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Navy's Undersea Technology Program: Marine Industries The Beneficiary

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MARINE INDUSTRIES THE BENEFICIARY

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ABSTRACT

The Navy is the leading developer and user of undersea technology within the Federal government. This development is accomplished by a world wide network of laboratories and operational commands supported by contract efforts with civilian industry and academia.

Generally speaking, both Department of Defense and the commercial world attempt to maintain a three year competitive edge in hardware development. Accordingly, the successful developments which the Navy funds, regardless of the developing activity, are normally available for commercial exploitation within a relatively short space of time. As a matter of fact, about 80 per cent of the data and technology that we produce is unclassified and is available almost immediately to the potential user who has the knowledge and initiative to seek it out. However, the processes by which the fruits of these Navy efforts are transferred to the civilian sector are at least as complicated as the technologies being transferred.

Perhaps the most direct process is through the funding of industrial research and development efforts. In these cases the industry concerned is, in effect, subsidized to come up on the learning curve and to develop methodologies and techniques which, when released to the public, usually have application in the commercial world.

Another direct method of transfer of technology from the Navy to the commercial world is via the extensive numbers of people that the Navy trains in various marine related skills and technologies who leave the service each year and enter commercial employment.

This paper will examine, in detail, the direct ways in which the Navy provides technological impetus to the commercial marine industry.

INTRODUCTION

The Navy is the leading developer of undersea technology within the Federal government. This development is accomplished by a world wide network of laboratories and operational commands supported by contract efforts with civilian industry and academia. These developments are currently purely mission oriented to the Navy's role in our national security effort. Some two years ago we had high hopes for a greatly expanded national effort in the development of marine technology. At that time, Mr. W. M. Magruder, out-going head of the President's Office of Science and Technology, was quoted as follows:

> "There are many programs that could be perceived as a national objective or goal in the area of the oceans. But, this perception of true ocean potential is, even now, new to the technician and is certainly not clear to the national/international policy makers. It will have effects upon our economy, food sources, natural resources, energy sources, the environment, waste disposal concepts, national security and our balance of trade. The United States needs a comprehensive national ocean program, especially when considering that by the year 2000 our population will be approaching 400 million citizens. The national ocean program should encompass at least five major issues. These include: (1) development of our nation's fisheries; (2) the resolution of the economic/environmental dilemma; (3) the exploration and development of natural sea resources; (4) the effective management of our coastal zone; and (5) the development of marine technology to carry out the national program . . . .
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> "Underlying all of these national objectives is an inadequate technology now available to sustain a national ocean program. This includes inadequate instrumentation for measurement; inadequate techniques for monitoring location and data transmission; inadequate mineral recovery techniques; inadequate technology for seafood production, processing and marketing; and inadequate assessment of seafood stock and harvesting techniques. The sea is the remaining frontier where we still hunt the food instead of domesticating and raising the food with modern techniques . . . ."

These were heartening words to those of us vitally interested in the development of undersea technology. However, Mr. Magruder has now departed the national scene and it does not appear that those currently in major decision making positions perceive our national goals as he did. Accordingly the major programs we had hoped for have not come to pass. However, the Navy continues to pursue mission-related undersea technology research and development within available funds, and the results of these efforts have a significant impact on our civilian maritime industry.

Generally speaking, both the Department of Defense and the commercial world attempt to maintain a three year competitive edge in hardware development. Accordingly, the successful developments which the Navy funds, regardless of the developer, are normally available for commercial exploitation within a relatively short space of time. As a matter of fact, about 80 per cent of the data and technology that we produce is unclassified and is available almost immediately to the potential user who has the knowledge and initiative to seek it out.

NAVY DEVELOPMENTS

To put the value of this technology into proper context I would like to run through a few Navy developments of recent years with their civilian applications and then touch on some of our current unclassified efforts and their potentials.

One area in which the Navy was the leader in research and development is weather modification. While this area has now been largely taken over by other agencies, it was the Navy who provided the initial breakthrough upon which subsequent efforts are proceeding. The commercial application of such capabilities as fog dispersion are many and varied.

This technology goes far beyond the maritime industries and the potential benefits to all mankind are tremendous.

Another Navy program which has had great commercial application is the Antisubmarine Warfare Environmental Prediction Service (ASWEPS). ASWEPS was concerned with developing:

a. new and improved techniques for predicting oceanographic factors significantly affecting ASW detection and weapons systems;

b. experimental instrumentation to observe environmental conditions and establishment of an observational network; and

c. methods of displaying environmental and operational predictions for ASW planning and tactical operations.

The civilian community is now using instrumentation such as the Shipboard Expendable Bathythermograph (SXBT), Airborne Radiation Thermometer and Salinity-Temperature-Depth (SDT) System which were developed and/or improved under the ASWEPS program. Our knowledge of the thermal structure conditions was increased greatly through ASWEPS research efforts. Civilian activities have been able to exploit this knowledge in their oceanographic programs. Several of the synoptic-type analysis methods for broad ocean areas developed by ASWEPS are being used by civilian activities. For example, thermal structure analyses show areas of strong currents and upwelling which contain relatively high quantities of marine food and support many species of fish. As a result, fishing activities are able to use the thermal structure analyses to upgrade their fishing capabilities.

Another Navy development of commercial interest is the Optimum Track Ship Routing System. This system provides for the application of long range predictions of wind, waves and currents to the selection of ship tracks. Test vessels were routed for the Military Sea Transportation Service (MSTS) now called the Military Sealift Command (MSC). The ship routing program was initiated in October 1956 as an experimental program. Thirty-two test crossings using MSTS ships were completed during the autumn and winter of 1956-7. Results of an evaluation of this test phase were encouraging. The economies effected in travel time, fuel consumption and distance steamed as well as increased safety and comfort prompted MSTS to request an immediate full-scale ship routing service to include all MSTS crossings. By October 1957, the Naval Oceanographic Office was routing approximately 70 ships per month. In 1959, the Naval Weather Service assumed the responsibility for routing Navy ships. Recent applications of the ship routing techniques to convoy and sonar routing have further enhanced DOD programs.

Commercial activities are now routing ships of most major countries. The Naval Oceanographic Office method is the basic technique used by private routing companies to prepare tracks.

As a broad, general area of research and development, the Navy's efforts in the area of remote sensing and observation of wave action; pollution dispersion; sea ice growth, movement, distribution and disintegration; and the mixing and diffusion of interwater-mass exchange, along with the technologies and techniques developed to support these efforts, have made a tremendous impact on our commercial industry. The results of these efforts have been basic enabling inputs to our capability to exploit the natural resources of the Arctic regions and to our improved capability to locate, track and harvest the fish in the ocean.

Some of the specific results of these efforts are:

Accurate Positioning of Equipment at Sea

The Navy, in order to perform acoustic measurements, developed an acoustic navigation system to accurately locate a point on the sea floor.

This technique, with refinements, has permitted commercial drilling ships to replace drill bits and return to the same hole. This technique will have greater commercial significance as near-shore shallow oil sources are depleted and more drilling is done in deeper water.

Ocean Search Strategies

In the past decade, the Navy has undertaken several large scale search operations involving the expenditure of millions of dollars. In one instance, that of the 1966 hydrogen bomb search off the coast of Palomares, Spain, the costs exceeded $5 million. As a result we have developed a procedure which provides systematic methods of search effectiveness at greatly reduced cost. The methods exploit initial target (object) location probabilities from search clues for planning search operations involving multiple search units and sensors.

Civilian benefits, in addition to the value of the search manual for lost submerged objects in salvage operations, have accrued from the adoption of the search strategies by the U.S. Coast Guard. The procedures have been programmed for implementation as computer-aided search and rescue at a New York Coast Guard station. The installation of the computer program will be conducted by the Coast Guard under direct contract to Daniel H. Wagner Associates.

Potential civilian benefits yet to be realized appear to be in such areas of search and location as in: law enforcement (fugitive localization), air search for downed aircraft in wilderness areas, and mineral exploration strategies for remote areas or in deep ocean areas.

Interface Chemistry

In order to improve the state of knowledge of the effects of films on the sea surface the Navy has invested widely in interface chemistry research. The research is leading to application in oil spill clean up and sea surface modification.

The work has provided DOD with an assessment of various organic surface-active films for application to a variety of Naval purposes including oil spill clean up, local fog stabilization, at-sea dye markers, etc.

This research has led to the development of a technique to contain accidental oil spills in harbors. The technique uses an innocuous surface-active "piston" film which condenses the oil into thicker layers for easier clean up operations. A variety of surface-active chemicals have been assessed as to their efficacy under different sea and weather conditions. The process can be incorporated into a shipboard kit, easily utilized by crews of commercial vessels.

A dye marker providing increased visibility in day and night has been patented as a result of this research. The marker combines the wave-damping properties of surface-active films with the color contrast of ordinary dyes to make an object at sea (downed pilots, lifeboats) more visible to searchers. This Navy-developed device provides the capability to measure surface currents and mass transport of water of any depth by means of a simple and inexpensive air-dropped dye probe. Domestic demand for these devices, primarily from the United States oceanographic community, has resulted in establishment of at least two manufacturing concerns. One, EOTECH, Inc., is producing more than 4,000 probes per year, with a gross sales estimated at more than $100,000 per year.

This device can be used from the smallest private aircraft and can effect significant savings over conventional airborne current measuring systems.

Shipboard Wave Height Measurement System

In order to optimize the design of ship structures so that the maximum load to dead weight ratio can be achieved, a knowledge is required of how stresses and strains are propagated through the ship's structural members as it impacts large waves at high speeds. Heretofore, strain guages appropriately located aboard ship assessed stress levels, but no good way was available to measure the waves impacted by the ship to conduct the correlation studies. Most sensors attempted for this purpose did not measure the true sea because the sensing area was perturbed by the ship's own bow wave. Utilizing a nanosecond pulse radar, it is possible to beam the sensing area away from the ship thus alleviating this problem. Such a radar was developed and is installed on the SL-7 fast cargo ship SS McLEAN for these studies. Initial performance of the radar is gratifying and, for the first time, a true correlation between impact wave spectra on a ship's hull can be correlated with the induced stress and strains. These studies will have a major influence on ship reliability design and performance for commercial carriers.

Directory of Hyperbaric Chambers

While this directory is not in itself a technological development, it is nevertheless a significant Navy contribution to ocean industries. The Navy requires a complete listing of all hyperbaric chambers in any area in which work by divers may take place. This directory provides a listing of all available hyperbaric chambers, their locations, and operational capability.

As commercial and recreational diving activities increase, so will the need for hyperbaric chamber facilities, and knowledge of their characteristics for treatment of decompression injuries. Additionally, hyperbaric medical and surgical procedures have recently been developed. This new branch of medicine, applicable to many diseases, will require an extensive distribution of facilities.

Geomorphology Radar

This instrument is used to detect, locate and define tunnels, buried communication lines, mines, munitions caches, water tables, etc. It also is used to determine the thickness of sea ice and the depth to subsurface ice lenses and wedges present in permafrost. These capabilites are requisite to successful amphibious and other shallow water and nearshore operations, and to runway and other facility construction in the Arctic environment.

This system has recently been used by various municipalities to locate buried gas and water lines and is presently being used by an oil consortium for pipeline routing and placement of facilities on permafrost. An application will be made very soon in which a building site must be laid out within an area undermined by abandoned mining tunnels, the exact locations of which are presently unknown. Now, let's take a look at some other areas of Navy-developed undersea technology and discuss their commercial applications and potentials.

In our search for methods to increase the speed of passage of solid objects through the water we discovered that certain polymers would act as drag reducers at surfaces over which liquids were passing in turbulent flow. Inventive minds quickly saw that the same elements of technology would be vastly useful in firefighting by increasing the flow of water through a given hose. Additional applications of this discovery are now being explored in connection with such diverse areas as sewage flow and reducing the power required for pumping coolant in steam power electrical generating plants. Additional commercial applications of this development appear to be almost unlimited.

A completely Navy development which has had great application in the commercial world is the saturation diving technique. This technique permits extended dives with only one compression and one decompression. The commercial results are lower costs per job completion.

Other Navy funded developments in the field of diving are advancements in hot water diver heating techniques and the closed circuit breathing apparatus. These, too, extend the working time of the commercial diver and thereby significantly lower job costs.

In the medical area, Navy funded efforts in baseline development for identification of asceptic bone necrosis have materially enhanced the safety of the diving profession and are indirectly saving industry vast sums in disability payments.

In still other areas, Navy research and development is producing technological breakthroughs of great commercial significance. Among these are:

-Work on a cable controlled unmanned recovery system; this work has direct commercial application in deep ocean research.

-Work in developing massive glass technology for the NR-1 emergency signal buoy. This technology is now in use in commercial buoys.

Work is in progress in optical and electromagnetic techniques of through-hull data transfer. This enables the transfer of data through a pressure hull without weakening cable penetrations and permits the substitution of lightweight light tubes for conventional, heavy, electrical cables.

Development of both wet and dry make underwater electrical connectors has been extensive. These have great application in both commercial power transmission and providing power for underwater operations.

Development of one-atmosphere underwater concrete structures has been pursued at Port Hueneme, California. These have significant potential for use in continental shelf operations as storage sites and repositories for power generation or even as living quarters for men working on the ocean bottom.

Development of both explosive and vibration emplanted embedment anchors is nearing completion. These are now in commercial use giving a substantial increase in holding capacity.

All of the developments which I have mentioned are the direct result of mission related Navy research and development efforts and are available for commercial exploitation.

However, the processes by which the fruits of these Navy efforts are transferred to the civilian sector are at least as complicated as the technologies being transferred.

DIRECT TRANSFER

Perhaps the most direct process is through the funding of industrial research and development efforts. In these cases the industry concerned is in effect, subsidized to come up on the learning curve and to develop methodologies and techniques which, when released to the public, usually have application in the commercial world. It should be noted that while this provides a direct benefit to the civilian economy as a whole, it is also unintentionally biased in favor of the developing company. They certainly are given a time advantage over potential competitors.

Another very direct method of transfer of technology from the Navy to the commercial world is via the extensive numbers of people that the Navy trains in various maritime related skills and technologies who leave the service each year and enter commercial employment. A classic example of this is open sea diving. According to best available estimates, 80 per cent of all commercial working divers received their basic training in the Navy. Further, 80 to 85 per cent of all commercial diving medical personnel have received Navy-supported training. In addition, a very high percentage of the merchant seamen in this country came from the Navy. So you can see, through the day to day training programs required to meet Navy needs significant maritime skills are developed which are subsequently put to use in the commercial arena.

Those are some of the more direct ways in which the Navy provides technological impetus to the commercial maritime industry. In addition, there are a number of discrete outputs of Navy research and development efforts which are available to the commercial world and which provide potentially valuable sources of technical information. I would like to mention a few of these and give an idea of their contents.

Let's start with the Deep Ocean Technology Handbooks. These are a series of handbooks which describe the existing technological spectrum as it pertains to stipulated areas. We currently have handbooks in the following areas:

- Electric and Electronic Circuit Interruption Devices
- Fluid Filled, Depth/Pressure Compensating Systems
- Rotary Shaft Seal Selection
- Electric Cable Technology
- Electric Penetrators, Connectors and Harness
- Fluids and Lubricants
- Development of Cable Controlled Underwater Recovery Vehicle (CURV)

These are available to qualified commercial requestors from the Defense Documentation Center. About 1,000 copies have been sold to date. We currently have identified five additional areas in which handbooks will be provided in the next year.

Another valuable source of technical information is the Deep Ocean Technology Projects Development Objectives Assessment. This book reflects the aggregate judgment of a selected group of the nation's foremost experts on the essentiality, probable cost and time required for successful development of a broad spectrum of specific technological events anticipated or proposed in the near term to meet Navy objectives. This book, too, is available to qualified commercial activities through the Defense Documentation Center.

In addition to these encyclopedic type works on ocean technology, the Navy is the source of a wealth of scientific papers and technical reports on varied areas of maritime interest. These are normally made available to commercial interests through the Defense Documentation Center, the National Technical Information Service or directly from the source. Additional technological information is provided to industry through such diverse means as the Navy Diving Tables, the Navy-originated National Oceanographic Data Center and through the cooperative efforts of the Navy managed Government-Industry Data Exchange Program and the Technology Utilization Office of the Small Business Administration. Each of these make Navy-developed knowledge available directly to the civilian user.

As I indicated in my introduction, the hopes of a couple of years ago for a greatly expanded national effort for ocean exploitation now appear dim. My personal opinion is that this expanded effort will only occur when, and if, the national decision makers clearly perceive a great national demand and a potential for significant national enhancement. In the interim, however, you may be assured that the Navy is well aware that our efforts, whatever their scope and level, are funded by the American taxpayer. We fully recognize our obligation to provide the fruits of these efforts to enhance American business and industry. We will continue to do this.