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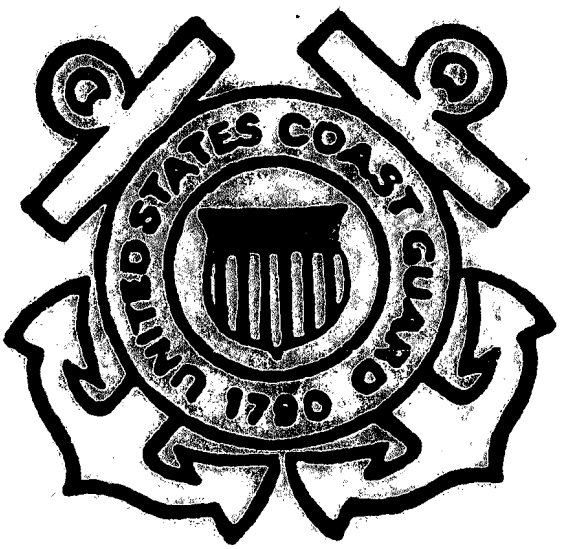
FUTURISTIC LOOK AT THE U.S. COAST GUARD IN THE YEAR 2020



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"FUTURISTIC LOOK AT THE U. S. COAST GUARD IN THE YEAR 2020"

compiled and edited by

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PREFACE

The objective of this report is to determine where research and development emphasis should be placed today to ensure that the Coast Guard can accomplish its missions effectively and economically in the future. The year 2020 was selected merely because the number denotes keen vision.

Material for this report was solicited from several project and staff personnel of the Coast Guard Headquarters, Office of Research and Development, the Research and Development Center, Groton, Connecticut, and the Coast Guard Detail at the DOT Transportation Systems Center, Cambridge, Massachusetts. The information received was compiled and edited by the Technical Director and the Technical Assessment Staff of the Office of Research and Development, and the illustrations were provided by the Research and Development Center.*

The observations, opinions and recommendations discussed in this report do not represent the official position of the Coast Guard. The information and views are presented to stimulate the readers in coming forth with other ideas on how best to enhance future operations of the Coast Guard in the year 2020.

(*The support provided by Captain Ron Polant, Lieutenant Commander Richard Davison, Lieutenant Commander Robin Wendt, and Heywood O. Shirer of the Technical Assessment Staff and Joseph Duddie at R&DC and Sam Powell, Director of R&DC, in the preparation of this report is particularly appreciated.)

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The Coast Guard has had to change its missions and objectives to meet the needs of the country throughout its history and we can anticipate that further change will be needed as we proceed into the future. This report attempts to predict what changes will be needed with the objective of determining where our research and development efforts should be directed. We begin by examining those aspects of the institutional and economic environments of 2020 that will affect Coast Guard activities. Using the results of this analysis we then outline future Coast Guard roles and missions. The options that will be available to the Coast Guard to accomplish its missions are analyzed next, followed by conclusions and recommendations for Coast Guard research and development activities.

The major conclusion of this paper is that by the year 2020, the technologies of sensors, information resources management, advanced marine vehicles, and aircraft will offer the greatest opportunities for the Coast Guard to increase its operational mission effectiveness as shown in figure 1. Effective application of these technologies will be consistent with the economic and institutional changes which we foresee.

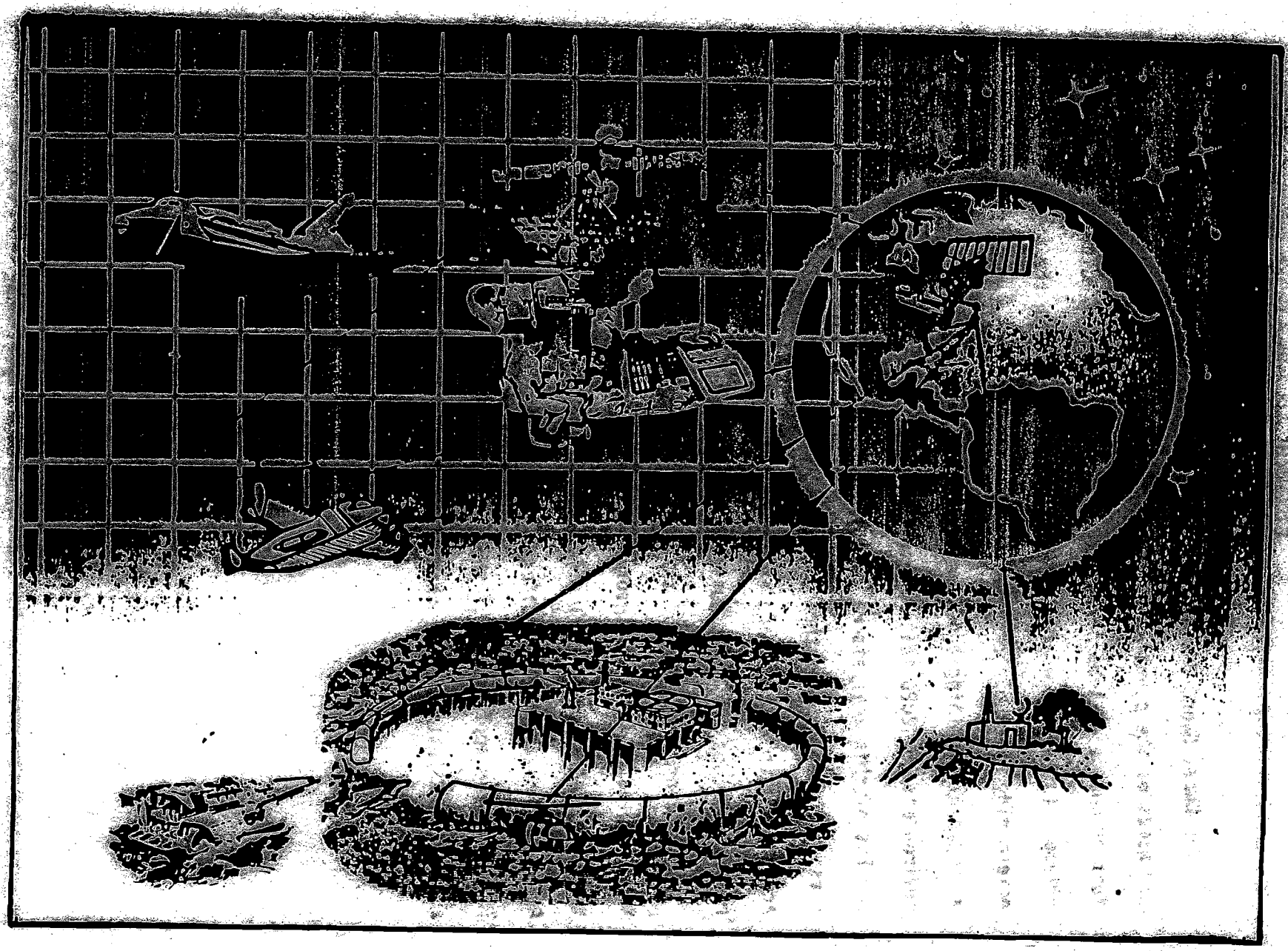

Figure 1 - 2020 Coast Guard Operations - Advanced Technologies

II. INTRODUCTION

". . . The Coast Guard's future will be influenced by specific national needs as they develop. The effectiveness with which we respond to these national needs will be determined in large part by our accuracy in anticipating the needs and our ability to satisfy them."*

We must accurately anticipate what the future holds for us to ensure that we can continue to accomplish our missions effectively and economically. With this counsel, we set out to predict what the future will be like in the year 2020 and from our findings, derive recommendations for future Coast Guard research and development efforts.

*Extracted from Commandant Instruction 16014.1B dated 2 February 1984, Commandant's Long Range View.

III. ECONOMIC AND INSTITUTIONAL CONDITIONS AFFECTING COAST GUARD ACTIVITIES

A. INTRODUCTION

We begin by postulating about the economic and institutional environments that will exist in the year 2020, limiting our discussion to those facets that will affect Coast Guard activities.

B. ECONOMIC CONDITIONS

1. Industrial Activity

a. Shipbuilding

The shipbuilding industry will construct U.S. Naval ships, foreign export vessels, domestic ships and various structures for fossil fuel mining and other mineral mining at sea.

It is expected that there will be a significant building of small ships for domestic trade. This activity will be the result of an increased demand for waterborne transport of energy and other raw materials domestically, and also the result of a heavy demand on the waterborne mode for transportation of hazardous cargo. Construction of deepwater mining structures, including floating platforms and submersible structures, will likewise be a significant factor in the well-being of the industry.

The success of the industry in contracting for foreign export ship construction will depend to a large part on the actions that the U.S. government will have taken in this industry by 2020. It appears that government cooperation will be needed in order for U.S. shipbuilding to resurge and maintain a leading position in shipbuilding technology. A new U.S. maritime policy will have to be formulated including a long term commitment to the existence of a merchant marine, with the federal

government accepting the idea of long term financial support for the industry.

Without government support the shipbuilding industry may continue to be depressed with persistent problems of high costs, labor disputes and tough competition from state-supported carriers. By the year 2020 the federal government may be forced to play an enlarged role in the management of the country's transportation system, including foreign export ship construction. If this occurs and if federal actions are sound, the industry will prosper.

We also see the federal government making commitments to further increase the size of the Navy. By 2020, this action along with the other activities noted above, could result in U.S. shipyards finding themselves deluged with orders.

b. Exports/Imports

Waterborne trade will remain; only trading partners, the commodities traded, and vessels employed will have changed. By the year 2020, the world will be more economically interdependent than at present, with manufacturing migrating to the most efficient locations, and with trade increasing. It is expected that a large portion of foreign trade will be in energy and other raw materials. Increases in volumes of hazardous cargoes are projected. For economic reasons, these cargoes will be transported by large vessels. International trade organizations with world wide assets will be regulated by international agreements.

c. Outer Continental Shelf (OCS) Vehicle Construction/Placement

OCS vehicles will vary in form from large barges, to floating and fixed structures, to submersibles. They will be designed and constructed for use in the deeper waters of the U.S. outer continental shelf and in some cases in deep ocean waters. Their numbers will increase as more

natural resources under the sea are sought.

2. Coastal Confluence Zone

a. Traffic Density

The volume of U.S. foreign trade (the number of ships calling at U.S. ports) will vary widely depending on the general world conditions that could prevail in the year 2020. Given that there is no general economic disorder or political instability that would inhibit waterborne commerce between the countries of the world, it is expected that foreign trade will slowly increase over the decades with a large portion of the trade involved with energy and other raw materials. Ships in foreign trade will generally have increased in size.

It is expected that domestic trade will increase by the year 2020. Waterborne transport of oil and hazardous cargoes will constitute a large portion of the cargoes. Generally, domestic trade will collectively favor smaller ships.

b. OCS Economic Activity

(1) Fishing/Aquaculture

The world will continue to regard fishery resources as an important source of food. Increased demand by countries of the world will require continuing clarification of territorial boundaries and strict enforcement. The U.S. fishing industry will remain small and independent but intact under the shelter of the federal government. Other state-supported fisheries will continue to ply the oceans with equipment more modern than their predecessors. Conservation will be a serious concern to all countries.

(2) Fossil Fuel Mining

Development of onshore oil and gas fields will continue, and there will be a continual increase in the exploitation of the oceans for

new hydrocarbon reserves. Efforts will be increasingly directed toward the deeper ocean zones of the continental slope and even the continental rise. Activity will continue in fields that have existed for decades in addition to discovered but unexploited deposits. Some new areas will be discovered.

The broad array of esoteric energy sources that might replace current fuels, those that were predicted after the first series of energy crises, did not forsee the practical engineering difficulties involved in creating technology required to switch over to new fuels, nor the economic consequences to the nations of the world. Consequently, oil and gas will remain the dominant fuels until the year 2000 with solar energy accounting only for about 20% of the total U.S. energy supply. There will be a slow, steady decline in conventional production after 2000, which will be offset by synthetic oil derived from oil, shale, and coal.

Similar to oil, synthetic gas from coal and increased imports mostly in the form of liquefied natural gas (LNG) will take up the slack in domestic output. The huge investments in development of alternate energy sources including solar energy and fusion energy will begin to bear fruit. Ocean Thermal Energy Conversion (OTEC) systems will be in operation in many coastal areas.

(3) Seabed Mining

There will be a keen interest in discovering and extracting new mineral resources on the Outer Continental Shelf (OCS) as well as in the deep sea. This is due to a gradual depletion of land reserves coupled with increased demands by the U.S. as well as other major countries of the world.

Coastal mining, which has occurred mainly in nearshore areas, will be moving farther from shore into deeper waters, spurred by demand and economic incentives. This trend to seaward mining will result in a decline in the use of floating pipelines and an increase in the use of

barges and tugs. Self-propelled, high-holding capacity dredges, capable of onboard mining and storage will become more common, though this trend may be partially offset by the continued use of submersible dredges and barge-mounted dredges.

The political issues surrounding coastal mining will be similar to those influencing onshore oil and gas development in the sense that offshore impacts, environmental concerns, commercial interests, and jurisdictional disputes will have to be considered. International politics will not be a significant factor though occasional violations by deep-sea mining concerns will occur. (International politics have not been a significant factor since the 1958 convention of the continental shelf which awarded coastal states the exclusive rights to natural resources from the coastline seaward to the base of the continental slope where technical feasibility permits.)

(4) Illegal Activities

Illegal activities will continue in many forms. Illegal entry of aliens will continue to compete with illegal drug smuggling as the leading activity and will be a priority for suppression.

Varying degrees of terrorism and sabotage involving U.S. ships will occur as U.S. policy (foreign policy and some controversial aspects of domestic policy, such as environmental practices) is perceived to be inimical to the goals or interests of certain groups. There will not be long-term trends.

The economic value of the ocean's resources will continue to increase and as a result, the Fisheries Conservation Zone (FCZ) and

economic zones of the U.S. will be violated.

3. Harbors and Rivers

a. Marine Traffic Density

In general, most ports will become somewhat congested due to increased waterborne transport of various kinds and a lagging port development from a lack of funds and other resistance.

Domestic waterborne transport of hazardous cargoes, and energy and other raw materials will increase, placing an added burden on most U.S. ports; consequently, it will be necessary to increase international efforts to control collisions and spills in port areas. There will also be an increase in foreign trade but this traffic will concentrate in a small number of major ports. There will be some development and building of deepwater ports to accommodate the larger foreign ships that will be constrained by channel depths in U.S. ports, however, this will lag behind demand because of cost pressures and other resistance.

Competition for water use will create increasing problems between commercial and recreational users.

b. Port and Harbor Facility Growth

Development of port and harbor facilities to accommodate gradually increasing domestic and foreign shipping will be inhibited by lack of funds and resistance by port authorities who speak for the general populace. Shortages will be offset somewhat by the continued development of some long established major ports and by deep water ports. Traffic management techniques and technological advances applied to aids to navigation will also help minimize the demand for changes.

c. Environmental Issues

Longer term environmental processes will require some significant strategies of land/water interface management and possible

redeployment of Coast Guard facilities (greenhouse effect may raise sea levels, erosion of Atlantic coasts is becoming less preventable as is the natural reshaping of the Mississippi Delta). Mean Sea Level is already rising at nearly 22 cm per century and is expected to increase.

4. Oceanic Zone

a. Ocean Law

There will not be full agreement with respect to international rights on and beneath the oceans. International conflict over ocean resources will occur though it will not reach crisis proportions. Bilateral agreements regarding deep ocean resources may become a trend in the future. In some areas of the world, ambiguities with respect to military versus law enforcement action will occur.

A clear definition of territorial limits will be needed to allow unhampered commencement of mining operations, because some private concerns will fear sudden overnight extensions of territorial limits by some coastal countries, rendering their investment useless.

Legal uncertainities with regard to ownership of the seabed resources will slow the pace of developmental activities of some of the mining firms as well as detering the introduction of new firms into the ocean-mining field. Stronger legislation will have to be enacted to protect mining companies' investments.

Fishing violations will be a problem, though by 2020 most peoples of the world will understand the worth of conservation of natural resources and will abide by the fisheries laws.

b. Ocean Policy and Management

Like ocean law, ocean management policy will not be established. Unlike the fisheries, there will be no general concern over the eventual depletion of the mineral resources. This is in part due to the

belief that available supplies from deep below the ocean will last the world for centuries. Nodule concentration in the Pacific is forming at an estimated rate of 10 million tons per year.

A form of management policy will be needed however as it impacts on the world economy and due to infractions of parties of one country on parties of another. Developing countries will voice concern about deepsea mining activities; these countries will be extremely concerned about a harmful decline in mineral prices if seabed mining continues without any international regulation. Policies will be needed to divert hostilities between countries resulting from competition in deep-sea mining.

Poor ocean policy and management will plague the world for many years to come. At present, the U.S. has no comprehensive ocean policy.

c. Traffic Density

Traffic density on the oceans will increase with increased interest in the ocean's resources. Except for coastal areas, this will not create a problem for safe navigation of the open water.

d. Fishing

U. S. deep sea fishing has never been a large effort as most all the ocean's fish populations tend toward the outer continental shelves of the world's continents. Expansion is not envisioned. Generally, conservation practices will be observed for whales, dolphins, tuna and other fishes which transit the open ocean.

e. Deep Sea Mining

The vast mineral resources of the deep oceans will remain virtually untapped until the end of this century. There will be great interest with regard to the minerals that can be extracted from manganese nodules lying on the ocean floor and metal-rich sulfide deposits that flank hydrothermal vents, but they will not be economical to mine. However, with

the belief that land-based U.S. domestic reserves of the minerals that can be extracted from the sea are soon to be exhausted, and partly due to the dependence on imports that results in a growing trade deficit, a large amount of activity will develop by 2020.

Ocean law and management policies, as noted above, will continue to inhibit quick expansion.

f. Illegal Activities

Illegal activities with regard to mining the oceans will be a problem as mining activities increase. Pirating of ore will occur and will be of concern to several countries involved.

C. INSTITUTIONAL CONDITIONS

1. Federal Government

A. Budget

It is anticipatated that the federal budget will realize a growth of 4% from the FY1984 to 2020 putting it at about $3500B, up from about $850B in FY1984. This represents little real growth. The Coast Guard share of the federal budget will remain constant, so that by FY2020, it will be about 10.3B

B. POLICIES AND ROLE OF THE FEDERAL GOVERNMENT

The Federal Government will continue to view its role in supporting areas of the three major sections of which this nation rests its foundation: (a) business, (b) government, and (c) society.

Business

The Federal Government will actively pursue its determined role in the regulation and control of business. Anti-trust laws will be closely monitored. Anti-trust laws and their interpretation will be a major concern of the courts because business will be be heavily relied upon for their

ethical and moral obligations to society. Major policies will be carefully reviewed to encourage the lead role of business in stabilizing the economy.

Government

National security will continue to remain a top priority.

Society

The responsibilities of government to society as defined in the Constitution will be adhered to. Social issues of constitutional importance will be investigated. Issues of public interest will be closely weighed on Marginal Cost vs. Marginal Social Cost ratio.

The above mentioned scenerios of human resources are very important to the Coast Guard. The Coast Guard must view its organization very much in the same sense as major public agencies. The policies and procedures regarding budgets will force the Coast Guard to make management decisions, with greater cost payoff than other branches of the military services.

The Coast Guard will not be able to meet all its personnel needs through monetary competition. The Coast Guard must make use of the most sophisticated technology and at the same time, pursue a plan of man and computer interface, which requires the least amount of technical expertise. By pursuing the plan of better man/machine dialogue, training and replacement of personnel can be accomplished at a minimal cost.

Productivity, job performance, employee morale, and quality of service performed, must approach an all time high.

2. Regulatory Consideration

The costs of domestic regulation have become apparent, and growth has strongly declined. Environmental regulations will remain pretty much the same. Maritime regulations (Commercial vessel safety and Hazardous Materials Transportation) will be rewritten to conform to world-wide standards, and will be much simpler to enforce. Recreational Boating Safety

regulations will probably remain mainly a federal responsibility as States, due to budget difficulties, will continue to balk at the notion that they should take over the RBS program.

3. International Law/Foreign Relations

It would be meaningless to predict who we will have favorable foreign relations with in the year 2020. Unrest in the Mid-East and in European countries over NATO arms agreements may well change current relationships. We do predict, however, that by 2020 the world will begin to come to grips with the value of the oceans and how nations will share them. Discussions will be opened to develop a new "Law of the Sea" (LOS) treaty.

Commercial vessel safety regulations, contained in 46 Code of Federal Regulations (CFR), are the U.S. implementation of Intergovernmental Maritime Organization (IMO) actions. The treaties or standards are not enforceable as written due to their vague wording. The Hazardous Material Transport part of 46 CFR is being revised to Intergovernmental Maritime Dangerous Goods (IMDG), but then IMDG is already optional for foreign shipments, net results: regulations will never be simpler than now. By the year 2020, we may hope for more uniform world-wide standards and regulations which will be enforceable by all countries.

4. Political Concerns

Political climate rides a sine curve, and we cannot predict where we'll be in the year 2020. States continuously reject attempts to have them take over certain federal programs. Federal agency roles and missions will be periodically examined to substantiate need, but organizational momentum and popularity of missions will keep them viable despite lack of a constituent base.

5. Resources and Environmental Factors

Scarcity of resources will become somewhat problematical with advancing technologies. Environmental policies established in 1970/80 time period will probably work well in the year 2020. Little growth is seen in this area. It is hoped that the acid rain problem between the U.S. and Canada will be resolved in the near future. We forecast that the U.S. will have satellite systems that can collect and focus solar energy to the earth creating a cheap source of energy.

6. Multi-use Marine Areas

Oil/gas developers, maritime traffic, fisherman, deep-sea miners, and to a small degree, recreational boating will be the principal users of the marine areas. Multi-use areas will exist in much deeper waters.

7. Law Enforcement Concerns

Federal efforts will continue in drug interdiction despite its many limitations and marginal impact on the drug market. The federal government will likewise have to deal with illegal entry of aliens.

8. Services to Public

Public concern over government service versus commercial service will continue.

9. User Fees

Attempts to develop user fees in the Coast Guard will be so fraught with inequities that they will largely be dropped.

10. Defense Considerations

The Federal and State governments will continue to be concerned with port security and will become involved in sophisticated port threat countermeasure systems. The Navy and Army will be needed to establish surveillance and identification requirements.

11. Energy Constraints

Costs of energy will have risen sharply, but energy will still be readily available. Land based solar power systems for the southwest will become a reality. Ocean Thermal Energy Conversion (OTEC) systems will be in operation in many coastal areas. Space systems reflecting and focusing sunlight to parts of the U.S. will be in early developmental stages. Offshore oil/gas developments will be very successful. Imported energy resources will still be available. Nuclear power will become safer and public policy will increase to emphasize it as a viable power source.

12. Economic Growth

U.S. and world economy will grow over the 36 year period to the year 2020.

13. Barriers to New Technology

None are foreseen. Funding may be a problem in certain situations.

14. Labor

Tremendous reorientation of skills of people will have taken place. Redundant tasks will be taken on by robots/automation, but industry, as yet, will not have found any viable substitute for the human being. The thought processes and multi-sensing systems of the human are just too complex to duplicate. Proliferation of robotics/automation in government processes may be slow in materializing. Management/policy science are being increasingly applied to personnel management in both the public and private sectors.

15. Space

Space efforts will concentrate on remote sensing. Tremendous advances will be made in Synthetic Aperture Radar (SAR) and InfraRed (IR) sensing. SAR gives ability to detect surface conditions of oceans, even ice

thickness and age. IR sensors are able to detect a wide variety of targets any time, day or night. More funding will be directed away from In Situ oceanography and towards remote sensing.

IV. COAST GUARD MISSIONS AND REQUIREMENTS IN THE YEAR 2020

A. INTRODUCTION

The economic and institutional conditions of the United States and the world in the year 2020 as discussed in the previous chapter provides some insight to help us predict the roles and missions of the Coast Guard in the future. Generally, we assume that we will remain the lead agency of the federal government in maritime affairs and will retain an inventory of land, sea and air platforms to accomplish the multitude of maritime tasks that we will have. This has been our history for nearly 200 years.

The following roles and missions are based on the above considerations. The reader will note that we are less positive about the role of the Coast Guard in some of the roles and missions listed including Marine Surveillance and Recreational Boating Safety. Our role in these areas could greatly increase or decrease depending on a variety of factors.

B. ROLES AND MISSIONS

1. Navigation Services

The Coast Guard will continue to provide and manage navigation services as required in the open ocean environment, coastal confluence zones, harbor/harbor entrances and interior navigable waters of the United States. This may include the operation of a satellite-based, radio-navigation system and a land-based system of visual and radar beacons, and high accuracy local radio navigation systems.

2. Vessel Transportation Management

The Coast Guard will: (1) inspect U.S. and foreign flag merchant vessels to ensure compliance with established standards, (2) review U.S. vessel plans and equipment for safety; (3) establish and enforce standards for U.S. merchant marine personnel; (4) supervize regulations and administration of federal anchorages, safety and security zones, and regulated navigation areas; (5) supervize development of plans for implementating, managing and enforcing rules for prevention of collisions, rammings and, groundings; and (6) participate in international organizations on vessel traffic routing schemes. Areas of application will be expanded to include the OCS.

3. Maritime Cargo Transportation Management

The Coast Guard will enforce various laws and regulations on both U.S. and foreign flag vessels transporting hazardous cargoes in or on U.S. waters, or in or on waters over which the U.S. exercises any control, to prevent loss to life, limb or property.

4. Marine Surveillance

In this area, many agencies have a vital interest, e.g. USN, EPA, DEA, Customs. A unified federal approach may be mandated. This could greatly increase the Coast Guard's role in maritime surveillance if we are picked as lead agency, or it could relieve us of most of our surveillance responsibility if another agency is chosen as the lead. In any case, we foresee the Coast Guard using land, sea, sub-sea, air and space sensors to meet operational mission requirements related to detection, identification, and observation of a wide range of ships, aircraft, people, surface conditions, and other targets of interest throughout the world.

5. Emergency Assistance

The Coast Guard will provide emergency assistance to distressed vessels, aircraft, and people on, over and under the high seas and waters under the jurisdiction of the U.S., including flood disaster relief. Search and rescue will remain a primary mission of the Coast Guard despite repeated pressure that will occur to yield to commercial endeavours in non-emergency cases. The emergency/non-emergency determination will prove to be unmanageable.

6. Marine Environment Maintenance

The Coast Guard will supervise efforts to protect the environment of the U.S. in all areas in which it has jurisdiction by maintaining the capability to respond to pollutants and effecting their removal.

7. Marine Applied Research

Through applications of the best technology available, the Coast Guard will solve its current and near-term problems while shaping a longer range policy, based on technological forecasts, of how it will meet tomorrow's problems with tomorrow's technology.

8. Military Readiness

The Coast Guard will administer a program designed to assure operational efficiency and military readiness, embracing all phases of preparedness for contingency operations, operations as a part of the Navy in time of national emergency, and peacetime operations. Emphasis will remain on the Coast Guard's role for port security, including anti-terrorist, mining, and anti-mining capabilities. New emphasis will be placed on the Coast Guard protecting U.S. interests on the OCS as industry extracts more mineral resources there. Closer planning with the Navy will be essential for the Coast Guard to attain a good military readiness posture.

9. Enforcement of General Laws and Treaties

The Coast Guard will enforce all federal maritime laws of the U.S. outside the regulatory programs already addressed, and enforce all provisions of international treaties to which the U.S. is signatory on and under the territorial seas, continguous zone, OCS, and special interest areas of the high seas. The Coast Guard will continue to be heavily involved with drug interdiction and the apprehension of illegal aliens.

10. Ice Operations

The Coast Guard will continue present responsibilities for icebreaking operations, and ice reporting.

11. Recreational Boating Safety (RBS)

It could be that the states will eventually take over the RBS program as was originally intended. This could decrease the program. It could also be that the states' refusals and public pressure to develop a standardized licensing system for boat operators will become so great that the Coast Guard must increase emphasis in this mission area. In any case the Coast Guard will continue to prevent recreational boat casualties by enforcing Federal laws and regulations dealing with the operation and construction of recreational boats; supervize the Coast Guard Auxiliary; establish safety standards; administer public education and training programs; and maintain liaision with state authorities.

12. Bridge Administration

The division of responsibility between the Army Corps of Engineers (COE) and the Coast Guard is illogical in this area. It may be that since the Coast Guard's primary concern in bridge construction is obstruction to maritime navigation, the entire "permitting process" would be transferred from the COE to the Coast Guard, greatly increasing program responsibility.

If this should occur, we foresee that the Coast Guard will ensure, through public permit processes, that bridges constructed on or over the navigable waters of the U.S. do not pose an unreasonable obstruction to navigation.

13. Port Safety

Consistent with U.S. legislated mandates, the Coast Guard will ensure a high level of safety for people and property in and adjacent to port areas of the United States by directing vessel movements and waterfront facility operations. More liaison with the Navy and Army will occur to establish surveillance and identification requirements.

14. Offshore Operations

The Federal government will call on the Coast Guard more and more to police areas with high multi-use competition. The Coast Guard may provide protection for U.S. firms involved in deep ocean mining.

V. COAST GUARD OPTIONS

A. INTRODUCTION

The last chapter predicted what our roles and missions will be in the year 2020 and we based those predictions on assumptions about those environmental and institutional forces that directly affect what the Coast Guard does. We now turn to a forecast of the resources that will be available to us to do our job.

B. FUNDING

1. Federal Budget

The Coast Guard appropriations will continue to be the primary source of support for its operations. We anticipate the total FY2020 Coast Guard budget to be about $10.3 billion. This is based on a 4% growth from FY1984. We should keep in mind that a day of reckoning with federal deficits may force the total federal budget to retract or at least halt its growth rate.

2. Cost Sharing

We don't forecast a great deal of federal - state cost sharing programs. The fiscal profiles of the states vary greatly and this creates a problem in uniformly administering cooperative programs. Cost sharing with other government agencies will always be encouraged whenever a commanality of interest exists. Efforts to streamline the federal government and dispense with duplicative agencies may actually reduce such opportunities within the federal government (The cost of activities such as boating safety and minor aid maintenance may be transferred to state responsibility, at least to some degree.)

3. User Charges

The Coast Guard has found it extremely difficult to separate legitimate government roles from traditional roles which appear to benefit only a few people. Most of the services the Coast Guard provides are classic examples of how it is impossible to assess the benefactors and the degree to which they benefit. The Aids to Navigation system is a prime example. The Coast Guard's position over the years has become one where most of their services benefit the U.S. society as a whole and charging any specific group for those services may seem unfair.

C. LABOR OPTIONS

1. Human

By the year 2020, people will in general, be highly oriented toward family and home location. Individuals will carefully plan their lives according to their goals, including careers and family. They will not want to be caught as their parents and their grandparents were, unprepared for the future.

People will display varying degrees of mobility over a career. Younger people and those approaching (full) retirement will be positively attracted to travel and relocation. Those who are most concerned with children's high school education, care of aging parents or chronically ill dependents, and critical stages of spouse careers, may be highly immobile. Personnel policies in general will give added weight to such stages and circumstances for individual employees.

Associated with planning will be the desire for education. Thus, the education level will gradually increase over the future years, including graduate level experience for a larger and larger portion of the population. People will generally be more literate than today in

mathematics, computers and science.

Individuals will want interesting and challenging work. This work value will complement the gradual disappearance of menial, repetitive jobs which may be done by robots. Training opportunities can continue to be a major motivation for entering, and remaining in, Coast Guard service.

By the year 2020, it is expected that careers in government service will receive more favorable recognition. This change in attitude will occur as a result of the lack of employment alternatives resulting from automation. It will be further encouraged as people begin to become increasingly aware of their need to actively participate in government activities to assure self-government for themselves.

Coast Guard work will likewise be looked upon as desirable, however the Coast Guard's needs in manpower will not be generally satisfied as competition for qualified people will be high.

*"The total number of persons in the 18-24 year age group, which is the major source of new entrants into the Coast Guard, peaked in 1980 after more than two decades of growth and will decline from 29.5 million in 1980 to an estimated 23.2 million in 1995. The increasing participation of women in the work force will mitigate the impact of this decline to some extent. The net result will be that during the present decade the number of persons 18-24 years of age actively participating in the work force will decline from 21.6 million to an estimated 19.1 million, with a further decrease anticipated in the 1991-1995 period. Innovative approaches to personnel

*Source - Commandant Instruction 16014.1B dated 2 FEB 1984, "Commandant's Long Range View."

resource management and recruiting will be necessary to minimize the number of people required from this age group through increased retention, productivity improvements and expanded use of technology to reduce and simplify workloads.

The proportion of minority personnel in the Service will increase, reflecting both their higher birthrate and the employment opportunities offered by the Coast Guard. Similarly, the proportion of female personnel will increase, reflecting their greater participation in the work force and the Coast Guard's demonstrated ability to put their talents to good use in all modes of service with few, if any, restrictions."

Coast Guard Policy Guidance:

- Will continue to offer the widest practicable range of opportunities for minorities and females that will enhance their promotion and retention rates.
- Continue our active commitment to equal opportunity for all members of our Coast Guard family with respect to race, color, national origin, sex, and religion, we will emphasize our efforts to help our civilian personnel overcome physical and mental handicaps.
- Maintain full understanding and commitment to the Coast Guard's Human Relations Policy and Concerns. This will be a requisite for advancement and retention of all supervisory personnel.
- Will continue to foster the development of strong leadership in our personnel, and accept nothing less than superior leadership from our officers, petty officers, and civilian supervisors."

The above projections will be similar for the year 2020 time frame.

The Coast Guard of 2020 will be forced to compete with other branches of the military services and businesses for resources. Its

missions, training, travel opportunities, espirit de corps, and the lure of the sea will be positive attractions.

The Coast Guard must plan to assure a high quality of working life to its personnel and to promote fully, adequate total compensation. It must increase its use of management/policy science in personnel administration. This will involve more selective use of recruiting/retention inducements, better monitoring and management unit of skill needs and workforce skill inventories, and the building and use of workforce planning/management computer models for "what if" analysis of policy options.

Continued monitoring of the Defense forces and civilian industry can keep the Coast Guard aware of research and innovations suitable for adaptation to Coast Guard use.

The workforce of the year 2020 may be divided into three major workgroups:

Group A represents 25% of society which will be very skilled in areas of high technonlogy. A suggested approach would be to use a less complex man/machine dialogue, utilizing the available human resources. Persons skilled in high technology will for the most part be unavailable to the Coast Guard because private industry will offer higher salaries. Group B represents 25% of the workforce who happen to be turned off by high technology. Group B represents that segment of society with interests in fine arts and other related areas. Sociologists view the position of Group B as very important in maintaining a balance within the total workforce. Group C represents 50% of the workforce having little or no skill in areas of high technology.

The Coast Guard should begin to make long range plans to utilize and train as many persons from group C as needed. The Coast Guard as well as

any government agency is primarily responsible for providing services for the public. Strategies must be developed to reach long range objectives.

Instantaneous decisions are the requirements of today's organization. The time span for the collection, organizing, classifying and interpretation of data has been dramatically decreased. Management constantly finds itself under pressure for data of very high reliability, integrity and accuracy.

Collection or banks of data stored in databases, connected through a series of networks, places an unlimited amount of data at our fingertips at a moments' notice.

The Coast Guard must begin to plan to use a simple man/machine dialogue with available human resources.

2. Robots

The advent of robots has and will continue to impact on human resources. There will be significant advances in robotics throughout the next 40 years; however, robotics with sophisticated forms of artificial intelligence will still be in its early stages by the year 2020. Robots are now largely restricted to highly structured industrial environments in which the position and path of motion of all objects are precisely known at all times. However, robotic research will continue to find new ways of dealing with less and less structured environments.

By the year 2020 robots will be used extensively for hazardous, repetitive and menial tasks in a wide variety of industries as well as government service. The majority of the robot population however will be found in the manufacturing environment. This is where the motivation for developing robots began and it will remain the prime mover for advancing the state of the art. Robots will produce tremendous increases in productivity and cost reductions. They will also have provided for a safer working

environment by completing hazardous tasks once assigned to humans.

Robots will perform the majority of industrial operations and the manufacturing labor forces will be reduced drastically. The age of electronic factories will have arrived.

Another popular area for robotic application will be for social "housekeeping". Robotic sweepers for large public spaces, such as streets, sports stadiums, railroad stations, and airports will become more and more common. Likewise, robotic lawnmowers with programmed awareness of boundaries of a grassy area will be in wide use. Robots will also be used extensively in firefighting, explosive ordinance disposal, ocean floor surveys, and repair of space vehicles. An outgrowth of robotic technology will have provided computer-controlled agricultural equipment for automatic plowing, cultivation and reaping.

Fall-out from robotics research will be evident in all Coast Guard activities, on land, in the air and at sea.

D. TECHNOLOGY

1. Platforms

a. Surface

(1) Conventional Design/Power

Stability and motion damping system will be widely used with monohull systems. Corrosion control and repair techniques will permit previously constructed vessels to have exceptionally long lives especially when combined with the expected progress in both wear and materials technologies. It is possible that existing vessels might be recycled and utilized for many decades. Alternatively, relatively short-lived vessel structures may be employed which would utilize relatively long life machinery.

Vessel payloads and efficiencies should improve greatly due to the use of enriched fossil and/or synthetic fuels and more efficient (i.e. high temperature) engines, thereby reducing the quantities of fuel to be carried, thus allowing smaller vessels to carry greater payloads.

Vessel operations should be safer in more extreme weather conditions due to the wide spread use of automatic piloting, steering, operating, and controlling systems.

(2) Advanced Design/Power

Diesel Wankel engines should be available which are capable of using various fuels and fuel mixes. Flywheel power storage systems may also be utilized to replace hydrocarbon fuels.

Chemical-based propulsion may be developed which eliminates or vastly reduces carbon dioxide output. Even large ships may be required to employ air pollution control techniques. This is based on estimates that worldwide shipping uses between 10 and 12% of liquid fossil fuel energy.

(3) Hybrid (Surface/Air)

Conventional vessels will be modified to employ stabilizers and foil systems for both lift and control purposes. In addition, new structural materials and fabricating techniques will permit the use of the same structures and lift systems for developing both aerodynamic lift and hydrodynamic lift. A hydrofoil-sea plane is a real possibility. Single hull, small waterplane ships are possible in the year 2020 time frame.

(4) Robotics

(a) Remotely-Controlled

Robotic technologies will have a significant impact on rescue and law enforcement equipment in the year 2020 time frame. Unmanned rescue craft will be prepositioned along the coastline awaiting activation and control from a distant control center. Extremely long range small

robotic craft may also be employed. The robotic systems in the year 2020 will be at least 10 to 12 generations old and thus should be fully integrated into the transport concept. It is anticipated that the Coast Guard will operate large numbers of remotely controlled craft by the year 2020.

(b) On-board Systems

Fall-out from robotics research will be evident in all activities, on land, in the air and at sea. On our operating platforms, robotic technology will be used to reproduce human sensory abilities. Robotic vision systems will have replaced the human eyes, computerized speech recognition systems will have replaced the ears, and robotic chemical sensors will have replaced the nose.

Robotic visual and ultrasonic range sensors will be used extensively for object location, however, robot image processing capabilities will have proved most useful for a variety of the detection and identification tasks in navigation and search operations. Computerized speech recognition systems will be a reality. Chemical sensor systems will be used for smoke detection and control, and for a variety of Coast Guard law enforcement duties.

Automated control systems capable of navigating marine vehicles, will be in place. The automatic navigator will be able to process data to determine a proper course of action. Depending on its programming, the system will be able to respond by automatically changing the vehicle course or speed or alert the controller on watch. Numerous other systems capable of monitoring the external and internal environment will be common, obviating the need for many watch tasks now performed by humans.

Robot technology will have made the operator's tasks immeasurably safer and efficient, but they will not be able to deal with

unforeseen contingencies. Thus, while the onboard compliment of personnel will have been reduced, unlike the industrial variety, navigator robots will not totally replace humans. Automation will have allowed human operators to concentrate on accomplishing mission tasks. The result will be an extraordinary increase in effectiveness and efficiency.

An interesting side benefit to onboard automation will be the much improved attitude of crewmen. With the number of menial tasks greatly reduced, natural sleeping and eating habits will be possible. Further, everyone in the crew will be able do devote his/her time to directly accomplish the mission. Figure 2 is an artist conception of the use of Robotics.

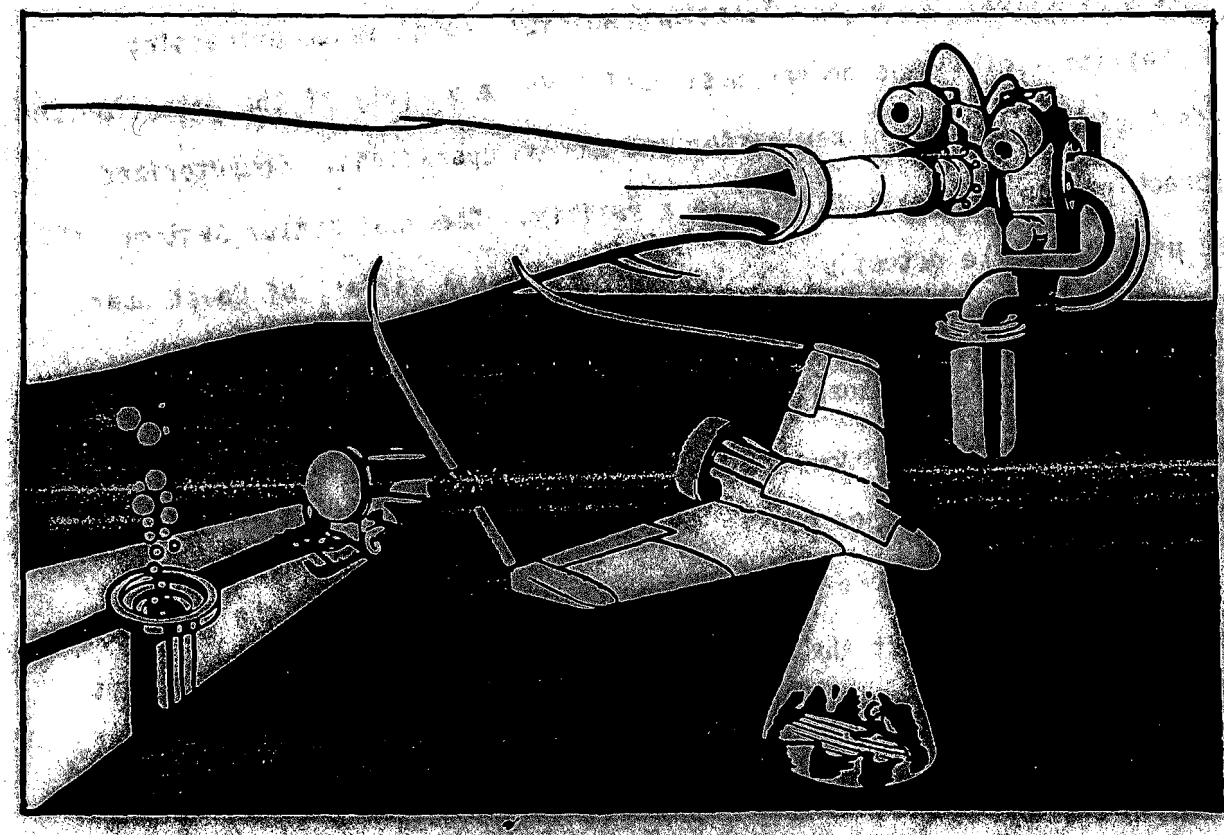

Figure 2 - Robotics

(5) Advanced Marine Vehicles (AMV)

Automated selection processes will help select and design advanced Coast Guard ships. The advantages of one craft over another will be analytically investigated to ensure that the most appropriate craft is matched to its set of assigned missions. Coast Guard missions will be described through elaborate computer resident scenarios. Consideration for mission environments will be integrated into the scenarios. Cost estimating programs will supply the denominator in all evaluations. Each new type of vessel procured will have undergone rigorous scrutiny before the first piece is assembled. The impetus for this process will be the realization that at some point new technologies offer too little in return for the investment required. In the 1960's it was within the Coast Guard budget to build the best patrol boats (WPBs) that money could buy. While the price of some technologies will decline, in the year 2020 the task will be to build the best ship that the expenditure can justify.

Advanced Marine Vehicles will be integrated into the Coast Guard fleet by the year 2020. These advanced vehicles will include Small Waterplane Area Twin Hull (SWATH), hydrofoils, surface effect ships and high speed planing craft. The emphasis will be on supplying the Coast Guard with the most cost effective capability possible. These vehicles will cost more per unit; however, the increase in benefit will outweigh their relative high cost. The increased effectiveness of wide-area surveillance will lessen the number of long deployments in favor of shorter intercept missions. This scenario will be applicable to all of the Coast Guard missions and will dictate more high-speed, all-weather, and shorter endurance craft. These features are characteristic of most of the AMVs. SWATHs and hydrofoils will dominate in areas of rougher sea states, while

Surface Effect Ships (SESs) and planing craft will offer the same capability in calmer sea states for a reduced cost.

The integration of AMVs into the Coast Guard fleet will be an evolutionary process. As a monohull cutter class is replaced, the assigned missions of these cutters will be distributed among several different resources. Conventional surveillance sorties performed by High Endurance Cutters (WHECs) and Medium Endurance Cutters (WMECs) will give way to airborne and spaceborne sensors. The intercept and boarding phase of the mission will remain with the surface platform. This concept will be equally applicable to all Coast Guard missions. The emphasis on boarding and intercept will drive the selection process toward AMVs in many locations. However, the relative low cost of small monohulls may dominate over the AMVs in geographic areas where the performance margin enjoyed by AMVs is small. The ultimate result will be a distribution of missions among several craft sizes and types by the year 2020. Figure 3 is an artist conception of the use of AMVs in a search and rescue operation.

(6) Coast Guard Fleet Scenario

Large SWATH surface platforms will be employed as mobile bases with an endurance of 6 months. These mobile bases will support small unmanned rescue craft and manned hybrid craft. The unmanned rescue craft will be remotely controlled from a Search and Rescue (SAR) command center on board the mobile platform. The hybrid craft will incorporate the features of the SWATH, hydrofoil, SES and planing hulls. This will result in a craft with high speed and good seakeeping that can efficiently perform expanded Law Enforcement (LE) and Military Readiness (MR) missions at low cost. Large SWATH buoy tenders will perform offshore Aids to Navigation (ATON) and maintain both surface and subsurface sensors. Small fast Air Cushion

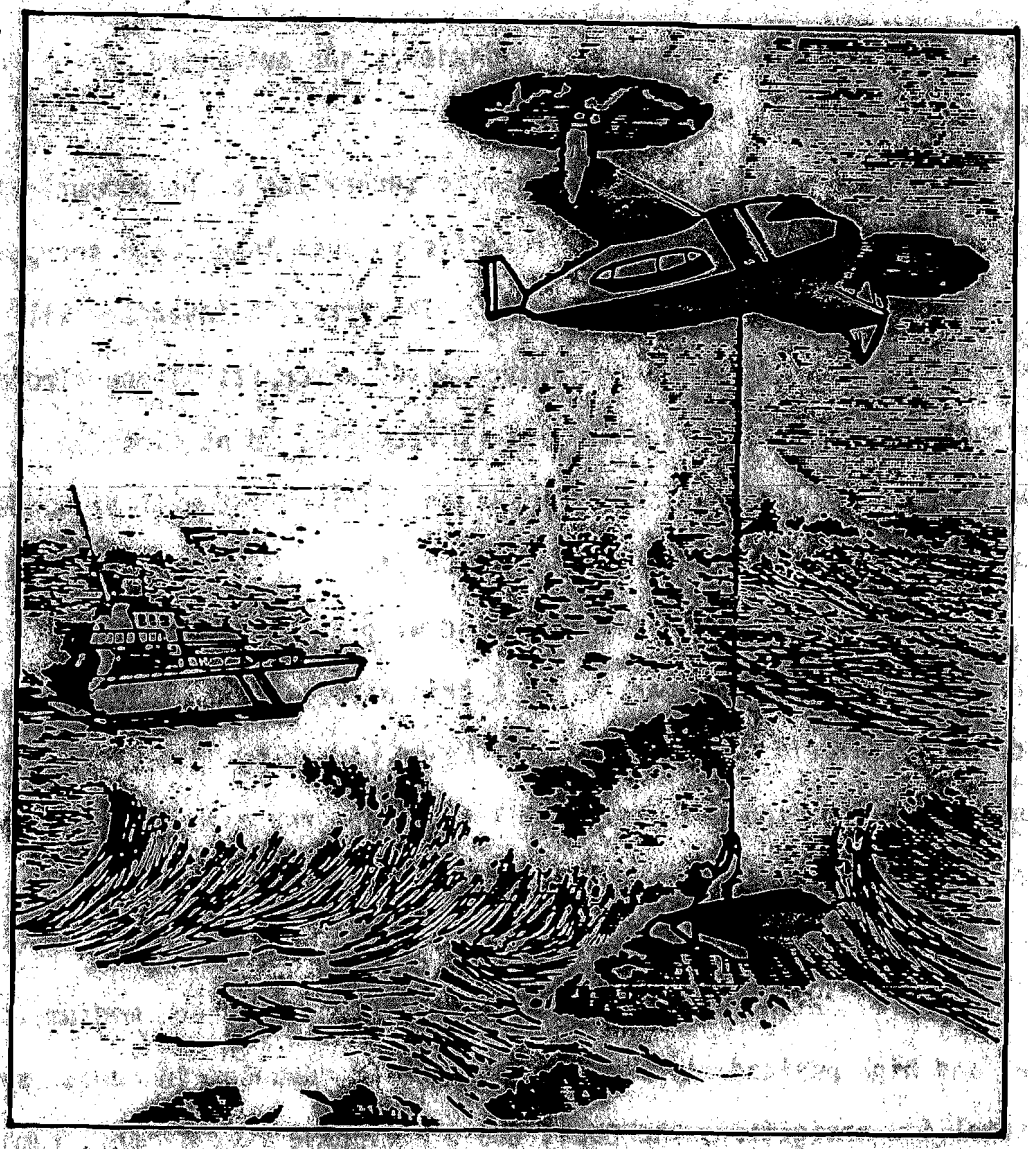

Figure 3 - Advance Marine Vehicles for Search and Rescue

Vehicles (ACVs) will support inland ATON and maintain the inshore surveillance systems.

b. Air

The Coast Guard will not be designing or developing its own aircraft, but will continue to procure aircraft already developed. It will modify and equip these aircraft to suit its own specific purposes. Aircraft will be lighter, more efficient, and less costly to maintain than now because of advances in such areas as composite and other high strength/low

weight materials, power plant fuel efficiency and automated operating/maintenance systems.

Because of advances in remote surveillance and communications, the Coast Guard will be operating relatively fewer long range search (LRS) and medium range search (MRS) aircraft. The aircraft inventory will be primarily short to medium range "interactive" aircraft. These aircraft will interact with the sea surface to perform recovery, identification, surveillance, and law enforcement missions. This fleet will be augmented by mission-specific remotely controlled aircraft.

The distinction between fixed wing and rotary wing aircraft performance will not be clear, since hybrid aircraft with a fairly high dash speed and a "hovering" capability will be in wide use. Therefore, in the following sections the discussion will focus on, for example, fixed wing performance rather than types of fixed wing aircraft.

(1) Fixed Wing

Fixed wing performance implies high speed, medium to long range, and high payload capability. Because of advances in remote sensing and satellite navigation, the Coast Guard will have few, if any, remote units which require Coast Guard fixed wing logistic support. Therefore, it will have little requirement for the C-130 type transport aircraft. The Coast Guard will however, require long range, high speed performance to investigate/identify/aid targets identified by remote sensors. This requirement will be met by a combination of resources consisting of conventional, long range, fixed wing aircraft and hybrid vehicles capable of both medium range, high-speed dash and on-scene hover. Long range requirements will be met by a much smaller fleet than the present LRS/MRS assets. Medium range and interactive requirements will be met by aircraft

better fitting in the present rotary wing requirements discussed in the next section.

(2) Rotary Wing

Coast Guard rotary wing requirements imply the ability to deliver and retrieve objects and people at sea. These requirements do not necessitate the use of rotary wing aircraft. On the contrary, the various advanced/hybrid concepts in development today indicate that pure rotary wing aircraft will be only one of many vehicles able to meet Coast Guard requirements in the year 2020. Compound aircraft, using both rotary wing and fixed wing/directed thrust concepts, and tilt wing/directed fan aircraft will compete favorably with conventional rotary wing aircraft.

For the 200-mile economic zone, a variation of these advanced concepts will meet the requirements of high enroute speed and hover capability. Whether these aircraft will also meet the close inshore needs now filled by rotary wing aircraft will be determined by cost effectiveness considerations. Suffice it to say that the requirements presently met by SRS, MRS and LRS aircraft will be met in the future by a mix of aircraft which can hover at the expense of high speed and those which are capable of both high speed and hovering.

(3) Lighter Than Air (LTA)

LTA aircraft defined herein include conventional "blimps" and aerostats (tethered blimps). In the near future blimps and aerostats would probably be a cost effective way of providing long range/wide area surveillance at the expense of being slow to respond to other than routine surveillance on patrol. In addition they can stay on station longer than aircraft but less than ships, or aerostats tethered to ships. Whether they will exist in the Coast Guard fleet in 2020 is problematical since their niche may have come and gone by then.

The future utilization of LTA will be predicated on and made attractive by today's improvements in materials, propulsion systems, miniaturization of electronic circuits for sensor and com/nav systems. These developments will make a modern airship into a quiet, comfortable, livable, efficient and very capable surveillance and response vehicle. It will be able to complement the capabilities of aircraft and surface craft and in some cases fill a gap where no other vehicle could perform a needed task (i.e., overnight or multi-day covert/overt surveillance and hot pursuit). It will be able to launch and retrieve a boat and boarding party at sea in moderate seas and have the armament necessary to protect its boarding party.

By the year 2020 LTA may not be as cost effective as satellite sensors for general wide area surveillance. Space based sensors will have the sensitivity to detect and identify all but our most intractable targets, people in the water and similar small targets. In addition, remotely controlled vehicles will be able to provide surveillance of specific areas for specific targets. Consequently, LTA vehicles may be used less for long range surveillance than for their ability to interact with the surface.

(4) Remotely controlled

Remotely controlled aircraft available for Coast Guard use will run the gamut from small, low altitude vehicles carrying infrared or optical identification sensors to large powered gliders "hovering" at very high altitudes and able to search large areas. The former will allow cost effective surveillance but will not replace the need for manned hovering vehicles since such vehicles will be unable to interact with the surface effectively. Larger remotely operated craft could deliver rescue equipment for example but their cost would approach that of manned aircraft. High

altitude "hovering" vehicles could be cost effective (compete favorably with satellite sensors) for specific missions in the same manner as LTAs.

Whether or not any of these vehicles will be used by the Coast Guard will be determined by demographic factors. In other words, some may be used for surveillance if the population available for crewing manned vehicles is too small to obtain sufficient numbers at reasonable cost. Population predictions indicate high competition for manpower of this sort. Consequently, some remotely controlled vehicles, especially low altitude craft, will be used to perform missions which do not require delivery or recovery of people from at sea locations. Thus future air stations and large cutters will be equipped with both manned and remotely operated vehicles.

E. SPACE

1. Funding

a. Dedicated (Owned)

The cost of dedicated satellites will drop significantly because of advances made in delivery to orbit by the successors to the space shuttle. The space platform needs of the Coast Guard, however, will not be significantly different from those of other users. Consequently, it is anticipated that the Coast Guard will not be funding its own dedicated satellites.

b. Shared (Jointly Funded)

The Coast Guard's needs for intelligence for law enforcement, search and rescue, and ice reconnaisance, are similar to those of other federal agencies and foreign governments. Therefore, jointly funded satellites will be the primary method for obtaining required intelligence. Search and Rescue Satellite (SARSAT) is a current example of the benefits of

a jointly funded space venture as shown in figure 4.

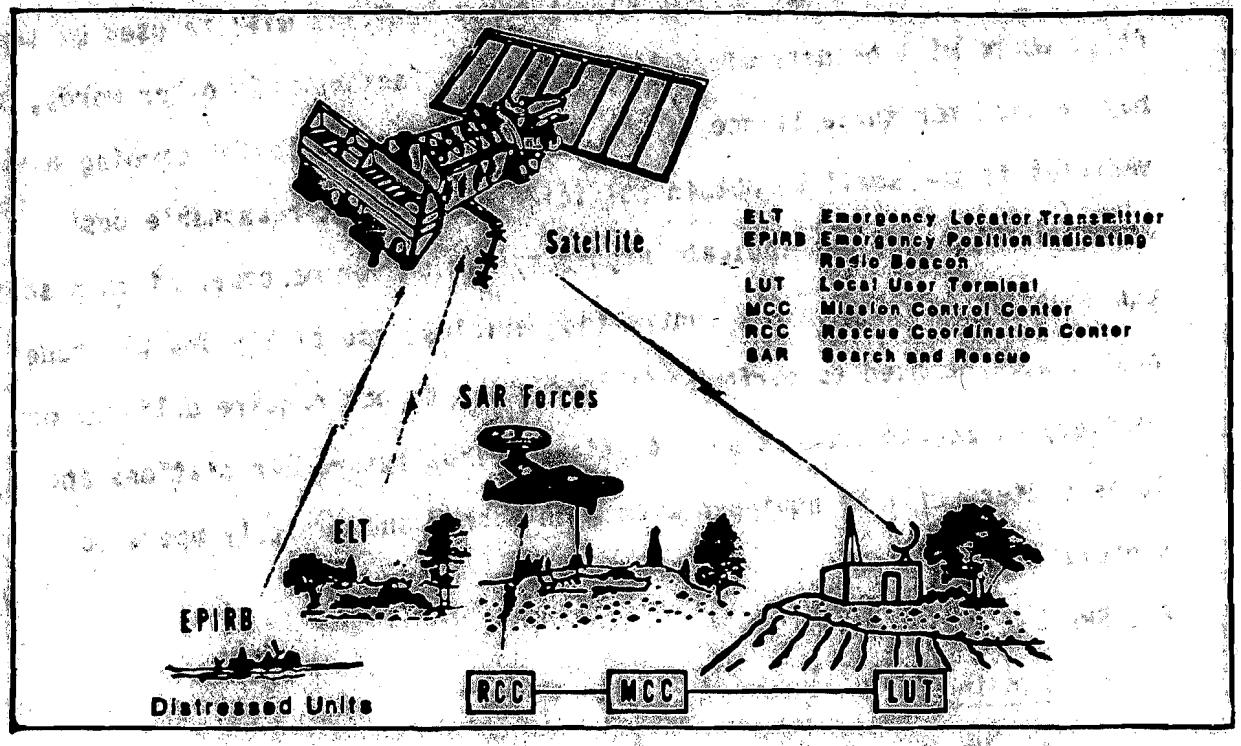

Figure 4 - Search and Rescue Satellite System

c. Leased

Leasing of space facilities includes the concept of user charges. The NAVSTAR Global Positioning System (GPS) is moving in this direction. An improved version of GPS, or its successor, will be operational in the year 2020. It will either require user charges or be funded from a federal source. Likewise many of the Coast Guard's communication requirements will be met by leasing satellite time. Figure 5 illustrates the Global Position Satellite Navigation System concept.

2. Use

a. Surveillance

Space-based surveillance systems will complement the improved versions of present day sensor platforms. Dedicated satellite systems such

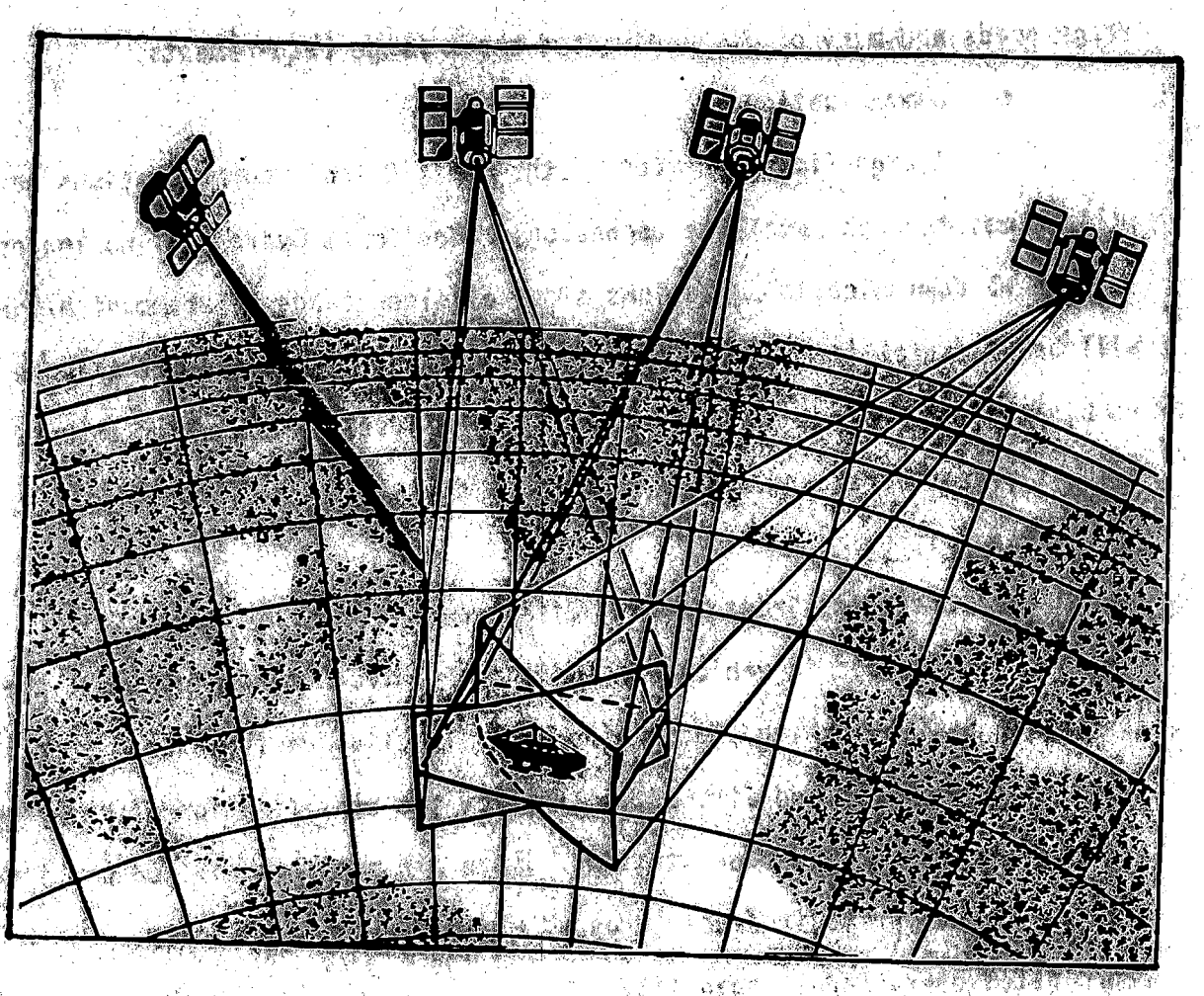

Figure 5 - Global Position Satellite Navigation System

as SARSAT will be augmented by space based surveillance for ship traffic, ice reconnaisance and iceberg detection. As previously mentioned, the satellites used will be jointly funded, or the Coast Guard will receive required data from the operator of the satellite system.

Satellite surveillance systems will not eliminate all the Coast Guard's intelligence needs but will gain coverage to areas we are presently unable to surveil.

b. Navigation

Satellite navigation systems will meet all Coast Guard long

range needs and many of its medium and short range requirements.

c. Communications

A significant portion of the Coast Guard's communications needs will be met through satellite technology. The Coast Guard will no longer operate HF Communications Stations since all long range telecommunications will be via satellite. Short and intermediate needs will be met through a combination of present day systems, satellite systems, and other methods such as meteor burst and spread spectrum systems.

3. Facilities

a. Operating Bases Inshore/Offshore

Advances in vehicle and offshore platform technology will create changes in basing strategy to provide cost effective performance. Increased speed of small boats and aircraft will allow the consolidation of resources in fewer, more widely spaced stations. More air stations will be combined with small boat units in "super groups" which will have advanced, coordinated operational capability.

Mining of OCS minerals will be a reality adding to the congestion of the continental shelf because of the then existing high density of oil rigs. The Coast Guard will be forced to move offshore to meet the requirements of this increased commercial activity. The Coast Guard will place, in selected areas in these economic zones, offshore platforms which will be bases for high speed patrol/interdiction vessels, remotely operated and manned hovering aircraft, as well as coordination centers for regulatory activity and traffic control. These "mini-districts" or floating supergroups will be redeployable to meet changes in offshore commercial activity both licit and illicit. They will be more cost effective than building new bases and transferring personnel to meet

changing needs. Figure 6 illustrates an artist conception of a future Coast Guard offshore staging platform.

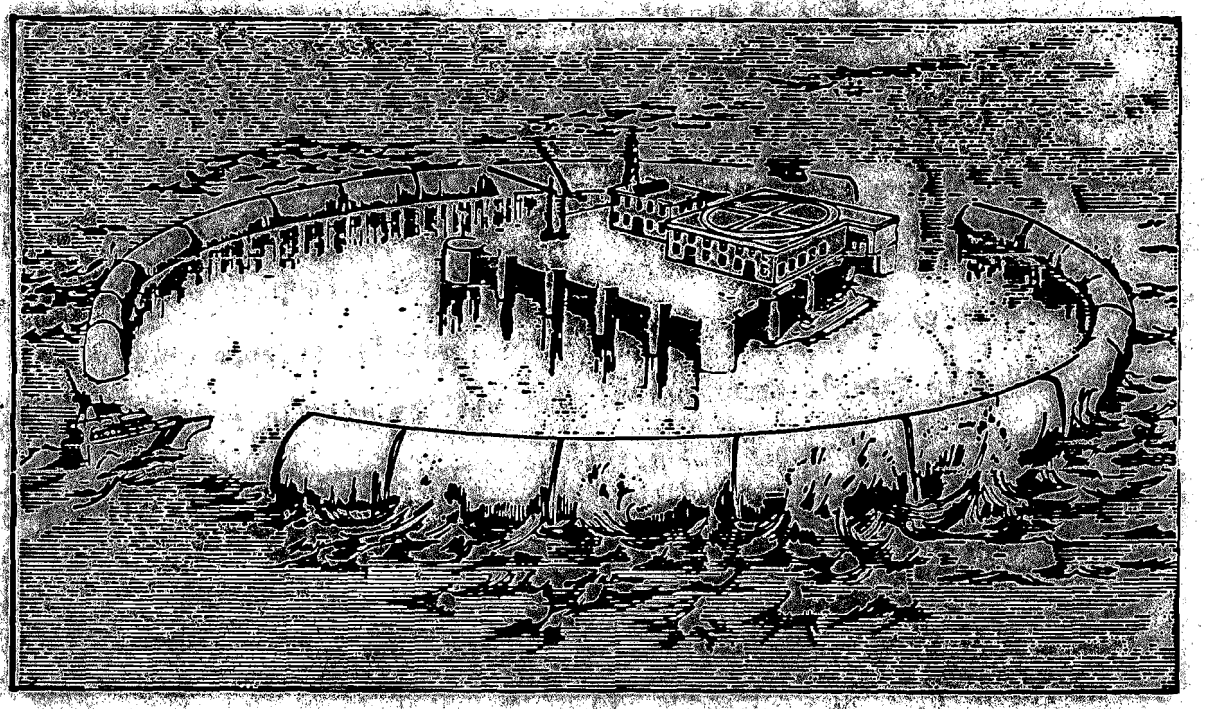

Figure 6 - Offshore Staging Platform

b. Maintenance

The trend toward consolidation of support activites already existing in the Coast Guard will accelerate in the future to produce a thoroughly centralized support system by the year 2020. These districts will be truely operational commands being serviced by a regional or Coast Guard-wide support centers. Advances in command, control and communications integration will enable the consolidation of districts thereby reducing administrative overhead and increasing operational effectiveness.

Advances in miniaturization, solid state physics, and automation will improve electronic equipment performance and reduce on-site maintenance to replacement of modules and entire equipments. Some components will be repaired at support centers but for many items replacement in kind will be

more cost effective. Information transmission "wires" will become "light pipes" (fiber optics) for the most part, thus reducing maintenance requirements as well as weight.

Advances in materials, lubrication, bearings, coatings, etc., will reduce maintenance requirements for mechanical equipment, "plumbing" and power plants and associated wiring. However, the corrosive atmosphere and the working of vessels (especially advanced concepts) in a sea way will continue to produce failures in systems. Material science will have produced more capable machines but they will be used in a more stressful environment. Thus mechanical maintenance requirements will still be a major concern albeit in a somewhat differnt form than at present. As a current example, consider that the Polar class icebreakers have suffered mechanical difficulties in operating conditions that older icebreakers were incapable of approaching.

c. Training

Technological changes that will impact the training system include the use of computer based instruction and the increasing use of visual systems (i.e., video disc, computer graphics, etc.). The size of computer chips will be smaller and cost less, software will become more "user friendly," and the use of artificial intelligence (expert systems) for computer systems will increase. For example, expert systems will augment maintenance procedures. Besides replacing maintenance manuals, they will lead a "minimally" trained technician through troubleshooting repair.

The increasing sophistication of computers and their use in systems, coupled with the demographic trend toward fewer people in the age 18-25 group, poses significant problems for the Coast Guard training community. Persons qualified to maintain/repair the system when it fails are going to be difficult to acquire and retain.

The major issue in training will be the continuing obsolescence of technologies and increasing diversity of technology applications. Meeting the increased technical skill needs entirely through fixed shcool training is already impractical and will become more so.

Supplementary strategies that will have to be considered for wide application include:

(1) Design of equipment systems for greater reliability as well as better ease of use and maintenance;

(2) Embedding training capabilities in operational hardware;

(3) Increased development and fielding of job performance aids;

(4) Better use of prior education and experience in making personnel assignments. Better career planning generally;

(5) Increased use of mobile training capabilities, deployed from schools and computerized courses accessed at schools by people at remote locations;

(6) Greater reliance on self-paced instruction at operational locations;

(7) Greater use of contractor maintenance, including remote monitoring diagnostics and advice via computer from a contractor's location to various operational sites;

(8) Lateral entry of skilled civilians into hard-to-fill Coast Guard billets.

4. Command, Control Communications Integration (C3I)

Command, control and communication networks and systems will be essential to effectively carry out the mission requirements of the future Coast Guard. Figure 7 is an artist conception of a Coast Guard Command and Control System. The process of command and control may be exemplified by a

set of basic functions for a given command level. These functions include:

- command
- information management
- action/engagement management
- sensor management
- communications management
- system management

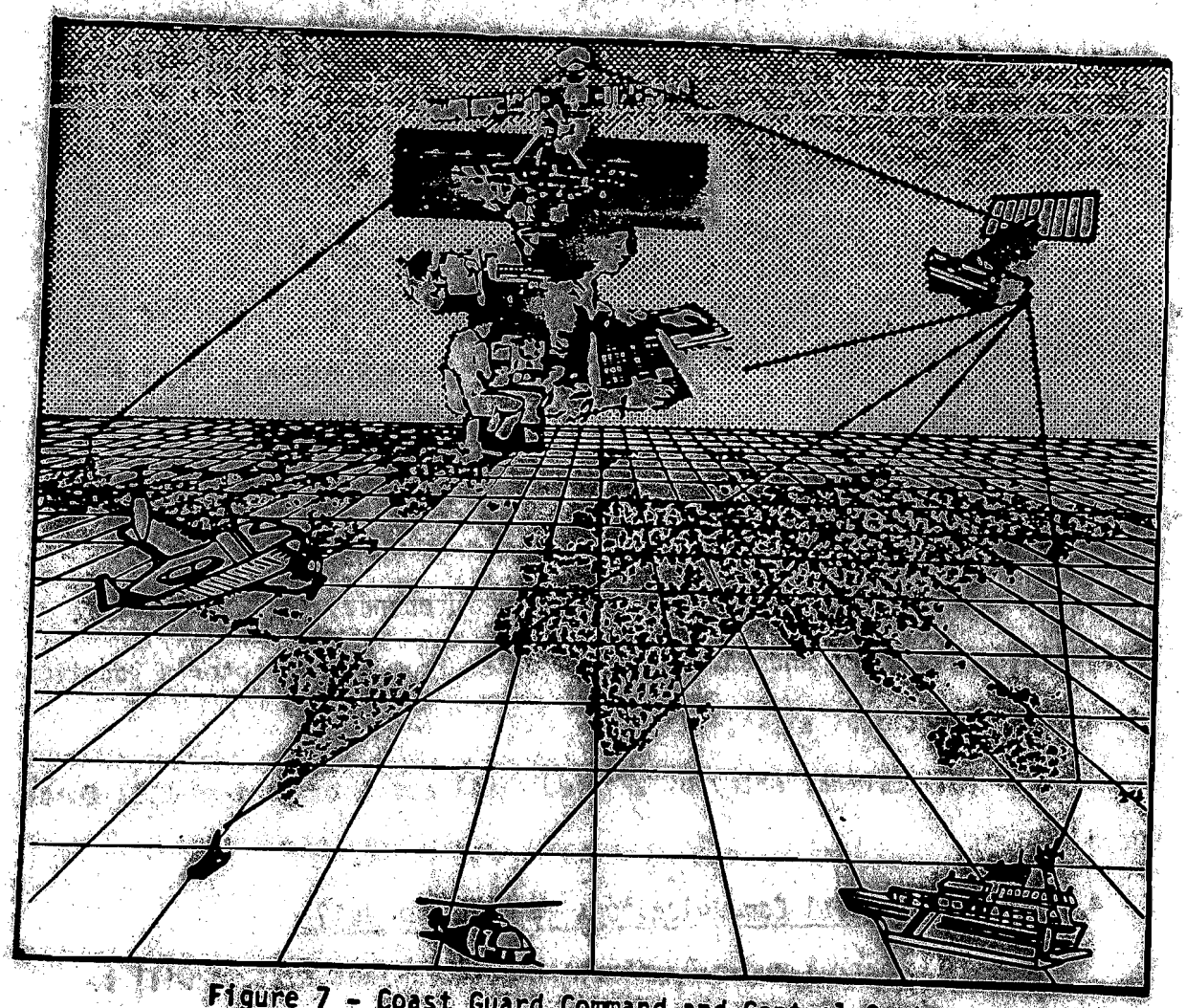

Figure 7 - Coast Guard Command and Control System

Command functions include planning, directing and assessing mission operations to achieve a given objective. Command structure should permit senior commanders to provide direction and guidance to subordinates who

interpret, detail and execute actions and support their commanders with supportive information and plans.

Information management functions include acquiring, processing, and distributing data and information. Information to all users must be timely, accurate and complete on a continuous basis.

Action or engagement functions includes allocating, controlling, coordinating, and monitoring all groups that are involved in the execution of a given missions operation.

Sensor management functions include allocating, controlling, coordinating, and monitoring all sensor or data collection sources. They support the command decision making process.

Communications management functions include allocating, controlling, cooordinating, and monitoring all communication elements. They provide the connections needed to implement the exchange of commands and information between all mission work elements.

The systems management functions include allocating, controlling, and monitoring all mission assets that comprise the command and control system with exception of the communications assets. The command and control system assets include information-handling systems, displays, and decision aids. Systems management allows the commander of the operation to establish and adjust command and control system condition, measure, and assess its status, and develop options and timing for system reconstitution in the event of any disruption.

The generic building blocks* of the command and control architecture is shown in figure 8.

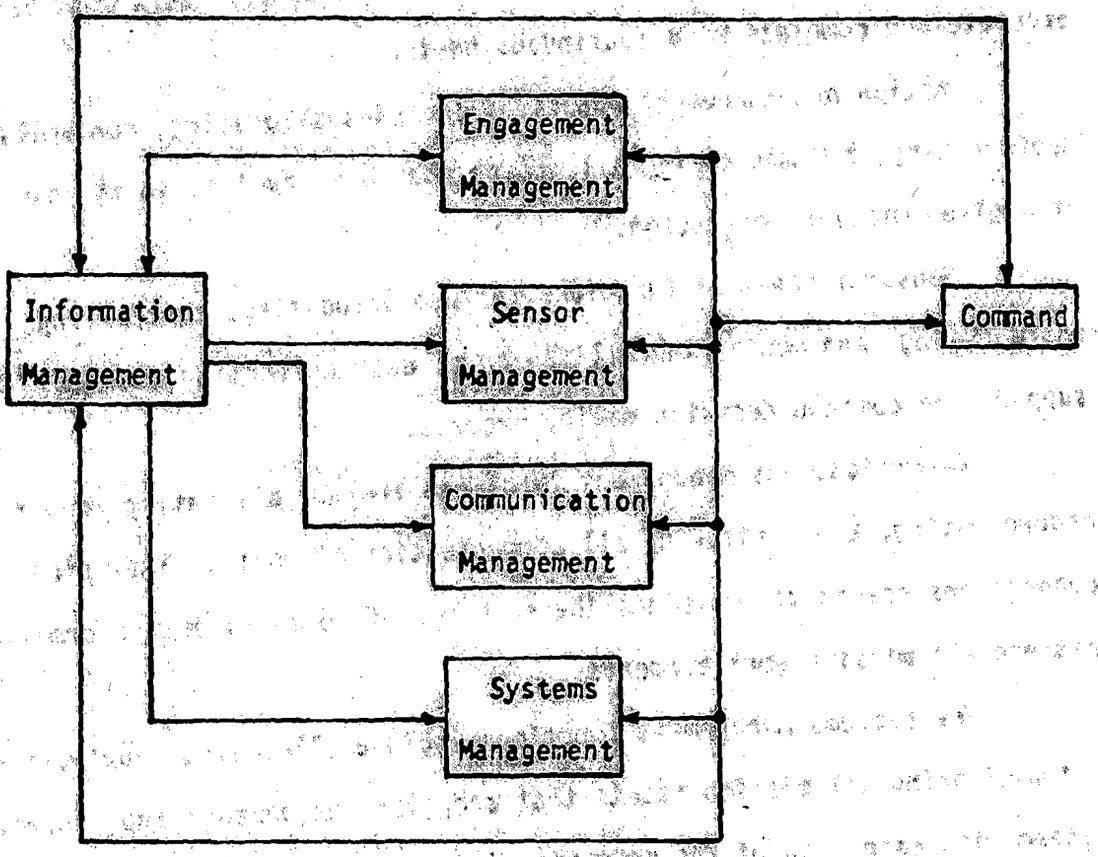

Figure 8 - Functions - Command and Control Process

*"A Concept for Navy Command & Control in the year 2000," George D. Halushynsky and Jay K. Beam, John Hopkins Technical Digest Review, Vol. 4, No. 4.

a. Information Resource Management (IRM)

During recent years, Coast Guard management has begun to realize that information is a valuable resource and should be preserved and recycled. The role of the Information Resource Manager is still being defined. One drawback of IRM is the reluctance of top management to elevate IRM duties from staff to line position.

The role of IRM is of such importance that its elevation to line management level at the earliest opportunity is essential in order to achieve maximum benefits in areas of cost and human resouces.

Qualifications of IRM managers and management information systems (MIS) managers is one currently being debated. MIS managers of the past have been data processing personnel who in the opinion of top level management, where not well informed in areas of the organization other than data processing. MIS managers from the areas of accounting, finance and related areas are well informed of the organization but weak in areas of data processing.

IRM and MIS managers of today in major organizations are coming from the ranks of Masters of Business Administration (MBAs), with strong managerial skills and versed in both areas. Persons not having the necessary skills are being trained by the organization in college level training programs. The organization looks upon the training invested in their personnel as an investment with future payoffs.

The Coast Guard Office of Command, Control and Communication has only recently been created. The disciplines of IRM are still in the stages of infancy. Colleges and universities are rapidly responding to national appeals to solving the problem of training persons in the area of IRM.

Many of the old methods of system design have been replaced by more sophisticated methods of design. From these sophisticated methods, a

popular opinion being shared by many scholars is the idea of using the organization structure and objectives for the purpose of collecting, manipulating, storing and recycling of data to run the organization.

The Coast Guard will have to carefully examine the areas of Human Resource Development to determine optimum return on its investment.

b. Data Processing

Data processing is in evolution. The entire field of data processing is under constant review. The Coast Guard's main concern should not be in the area of high technology, however, but in the field of management. Data processing, office automation, and telecommunication in recent years has always existed within separate departments. Today processing of information is viewed as a combined effort and all of the major disciplines are merging into one line management level within the organization.

The Coast Guard's approach to problem solving in the area of data processing will be based upon its ability to use general generic type software, maintain standardization, and utilize the facilities of IRM.

Some of the cost saving features of microfiche, microfilm, optical character reader (OCR), magnetic imprint character reader (MICR), voice, and image recognition will become common tools of the everyday working environment. There is a very strong indication that data processing will return to the status of a workshop, as more and more end users become more skilled in the use of computers, especially microprocessors.

c. Telecommunication

Office automation, data processing, and telecommunications are moving toward the formation of one conglomerate. LAN (local area networks and long-haul networks) will become the state-of-the-art.

Over the next few years telecommunications networks will become defined by software; the topography of a network will be stored in tables in network's switching machines and operations systems. The route - and the servers they provide - can be reshaped and reconnected in an almost infinite variety of ways as demands indicates. Included in the digital trend are lightwave transmission (fiber optics) systems that have grown greatly in capacity while costs have dropped. These improvements are a result of shifting to data carriers with shorter wavelengths, reducing losses in the fiber medium, and increasing the power and stability of the laser transmitters.

Lightwave (fiber optics) is the technology of choice for virtually all routes of a few kilometers to many long-haul routes of hundreds of kilometers. Lightwave systems will dominate new constructions, (ships, aircraft, and within buildings, in the local loops, in circuits between switching offices, and in long hauls) wherever there are moderate to large amounts of traffic to be carried.

For transcontinental and intercontinental routes with lighter traffic, satellites will continue to be important. Satellites also now have a real edge in wideband one-to-many distribution, such as for television.

Standard radio transmissions will coexist with fiber optic systems and satellite systems. Advances in very large scale integrated (VLSI) circuits have made digital radio systems cost-effective, and technological advances have made digital transmission quality equal to long haul standards. Further progress in digital processing is expected to increase the information-carrying capability of digital radio.

d. Navigation

Today there are six principle types of navigation systems in

operation. A comparison of these systems is shown in figure 9.*

System	Position Accuracy (m)	Velocity Accuracy (m/sec)	Range of Operation	Operation
GPS	16 3-Dimensions	0.1	Worldwide	Operational worldwide with 24-hour all-weather
Loran-C	180	—	U.S. Coast, Continental U.S. Selected Overseas areas	Operational with localized coverage. Limited by skywave interference.
Omega	2,200	—	Near global (90% coverage)	Current operational with localized coverage. System is subject to multipath errors.
INS	1,500 max after 1st hour	0.8 after 2 hours	Worldwide	Operational worldwide with 24-hour all-weather coverage. Degraded performance in polar areas.
TACAN	400	—	Line of sight	Position accuracy is degraded mainly because of azimuth uncertainty which is typically on the order of ±1.0 degree.
Transit Satellite	200	—	Worldwide	The interval between position fixes is about 90 minutes. For use in slow moving vehicles.

Figure 9 - Navigation System Comparison

*Source - Rockwell International

By the year 2020, the NAVSTAR GPS or its successor will be the Primary Marine Radio Navigation System, having replaced Transit, OMEGA, and Loran-C. The Coast Guard will operate a National Vessel Traffic System which will monitor the position and status of marine vessels through a series of geostationary data relay satellites. Technological advances will result in extraordinary changes to the marine navigation receiver. A "standard" marine navigation system will provide not only positioning information but also route planning, steering control, precise piloting, collision avoidance, and bi-directional data transfer capabilities. These technological advances will also bring about operational changes. Navigation charts will no longer be printed, but will be distributed on extremely high density recording media which will be read directly by a chart "printer". This will require media with a recording capacity in excess of one gega (G) bytes(10^9 bits) and a package size of 15 cubic inches or less and capable of read and write operations. Voice recognition and synthesized speech will be standard features of navigation receivers along with touch sensitive flat panel color graphic displays. Advances in Artificial Intelligence will reduce receiver control to a series of verbal commands. The development of artificial intelligence (AI) systems is critical to this projection. It is assumed that this area of hardware will mature to the point that these functions can be performed in a machine which is suitable for ship and aircraft installation and is realistically priced. Optimum route selection, routine navigation decisions, recording ships navigation log, warnings of impending danger, and the evaluation of "what if" problems will be routinely handled by the receiver using the platform characteristics which have been pre-programmed into the system. For the surface vessel the receiver will automatically rebroadcast its position and status information to the Vessel Traffic System (VTS) via the data relay

satellites. The VTS will in turn broadcast local differential corrections and the position and identification of all vessel traffic in the user's service area. The receiver will automatically process all of the available information, integrate it with its own ship radar, and present the user with a real time color graphics display of his navigation situation, complete with chart overlays and all local traffic. Related navigation data, such as local notice to mariners and weather information will also be passed by the VTS.

Emergency Position Information Radio Beacons (EPIRB's) will be designed to operate within this system. An activated EPIRB will retransmit raw GPS ranging data to the VTS via satellite. The VTS computer will poll the system for vessels in the vicinity of the computed EPIRB position and request emergency assistance. Those vessels responding will be continuously updated with the most recent EPIRB position data from which steering commands will be computed. This system has the added capability of automatically broadcasting the type of distress situation permitting VTS to be more selective in the type of response vessel. Response information could be telemetered back to the EPIRB unit, providing the user with a real time situation evaluation. This system will provide rendezvous/rescue accuracy on the order of meters under all conditions. The ability to home in on the distress transmitter using real time position data based on a common navigation system will greatly reduce search time and cost.

With the availability of such navigation equipment, there will be less need for an extensive system of short range aids. Radio beacons and large light structures will be partly eliminated. The number of channel buoys and visual ranges will be reduced. They will serve as a backup system for large vessels and will continue to be the primary system for smaller vessels and pleasure craft. These remaining buoys will be constructed of

man made composite materials requiring virtually no routine maintenance. They will be tethered to permanent anchors via synthetic moorings. Power will be provided by high efficiency solar cells and the buoys will contain integrated modular electronics packages to monitor their own position and status and report any errors to the VTS via the data relay satellite system.

Given present Coast Guard responsibility for the Omega and LORAN-C systems, the objection of the national and international civil communities to using a Department of Defense (DOD) operated system and a probable loss of interest by DOD in maintaining GPS (given its track record in present and past navigation systems) it seems highly probable that the Coast Guard will be designated as the agency responsible for providing GPS service.

The Coast Guard will be providing services to missions of air and waterways. The NAVSTAR GLOBAL Positioning Systems (GPS) or its successor will be the primary marine radio navigationing system having replaced most of Transit, OMEGA, and Loran-C systems. Some of these older equipments may remain as backup systems to GPS. The Coast Guard will operate a National Vessel Traffic System which will monitor the position and status of marine vessels through a series of geostationary changes to the marine navigation receiver.

Artificial intelligence will be relied upon to provide the necessary information to make management decisions.

5. Sensors

Although the methods employed to retrieve and transmit information will be modified substantially, the present basic Coast Guard missions will still be applicable in the year 2020.

In performing these missions, we currently rely heavily on a time-proven and valuable sensor - the human eye. Although we could expect

the mission areas to be similar in the future, and information needs nearly identical, the nature of this "eye" will change significantly.

A major drawback which must be considered when utilizing the human eye is its loss of reliability under certain environmental conditions. If the Coast Guard is to achieve any significant improvement in operations, it will be imperative that our resources not be thwarted by darkness or bad weather.

It is conceivable that by the year 2020, all types of Coast Guard platforms will possess some level of an integrated, all weather, day/night short and long range sensor package consisting of such devices as IR, AGTV, LLLTV, synthetic aperture radars, image processors, satellite links, etc.

For example, in order to reduce the resource expenditures associated with extended patrols of major cutters, law enforcement missions of the future commonly will make use of remotely piloted vehicles, whether drone type, aerostats or blimps, to accomplish routine surveillance and to obtain initial contact of suspect vessels. After an IR and TV scan to determine the type of vessel and its cargo, based on a reference bank of applicable substance profiles/signatures, the IR video as well as geographical data would be transmitted via satellite link to a Central Office where the decision to apprehend and dispatch a Coast Guard resource would be made. If a cutter or aircraft was dispatched, it could be guided to the suspect vessel by a remote piloted vehicle (RPV) through a satellite link relaying changing geographical position, course to steer, and time to intercept.

The future search and rescue scenario will be greatly improved through the use of low-cost personnel/vehicle EPIRBs which would be automatically activated and transmit via NASA or NOAA leased-space satellite, information such as type of vehicle, registration number,

position, time of incident, etc., which will then be readily available at the rescue coordination center.

In other mission areas, the pollution control and ice operations programs would be enhanced by the use of synthetic aperture radars and IR devices carried aboard NASA/NOAA satellites or the Space Shuttle. This would provide near real-time images of ice conditions and pollution incidents which could be transmitted to RCC's or vessels as appropriate. Icebreakers in particular, can benefit from RPVs equipped with lightweight radars and imaging sensors. Harbor surveillance partrols will routinely be conducted by RPVs equipped with high resolution IR and LLLTV sensors.

Thus, although the mission areas will remain basically unchanged, the "eyes" (or electromagnetic sensors such as radars, beacons, infra red, ultraviolet, television and lasers) used to obtain the data to pursue these missions will be greatly enhanced.

The missions of the Coast Guard can be better accomplished through the use of high technologies. Many of the areas of uncertainty, and risk would have a higher probability of success with the aid of new technologies.

Robotics, artificial intellegence, and sensors, will be used in areas of chemical warfare, biological warfare, chemical spills, air/sea rescue, and newly defined duties in space patrol.

Although the methods employed to retrieve and transmit information will be modified substantially, the present basic Coast Guard missions - without the exception of the new space duties - will remain the same.

Types of Sensors

(1) UV, IR, LASER, Electromagnetic (radar, beacon, responder, etc.) Expanded research and development anticipated in above areas.

(2) Chemical

Expanded research in chemical sensors and use of microprocessors in the

interpretation of the findings will be accomplished.

(3) Physical

Expanded research and use of high technology can be expected.

(4) Integrated sensor systems (multi-sensor).

The success of future sensor systems will be highly dependent on the optimum integration of multi-sensors.

VI. CONCLUSIONS

1. Emergence of a New International Marine Environment

A whole new international marine environment will emerge by the year 2020. Changes in the historical, technological, social, cultural, and physical factors of today's marine environment are in the early stages of formation.

Depletion of our land resources, coupled with perceived abundance of resources in our oceans is stimulating a seaward movement of the economies of all the advanced industrial countries. The availability of vast quantities of ocean resources such as minerals, fuels, plants, fish, and thermal energy will give rise to many changes. Efforts in fossil fuel recovery will be directed towards deeper zones of the continental slope. Some of these efforts, however, will be offset by new developments of synthetic oil derived from shale and coal.

Extraction of minerals from the Outer Continental Shelf will become a major industry. Seafood and plant resources will become a primary source of the world's food supply; consequently, the conservation of these resources will become a problem.

Ocean thermal energy conversion (OTEC) systems, having been successfully tested, will be in operation in many tropical and sub-tropical coastal areas.

Political controversies in governing the new marine environment are bound to occur. Full agreement with respect rights on and beneath the oceans may not always be achievable; however, bilateral agreements will be the trend in the year 2020 and should alleviate some of the problems. Because of legal uncertainties in mining deep ocean, ocean resources, stronger legislation will be enacted to protect mining companies' investments.

The complexity of governing the new marine environment will demand some institutional innovations. We must (1) establish comprehensive policy objectives, (2) develop a comprehensive plan to achieve policy objectives, and (3) continually evaluate the plan for needed changes to achieve policy objectives.

2. Coping with the New Marine Environment

A. Technology applications

The Coast Guard will have many new resources available to meet the challenges of year 2020. Applying technological innovations is one way to address a possible future imbalance between mission requirements and available resources. In order to capitalize on new technologies more effectively, the Coast Guard must be willing to consider new approaches in accomplishing its missions. For example, the Coast Guard could become a very powerful law enforcement agency if it concentrated its operations on a nationwide intelligence and oceanwide surveillance network.

The technologies offering the Coast Guard the best opportunities for meeting its mission requirements in 2020 include:

- Information Resources Management (IRM)
- Advanced Air and Marine Vehicles
- Advanced Sensors and Navigational Aids
- Robotics

Advances in IRM will provide the Coast Guard a major opportunity to enhance its operational effectiveness through a centralized direction. Acquisition of information and data from space, air, land, and sea will make available to all necessary working elements of an operation a complete picture of a particular situation in near real-time. The success of the Coast Guard's application of IRM technology to command and control networks

will depend on concurrent applications to a comprehensive intelligence and surveillance network.

New technologies in advanced air and marine vehicles will further enhance the operational effectiveness of the Coast Guard in 2020. The advanced Coast Guard fleet will contain a mix that includes surface piercing hydrofoils, surface effect ships, Small Waterplane Area Twin Hull (SWATH) vessels, and to a lesser extent, conventional monohulls. High speed interception actions will replace present economical cruising speed patrolling. Although fuel costs per mile for high speed operations will increase, overall costs per successfully completed mission will decrease.

The advanced aircraft fleet of the Coast Guard in 2020 will consist of convertible high speed hovering aircraft for search and rescue, remotely controlled solar powered aircraft for long range surveillance, ligther-than-air for both search and rescue and surveillance, and to a lesser extent, conventional helicopters.

In the area of navigation, the NAVSTAR Global Positioning System will replace the TRANSIT, OMEGA, and LORAN C systems, although some of these systems may remain as backups. The Coast Guard will operate a national vessel traffic system to monitor the position and status of marine vehicles through a series of geostationary changes to the marine navigation receiver.

Optical, thermal, chemical, and electromagnetic sensors will be used extensively by the Coast Guard for surveillance, detection, and identification in its mission operations. Coast Guard platforms will possess complete sensor packages consisting of Infrared, Laser, AGTV, LLLTV, Synthetic Aperture Radar, image processors, and satellite links.

Advances in robotics and artificial intelligence will enable the Coast Guard to conduct safer and more effective missions in search and rescue, law enforcement, and environmental protection. Robots with sensor capabilities

will also serve a useful role in routine, hazardous, and fatiguing operations.

B. Reducing Financial Burdens

Some of the methods/procedures that may be implemented to reduce the overall financial burden of the Coast Guard in carrying out its mission objectives include:

- Executive and legislative orders to place certain regulatory responsibilities on State and Local governments.
- Assistance from the Navy in law enforcement functions.
- User Fees
- Sharing certain operations with U.S. industries
- Establishing laws requiring industrial users of the marine environment to insure themselves fully against damage to the environment either through a Super Fund, self-insurance or other methods.

C. Personnel and Capital Resources

With increasing use of automated systems and remotely piloted vehicles, the Coast Guard in 2020 will be able to meet its objectives and still reduce significantly the number of billets required; thereby reducing its operational and support costs.

D. Political Considerations

Political issues surrounding operation in the 2020 environment will stem primarily from offshore mineral development and mining operations. The Coast Guard may be tasked to protect U.S. mining operations during international political unrest regarding rights to these resources.

Illegal activities will continue in many forms. Aliens entering the U.S. illegally will continue to compete with illegal drug smuggling. Terrorism and sabotage against U.S. policy is perceived to be inimical to

the goals and interests of certain groups. The technological advances expected by the year 2020 in surveillance, intelligence, and communications will better equip the Coast Guard to deal with these contingencies.

3. General Conclusion

The technological growth between today and the year 2020 will be one of prodigious magnitude. This growth will cause significant cultural changes. The nature of these dynamic forces and their variables will make it very difficult to forecast the outcomes. Close monitoring of the variables associated with technological and cultural changes will give us some appreciation of emerging trends. Some of the variables of importance to the Coast Guard include:

- Personnel Requirements
- Transferability of technological skills to new technologies
- Shift to Capital Intensive Operations
- Computers
- Management processes and techniques
- Impact of new Military technologies on Coast Guard relationship with Department of Defense.

The degree of success with which the Coast Guard accomplishes its mission objectives in the year 2020 will depend on how we respond to emerging trends and utilize advanced technologies in preparing for that year and beyond.