improved Cargo Manifold Design	N.A.
Greater Automation of Cargo Operations	N.A.
Vessel-Terminal Interface	
Greater Use of Navigation Aids and Traffic Management	1
Use of Weather Warning System	3
Improved Ship-Handling Techniques	3
Harbor Development	
Improved Dredging	
- Deepwater Equipment	2
- Turbidity Control	2
- Spoil Treatment	2
- Spoil Disposal	2
Improved Breakwater Design	3
Island Construction	2
Berthing	
New Berth Configurations (SPMs, Docks, Semi-Submersibles)	1
Improved Docking Aids	1
Self Mooring to SPMs	2
Improved Dock Fendering	2
Cargo Transfer	
Methods for Higher Discharge/ Loading Rates	2
Greater Use of Automation	2
Improved Spill Prevention Devices	1

Improved Surge Protection	1
Improved Cargo Transfer Hose	1
<u>Storage</u>	
Improved Container Design and Construction	1
Greater Use of Automation of Operation	1
Improved Underwater Containers	2
<u>Transshipment</u>	
Submarine Pipelines	
- Improved Deepwater Burial Methods	3
- Improved Leak Prevention and Detection	1
- Underwater Pumping System	1
- Improved Insulation and Heating	3
Small Tankers or Barges	
New Set of Problems Similar to Deepwater Terminals	N.A.
<u>Ballast Water</u>	
Greater Use of Pumped Ballasting	1
Ballast Water Storage and Reuse	2
Improved Ballast Water Treatment	1
<u>Oil Spill</u>	
Improved Prevention Methods	1
Improved Containment Devices	1
Improved Recovery Methods and Equipment	1
Improved Spill Detection Devices	1
Nonstick Coatings	2

1. Highest priority for engineering development since generally related to spill prevention, containment or cleanup.

2. Important that state-of-the-art be advanced.

3. Current state-of-the-art is satisfactory but will improve.

N.A. Assignment of priority not applicable.

evaluation. This evaluation was greatly influenced by abundant evidence that the overriding problem facing super-terminal proposals is sufficiently reducing the probability of detrimental oil spills so that public and governmental agencies will permit super-terminal construction. Thus, highest priority is assigned to items related to oil-spill prevention, containment and cleanup.

Although much can be and is being done in improving tankship design to reduce the probability of oil spills, this is beyond the scope and control of the super-terminal designer. Items related to oil-spill prevention that can be influenced by the terminal designer include the following:

1. Greater use of navigational aids and ship traffic management.

2. Improved berth design and docking operations.

3. Improved cargo transfer systems and operations.

4. Improved storage facility design and operations.

5. Improved submarine pipeline design.

6. Improved ballasting and ballast treatment facilities.

Better oil spill containment requires development of improved terminal layouts and berth configurations, as well as improved oil containment devices. Oil spill recovery and cleanup equipment is being rapidly developed by industry working closely with terminal engineers.

Clean Terminal Concepts

Even if oil-spill prevention developments are undertaken and adopted in all aspects of super-terminal design, it will never be possible to guarantee that an oil spill will not occur. Under these conditions, oil-spill containment becomes an extremely important second line of defense against the contamination of beaches and shorelines.

The sample concepts presented in this section deal mostly with oil-spill containment although one idea also deals with detection and another with prevention. Remember that most are only preliminary concepts and not necessarily proposals. The purpose of presenting them here is to stimulate thoughts that may generate new and better ideas.

Finger Pier Containment Basin. The conventional finger pier has a tanker berth on each side, and the tankers at the berth must be individually boomed. The long boom is usually deployed by a crew using a special service vessel.

The finger pier containment basin layout has single-sided finger pier berths with trestle and dolphin structures that act as permanent booms to form individual basins for each tanker. Each basin can then be closed by a short boom that is easily and quickly installed without a service vessel.

Containment Structure. Conventional pile-supported dock structures normally have their working platforms and walkways at an elevation well above water level. An oil spill can pass under such a structure, and it is difficult to clean the spill under the deck and around the piles.

In contrast, containment structures have a platform or walkway superstructures that extended well into the water to form a permanent and easily cleaned obstruction to the passage of oil.

Super-Boom. The development of oil spill containment booms has been rapid in recent years and has resulted in a number of new designs for booms of greater efficiency. However, development has been subject to the constraints of competitive costs and to the requirement that booms be easily deployed.

The super-boom concept is simply to make the containment booms bigger so that they do the job more efficiently. The super-boom might not be 20 feet tall; but then again, if for use in an open sea environment, a 20-foot boom might not be large enough. Such booms might be permanently deployed float-sink booms or permanently deployed floating booms. They might also be deployable provided such methods suitable for super-booms can be developed.

SPM Containment. This is a simple although probably expensive concept for containing spills that might occur at a single point mooring. It involves the permanent deployment of a float-sink super-boom large enough to encircle the moored tanker so that the tanker can still weathervane at the mooring. If a spill should occur, the oil would be blown to the downwind side of the containment boom where it could be cleaned and recovered. Cleanup could be accomplished either by dispatching a cleanup vessel to the mooring site or by using tanker-based cleanup equipment.

Submerged Arm Mooring. The conventional single buoy mooring is connected to the submarine pipeline by underbuoy hose and has a long floating hose for connection to the tanker. Both the underbuoy hose and the floating hose are subjected to severe strain when the buoy surges in heavy seas. The strain weakens the hose, creating a potential oil spill.

The submerged-arm mooring concept consists of a bottom swivel connected to a submerged loading arm that terminates in a length of hose that is also submerged when the mooring is not in use. The swivel can be shrouded, and the submerged arm made with a double-walled pipe construction, thus providing greater protection against a leak possibility. Furthermore, all oil-carrying components of the system are submerged and away from the air-sea interface where the effects of wave action are most serious.

Double-Walled Submarine Pipeline. The conventional submarine pipeline consists of a steel pipe with an external corrosion coating and an external weight jacket of concrete.

The double-walled submarine pipeline concept consists of two concentric steel pipes also with an external corrosion coating and an external weight jacket of concrete. Oil is carried by the internal pipe, and the annulus between the internal and external pipes contains a pressurized inert gas such as nitrogen. The pressure of the gas in the annulus is higher than either the pressure of the oil in the inner pipe or the external hydrostatic pressure of the sea. If a leak occurs in either the internal or external steel pipe, the gas will escape; the escape of gas from the annulus will cause a pressure drop signifying a leak. This pressure drop can be used to initiate the shutdown of pumping operations after which a suction can be applied to the oil conduit to prevent escape of oil into either the annulus or the sea.

Obviously there are many alternative concepts in addition to those presented here that will solve the same problems in different and perhaps better ways. The point is that new and better concepts are going to be developed in the near-term future to demonstrate the feasibility of building and operating super-terminals without endangering the shorelines of our nation.

Conclusion

Some of the obvious problems associated with super-terminal design have been presented, and the new role of the engineer in dealing with environmental protection has been highlighted. The engineer can no longer hide behind a wall of calculations and of cost-benefit ratios; he must accept a greater social responsibility that is, in a way, an extension of his responsibility relative to the safety of the facilities that he designs. The safety philosophy has now been enlarged to encompass a more comprehensive philosophy of survival.

It should be obvious that concepts will be developed to satisfy a new set of criteria based on our current knowledge of coastal and ecological processes. Most importantly, engineers must continue to test today's criteria and to participate in the development of improvements for these criteria.

Future Guidelines for United States Deepwater Port Development

J. Leslie Goodier
Arthur D. Little, Inc.

With few exceptions the configuration and use of our nation's port facilities can be compared to the fire hydrant -- there has been little change in the past 200 years. However, during the past 10 years a number of maritime nations have introduced changes to permit the operation of large bulk carriers, the design and use of which can be directly attributed to marine transportation freight rates and to an increased demand for marine-transported materials. The European Port Authorities have led the field in deepwater port development, and these "first of a kind" facilities can always be improved following a few years of actual operation. Currently there are 50 deep ports either in operation or in construction, 15 of which are in Europe, 10 in Japan and 5 in Canada.

Within the United States deepwater port development has been slow. The maritime industry is still considering future needs while the U.S. Army Corps of Engineers continues to follow closely and monitor foreign port development, hoping to benefit from engineering successes and failures of port developers.

The main problems rest with the development of a coastal or offshore port. I favor the latter type of facility when geographical and political factors are favorable.

Existing U.S. Facilities

On the Atlantic seaboard the nation's largest port, New York, should be examined. A tour of the waterfront will reveal dilapidated docks and berthing facilities that are rat- and thug-infested; the remaining operational piers are mostly obsolete, lacking automated cargo-handling equipment for off and on loading and warehouse-material handling. The cargo-handling equipment of individual ships is still largely used. Unfortunately, New York and most coastal ports on the eastern seaboard are unsuited for deepwater port development due to factors such as existing traffic congestion, adverse seasonal climate conditions and obsolete railroad facilities. The last factor can be substantiated by the rapid increase in truck traffic over the past decade. The most important restriction stems from limited depth channels that are already down to bedrock, making deepening of the port cost-prohibitive and developing untold environmental problems in rock removal. It has been estimated that to deepen the Delaware River to a modest 50 feet would entail dredging 330 million cubic yards of material at a cost in excess of $750 million.[1] The entry into Chesapeake Bay has been depth restricted by construction of the bridge and the tunnel connecting eastern and western shores of Virginia. And so it continues along the entire coast.

Opportunities for developing a deepwater port on the Gulf Coast are also problematic should any coastal port be selected for development. The Corps of Engineers has determined rock substrates at depths of 30 to 52 feet along the Gulf Coast. The presence of aquifers would also influence the dredging problem. Assuming that a 36-foot channel into the selected port exists, an extensive offshore shelf would have to be dredged to accommodate deep-draft ships of anticipated 1980-2000 year design (60 ft-150,000 dwt to 130 ft-1,000,000 dwt). The dredging operation would be of mammoth proportions, even if only a single-ship channel is dug. Such ships require a channel width of three times their beam, which can be as much as 270 feet. If a passing channel were constructed, a width of five times the beam would be required.

The type of material forming the Gulf shelf would further require a channel angle of at least 30 degrees repose. To further complicate the problem, the intensive drive to protect the national aquatic environment has placed restrictions on dredge spoil disposal and has developed water quality standards that are difficult to live with during new channel construction and maintenance. It should be noted, however, that Alabama's Port Morgan in Mobile Bay does have a natural water depth of 54 feet.

On the West Coast, fog and adverse water conditions at various harbor entrances restrict deepwater port development although all three U.S. ports that could accommodate some supercarriers are on this coast. Puget Sound has a natural water depth of 100 feet while Los Angeles and Long Beach now have 60-foot water depths.

To further the problem the U.S. coastal area is strewn with wrecks that are not presently considered a hazard to navigation. With deep-draft ships in service, it would be necessary to remove many of the wrecks. During development of the new channel (62 feet) for Rotterdam's Europort, a number of submerged wrecks were physically removed to clear the outer channel site; in the inner

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[1] General Groves, U.S. Army Corp of Engineers.

channels, areas were excavated to permit nearby wrecks to slide into the excavation.[2]

Environmental Impact

The greatest damage to the natural environment experienced during port development was the action of multiple dredges during channel construction. Twenty dredges were used in the construction of Rotterdam's channel, 18 miles long and 4000 feet wide. Deepening of the channel from 32 to 62 feet had an adverse effect on surface water conditions. During adverse weather the inner harbor's small craft experienced difficulty coping with deepwater, free-rolling combers. The suction of dredges, coupled with wave action and undertow, increased up-river erosion. This erosion is combated by dredging "catch basins" at strategic locations to collect the sediments and to reduce maintenance dredging. The deepening of the river permitted salt water to intrude further up-river than ever before. To control salt intrusion a gravel filter bed is positioned on the channel bottom to filter out salt.

The Europort entrance was designed with a protective seawall, mole or breakwater that protrudes at right angles into the North Sea. This well-constructed mole now diverts the longshore current that hydraulically transported sediment to "nourish" the northern coastline. The diverted current eddies around the northern side of the mole and precipitates sediments at a rate calculated to position Hook Von Holland, a seaside resort, three miles back from the sea within the next 10 years. This situation is being accelerated by pumping dredge spoil into the silting site.

The new deepwater port at Dunkirk, France, also has severe environmental problems. The French extended the old port with a 3.5-mile-long maritime basin, one side of which is diked against the sea, while the inland side provides an industrial complex currently utilized by a phosphate plant, a steel plant and a refinery. Unfortunately, entry to and departure from the maritime basin is controlled by the tide; a superbly constructed lock system, opened only at high tide, eliminates tidal flushing of the basin. The existing industrial plants (more are planned) discharge their industrial effluents into the maritime basin. When coupled with rainwater drained from open stockpiles of leachable industrial materials, the overboard discharges from ships and a continual effluent discharge from an extensive barge canal that

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[2] "Foreign Deep-Water Port Development" de Frondeville, Goodier, Putnam and Huston. A.D. Little, Inc. Report to U.S. Army Engineer Institute for Water Resources, September, 1971.

terminates in the basin, it appears that Dunkirk's new maritime basin will develop into one of the largest cesspools on the European continent.

Site Selection

Most existing ports have had haphazard, unplanned development; the original sites were selected to suit settlers who did not necessarily live in the most convenient or best-suited locations for port construction and development. The supporting industries then located near convenient labor or material sources that frequently warranted land transportation of marine-transported goods into the hinterland. The present European trend to locate industries at the port site has many advantages; as examples, material handling for import and export goods is reduced, the servicing population is subjected to a needed redistribution, and new townships are developed.

When Gulf Oil selected Bantry Bay in southern Ireland as the site for its offshore island deepwater oil transshipment port, the choice was made only after careful study indicated a minimum of existing marine traffic, good climatic conditions that included a minimum of fog days and a 20-mile natural channel 120 to 180 feet deep and two to three miles wide. The only work required for port development involved the construction of the onshore bulk storage plant and of the on and off loading berth. By contrast, all ports on the European continent have a severe marine traffic problem. The narrow Straits of Dover, in addition to having dangerous sandbanks, shoals, frequent fog and severe tidal conditions, must provide passage for 1000 ships per day. The north-bound vessels hug the French coast while the south-bound travel down the English coast. Meanwhile, ferries ply back and forth diagonally across the channel. The traffic situation can become more acute since each newly developed port facility desires an offshore facility. Most of the countries already have development plans under review. Obviously one strategically located transshipment port could service the entire continent, but the political and competitive transport situation is not likely to permit such an installation.

Obviously traffic congestion, weather and natural geology must have a definite bearing on U.S. deepwater port location.

Cargo-handling Facilities

The European ports are well in advance of the United States in providing dockside cargo-handling equipment. There are few major ports that remain dependent on the utilization of shipboard cargo-handling equipment. Dockside heavy lift cranes can have an impact on cargo handling in the United States, since dockside capacity greatly exceeds the shipboard capacity frequently used when unloading European cargoes in the United States. Automated technology for cargo-handling, evident in a number of European ports, should be used as a guide for U.S. port development.

Summary

The modification of old ports into deepwater facilities has, in most cases, brought environmental catastrophes and inefficient installations, leaving most developers with desires for additional offshore port facilities. The adage of making a silk purse from a sow's ear can best describe this type of port development.

Gulf Oil's action in Bantry Bay should be used as a model for U.S. port development since most facilities in the port are worthy of reproduction for any new U.S. marine terminal. In conclusion, proof of the success of the basic design can best be indicated by stating that since its construction for $45 million in 1969 only $300,000 has been spent on plant improvements.

Deepwater Terminals — The Challenge of the 70's

James R. Bradley
Texas A&M University

The energy crisis that the United States soon will face is going to require bold and imaginative planning to resolve. If this country is to grow and prosper, new or different energy sources must be found to supplement, and eventually to supplant, the traditional ones such as oil, gas and coal. However, until this is done it appears that the most feasible solution on a short-term stopgap basis is the importation of sufficient foreign oil and gas to fill the growing gap between demand and domestic production of these commodities. In order to make possible the economical movement of foreign oil to our shores, the installation of deepwater terminals at several selected locations appears to be an immediate necessity.

Ever since the possibilities of massive oil imports and of deepwater terminals to receive them became common topics of discussion in this country, we have seen waves of controversy, indecision, uncertainty and even fear roll across the land as committee after committee has issued reports about such topics as the energy crisis, the dire need to import oil, the danger of becoming overly dependent upon others for a large part of our total energy supply, the need for deepwater terminals to handle giant oil tankers and the severe environmental hazards of giant ships and offshore ports.

I feel that all this activity -- the self-examination and self-recrimination -- is good for the country, but much of it does little to get the job done. And, like it or not, someone is going to have to make a decision sooner or later as to whether this country is to continue to progress as it has for 200 years or whether we intend to let ourselves become a second-rate nation unable to even defend ourselves from foreign aggression.

Let us look at a few points that may help to clarify what I have just said. I would like to refrain from talking about the energy crisis because that is a subject with which we are familiar. I will also stay away from the environmental question because this is a complete issue in itself. However, I would like to dwell for just a minute or so on some of the other important questions involved in the oil import and deepwater terminal issues.

National Defense

First, let us look at national defense. I think we agree that preservation of our lifestyle is very important to us. Even those persons who have advocated a lowered living standard to achieve environmental protection generally agree that we cannot afford to become so weak in our defenses that our nation is placed in jeopardy.

The part that oil plays in the defense posture of the United States is vitally important. It is a strategic material and one of the few items that is absolutely essential and foremost in the minds of our military commanders. Petroleum cannot be stockpiled like hardware -- the quantities required are too great -- nor can our military forces operate very long without backup support from the petroleum industry.

The United States Department of Defense is the world's largest single oil purchaser. The very chance of success or failure in any conflict hinges on oil. As a matter of fact, the most striking point of commonality between the major weapons systems of the military departments is the thirst for oil.

Subsonic tactical aircraft have been almost totally replaced by supersonic fighters that burn two to three times as much fuel per hour as the jet fighters used in the Korean conflict. The continuing mechanization of Army equipment and greater mobility of its troops assure a steady increase in its fuel requirements. While some Navy ships are now propelled by nuclear power, it will be many years before there is any appreciable decrease in the Navy's petroleum requirements.

In Southeast Asia at the height of the Vietnam war, about 50 per cent of the tonnage shipped to the military consisted of petroleum products. In 1949 military petroleum requirements were about 330,000 barrels daily; by 1967 they had passed one million barrels per day and the curve was still upward. Today they are about 10 per cent of our total national demand. In 1969 15 per cent of the oil used in Vietnam came from the United States, while 65 per cent originated in the Persian Gulf and the balance came from the Caribbean and local sources.

Dependency on Foreign Oil

What about the defense and national security implications of becoming heavily dependent upon foreign countries for our oil supplies? Security of oil supply in recent years has come to include all extraordinary changes in market conditions that will alter supply. The national security concept implies military problems, but these are only a part of the question. Indeed, the traditional military crises may be the least relevant aspects of security. Nevertheless, they receive the most attention.

Political instability in the Middle East and North Africa is probably of more concern than the threat of military problems; it can even be argued that this instability is the whole problem. In viewing the Middle Eastern area, however, it is not enough to say the area is unstable. Rather, there must be established a scale of crisis levels and an attempt made to assign to each crisis level a degree of jeopardy to oil supply continuation.

While no firm assurances are possible, it is important to note that the freedom of action of the Middle Eastern OPEC nations may be limited. All rely almost entirely on oil to earn foreign exchange. In some cases, oil is the only industry of any significance. These countries must sell oil or endure deep depressions that they can ill afford to undergo. Thus, enormous pressures exist to limit disruption. Past events seem to bear this out. For example, before, during and after the June conflict in 1967, American oil companies continued their activities in Egypt at the specific request of that government. The total embargo against shipment of crude oil to certain Western destinations lasted only one week, after which Arab oil began to flow again.

It appears then that there exists a mutuality of interest between the Middle East oil producers and the global and economic aspects of United States national security. This national security is of a direct and indirect nature. As Middle East and African producers look to the Western nations to provide outlet security for the oil upon which their economic life is largely dependent, so does the United States as a consumer search for supply security. Therefore, a direct clash of these economic interests need not, and probably will not, come about.

Economic Implications

A very important consideration of the deepwater terminal issue concerns economic implications of our failure to provide facilities for importing supplemental oil supplies.

> In 1968, total United States energy use was 62.2 quadrillion BTU or the equivalent of about one-half gallon of oil per dollar of gross national product. Since oil constituted 40 per cent of total energy

used that year, the loss of a million barrels, or 42 million gallons, of oil could have cost the nation $34 million in value of output, not to mention the comfort and health of our citizens if a shortage kept them from having adequate heat in winter.

If these 1968 relationships still hold in 1985 and if we are unable to import the predicted 10 to 15 million barrels of oil per day that we will need by then because deepwater terminals are not built, then we could see a loss in gross national product of $336 to $504 million per day, provided alternate energy sources are not available to us.

Today the country stands at the threshold of making a decision on whether or not the petroleum refining and petrochemical industries will remain a major component of this nation's economic base or whether these industries will relocate where they can be assured adequate supplies of their basic raw material, oil. No one can deny that these two sectors of our economy make significant contributions to the nations's well-being. In addition to providing energy to fuel our society and furnishing raw materials for plastics, fertilizers, pharmaceuticals and food, these sectors also provide high levels of direct employment and, through capital expenditures, stimulate prosperity in other sectors of the economy.

In 1970 the combined employment of petroleum refining and petrochemical establishments exceeded 250,000 persons, who were paid wages of over $2 billion. These industries together produced over $30 billion worth of output and spent nearly $2 billion for capital goods. And during a year's time the industry will spend another $1.5 billion for maintenance and $20 billion for operating costs.

What is the possibility that this important component of our economy may relocate to other parts of the world? I say that the possibility is real enough for all of us here to be concerned and alarmed. Although the tax life of a refinery is 20 years and the useful life is about 40, the present high cost of money causes many industry executives to plan for a five-to seven-year payout on new plant investments. Thus, we could conceivably see the shutdown of plants start at any time.

Just last week, for example, a refinery at Cushing, Oklahoma warned that it would have to shut down by the middle of this month (October) if supplies of crude oil could not be located to feed the plant. It seems that management had contacted 25 other companies and four federal agencies in a search for crude oil but were unsuccessful in getting enough commitments to keep the plant operating. In this particular case the refinery operator is a small, local company and is not likely to pick up its operation and transfer it to the Bahamas or Canada in order to stay in business. But, what if this were a major international firm? Doesn't it seem likely that a larger firm would take action in a similar situation to retain market share by continuing to produce output wherever possible? I feel that this would probably be the case.

Conclusion

In conclusion I would like to reiterate what I said at the start:

> The energy crisis that the United States is now, or soon will be, faced with is going to require bold and imaginative planning to resolve.

The sooner we realize this and take steps to assign the approproate national priorities to the issue, then the sooner we will be able to move ahead toward the implementation of workable solutions -- such as deepwater terminals -- to this serious problem.

INDUSTRY

Joint Raytheon Company — University of New Hampshire Sea Grant Project

A. S. Westneat
Raytheon Co.

A unique Sea Grant program involving a working partnership exists between the University of New Hampshire and the Raytheon Company's Submarine Signal Division. The project differs from most in that it possesses a shared leadership in a fully integrated, complex research effort. Unlike more common client-consultant relationships in the Sea Grant program, we are attempting to make scientific progress in a difficult technical area by building on the very different skills in two disparate organizations.

We are tackling the problems of developing a science and a technology for using the sea floor in the coastal zone. More directly, the team is attempting to develop techniques and devices for assessing the sediments on the sea floor from a remote platform.

The project, now in its third year, has three major thrusts:

a. To develop an ability to classify the mineralogy of the sea floor from surface platforms.

b. To develop a remote instrumentation system for estimating the load-bearing characteristics of the bottom.

c. To establish the environmental impact of off-shore mining.

Of the three targets, the third has the greatest societal impact and is the most urgent to law-makers, to industries and to interested citizens. This task has recently spawned a major project, now called NOMES (New England Off-Shore Mining Environmental Study). The project, led by MMTC (Marine Mineral Technology Center) of NOAA, joins UNH and Raytheon with the NOAA laboratories, the Commonwealth of Massachusetts and M.I.T. The new funding and new leadership are drawing needed attention to this problem, and we are pleased that our awareness has produced this important collateral effort.

The university and our company began this project with preconceived perceptions. UNH hoped to find a coherent purpose in its ocean-directed studies, a source of useful thesis subjects, some matching funds and available supporting facilities in a purposeful industrial research organization.

Raytheon, willing to provide a substantial matching sum for the long-range project, hoped to benefit from academic research applied to a commercially attractive program and to develop useful hardware that could be exploited. They were willing to support research to achieve intermediate-term results.

After three years together, we still find it easier to perceive than to achieve. The fact that we have stayed together and produced results is, in itself, evidence of a successful project. We have learned lessons that are important to those seeking to create an intimate university-industry relationship.

Our two organizations live in drastically dissimilar worlds with different value systems, payoffs, command structures and personality types. The loosely structured university stresses education and sponsors research that need not be utilitarian. It is staffed by scientists on tenure, has essentially no line organization that retains control authority and is far different from a typical industry.

The industrial technician,under constant result and time measurement in his highly directed world, must optimize his results on a short-time scale. Unprotected by tenure, he has difficulty communicating with his academic partner on a sustained project. We have attempted to impose a complex interdisciplinary problem on this societal mismatch and to generate results that are acceptable in each of our value systems. Surprisingly, we are succeeding. Patience, forebearance and a sense of humor help us deal with strange people on the other side of the fence.

There is much potential for good in combining the university's insight and depth with industry's drive and result-orientation. The key factor is the interfacing "manager" in each organization, the man who listens, communicates, leads, cajoles and works to bring out the best of both groups. Honesty, inventiveness, total commitment -- these are key traits that have kept us going.

Speaking from the industrial side, I have a difficult time justifying the expenditure of hard-earned dollars for a long-term, not yet practical technology. It is our good fortune in Raytheon to have a far-seeing management that is willing to gamble on the values implicit in this Sea Grant team.

Sea Grant Contributions to the Fishing Industry

Dr. Arthur F. Novak
Louisiana State University

During the past several years, participants in the Sea Grant program have made many contributions to producers of fishery products, and without this help some of the companies might not have survived.

At Louisiana State University the Food Science Department faculty, working as a Sea Grant team, has consulted on a gratis basis with fish and shellfish industries when called upon by industrial personnel. Participating with industry to solve short- and long-term problems, the department has developed the know-how to assist industry in the following efforts: (1) to continuously improve the high quality of fish and shellfish products; (2) to develop according to company requirements new products for existing or newly created markets; (3) to develop and investigate new, improved production methods; (4) to develop new uses for existing products and processes; (5) to effect savings in costs, including under certain circumstances a study of production; (6) to abate dangers by constant investigations that would prevent toxic or poisonous ingredients from entering or developing in products; (7) to assist in the prevention or correction of production difficulties; (8) to assist in product standardization by instituting numerous quality assurance laboratories and training personnel to manage them; (9) to participate in the design, construction, operation and evaluation of pilot plant products; (10) to serve in specialized "trouble shooting."

Sea Grant personnel have urged the initiation of research projects in the plants. The projects must accomplish one or more of the following factors: (1) Reducing production cost. Included in this category would be studies on raw material substitution, increased production rates, improved manufacturing or packaging processes, cheaper storage, boat research, etc. (2) Increasing product utility. Would an expansion of uses be practical and profitable? How much is required? What alterations are necessary? (3) Increasing sales appeal. New discoveries and rapid public education in fish and shellfish foods, as well as in nutrition, demand periodic changes to cope with changing ideas of foods. (4) Related new business. Other products also necessary should be considered and formulated. (5) Related technical information. Research data from one project can be applied to others, such as oil spill damage on shellfish growing areas.

Today the fishing industry needs continuous assistance to avoid regulatory problems. Sea Grant personnel have aided packers and producers in conforming to good manufacturing practices and to other laws.

The key to success in food industries is sanitation, and the FDA has now published its final Good Manufacturing Practice (GMP) regulations in the Federal Register, April 26, 1961. A distinction is made between regulations and recommendations; mandatory regulations are phrased "shall" while recommended practices are termed "should." Good manufacturing practices are included for grounds, plant construction and design, equipment and utensils, sanitary facilities and controls, processes and controls, general maintenance and personnel. This latter category considers that most food damage is done by people who are not subjected to proper education and training by supervisory employees.

Product rejections or seizures by the FDA usually result from fishery products that include contaminants, pathogenic microorganisms or decomposition. Good products produced under unacceptable GMPs may or may not be accepted, according to other factors involved.

Generally, fishery products may be rejected for one or more of the following reasons: (1) packed under unsanitary conditions, (2) taken from polluted areas, (3) mislabeled, (4) contaminated, (5) adulterated, (6) decomposed, (7) improperly packaged, (8) unacceptable or misused additives and/or disinfectants or (9) contain poisons or toxins.

Microorganisms involved in foods can be placed in three categories: (1) those that synthesize toxins or (2) undesirable pigments, and (3) those that are used in manufacturing for a specific purpose, such as making by-products. Pathogenic microorganisms create most health hazards, and emphasis must be placed upon their control and elimination. Some fish may have a high bacterial count and be relatively safe to eat, while others may have an insignificant total bacterial count but be relatively dangerous because of the presence of pathogens. Good quality raw materials and good manufacturing practices usually result in the production of safe, wholesome food, providing that the food itself is produced under good environmental conditions.

One criticism of regulatory agencies is that they often examine fishery products for defects that do not produce health problems. A good example is oysters, which are often tested for total counts, fecal coliforms and decomposition products. Yet the only recognized danger from eating oysters has been a number of hepatitis cases, and I know of no incidence where the presence of the causative agent is tested before the questionable products are marketed. On the other hand, it is almost impossible to handle foods or expose them to air without getting some contamination from coagulase-positive staphylococci.

Regulatory agencies must train their personnel to apply practical, commercial solutions to food industry problems and not to rely entirely on laboratory results. Analyses should enable a sanitarian or an inspector to ascertain the nature and source of contamination and spoilage, as well as facilitate his ability to recommend corrective procedures.

A good example of how the faculty has assisted a major industry through Sea Grant is found in a review of the progress made by the shrimp industry during the past 10 years.

During the past decade, members of the shrimp industry, producers, processors and packers have been working together to offer the consuming public superior shrimp products. Shrimp, an important food because of high nutritive value and palatability, are a delicate, highly perishable commodity that requires special precautions in handling and preservation. From their removal from water, throughout cleaning, processing, packaging and storage operations, shrimp are under continuous surveillance. For each operational step the shrimp industry maintains quality control procedures to assure a final product that is nutritious, safe and wholesome. In these endeavors members of the shrimp industry have anticipated needs for standardizing their products; they have joined with technical and research personnel from state and federal academic institutions and government agencies in developing various quality control tests. Results of these research studies and investigations have led to the development and introduction of rapid microbiological tests that enable packers to recognize and reject any inferior quality shrimp that might produce an undesirable product. Physical and chemical laboratory tests, as well as organoleptic or "taste" evaluations, are also employed to ensure consumer foods of high quality.

Packing plants purchase shrimp only when they are satisfied that boats are clean, operate under sanitary conditions and have proper refrigeration facilities. Packers demand that all shrimp be brought ashore without undue delay and be processed as rapidly as possible. Their laboratory personnel cooperate with representatives of regulatory agencies to maintain and to ensure the high quality of products that reach the consumer.

Through cooperation with its Sea Grant associates, the shrimp industry encourages its members to organize and to present scientific seminars in various areas of the country, with experts as speakers and teachers to aid in disseminating the latest information available in plant sanitation and microbiological control. FDA inspectors explain how they emphasize plant sanitation during their inspections and how they make thorough examinations for undesirable bacteria. At the time of inspection, the management is asked to review its educational program for employee sanitation practices. Although these policies impose a financial burden on companies, the programs result in desirable practices and superior products among shrimp processors.

Shrimp sales are increasing rapidly because this popular nutritional delicacy is now offered in preprepared items such as breaded shrimp, in convenience products such as shrimp cocktails and also in soups, gravies, gumbo and pastes. Among the most popular is packaged breaded shrimp, which is convenient, easy to prepare and can be served as the major meat portion of a meal or as a component of cocktails, snacks and other entrees.

"Shrimp" is now a major word appearing on most restaurant menus. The quality of shrimp cocktail can influence a customer's opinion of the excellence of an entire meal, regardless of its price. Most restaurateurs, realizing this dilemma, will pay premium prices for the best shrimp available. If ever a profit can be made on a food product solely by ensuring proper handling and refrigeration, it is with high quality shrimp. This success is directly the result of Sea Grant aid.

Superior shrimp products are now available on a continuous basis because fishermen, processors, distributors and regulatory personnel have united their efforts on a cooperative basis.

The Sea Grant program in food science has proven to be highly successful. Participants are assisting industry in solving their critical problems and in assuring their present and future success on a long-term basis.

Solutions Needed

Don Toloday
Singleton Packing Company

1. Regulatory problems are compounded by lack of definitions, unrepresentative samples and unknown levels of compliance.

2. Improved rapid easy quality assurance tests and the validity of these and existing methods should be developed and correlated with different levels of adherence to Good Manufacturing Practices (GMPs).

3. Research and development of product preparation methods of the same or better quality levels, produced with higher sanitation and improved line operations in order to automate more economically and to utilize all by-products, is needed.

4. Shrimp, fish and other marine animals should be investigated to assure the availability of a continuous supply of proper quality.

5. Imported products need to be evaluated more fully in relation to weights, sanitation, quality and inherent health hazards.

The Development of Multidisciplinary, Multi-Institutional Research Teams and Their Value to Industry

Lewis R. Brown
Mississippi State University

Most professional personnel today realize that effective solutions for many problems facing society are so complex that they require the talents of a diverse group of experts working together in a coordinated program. The team approach is important in conducting research and even more important in formulating the plan of attack. Ideally, if we could find one man who could dissect a problem with accuracy, identify the individual investigators required and delineate each investigator's project, this problem of team approach would not be so important. Unfortunately, these geniuses are in very short supply so that, instead, a team of experts is required to formulate the plan of attack. Many problems arise, and critical time can be wasted when groups of experts attempt to formulate overall plans, unless these groups are experienced in multidisciplinary research techniques.

Historically, many industries have met this problem by retaining individual consultants. This approach has served as a partial solution, but experience has shown it to have disadvantages as well as advantages.

The universities are a reservoir of diverse expertise, and one of their primary functions is service. Thus, it is in the best interests of universities to develop multidisciplinary teams of experts who can work together efficiently toward effective solutions of the problems facing all of us.

I would like to describe briefly our efforts and experiences in forming effective multidisciplinary teams of experts working in coordinated research programs. I would like also to illustrate the role we envision for the relationship of these teams with industry.

I. Development of Multidisciplinary Teams

Original Trial

The first attempt of our university to synthesize a multidisciplinary program consisted of selecting a group of 10 or

12 people representing different disciplines (sociology, economics, electrical engineering, microbiology, etc.), then having them formulate an overall program in which each discipline would play an interrelated role. The net result of this undertaking, which lasted approximately a year, was zero. Not surprisingly, we found that we could not even communicate with each other; and, as might be expected, a number of personality conflicts developed quickly. In my way of thinking, this undertaking was analogous to a medieval alchemist trying to create life through some mystical formula, especially since both attempts boiled and bubbled but failed to produce a viable entity.

NASA Ecology Team

It was intuitively obvious from this first experience that another approach to the problem was required. With the assistance of some financial support from NASA, we were successful in assembling a small group of scientists from closely related disciplines and in utilizing their respective expertise toward a common goal. The initial team consisted of a mammalogist, an ichthyologist, a microbiologist, a hydrologist, a chemist and a wildlife management scientist with a common goal of characterizing the ecosystem of the land and waters of the Mississippi Test Facility. The following year this basic team was expanded to include several engineers and a number of other biological scientists. Thus far the overall program has been highly successful, and we have found that we can easily expand our team effort by adding personnel when need for their specific expertise arises. In the course of our investigations, we all have learned to give-and-take in the interest of a common goal.

Universities Marine Center (UMC) Ecology Team

Our original Sea Grant proposal included a project involving a multidisciplinary, multi-institutional effort to develop the capability of predicting ecological alterations caused by pollutants. As with the NASA Ecology Team, the persons involved in this program were from closely related disciplines (chemistry and biology) although a number of the principal investigators had never met before. After numerous meetings, which involved considerable haggling and hard work, we welded into one coordinated program 15 senior scientists from four institutions. The major obstacles to overcome were personality differences and pet research projects. In retrospect, we feel that our program has been highly successful. The preparation of our new proposal was smooth, and it provides for the addition of new people to the team because of the need for their specific expertise. Also, we have made preliminary overtures to other persons in the fields of economics, sociology and law whom we feel must be an integral part of our program in coming years.

EPA Oil Program

For some time I have been personally involved in studies relative to effects of oil on the environment, and I have actively sought funds for this research. Until recently, all my efforts had been from the standpoint of a microbiologist and did not involve a multidisciplinary approach. About a year ago, the Environmental Protection Agency published a Request for Capability (RFC) to perform a multidisciplinary research program directed toward determining the fate and effect of oil in the environment. While our university felt that we could bid on the entire proposal, we also felt that it was in the best interests of the program, the state and the university to respond to the Request for Proposal by utilizing personnel from other institutions. Most of the principal investigators named had been working together either on NASA-related programs or on the UMC program. All of us involved were extremely pleased to receive an award for more than $1 million this past July; this had been won on a competitive basis with other institutions and industries throughout the country. To me personally, all the hard work and hours dedicated to the development of multidisciplinary teams have been worth the effort.

2. Assets and Liabilities of the University

The assets and liabilities of the university and industry are shown on the accompanying figure. Note how the assets of one neutralize the liabilities of the other. Thus, when the assets of both are taken collectively, all ingredients for success are present. Therefore, success in any given university-industry venture requires only the proper mixing of assets, providing that the individuals involved can and will work together.

3. Examples of University-Industry Cooperative Ventures

Until now, we have not actively solicited the participation of industry in our research activities. On the other hand, our interdisciplinary team has been approached by three separate organizations for its assistance in preparing Environmental Impact Statements, and we currently are finalizing agreements. In addition, we have been contacted in regard to formulating several research projects involving a university-industry partnership. These projects are only in the planning stages now, but we look forward with interest to this new partnership.

In summation, in the university we have learned (sometimes painfully) how to create a multidisciplinary team of specialists who can successfully and effectively conduct a coordinated research program to develop solutions for complex problems. Today, we look forward to a new partnership with industry that we believe will bring greater strength, flexibility and capability to both of us.

Figure 1. Assets and Liabilities

UNIVERSITY		INDUSTRY
	PRO	
1. Diversity of Expertise		1. Money
2. Large Force of Experts for Short-Term Effort		2. Short Reaction Time
3. Lowered Cost (Grad Students)		3. Awareness of Local Conditions
4. Expensive Equipment		4. Management Capabilities
	CON	
1. Lack of Money		1. Lack of Diverse Expertise
2. Unresponsive Due to Structure		2. Lack of Awareness of Research
3. Narrowness of Vision		3. Lack of Low Cost Expertise
4. Not Programmed for Routine		4. Lack of Diverse Research Equipment

A Little Bit Goes a Long Way

Dimitri J. Stancioff
Marine Colloids, Inc.

The purpose of this presentation is to tell you how and why Marine Colloids has participated in Sea Grant research, what results have been achieved and what advantages have been gained from this type of cooperative research. I also want to tell you the moral of my story, for no story should be without one.

Marine Colloids, Inc. is a small company located halfway down the beautiful coast of Maine at Rockland. Our principal business is the manufacture of carrageenan, a red seaweed extractive. The principal species from which this extract is derived are Chondrus crispus, locally known as sea moss or Irish moss, and Eucheuma spinosum, a tropical plant from the Far East. Other species of Eucheuma and Gigartina are also used. Carrageenan, a water-soluble hydrocolloid with viscous and gelling properties, is used as a stabilizer in many foods, pharmaceuticals and cosmetics.

The main purpose of our business, just like that of anybody else, is to manufacture a useful product so that we can stay in business, make a profit and grow.

Since our product comes from the sea, profit and growth depend on a reliable source of raw, good quality material at reasonable cost. How do we ensure such a source? One of the first things, of course, was to make a mechanical harvester. We have worked on this for many years; and although we have produced several functional prototypes, we have yet to operate one profitably. When our industry was smaller, the harvester idea was sufficient; as business grew, however, we realized that this was not enough. We sought new seaweed sources and conducted surveys in many countries. We also tried to obtain the aid of commercial and academic groups.

Whatever the Utopian may say, we know that the resources of the sea are not inexhaustible, that surveys and mechanical harvesters are not enough. Many useful species of algae grow sparsely and can be quickly overharvested. Our management realized that, in order to secure a reliable source of raw material, we needed to farm seaweeds like the Japanese have done for centuries.

The question was: How to go about it? After a few trials and many errors, we quickly found that seaweed-farming was a formidable undertaking and far beyond our capabilities. Although we had contacts with several phycologists and were supporting limited research with limited funds, we still could not tackle the job by ourselves. Bill Anderson, our ecologist-phycologist, was busy with surveys; the rest of us were busy with other problems. Besides, none of us knew the first thing about cultivating. Furthermore, our primary interest was in two tropical species of Eucheuma, and the icy waters of Maine were hardly the place to begin.

This is where Sea Grant came in. Jim Moss, who was president of Marine Colloids at that time, and Sid Upham, then our technical director, lost no time in contacting the Sea Grant office. I cannot go into the details of each project, but in less than two years we were participating in four Sea Grant projects. The following ingredients made this possible:

1. A specific objective -- a useful product.

2. An exchange of ideas between three parties -- Sea Grant, the universities and Marine Colloids.

3. The development of a common interest.

4. The realization that each of us had something different to contribute.

As an example, I would like to describe our Sea Grant project with Dr. Maxwell Doty of the University of Hawaii. The objectives of the project were to develop new supply sources of colloid-containing algae by:

a. Providing industry with taxonomic, ecological and physiological information on tropical species.

b. Providing industry with economic and sociological information for establishment of viable new industries.

The advantages of working with Max Doty were numerous. He was knowledgeable about tropical seaweeds, located in a tropical area and equipped to make the necessary physiological and ecological experiments. In addition, Marine Colloids already had a working organization in the Philippines that was engaged in harvesting the Eucheuma species in which we were interested.

At the same time Marine Colloids launched project "Appleseed." This project, named after the proverbial Johnny, was a gamble on a long-shot. The intent was to farm by trial-and-error, employing various physical systems without knowledge of the underlying physiological and ecological plant responses. To a large extent, "Appleseed" was independent of the Sea Grant project. By merging the two, however, we accomplished more than was possible by either one alone. Dr. Doty tried many of his experiments on systems and with personnel from "Appleseed"; Marine Colloids had immediate access to his latest developments and findings. The projects were synergistic.

On the actual Sea Grant project Marine Colloids contributions included direct cash outlays, logistic support in the Philippines, laboratory analysis of seaweed sample, evaluation of seaweed extract for commercial usefulness, consultation and travel.

The results have been gratifying though not outstanding. On a three-fourths hectare farm we have had for several months sustained seaweed yields of about 20 tons of dry weed per year (eight tons/acre). Unfortunately we have had political difficulties in the Philippines, and the problem of logistics in working on almost inaccessible islands has slowed our progress. Eventually some of this work will be continued in Hawaii where these weeds grow well though they are not native to the area. This new location should alleviate political problems of the kind encountered in the Philippines, though it could give rise to others.

What have we learned from our work with Sea Grant? We have found a) that Sea Grant welcomes industry and b) that university people are not unhappy to work toward a useful objective if the problems involved are intellectually challenging. We have learned c) that obtaining a Sea Grant loan is primarily a question of having well-defined objectives, d) that a successful outcome is based on free exchange of ideas and the development of common goals and common interests, and e) that several technologies and points of view must be combined. Finally, we know f) that much more can be accomplished with the combined funds of industry, the university and Sea Grant than by going it alone for a much lower <u>total</u> expenditure.

Many years ago Marine Colloids promoted a slogan that emphasized the ability of its seaweed extracts to stabilize many products at very low concentrations. The slogan was "A little bit goes a long way." The point of my story is that a small amount of the right kind of research, done by the right people, can go a long way toward solving problems that otherwise seem insurmountable. Universities and industry have different outlooks on science and technology, and a small contribution of ideas from one side can open new vistas for the other. Both industry and the university have a large investment in different facilities and equipment. Sharing these facilities increases the efficiency of both partners, and the net result is more accomplishment at lower cost.

So, you see, my story does have a moral -- A little bit goes a long way.

Economic Development in the Texas Coastal Zone

John Miloy
Texas A&M University

Today I would like to present three items. One concerns a program of the State of Texas; another refers to a study under that program; and the final item concerns one aspect of the study.

Operating under the Office of the Governor and the Interagency Council on Natural Resources and the Environment, the Coastal Resources Management Program of Texas established several ambitious goals.

The Coastal Resources Management Program set out to achieve the following:

1. A comprehensive inventory of resources in the coastal zone of Texas.

2. Identification of problems existing in the coastal zone.

3. Specific evaluations concerning the allocation of resources in the coastal zone.

4. Recommendations indicating the range of choices available for future decisions involving preservation, protection and development of resources in the Texas coastal zone.

Six research studies were identified to provide useful information on the coastal zone. Five of the studies were concerned with bay and estuarine management, power plant siting, legal/institutional aspects, transportation and waste management alternatives.

The sixth study involved economic development. As a matter of local pride, I would point out to you that of the six studies three were conducted by Texas A&M University. In addition to the economic development study, Texas A&M also carried out the transportation and waste management studies.

Information from the six research studies and other sources will culminate in specific recommendations for action by the state legislature. These recommendations will be presented to the legislature in December of this year. During the past year the Industrial Economics Research Division has been involved in the preparation of a 130-page report titled "Economic Development Study of the Texas Coastal Zone." Sponsored by the Texas A&M University Sea Grant Program and the Coastal Resources Management Program, the study was an opportunity to produce a baseline study on economic, human and natural resources of the 36-county coastal zone of Texas. Also, it was an opportunity to compare the level of economic activity in the coastal zone with the total economic activity of the state.

I do not intend to present the statistical results of our study today. I will give you a brief resume of our outline for the study, and then I will discuss one methodology we used to present industrial growth in the coastal zone.

To clarify the relationship between economic activities in the coastal zone and in the state, we evolved a history of economic growth for the two sectors from 1940 to 1970. This exercise established the relative trends of the two levels for population changes, industrial growth and employment and income levels. This was followed by analysis of current resources with emphasis on renewable resources as contrasted with nonrenewable resources. Since people appear to be a major resource, we then analyzed the urban and rural changes in the coastal zone. The final chapter of our study covered future assumptions and economic projections to the year 2000.

One way to measure regional economic development is to analyze the number of firms involved in the various economic activities. There are three major stages of economic development that an economy generally experiences; these stages concern the amount of involvement of firms in primary, secondary and tertiary levels of economic activities.

The primary industries are those based on the natural resources of the earth such as agriculture, forestry, fisheries, mining and extraction activities. Secondary industries consist of those involved in manufacturing, processing and construction. Tertiary industries consist of those firms that provide services to the primary and secondary industries. Typically an area will first experience the development of natural resources. Most industrial activity is involved with the production or preparation of crops and livestock, lumber, fish products and mineral and fuel extraction. As the industrial development of the area becomes more sophisticated, the secondary industries begin developing due to the economic linkage effects of vertical integration and economies of scale in production and manufacturing systems. With the expansion of secondary industries comes the demand for many additional supporting services of tertiary industries in the areas of transportation, communication, wholesale and retail trade, finance and recreational and professional services. The typical development process requires that the region be able to shift emphasis from one resources base to another. For example, the primary activities are basically oriented to the location of the natural resource inputs; whereas, the secondary activities are more concerned with the factors of proximity to markets, raw material, labor, semiprocessed inputs or other factors determining the profitable operation of their firm. Finally, tertiary activities are mainly oriented toward population and consumer marketing centers.

Presenting industrial growth in such categories produces one great advantage: the audience has a clear-cut perspective of the contribution of each sector (i.e., primary, secondary and tertiary) to the total economic activity. In spite of the danger of oversimplification, we feel that such a method of presenting economic information has real value in clarifying and developing perspectives. Most researchers become so involved with their project that they consistently fail to consider their potential audience. By presenting economic changes in the light of primary, secondary and tertiary relationships, we feel that readers of our study have a better chance to understand economic changes taking place in the coastal zone.

This Sea Grant Association Meeting is an example of tertiary economic activity, and I direct your attention to the next presentation on this afternoon's program. Dr. Gillespie's activity operates at the tertiary level, but his eventual impact on the primary and secondary levels may prove to be substantial.

Let me close my brief remarks by saying that, for those of you interested in receiving a copy of our economic development study, please contact me or the Center for Marine Resources at Texas A&M University. We expect to have our final draft ready for publishing within the next 30 days and we would be happy to send the study to you.

Surfing Into The Future: The Recreational Role in Advancing Oceanic Education

Gilven M. Slonim
The Oceanic Educational Foundation

Athelstan Spilhaus, father of Sea Grant, inadvertently selected the title for my paper when he commented on Dr. Doug Sessoms' lecture with the phrase "Oceanic Recreation -- Wave of the Future." Either seems to fit conceptually for developing the thesis that oceanic recreational trends are inextricably tied to the pragmatic, philosophic evolution of oceanic education. What triggers this conclusion is an interesting pattern evolving in two courses, "Humanities of the Sea" and "Sciences of the Sea," at the University of Virginia. This same pattern was evident when we launched the initial "Humanities of the Sea" course in the Center for Tomorrow at Ohio State University on the fifth of this month.

As students reporting to class disclose their attractions for a comprehensive World Ocean study, about 10 in each class are identified as teachers interested in an obstensibly exciting new field of education; another 10 are scuba divers who enjoy the water and want to learn more about their new arena of adventure. Those who are attracted to our new educational program by their recreational water involvement, I suggest, reflect the remarkable population shift to seaward. I contend that those "hooked" by wonders of the water world are our real hope if this country is to regain an understanding of the seas tantamount to their fuller use.

If these water enthusiasts represent the alpha of oceanic understanding, then certainly teachers are the omega of the operation. Doug Sessoms, the dean of oceanic recreation who perceptively discerns and develops the thesis that leisure serves as the catalyst for lifestyle changes, reinforces this conclusion. In turn, Alvin Toffler adds appreciable validity in *Future Shock*. As a former boxer and hockey player, as well as one inordinately slow in learning to swim, I was conditioned by constant admonitions of the dangers of the environment. I felt that sports and recreation were carried out for their own sake -- fun and zestful feelings being the end aim. But Dr. Sessoms has added a more profound interpretation in his provocative lectures at the University. I certainly subscribe to his brilliant thinking that the water world -- ocean, rivers, lakes and estuaries -- is leading people toward greater adaptability and a more fulfilling future.

Indeed, this creative recreational concept promises a more satisfying use of increasing leisure time. At the heart of this promising success story is education. One cannot enjoy, either fully or safely, an active involvement with the oceans without education. To survive, one is obliged to learn. But beyond the discipline of survival there must be an understanding of the new medium.

The oceans still remain foreign to the thinking of most Americans living in the last third of the 20th Century. And too often one is obliged to add an explanation each time he mentions Sea Grant publicly, despite the dramatic national success of the program. Here I should like to digress to March 15th of this year, the date the President sent his Scientific and Technological Program proposal to Congress. As we recall, 1972 is the third year of the Decade of Oceans. Several years have already passed in our conquest of man's last great frontier. Unfortunately, the President failed to mention the oceans even once in this particular program proposal; perhaps, this was because there has been no submarine threat to Vietnam, as yet. Significantly, it was ASW (Anti-Submarine Warfare) in World War II that marshalled the best, foremost scientific minds to meet the ominous underseas threat that might have severed the communication lines to our island nation. Hirohito's and Hitler's submarines proved to be the great oceanic boom -- the strongest stimulant to oceanographic scientific study in world history.

But ostensibly we learned from that lesson: we organized after the war, we passed oceanic legislation. 1966 was a watershed year. We created the Marine Commission, the Council. We elevated the oceans to the highest level within our government; the Vice-President went into oceanic intellectual action as the President's executive. The same year Congress enacted the National Sea Grant program, which accounts for our presence here. But one "chink in the armor," a fatal flaw in our thinking, remains -- we failed to reach the American people educationally. There still is no oceanic constituency. And this, we might say, is where oceanic education entered the picture. Dr. Robert B. Abel, head of Sea Grant since its inception, time and again reiterates, "The ocean program has still to get into high gear!" He contends, "We concentrated too much effort on educating oceanographers and placed too little emphasis on teaching our peoples about the oceans."

To gain steerage, there must be interest. The first year is an endeavor to rectify this challenge by adding a new dimension of humanistic study to our schools' curriculum. I believe our first solid step in gaining Americans' commitment to ocean education must be through recreational involvement. Sports page statistics on readership may give us a clue on the whys and wherefores.

But whether the lure is in the form of scuba diving, deep sea fishing, power boating, yacht racing or contemplation of a Pacific sunset, the accent is on innovation. The creative concepts in developing recreational programs with long-term vision will prove to be the payoff. Whether or not we can induce a broad cross-section of our population into the sea-schooling process will be, in essence, a function of how well we thread the water-bait -- how well our "come on in, the water is wonderful" message is conveyed.

We still have numerous areas that attractively invite the mounting population. Some 22,000 miles of recreational seashore are, indeed, part of our truly great resources -- a balance wheel upon which a better future may hinge.

If innovation is the name of the game, let us practice some solid, innovative long-range planning that truly taps the rich rewards to be derived from recreational programming. Most of all, I would suggest: let us not stop at the waters' edge, whether there are hickory branches to be found or not. Recreational planning must gain global perspective early in the game. Our plans must relate to probably the most predominant characteristic of our population today -- its mobility. Then we must find an avenue to the fun-loving people's minds and make water a part of their intellectual process. Let us see what prospects are portended.

I have heard planners say that only 10 miles of ocean water beyond our coastal zone is useful for oceanic recreation. What nonsense! What circumscribed thinking! This great World Ocean, spanning seven-tenths of our earth, is open for grabs by an affluent society with excessive leisure time on its hands. While considering tomorrow's global recreation, let us include all shores of the world in our master plan to recreate a tense 20th-century people who desperately need oceanic space to unwind. Let us think in terms of Sheratons in Turkey, Tokyo, Tel Aviv and the like as part of the sea scheme to recreate people, as the first giant step toward true oceanic understanding.

Americans are intensely mobile, and travel is part and parcel of their swiftly moving existence. If we are going to wind down to a humane living tempo, let us use our ingenuity to encourage sea travel. Let us make ocean travel convenient, cheap and within the grasp of young and old alike. I own no Cunard stock nor U.S. Lines. But the cultural cruise can be a key factor toward gaining global oceanic recreation. While adding an educational dimension to the recreational role, water experience is essentially sought to gain an environmental grasp.

Norfolk, Virginia, as we observed on a field trip to Tidewater at our first "Humanities of the Sea" summer institute for educators, has done an impressive job of selling the idea of Caribbean cruises. The market is mounting. Unfortunately, cruise ships fly foreign flags while the U.S.S. United States, the finest passenger ship afloat, is tied up in this port city. But recreation-vacation dollars are pouring into the port, and this profitable business portends public understanding if the cruises are structured with a degree of educational attractiveness. The Oceanic Educational Foundation is endeavoring to get a handle on this mounting market in an effort to couple oceanic education with this burgeoning cruising business. What bolsters my confidence is the fact that the cultural cruise stands to flourish in the future of a 35-hour workweek with retirement at age 55. But what excites my interest most is the prospect of sending students of all ages to sea to spark their interest in sea-oriented professions. We worked the destroyer Irwins into a cultural world cruise after the Korean armistice, and our people gained an exceptionally fine grasp of global geography that might have been missed if all our leisure cruising time had been spent polishing brass work or playing bridge. This creative-cruise concept led to a conviction that time at sea can be profitably and educationally utilized for the enjoyment and enlightenment of participants. It was the genesis for the comprehensive World University Afloat program that Ambassador Glenn Olds and Buckminister Fuller undertook to develop with OEF at Southern Illinois University.

With this backlog I urge you not to sell the cultural-cruise concept short in our probe of the recreational potential of the oceans. This concept may be one of the best ways to keep peoples' minds in high gear and issue-oriented, despite the trend toward early retirements, shorter workweeks and computerized thinking. Television also looms as a significant contributor in educating our people about the sea. Cousteau demonstrates the fact almost daily. His success in expanding oceanic interest highlights the importance of the marriage of television with oceanic education to gain grass roots understanding of the seas.

To highlight the innovative opportunities afforded by ocean development, I would like to focus on the futuristic projection of a Global Complex of Oceanic Parks. The Foundation developed this long-range park concept that utilizes television to gain worldwide participation in the educational process. This concept again stems from the essentiality of thinking in global terms as we project the oceanic recreational dimension of the future. The plan adheres to population trends while endeavoring to influence expanding programs of oceanic education worldwide and links participants through personal contacts and television. This thinking is predicated upon the assumption that multichannel communications will be with us soon and that we can anticipate at least two-way channels of educational operations as the park complex becomes a reality.

To first define an Oceanic Park: the individual park would be located at the beautiful interface of land and sea, as are other seascape, marine parks. The environment would be conducive to enjoyment and recreation that would fill people's leisure hours. But the parks, from the outset, would utilize the lure of leisure activity and the enjoyment of a water environment to initiate education for all age groups of park participants. The park would be linked to a leading university, as well as to the local school system; in this manner the innovative structuring of educational-recreational programs can be made truly productive. It is assumed that pleasurable recreational activity at the park would stimulate curiosity and encourage the study of some aspect of oceanic education.

The park design should provide oceanic artists with incentive to paint and to undertake a variety of artistic development.

There would be museums to depict the maritime heritage of the locale and to offer courses in oceanic history.

To the extent practicable the boating, sea planning and submerged cruising facilities would be provided with the latest types of watercraft. In turn, the recreational water area would serve in a research role to encourage art technology in pleasure crafts. The park would endeavor to stimulate imaginative thinking in ship and boat designs to enhance the aim of sending 20th Century technology to sea. The catamaran oceanographic ship Hayes is a concrete example of the benefits recreational boating can add to ship design if there is purposeful planning. The accent in park planning and park operation would be creative, with emphasis on the development of dynamic ideas that would create an exciting rationale for park participants who recognize their individual roles in creating ocean-oriented change with fuller recreational use of the sea.

At each park I envisage world centers of oceanic study with the latest equipment for seminars, symposia and conference utilization. Here scientists, scholars and students would gather to probe the great potential of the oceans, to solve pressing problems and to advance the quality of life for mankind.

Here through the meoium of multidisciplinary oceanic education, a new thrust toward deeper insights and a more comprehensive grasp of man's great globe and of his complex endeavor would be within our reach. This innovative educational process would become basic in "helping people to survive and to crest the wave of change." A new sense of mastery over one's destiny could be gained as the relevance of future education in meeting opportunities would be tested. The oceanic parks would become nerve centers of the new oceanic-oriented pursuit of knowledge, serving as a major springboard for more resolute studies and research in the sea environment.

The parks, linked by multichanneled educational television, will make the learning process truly global in nature, bringing the people of the world into closer cooperative communications through the intellectual vitality stimulated by oceanic study.

I have termed "Humanities of the Sea" the antidote to *Future Shock*. The potential the oceans possess for conditioning and cushioning lie in three broad dimensions: geographic space, psychological dampening and futuristic education.

The oceanic park would utilize oceanic recreation as a spearhead in "Surfing into the Future" and the innovative spin-off from dynamic recreational-educational functioning would indeed serve the betterment of all mankind.

The dividends from development of the park complex are as wide and varied as the mind of man can perceive. The educational investment in a fuller future would seem to warrant serious consideration as we stake out our claims in the Great Frontier of the Future -- Man's World Ocean.

New Drugs from the Sea: State-of-the-Art

Judy Joye
Oceanographc News Service

Investigators conducting a systematic search for new drugs from the sea have uncovered an area of biologically active agents that could eventually increase the number of drugs known to man by five-hundredfold or more.

Dr. Paul Burkholder, former chairman of biology programs and senior research scientist at the biological laboratories of Lamont-Doherty Geological Observatory (Columbia University), recently predicted "that when fully exploited, one-third to one-half of all sea life will exhibit some form of drug activity." It is important to mention that four-fifths of all animal life on earth, representing more than 500,000 species in 30 phyla, live in or on the water. Only three per cent of the plants on earth have been chemically and pharmaceutically evaluated, and less than one per cent of the thousands of marine organisms that are known to contain biotoxic substances have been examined for pharmacological activity.

In one experiment with Caribbean sponges, Lamont-Doherty found that 35 per cent of the sponges tested were active against gram-positive bacteria, 15 per cent active against gram-negative bacteria, and 10 per cent active against *Candida* species.[1] On a random sampling basis, ±30 per cent of all sponges tested exhibited antibiotic activity. In addition to antibiotic activity, an estimated 20 to 28 per cent of sponges tested exhibited activity against leukemia as well as other forms of cancer.

Based upon current research, marine plants and animals appear to be an extremely large, unexploited source of biologically active compounds. In the area of antibiotics, not one but a whole new family of antibiotics appears to be emerging from the sea. It is important to mention that a number of these compounds are

[1] *Candida* is a genus of yeast-like fungi used for general screening. These fungi are primary etiologic agents for many infections caused by microorganisms in man.

demonstrating laboratory activity in reaction to small viruses against which we have no known defenses. All antibiotics in use today are active against bacteria and certain large viruses, but no known drug is active against small viruses.

Although the physician has a seemingly adequate selection of antibiotics at his disposal, the frequent appearance of drug-resistant strains often requires the use of supplementary countermeasures.

A common example of drug-resistant strains is noted with staphlyococci, which can multiply from 1 to 10 within 30 minutes, while other organisms may multiply from 1 to 10 within 48 hours. When treating a staphylococcus infection, the organism multiplies at such a rapid pace that drug-resistant strains appear within hours after the first application of antibiotics. A similar problem with drug-resistant strains is noted in certain forms of malaria, diarrhea and fungus infections for which there are few effective drugs.

In 1963 New York City Health Commissioner George James stated that, after the introduction of Isoniazid in 1953, new cases of tuberculosis declined rapidly and steadily. However, drug-resistant bacilli have been noted, with three per cent of new cases being drug resistant. Commissioner James stated that further research to develop new drugs to supplement Isoniazid is needed. I would like to add that one of the sponges investigated by Dr. Burkholder has shown specific laboratory activity against tuberculosis.

Although statistics on epidemic diseases indicate that resistant strains present no serious threat to the general public, the government has no statistics on the frequency or effect that resistant strains have on the many nonreportable diseases affecting the general population. As an example, within the past few years there has been a noticeable increase in the number of diarrhea cases among children whose illnesses appear resistant to numerous antibiotics. It is believed that in these cases the child's infection responded to drugs at first and then, within a week or two, became resistant to several drugs at once.

Commenting upon the need for new drug research, the New England Journal of Medicine wrote in a 1966 editorial that "unless drastic measures are taken soon (against drug-resistant strains), physicians may find themselves back in the pre-antibiotic Middle Ages in the treatment of infectious diseases." Although there is no immediate evidence that we will return to the Dark Ages of Medicine in the near future, many researchers are convinced that this new family of drugs, emerging from the sea, will answer this drug-resistant problem and much more.

Although most researchers -- and especially pharmaceutical firms -- are reluctant to discuss their work in public, a partial listing of compounds under investigation has been prepared. The diversification of this list emphasizes the broad scope of drug activity to be found in marine organisms:

1. Sponges -- Antibiotic; antitumor; antiviral; antifungal; antiyeast; controlling bacterial pollution of bays and estuaries. In laboratory tests of pollution control, after six days bacteria count for each cc. was 5,000 while control vats had a count of one million per cc.

2. Sea water (in certain areas) -- Antibiotic, with activity against penicillin-resistant and penicillin-sensitive staphylococcus. Noted in Vinyard Sound, Massachusetts, and Narragansett, Rhode Island, while absent in the Gulf of Mexico. Attributed to local microorganisms in water.

3. Abalone, conch, oyster, clam and other shellfish -- Antiviral; antimicrobial; antitumor. A shellfish extract called Paolin I protects mice against _Streptococcus pyrogenes_ (scarlet fever, sore throat, etc.); against _Staphylococcus aureus_ (boils, carbuncles, abcesses); and against certain bacteria. In mice and monkey kidney tissue Paolin II was active against polio and influenza viruses. Extracts from clams reduced the incidence of tumor induction in experimental animals. Extracts from miscellaneous mollusks showed activity against _Herpes simplex_ (so-called fever blisters); polio; influenza and tumors.

4. Hagfish -- Cardiac stimulator; skin graft research.

5. Octopus -- Anticoagulant, paralytic agent similar to curare.

6. Coral -- Antibiotic.

7. Seaweed (algae) -- Antibiotic; antiyeast, antiviral; coagulant; anticoagulant; antiulcer; antifungal; vermifuge (to expel intestinal worms); cathartic; marine antifouling agent. Antibiotic activity was first recognized by Pacific Island natives who wrapped freshly caught fish in local seaweed to prevent spoilage.

8. Portuguese Man-of-War -- Membrane permeability (to carry drugs to different parts of the body).

9. Protozoa (paramecium) -- Bioassay (screening pharmaceutical agents for toxicity and side effects).

10. Stingray -- Cardiac inhibitor.

11. Pufferfish -- Nerve-blocking agent (a narcotic 160,000 times more potent than cocaine) cardiac inhibitor; antitumor; anticoagulant; antispasmatic.

12. Sea cucumber -- Antitumor; nerve-blocking agent; antispasmatic.

13. Sea anemone -- Anticoagulant.

14. Starfish -- Contraceptive; antiviral.

15. Sea urchin -- Nerve-blocking agent.

16. Stonefish -- Vasodilator.

17. Marine worms -- Insecticide; contraceptive; antibiotic; antitumor.

18. Electric eel -- Antidote for pesticide poisoning.

19. Barnacle -- Adhesive for dentistry, bone surgery and broken bones.

20. Marine microorganisms (bacteria) -- Antifungal; antiyeast; antibiotic. Note that fermentation techniques commonly used in antibiotic production by industry may also be applicable to antibiotics produced from marine microorganisms.

21. Murex (snail) -- Respiratory stimulator.

22. Toadfish -- Management of diabetes (through a substance that burns blood sugar).

23. Seafan -- Antibiotic.

24. Jellyfish -- Antitumor.

25. Tunicates -- Antibiotic; antileukemia.

The Status of Reach: Industrial & Academic

For want of a better reference scale, the status of marine pharmacology research can be graded as 3 on a scale of 10. At the present time almost all large pharmaceutical firms are engaged in research on drugs from the sea or, at the least, have investigated the economic potential of entering this field. A small number of drug firms have reasonably extensive commitments while the rest are engaged in lower priority research. The extent of funding and corporate involvement are closely guarded secrets.

Generally few companies have more than one part-time chemist extracting compounds; the average time required to screen a collection of 100 or more marine specimens is a year to a year-and-a-half. Since the shelf life of marine compounds is believed to be unstable, the negative results of a screening program that extends beyond three to six months must be considered inconclusive.

Although most pharmaceutical firms enter the marine field with strong confidence in their investigative capabilities, each firm for which I have collected committed grave errors when processing their first collection. In every instance the company's first effort in this field was all or partially discarded because of irreversible staff errors. The worst example I witnessed involved a numbering error that prevented a company from identifying specimens in which activity was found, and a year-and-a-half of research involving a collection of 300 specimens was quietly discarded without hope of recovery.

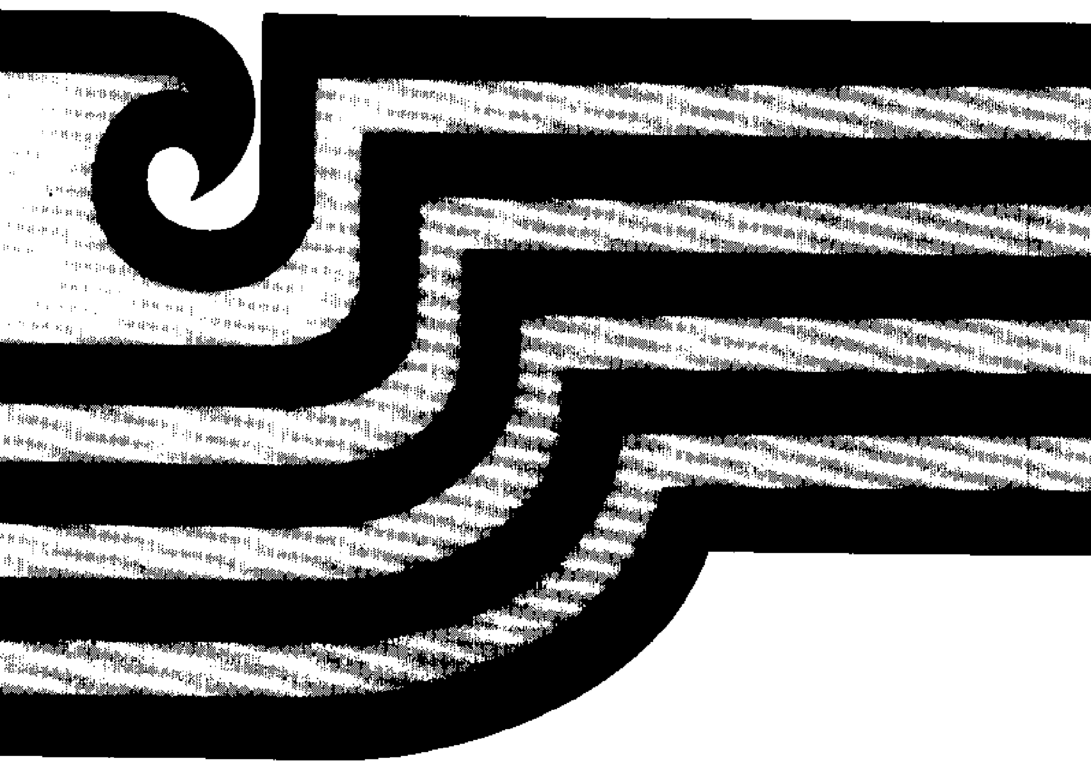
Although most of my collecting is for industry, my contact with the academic community indicates that similar errors and problems occur in nonprofit laboratories. Those problems are magnified when the investigator begins his first screening program with marine flora and fauna.

The future of marine pharmacology is encouraging not only for the development of new pharmaceuticals but also for the fantastic earning potential that awaits this neophyte industry. It has been said that when drugs from the sea are fully exploited -- in 20 to 30 years -- marine pharmacology will be as big a money earner as offshore oil and gas. In present-day markets one antibiotic can earn as much as $50 million a year; and, as stated before, research indicates that not one but a whole new family of antibiotics is emerging from the sea. It is this vast earning capability, with the added dividend of possible activity against small viruses, that inhibits most companies from discussing their work publicly. Quite frankly, I cannot blame them. Research in this field is highly competitive, and some companies publicly deny their involvement in the hope of discouraging competition from establishing higher priority programs.

But even with industry's participation in this field, scientists complain that pharmaceutical firms refuse to invest their dollars in basic research that must be completed before meaningful discoveries are made. Acknowledging this impasse, many researchers agree that the only way for new drugs from the sea to reach full potential is for government funds to lay the foundation upon which industry will eventually build its profits.

As the world's needs and population rapidly expand, we realize that we have just begun to identify the great benefits lying in and under the world oceans. The oceans will provide us with new sources of food, with vast supplies of mineral resources, with a new understanding of our weather and climate and with new drugs that promise to cure mankind's most dreaded diseases. Although we have learned more about the oceans in the past 10 years than we have known in our entire prior existence, the process of unwrapping this great gift has just begun. The oceans are indeed God's unwrapped gift to mankind.

BUILDING A NETWORK



A National Marine Advisory Service (NMAS) — An Overview

Howard H. Eckles
National Oceanic and Atmospheric Administration

Ladies and gentlemen of the Sea Grant Association, I feel it is a matter of importance and pleasure to discuss with you the view of the National Oceanic and Atmospheric Administration on Marine Advisory Services. Before proceeding, however, I would like to define what we mean when we speak of Marine Advisory Services.

A short definition: Advisory services are informal educational actions that help people solve practical problems by transferring information to users and by communicating needs to researchers and managers.

The objective is to assist those who are interested in and responsible for the development, utilization and management of the ocean and its resources through an efficient system whereby results of research, availability of services, experience of industry and other sources of information are quickly made available to users.

The subject matter involved in the Marine Advisory Service includes the full range of information required by ocean activities and includes, in addition to technical information, social, legal and economic aspects. Examples of principal subjects of strong current interest include recreation, environmental quality and pollution control, environmental monitoring and forecasting, living and nonliving resources, transportation, coastal zone management and other activities in research, education and government. The subject areas of concern include those for which NOAA and Sea Grant programs are responsible and also extends to other federal and state agencies whose missions can be facilitated by cooperation in the Marine Advisory Program.

The need for marine advisory services has been recognized many times in the past. Congress took action by including marine advisory services in authorized legislation for the Sea Grant program. The Commission on Marine Science Engineering and Resources recommended a strong national marine advisory program. More recently, the Marine Fisheries Advisory Committee to NOAA recommended that marine advisory services be improved and expanded. In no way the least important is a recommendation from this Association of Sea Grant Institutions that NOAA set up a unified Marine Advisory Service program and assign to the Sea Grant Office a lead role in its development. Much of the rationale behind the current organization of the NOAA Marine Advisory Service follows the recommendations made to NOAA by a committee of this Association.

On this occasion, I feel it important to say that the top administrators of NOAA regard the organization of a Marine Advisory Service as one of the most significant policy and program decisions that has been made since NOAA was established in 1970. The Marine Advisory Service is regarded on a par with other major program developments, such as the Manned Undersea Science and Technology program and the Marine Ecosystems Analysis program.

The Marine Advisory Service (MAS) is an opportunity to complete NOAA's organization as a national leader in ocean affairs. Equally important, the MAS is an opportunity for improved coordination with local university and state programs and for gaining a "feedback" mechanism that will assist with better program design to meet total responsibilities in ocean affairs.

The NOAA Marine Advisory Service is being organized on the premise that states working via Sea Grant or other programs will provide a means of coordinating marine advisory services on a local basis. The primary interface between the advisory program and the public will be carried out at the local level by state or Sea Grant organizations. NOAA will work through and support local organizations, at the same time assuming basic responsibility for the continuity, completeness and overall success of the advisory program.

NOAA has assigned the Office of Sea Grant responsibility for the leadership of the NOAA Marine Advisory Service. The Office of Sea Grant, through the Program Manager for the Marine Advisory Service, will manage marine advisory services provided and funded by NOAA organizations and will coordinate advisory programs supported by Sea Grant funds. The Office will be responsible for the evaluation of the status of advisory services on state, regional and national bases and will encourage establishment of state advisory programs, improvement in services and necessary implementation of new services. The Office of Sea Grant will also recommend increases and changes in NOAA's activities on advisory services.

Office of Sea Grant will prepare annual and long-range marine advisory service plans for NOAA. These plans will be based on Sea Grant and NOAA organizational programs and will include specifications of working relationships, budgets and personnel requirements, in addition to rationale and justifications for the programs.

Office of Sea Grant will take the lead and promote necessary actions to implement the plan. The Office will work in cooperation with NOAA organizations, Sea Grant advisory programs, state organizations and other federal agencies.

A particularly important aspect of this function is establishment of guidelines and of criteria under which local programs will be funded. For example, Office of Sea Grant will stress the need for multidisciplinary, balanced programs to serve the needs of the total marine community. We will also insist on adequate local planning and coordinating mechanisms.

An additional important function of the Office of Sea Grant will be to coordinate common services such as training, publications, program evaluation and feedback.

Thank you for the opportunity to present NOAA's overview of the MAS program.

Implications for Sea Grant

Daniel A. Panshin
Office of Sea Grant
National Oceanic and Atmospheric Administration

The fundamental element of the NOAA Marine Advisory Service is the local marine advisory program. To this end, a marine advisory program needs to be established in all 30 coastal and Great Lakes states. Most local advisory programs will be university-based and will operate under Sea Grant sponsorship. Within the NOAA Marine Advisory Service, local programs will serve as the focal points for direct and regular contact with ultimate users.

What Kind of Advisory Programs Do We Need?

There is no one magic mold or mode, but certain common features are essential to all programs:

1. Strong administrative support.

2. Clear public visibility.

3. Substantial fieldwork -- implementation of the concept of "county agents in hipboots" -- in which people help people face-to-face in their home communities.

4. Nucleus of personnel for whom advisory services are a primary assignment.

5. Pursuit of an approach that is systematic, broadly interdisciplinary, committed to serving the entire spectrum of marine industry and interests and especially dedicated to resolving conflicts.

6. Preparation of annual and long-range plans for action programs that will take place within their respective geographic areas (these plans will be prepared and carried out in cooperation with the various NOAA components and others having appropriate expertise).

Where Are We Today in Advisory Services?

There are presently 28 local advisory programs in 22 states. Sea Grant supports 24 of these programs; the National Marine Fisheries Services supports another three programs through Public Law 88-309 funds; and Sea Grant and NMFS jointly fund one program. Three coastal states and five Great Lakes states have no advisory program.

Annual federal funding totals $2.3 million matched by $1.1 million from nonfederal sources. The statistical report of the Office of Sea Grant dated June 30, 1972 shows that advisory services were receiving 11.1 per cent of Sea Grant funds as compared with the year-earlier figure of 8.7 per cent. Local-program staffing numbers about 95 full-time equivalent professional positions. Major program areas are commercial fishing, seafood processing and marketing, coastal zone management, marine recreation and marine science education. Among the local programs there is great variation in funding, staffing, program emphasis, scope, state of development and quality of effort.

Where Should We Be Going in Advisory Services?

Our goal is the development of a strong, well-developed advisory program in each coastal and Great Lakes state by 1977. This kind of program will cost about $13 million per year and will require a staff of 300 people. Steps toward attaining this goal include establishment of advisory programs where they are now nonexistent, strengthening of those programs that are weak and clarification of relationships in states where multiple programs exist.

With the creation of the NOAA Marine Advisory Service, Sea Grant will accept significant responsibilities. The responsibilities likewise convey a compliment to Sea Grant for the success, vitality and impact of its advisory programs.

But benefits will also accrue to local programs through establishment of needed communications channels, access to additional resources and new disciplinary specialists and increased efficiencies from coordination in areas such as publications and training. As a result, local marine advisory services can become even more effective.

Federal Responsibilities in NMAS

J. Gary Smith
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

The Marine Advisory Service network will be composed of NOAA administration, its organizational components and local state and Sea Grant advisory programs. The network, as I see it, is a partnership between local advisory programs and the federal government; it is being formed to develop and to coordinate federal advisory capabilities that complement and support local programs.

In this context, the organizational components of NOAA are partners in the new NOAA-wide Marine Advisory program. Before the creation of NOAA, each agency had provided informal advisory information to user groups in its own way. Now, with all marine resource experience and knowledge combined within one organization, we see an opportunity to put our expertise to greater use. Speaking for the NOAA agencies in the Marine Advisory Service, I would like to discuss our responsibilities and views of the new program.

Within the NOAA organization, six agencies will identify, develop and establish advisory capabilities to support the new advisory service. These agencies have advisory products and supportive services especially useful to our marine constituents.

The National Ocean Survey (NOS) prepares and distributes nautical charts and tide and current tables important to mariners. NOS maps and charts U.S. coastal waters, the Great Lakes and other waterways.

The forecasts and specialized reporting services of the National Weather Service (NWS) are especially important to mariners and allied industries that rely on an accurate knowledge and understanding of weather for their livelihood.

Sport and commercial fisheries are the responsibility of the National Marine Fisheries Service (NMFS). Biological, ecological and economic research studies are conducted on important marine fish species and their environments. Product technology and inspection, marketing assistance and statistics and market news reports are also provided. This service administers a vessel-loan program and a state-federal management program; it also conducts enforcement and surveillance operations. The NMFS also has the only active NOAA agency extension program with full-time extension personnel.

The National Environmental Satellite Service (NESS) plans and operates environmental satellite systems that are able to provide real time data on atmospheric and oceanic phenomena.

Data on the physical environment are gathered by NOAA's Environmental Research Laboratories (ERL). The Marine Mining and Technology Center will provide the primary advisory activity of ERL through assistance to local programs and to industry on developing tools and techniques for accurate delineation and economic evaluation of marine mineral deposits.

The Environmental Data Service (EDS) maintains centers that gather environmental data on a global scale. Through their services, users may retrieve desired data. EDS is also responsible for NOAA's scientific and technical publications, library services and dissemination of technical information.

The immediate responsibilities of these agencies to the NOAA Marine Advisory Service are twofold.

First, each agency must identify and develop an advisory commitment to the NOAA service. As I previously mentioned, the National Marine Fisheries Service has the only operational advisory program that meets the definition given by Mr. Eckles. Other NOAA components have some elements of advisory services that have been available on an ad hoc basis. During the next few months, each agency must begin to pull these elements together into a visible network of personnel, programs and fiscal support.

The second responsibility requires each NOAA component to affirm its commitment by providing technical support and manpower to the NOAA Marine Advisory Service. This will be accomplished by identifying the products and services of a practical nature that exist within their respective organizations. This responsibility further requires each agency to develop a delivery mechanism for providing their products and services to the Marine Advisory Service.

In meeting these responsibilities we also recognize the need to assist the NOAA Marine Advisory Service in preparing joint action plans, programs and budgets. This will require close cooperation with other federal agencies and local Sea Grant and state advisory programs. Through this process we are assured the development of realistic programs, based on common goals, that will be responsive to local needs.

Ultimately, a complete network will be established that provides technical support from NOAA component agencies for local Sea Grant programs. The network will also provide an option for local programs to request needed information from an appropriate NOAA agency.

The implementation of this system has already started.

Each NOAA agency has assigned senior advisory personnel to begin orientation and planning within their respective organizations. Drawing upon talent and experience of their personnel and upon the wide range of facilities, the agencies have also designated other key persons as liaisons or contacts for advisory services. The number of persons designated range from one in NES to 32 in NMFS, each agency making assignments according to its anticipated services. At the present time about 65 persons (some full-time, others part-time) and $300,000 have been committed to the new service. More manpower and money will be provided as each agency identifies its needs and as requests for technical support are made.

This is just the beginning. Admittedly, the building of an effective advisory network will require adjustments and a period of internal education to obtain full support.

Presently, there are as many definitions for advisory services as there are people involved. The NOAA agencies are unsure of their commitment to the new NOAA service. We are unsure of the extent of participation required, the job to be accomplished and the manpower and dollars needed. We are concerned about the role of Sea Grant and state advisory programs. Where do our responsibilities end and local programs begin? Who will receive credit for accomplishments? Who reports benefits? Where are the qualified personnel who will meet projected manpower needs?

Despite these concerns, I am convinced that given time, a common set of goals and a commitment to serve our constituents, we can build an effective advisory network.

The NOAA Marine Advisory Service will provide the organizational framework to bind the network together. We in NOAA agencies will provide a national technical base to complement and to support local Sea Grant advisory program needs. We will expect information requests from local programs and, in turn, expect them to transmit our products and services to user groups.

Speaking for NOAA agencies, we look forward to our partnership with local Sea Grant advisory programs. Through our cooperative efforts, I am confident we can provide the quality of service that our constituents desire.

NMAS: A Sea Grant Director's View

Stanley R. Murphy
University of Washington

Those who have worked hard on the formulation of the NOAA Marine Advisory Sercice (MAS) should be commended for laying a foundation of an important program. The concept of MAS is worthy of considerable effort. NOAA contains much knowledge that individual citizens could put to use. Sea Grant advisory efforts are oriented toward getting that knowledge to people who need it and toward getting the problems of people to those who can provide useful knowledge. MAS can apply more resources to these efforts than Sea Grant by itself ever could. The MAS idea has a lot to offer.

As I understand it, at present the concept of the NOAA Marine Advisory Service is primarily contained in two documents -- the National Marine Advisory Program Conceptual Plan dated January 14, 1972, and the July 18 draft of Guidelines on Responsibilities and Organization of the NOAA Marine Advisory Service.

If I were at the national level, the documents would seem quite promising. They include mechanisms to combine budgets, to develop comprehensive plans and to conduct an overall program review at the national level. These documents address major concerns of Main Line Component (MLC) and of Sea Grant people such as manpower and budget control; they also recognize the importance of local-need orientation.

But I am a state Sea Grant program director. What does this mean? According to the conceptual plan of January 14, this means that my Sea Grant advisory program becomes the state lead-unit. This is appropriate because the conceptual plan points out on page five that "the lead unit must be such that local participation is built-in, that cooperation is maintained at the local level and that the system is flexible to meet the particular local needs of the state and the region."

Furthermore, this idea is consistent with the draft guidelines of July 18 that also on page five state, "The fundamental element of the NOAA Marine Advisory Service is the local marine advisory program." Therefore, it must be realized that in the states which have a Sea Grant advisory program this program is the lead-unit, the local marine advisory program and the fundamental element of the NOAA MAS referred to above.

The same guideline document describes the characteristics of the local marine advisory program in terms of operation, including annual and long-range plans of work prepared in consultation with the various NOAA MLC marine advisory organizations. The document also emphasizes the importance of feedback, user needs and cooperation with organizations outside NOAA. This, to the best of my knowledge, describes what a state Sea Grant advisory program is all about. And the designation of a NOAA lead-unit, which serves as a fundamental element of Sea Grant and provides local marine advisory program responsibility, is therefore appropriate.

Against that background and as as state Sea Grant program director, I offer two suggestions so that we can progress from the present conceptual plan and guidelines to a workable, effective operation.

First -- as I said earlier, the local Sea Grant program is already executing the job outlined for NOAA's local marine advisory program -- within the limits of the resources it can bring to bear. The only real difference is generating, publishing and defending the advisory aspects of annual and long-range plans of all NOAA components for that state, as part of the input for NOAA's national program memoranda and budget documents. Our present resources support the annual and long-range planning we now do, but the total NOAA local planning of these documents is a much larger effort and must have commensurate resources. In simple terms, this means increased funding through Sea Grant, which raises the problem of increased nonfederal matching. However willing we are to develop the MAS program, this may create local problems in specific states.

Second -- in constructing the management structure of a system to enhance and to develop cooperative efforts among semi-independent institutions, we must give serious attention to providing the "glue" that pulls the effort together.

The organizational structure in the guidelines shows no "glue" below the national level. MLCs are to assist in program preparation and support at the national coordination level by cooperating with local advisory programs. The formal ties, then, are only at the national level.

In my judgment, we can make this structure work if the people involved want to do so. I believe we do. Nonetheless, I strongly urge that we seek ways and means, beyond what is presented in these two documents, of tying together the local program.

How a University Marine Advisory Program Views NMAS

Maynard W. Cummings
University of California Sea Grant

These remarks are interpretations of the NOAA Marine Advisory Program Plan of January, 1972, and the Guidelines on Responsibilities and Organization of the NOAA Marine Advisory Service of July, 1972. The agency plan, or guide, is an idealistic concept in which each organizational level of responsibility is harmoniously fitted to all others and in which all organizational components unselfishly serve the common goal of extending marine resource management information. The fundamental element, an actual delivery system, is the local marine advisory program, characteristically a university-based Sea Grant advisory service.

The key question is whether idealism can be realism. The first sentence in the Guidelines says the NOAA Marine Advisory Service is to be organized such that each state will provide means of coordinating local marine advisory programs which will be the primary public contacts. That premise neatly glosses over what may be the most vexing problem, at least in California: how do you coordinate locally the multiple advisory projects that NOAA Sea Grant is separately funding and individually encouraging within a single state?

The Guide's next statement, however, is that the Office of Sea Grant will be responsible for coordinating advisory programs funded by Sea Grant. Maybe that sets things straight -- or does it?

The Guide's next quick, easy statement regarding a large, complex reality is that NOAA Major Line Components (MLCs) will assist in local budget planning, programming and reporting under local Sea Grant leadership to present a single, comprehensive picture of local advisory program goals and needs. To get done at all, especially to get done within planning and reporting deadlines, these activities will really require coordination.

Furthermore, each MLC will make sure that its particular subject area is adequately represented and budgeted locally and nationally. I think MLCs will do this, perhaps overzealously.

This leads to the biggest problem, which seems to be a grave inequity in the plan for coordinating MLC advisory responsibility with Sea Grant advisory responsibility. Each MLC is to have adequate "staff to meet specified responsibilities" and "its own budget" while Sea Grant advisory budgets and, therefore, staff are dependent upon matching funds that can be counted. Making state Sea Grant advisory programs responsible for obtaining matching support while federal programs are directly budgeted is not a compatible or parallel arrangement. There is tremendous advantage in a direct budget.

Unlike research and teaching projects, advisory programs are mandatory and continuing. Consideration should be given to direct budgeting of a certain amount of support, a base upon which matching funds would accumulate if additionally needed.

In summation, guideline documents are just that -- a guide to policy. Programming within that policy remains a local responsibility. Effectiveness within a state will be proportionate to the leadership strength and to the unity it can generate. That leadership must be delegated and supported.

SPECIAL REPORTS

Sea Grant Unified Activities

Harold L. Goodwin
Office of Sea Grant
National Oceanic and Atmospheric Administration

(Editor's Note: The following outline covers the substance and conveys the meaning of Mr. Goodwin's remarks to the members of the Sea Grant Association at the annual conference.)

Given the state of the Sea Grant Budget for the current year and its prospects for the future, no additional unification activities are planned at this time. There is still a clear need to review and unify other areas of Sea Grant and NOAA operations. It is by no means certain that funds will be available for the seven activities listed.

1. Seafood Processing Waste Utilization

Objectives

To develop economically valuable uses for seafood wastes in order to alleviate industry problems arising from new effluent and disposal regulations, and to better utilize natural resources.

Approach

To bring industry, the universities and government together to agree on priorities, define present and potential problems and conduct research directed to problem solution.

a. A project to produce sufficient chitin and chitosan from shellfish wastes for product research already is underway, and proposals for such research are in preparation to augment research now underway.

b. A joint industry-Sea Grant-NMFS project has been developed to establish communication, produce precise definitions and agree on research priorities both for short and long range.

c. Based on results of the project outlined in b., ongoing Sea Grant research will be reviewed and evaluated for consistency with new goals.

2. Ciguatera

Objective

To structure a program that will accelerate solution to the ciguatera problem in both the Pacific and Caribbean U. S. Territories.

Approach

Ciguatera researchers representing several disciplines and approaches were brought together and a program outlined. Principal problem in implementing the program is sufficient funds for collection and processing of toxic materials.

3. Aquaculture

Objective

To bring unity into the NOAA aquaculture program and establish priorities for research and development, including identification of species ready for pilot scale demonstrations.

Approach

The first step was to define the state of aquaculture and seek consensus on principal needs to bring aquaculture of selected species to the commercial stage. This step was completed under a University of Hawaii project with subgrant to Mardela, Inc. The initial report is in preparation. Additional steps depend on clarification of internal NOAA organization and availability of funds. Priorities are nutrition, disease and economic evaluation of potentials.

4. Lobster Culture

Objective

To bring lobster mariculture to the commercial stage in the shortest possible time.

Approach

A workshop for principal lobster researchers was held and a general program outlined. The program is now being implemented through funded proposals. The principal barrier at present is lack of an optimum lobster feed.

Participants in the lobster program include the Massachusetts State Lobster Hatchery (proposal in process), Woods Hole Oceanographic Institution, University of Rhode Island, University of California at Davis, San Diego State College, State University of New York and Maine Department of Sea and Shore Fisheries.

5. Small Boat Fisheries

Objective

To develop an all-NOAA program to bring unity and priority into Sea Grant and NMFS small-boat fishery activities with special emphasis on subsistence fisheries of the Pacific Northwest and Alaska and U. S. possessions in the Pacific area.

Approach

We have agreed with D. L. Alverson of NMFS and Barry Fisher of Oregon State and with Frank Hester of NMFS-Honolulu that an initial planning session should be held as soon as practicable. It already has been postponed twice; earliest possible date for an initial meeting is spring 1973.

6. Technician Training

Objective

To review the state of technician training, with emphasis on Sea Grant, as the basis for revising policies and procedures if indicated by employment history and potential.

Approach

An initial survey of ongoing projects was made by Leonard Mitchell, with the survey providing the basis for continuing evaluation and workshops to clarify procedures and determine future directions. The University of Delaware has taken the lead.

7. Modeling Activities

Objective

To evaluate Sea Grant modeling activities of various kinds in terms of their real utility to user groups, and to initiate program changes in accordance with findings.

Approach

To have all modeling activities reviewed and evaluated by outside experts, including users, as guidance to the Office of Sea Grant. The exact method has not been decided.

Review of Law of the Sea Conference Activities

John A. Knauss
University of Rhode Island

Movement to reopen the conventions agreed to at the 1958 Conference on the Law of the Sea (LOS) began about five years ago and was culminated at the 1970 session of the United Nations General Assembly with the passage of Resolution 2750XXV calling for a law of the sea conference in 1973. Different nations had varying reasons for supporting this resolution; however, it can be assumed that all matters relating to the 1958 conventions will be reopened and that a number of items not considered in 1958 will appear on the agenda.

Since the call of the General Assembly there have been four preparatory meetings of four to five weeks each, two in 1971 and two in 1972, meeting alternately in New York and Geneva. This preparatory work is being done by the Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction.

The General Assembly will decide this fall whether sufficient progress has been made by this committee to call for an LOS Conference in 1973 or whether to postpone the assembly. Membership on the preparatory committee now numbers 91. Thus, in the minds of many, the LOS conference has already begun since it is unlikely that the conference itself will have more than 135 members.

There is an important difference, however, between the initial gatherings and the conference. During the preparatory committee meetings decisions are made by "consensus." As a result, movement is slow and difficult decisions postponed. At the conference of plenipotentiaries, decisions must be reached on what is to be included in a convention and on the exact wording. These decisions will be reached by vote.

In the eyes of many observers these preparatory meetings have accomplished comparatively little. There are several reasons for this; one of the most important is that the issues are extremely complicated and many are interrelated. Thus, it is not sufficient to reach a position to one issue without attempting to determine the consequences of this decision on other issues.

Even a country with the resources of the United States has taken considerable time and effort to arrive at a consensus position on all major issues. For the developing world with many fewer resources, the required learning time is much longer.

However, there is at least one additional reason why progress has been comparatively slow. Several Latin American countries have appeared to believe that it was in their own best interest to delay the conference for some years. Generally, these nations such as Peru have opted for extended national jurisdiction seaward and apparently believe that time is on their side; the longer there is no agreement, the more nations will follow their lead and make unilateral claims to resources off their coasts.

These Latin American nations were among the very few from the developing world to have reasonably thought through national postures on the law of the sea. They have played an important leadership role in the developing world, particularly when their position has been contrasted to that of the major powers, who for the most part are anxious to begin substantive discussions on the issues.

There now appears to be some movement on the part of most nations. I suspect that this is, in part, because most have finally begun to develop their own ocean policy. Having done so, there appears to be a slowly gaining consensus that it is now time to move toward a law of the sea conference rather than to delay any longer.

Perhaps equally important, there is a growing sense of urgency about the issue of a deep seabed regime for the harvesting of deepsea manganese nodules. If the LOS conference does not act quickly they may find a de facto regime established by those nations with the capability to mine the deep seabed.

1. The Issues

Navigation

The first concerns the width of the territorial sea and the concurrent question of passage through international straits. The 1958 Conference on the Law of the Sea reached agreement on the limits of sovereignty within the territorial sea but could not agree on the width of the territorial sea. A six-mile territorial sea failed by one vote. There now appears to be general agreement for a 12-mile territorial sea.

Discussion to date suggests that there will be no substantive changes in the rights and limitations of sovereignty as defined by the 1958 Territorial Sea Convention. However, tentative agreement on the territorial sea breadth raises problems concerning straits that are part of the high seas with a three-mile territorial sea but are not part of the high seas with a 12-mile territorial sea. Two straits of particular importance are the Straits of Gilbraltar, which is eight miles wide, and the Straits of Malacca. The United States and the USSR have indicated they cannot agree to a 12-mile territorial sea unless there is some special arrangement concerning passage and overflight through straits that would be "closed" by such an agreement. Although there seems to be a consensus among Seabed Committee members on the 12-mile territorial sea, there is no general agreement as to what special rights should exist through straits that are more than six and less than 24 miles wide.

The most complicated set of issues concern the extractive resources: oil, fish and minerals of the sea floor such as manganese nodules.

Oil

The 1958 Convention on the Continental Shelf gave to the coastal state exploitation rights of the continental shelf resources to a depth of 200 meters or beyond that limit where these resources are exploitable. Implicit in the Convention on the Continental Shelf is the concept of "adjacency." Although the nations bordering the North Sea may divide resources of the continental shelf between them, one cannot presume that a coastal state could extend its control over resources of the seabeds thousands of miles seaward.

A key issue of the forthcoming law of the sea conference is to define these limits of national jurisdiction, either by defining them in terms of sea floor depth or in terms of distance from the shoreline.

The United Nations General Assembly is on record through Resolution 2749XXV that resources of the sea floor beyond the limits of national jurisdiction are the common heritage of mankind. The problem is to define the limits of national jurisdiction. However, no one is seriously suggesting that no management is required for the resources of the deep seabed. It is not presumed that oil companies and deepsea mining companies can move at will to exploit resources of the seabed in the region beyond national jurisdiction. Some form of international regime is required.

Although there is general agreement that coastal states should have at least some jurisdiction over the resources of the seabed beyond a depth of 200 meters, there is no agreement as to what those rights should be. Some states are suggesting that coastal state control of seabed resources should be absolute to a depth of 2500 meters or 200 miles from the shore, whichever is farther seaward. Others are suggesting that national jurisdiction beyond a depth of 200 meters should be severely limited and that the international community should have jurisdiction beyond this limit.

The official U. S. position is a complex one, since it is subject to change, there is no need to go into great detail. In essence, it suggests a three-stage regime. The first regime is that of the 1958 Continental Shelf Convention where the coastal state has complete control of seabed resources to a depth of 200 meters. For the central ocean basins there is an international seabed regime. Between these two is some form of intermediate zone with mixed local and international jurisdiction.

In my opinion, the primary U. S. interest is to insure that the oil of the ocean seabeds will be exploited efficiently and rationally and that the U. S. will have an opportunity to buy what it requires. The U. S. should be less concerned with who exploits the oil than with how it is exploited. As a major oil consumer, the U. S. must be assured of a politically and economically stable supply.

Our domestic oil industry is of the opinion that U. S. interests can best be served by extending national jurisdiction seaward. In spite of growing difficulties in dealing with Oil Producing and Exporting Countries (OPEC), U. S. oil industries apparently prefer doing business with "a known evil" versus facing the "unknown evil" of an international agency whose control and degree of politicalization is presently unknown.

Deep Sea Minerals

The hard mineral industry, on the other hand, realizes that the manganese nodules in which they are most interested are well beyond the limits of national jurisdiction. They recognize that they must deal with an international agency. At issue is how much power this international agency should have. The United States mining industry believes it should be limited. Perhaps it could be as simple as an international registry that processes claims and promulgates certain rules concerning procedures.

The other extreme is an international agency with monopolistic rights to resources and with the ability to exploit and to market them. The issue facing the LOS Conference is to find an area of agreement between these two extremes.

The U. S. hard mineral industry is concerned that progress is too slow. Introduced in the recent 92nd Congress was legislation to establish an interim regime to allow further development and exploitation to continue until some kind of international agreement is reached (Senate Bill S-2801). It has been suggested that other nations with similar interests in exploiting deep seabed resources should consider similar legislation.

Although I have been told that S-2801 was hurriedly drafted and will be subject to substantial change before and if brought to a vote, I think it is clear that the mere introduction and consideration of this legislation has had some effect on the rate of movement within the Seabeds Committee. Many nations are now beginning to realize that, if progress at the international level is not made quickly, unilateral actions may be forthcoming.

Fisheries

Of all exploitive resource problems, resolution of fisheries issues is most complicated. There are a variety of interest groups, nearly all of which are represented by different fishing interests within the United States. The present U. S. position attempts to accommodate all of them.

In my opinion, the U. S. position provides the elements for resolving the most important problem concerning fisheries, the development of a rational management scheme for a resource that must be considered limited. Nearly everyone is convinced that we can no longer afford the 1958 Fisheries Convention, which contains the implicit assumption that the living resources of the ocean are infinite.

The U. S. fishing position attempts to accomodate four different fishing interests:

A. Coastal fisheries such as those off the northeast and northwest shores of the United States.

B. The deepwater pelagic fisheries such as the tuna fishery, a resource that moves throughout the world's oceans and may be offshore one nation at one time and offshore another nation later.

C. The anadromous fish such as salmon whose well-being is dependent upon the coastal nation maintaining the spawning grounds.

D. The distant-water fishing fleets such as the well-publicized Russian and Japanese fleets that fish off the United States coast.

What is less well known is that the most valuable fishery in the United States, the U. S. shrimp fishery, is in part a distant-water fishing operation. Much of the U. S. catch is from waters off Brazil and Mexico.

The U. S. proposal gives to the coastal state all rights to anadromous fish such as salmon and primary control of all species that are truly "coastal." It suggests that distant-water fleets should have the right to harvest the unused capacity of the coastal species not caught by the coastal state and that provision be made for accommodating historic fishing rights. The proposal calls for international arrangements to be made for the truly pelagic fisheries, such as tuna.

The U. S. position is a complicated one when examined in detail, and this is perhaps its most obvious fault to many nations. My own opinion is that the U. S. position might prevail except for the provisions of historic fishing rights and except for rights of distant-water fleets to harvest those fish not presently of interest to the coastal state.

In my opinion the coastal state is going to gain control of all its coastal species. Thus the shrimp off Brazil and Mexico, as well as the haddock and flounder off the U. S., will belong to the coastal nation. The Russians will be required to negotiate with U. S. for fishing rights off our coast and our shrimp fishermen will have to negotiate with Brazil and Mexico and pay for the privilege of catching "their" shrimp.

Scientific Research

As international arrangements are made for the deep seabed and as national jurisdiction over the exploitive resources moves seaward, the constraints of freedom of scientific research are apt to increase. Those of us interested in freedom of scientific research are trying desperately to find an accommodation that will permit the maximum amount of freedom to do research under this trend of increasing national and international jurisdiction. It is not an easy task.

For example, if the coastal state should gain absolute jurisdiction over the exploitive resources off its coast to a depth of 2500 meters or 200 miles, whichever is further, the coastal state will probably attempt to exercise control over scientific research in this region. Depending upon how one treats these "resource zones" around islands and archipelagos, as much as 40 per cent of the ocean can come under control of coastal states.

Furthermore, it has been suggested that a strong international seabeds agency might exercise at least some control over research in the remaining 60 per cent of the ocean. The problem for marine scientists is to develop a mechanism that allows maximum freedom of scientific ocean research in light of these developments.

2. Effect on Sea Grant

If I am correct in my assumptions , the U. S. will soon have complete control over not only its coastal fisheries but also its salmon fishery, subject to whatever bilateral accomodations are worked out with Canada. Whether the U. S. can move swiftly and decisively toward effecting a rational management scheme for these fisheries remains to be seen.

Will it be possible to impose some form of limited entry? Can a management scheme be derived that will attract sufficient capital to make fishing a less labor-intensive operation? Can the U. S. delay much longer the establishment of federal fishing regulations as distinguished from state regulation? I do not know the answer to these questions, but I would suggest it as one of the more challenging problems facing Sea Grant during the next few years.

A second area of particular interest to Sea Grant is mutual assistance. Throughout the law of the sea discussions, many developing nations have indicated a need and desire for making better use of their marine resources. "Transfer of technology" is one of the items on the agenda of the law of the sea conference. The United States has taken note of this point and has indicated its willingness to help. Let me quote briefly from a statement made by Donald L. McKernan before Subcommittee III at the Seabeds preparatory meeting, August 11, 1972:

> In this connection [technical aid] the U. S. wishes to indicate its willingness in principle to commit funds to support multilateral efforts in all appropriate international agencies with a view toward creating and enlarging the ability of developing states to interpret and use scientific data for their economic benefit and other purposes; to

augment their expertise in the field of marine science research; and to have available scientific research equipment including the capability to maintain and use it.

Remarks in such forums by official U. S. spokesmen are not made lightly. Statements implying commitment of funds are cleared at a very high level within the administration.

I think it interesting to consider the McKernan statement in conjunction with the statement in the first National Advisory Committee on Oceans and Atmosphere report, "Thus a new candidate for international programs is the United States Sea Grant Program . . . we cannot properly compare the fledgling sea grant program of the Department of Commerce with the Land-Grant program activity developed over the past century, but the potential is there."

One of the more important Sea Grant challenges of the next decade will be the development of an international out-thrust to our present programs.

Ocean Technician Training in the United States

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The term "Ocean Technician" is of relatively recent vintage, emerging during the early 1960's and having its origin in the growing sophistication of the oceanographer's work at sea. Actually, there have been ocean technicians as long as there have been oceanographers and ships to carry them. Just as scientists who transported their skills to the wet arena suddenly discovered themselves to be oceanographers, persons performing in supporting roles became formalized by title.

To complete the record, the technicians' role never has become, nor will it, uniform throughout the world. Technicians maintain, calibrate and repair instruments; conduct shipboard observations and operations; and process data to the point of research. They conduct chemical analyses of sea water, identify organisms and assess ocean bottom samples.

Given the increasing sophistication of the ocean technician and his tasks, it is sometimes difficult to delineate his responsibilities vis a vis those of the research scientist. A major factor in this growth of sophistication is the improved educational system from which the ocean technician now emerges. Once he may have been anything from an auto mechanic to a milkman who received all of his training on the job from an understaffed scientific team in desperate search for cheap labor. Now, however, he is normally the product of a two-year college curriculum designed specifically to turn out a highly accomplished citizen of the sea.

When the national oceanographic program was given its first big boost by government, about 1960, there were no schools in the United States ready and able to offer this type of education. By mid-decade, only two -- Cape Fear Technical Institute and Southern Maine Vocational Technical Institute -- had established such curricula. Nearly 20 schools joined the effort over the next five years, enormously strengthening the manpower pool in ocean technology.

Perversely, however, growth of the nation's ocean program has now suddenly slowed down, opening up the possibility of a superfluity of these highly strained personnel. Since such an excess could be as harmful to the program as a dearth, it was clearly the responsibility of government, which had stimulated the buildup (primarily through the Sea Grant Program), to return stability to the system. First, of course, it was necessary to pulse the system to determine the present status and probable future trend of the supply/demand rates.

For this determination, Mr. Leonard Mitchell of the U.S. Department of Commerce was recruited by the Sea Grant Program office. He immediately was commissioned to study the technician training program in depth, with particular reference to current employment and trends for the future.

At this point in time, Mr. Mitchell's study is about one-third complete; his first findings and assessments are just that -- preliminary and tentative. He is currently completing his surveys, analyzing employment histories and compiling information on the present and future demand as part of the University of Delaware's Sea Grant Program. When his report is completed, it is expected that it will be put to excellent use even if it proves lethal with respect to some parts of the system.

Mitchell's study is addressed to many questions, emphasizing but not limited to the following:

1. How real is the demand for ocean technicians?

2. How are students recruited into the academic program? Is the recruitment process geared to the demand?

3. What is the curricular balance between education and vocational work?

4. What are typical employment histories for graduates of these schools?

5. What are the natures of the links between work and study facilities and use of equipment, faculty exchanges and cooperative funding (i.e., between government and industry) of the schools' programs?

The answers to these and other questions will provide valuable feedback for future planning.

Earlier today Nancy Richards of the Department of Commerce Budget Office enunciated certain principles of regionality; these have special application to this study. For instance, given two schools with similar curricula in the same region, it is necessary to determine whether the nature and size of the markets justify continuance of both of them. If not, their fates will be determined by relative (competitive) assessment.

Some Preliminary Findings

Although the study is not completed, some tentative findings can be reported.

1. Mitchell first points out that thus far the wealth of data has been extremely variable, both in nature and in quantity. Some responders to Mitchell's survey have been most meticulous; others have given him next to nothing. Unfortunately, for purposes of our analysis we cannot afford to give incomplete responders the benefit of the doubt because we must assume that the best data will be turned in by those with the best instructional and placement records.

2. Mitchell's second finding is that nearly all of the other federal agencies who had begun programs in support of technician training curricula have since discontinued them. We in Sea Grant worried about the effect of proliferation of such programs on the employment market. Among other agencies supporting this work were the Labor Department, the Office of Education and its subordinate Office of Vocational Rehabilitation, the Office of Economic Opportunity, the National Science Foundation and the Environmental Protection Agency.

3. Statistically, Mitchell reports that:

a. Sea Grant support for these curricula aggregated about $2.5 million during the period of fiscal years 1970-72; approximately an equal amount was contributed from other sources as matching funds.

b. Student enrollment in ocean technician training programs averages between 20 and 25 in any given academic year.

c. There are a large number of dropouts, but these are occasioned more often by lucrative employment offers than by inability or unwillingness to stick with the program. At the present time, between 20 per cent and 60 per cent of the students complete the courses.

4. Mitchell finds (very tentatively) that about two-thirds of the graduating students are finding employment. He introduces the concept of "phony jobs" relating to employment figures

reported by the schools that include, in actuality, jobs that could have been obtained by the student without their specialized training.

5. Program directors almost unanimously blame the decline of the national marine science program for their placement problems. (The National Sea Grant Office neither endorses nor refutes the concept of a declining national program; we merely report the directors' concensus.)

6. Mitchell detects a sort of more among the types of students customarily enrolled in these courses -- an unwillingness to move from their locale, regardless of the temptation of the job market elsewhere. If corroborated by his later findings, this could be an important factor in future planning.

7. The available evidence relates the success of these programs closely to the types of links that the program directors have forged with local industry. Some of the programs and schools have established industrial advisory committees that appear to serve ambivalently as curriculum counsels and as employment agents.

8. The most successful of the program directors conduct periodic market surveys, regulating admissions levels in accordance with their findings. This is, of course, a laudable approach, exemplifying sophistication of the program, its director and the college itself.

9. Some schools, e.g., Suffolk County Community College (one of the earliest to introduce this curriculum) are dropping these programs in anticipation of an unbalanced supply/demand situation. (Note: Several of the programs begun under Sea Grant auspices have also terminated; others are expected to follow in 1973.)

10. Mitchell reports very little consensus among the program directors with respect to the optimum:

a. Length of program.

b. Degree of specialization.

c. Curriculum format.

d. Value of retraining or updating programs (most, however, felt no need -- in particular they disliked the concept of re-teaching aerospace technicians).

In summary, a few points are offered for the attention of persons involved in the planning, supervision or actual conduct of ocean technician training programs.

First, it is highly profitable to establish and to preserve the closest possible links with the local and regional community. Such links can include, but not be limited to, extension courses; cooperative work/study programs; faculty exchanges and adjunct, visiting and guest lecturer arrangements; and cooperative funding.

Second, feedback is crucially important in program planning and in execution on the national as well as local levels. It is necessary to take great pains to maintain careful and accurate records. From our national office viewpoint, in absence of such data, we simply have to err on the conservative or pessimistic side in assessing progress and granting future support.

Again, it must be emphasized that Mitchell's survey and our analyses are in very preliminary stages; much work has yet to be done before we can draw and report reliable conclusions.

APPENDIX

Business Meeting

Dr. Robert A. Ragotzkie of the University of Wisconsin succeeded Dr. Herbert Frolander of Oregon State University as president of the Sea Grant Association for 1972-73. Selected as president-elect for the current year was Dr. William S. Gaither of the University of Delaware.

Elected to terms on the Association executive board were Dr. Jack R. Van Lopik of Louisiana State University, Dr. Peter Dehlinger of the University of Connecticut and Dr. Donald F. Squires of the State University of New York. Preceding the Association annual meeting, Dr. John A. Knauss of the University of Rhode Island was reappointed secretary of the Association.

Members approved unanimously three technical amendments to the articles of association to conform to Internal Revenue Service requirements for tax exemption. Other resolutions adopted included:

1. A resolution calling for future nominating committees to be more representative of the total Sea Grant program geographically and independent of the executive committee of the Association.

2. A resolution encouraging the Association to explore the possibilities of making use of the experience of the Land Grant College Association in establishing effective mechanisms for government-wide liaison at an early date.

3. A resolution to invite the National Sea Grant Panel to meet with the Association and the Council of Sea Grant Directors at the time of the annual conference in the fall of 1973.

4. A resolution instructing the president of the Association to pursue the subject of cooperation with the Council of Sea Grant Directors and urge the latter group to hold its semi-

annual meeting in conjunction with the annual meeting of the Association.

5. Resolutions of thanks to Dr. Herbert Frolander for his service as president during the 1971-72 term and to Texas A&M University for its efforts in planning and coordinating the Houston conference.

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