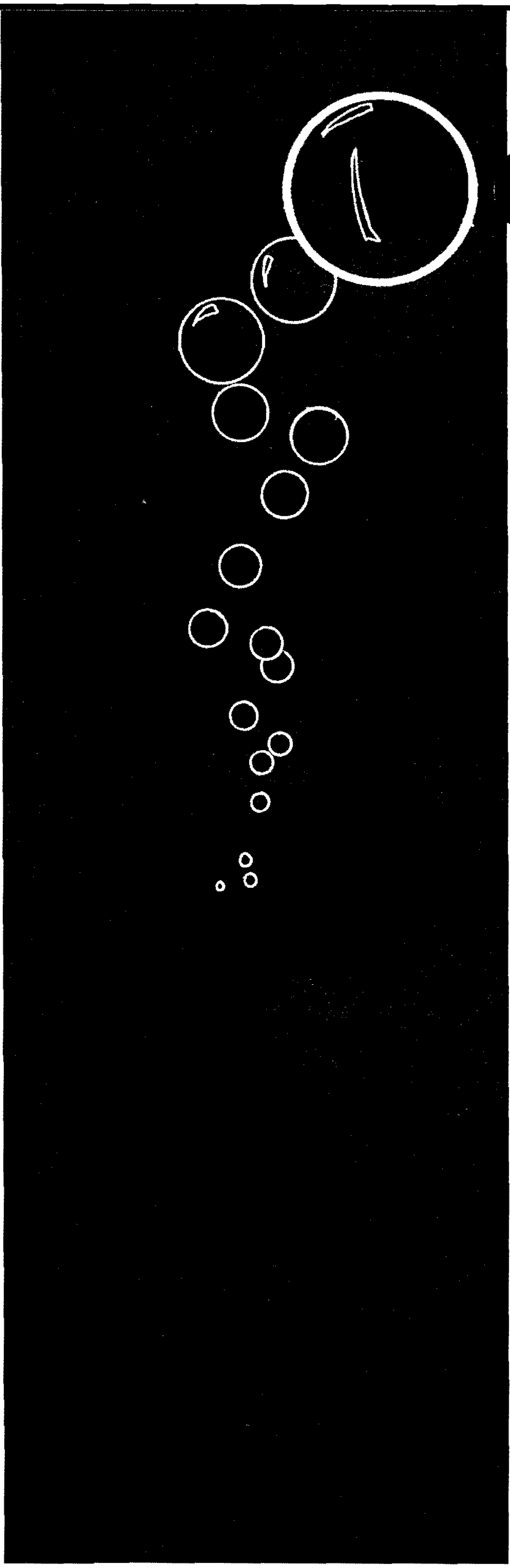


Ocean Engin

• Port Hueneme, Calif.

In recent years the term "ocean engineering" has appeared with greater frequency and increased emphasis in current professional literature. The number of universities offering courses and degrees in ocean engineering are increasing. The interest and activity in the ocean is shown not only by the Navy but by other government agencies, industry, and institutions.

But a surprising number of engineers, including CEC officers, have only a hazy notion of what ocean engineering is really all about and why the Civil Engineer Corps is involved in the ocean in the first place.

If you were to ask a group of people the question, "What is ocean engineering?", the answers would be most interesting.

To some the term is somewhat vague and abstract, without any definite meaning at all except that it involves engineering and the ocean in some way. To others ocean engineering may mean the study of wave forces on offshore structures, research on the corrosion and biodeterioration of materials in the ocean environment, the study of beach erosion processes, or the development of deep submergence vehicles.

Ocean engineering is all of these and more.

Ocean engineering can best be defined as that body of technology necessary for the effective use of the sea to meet the needs of mankind. Ocean engineering is multidisciplinary in nature, involving nearly all of the standard engineering disciplines such as mechanical, electrical, civil, structural, chemical, and metallurgical engineering.

The ocean engineer is a new breed who most likely has been trained in one of these traditional fields and has directed his interests and experience to systems for overcoming the problems of meeting man's needs in the ocean environment. He has adapted his engineering skills to those conditions which are peculiar to the ocean environment.

The two key words in understanding the field of ocean engineering are *needs* and *problems*.

Man looks to the ocean to fulfill many of his needs. Since the dawn of history, the sea has provided him with food and a mode of transportation. Over the years man has learned to use the sea to fulfill other needs – for national security, recreation, and non-food resources such as petroleum, minerals, salt, and fresh water.

Today scientists study the oceans and atmosphere together in order to better understand the weather, most of which is manufactured at the sea/air interface.

And Oceanography?

People often confuse the field of ocean engineering with oceanography. There is a difference. Ocean engineering differs from oceanography in the same way that any engineering differs from science. Oceanographers are scientists who study, observe, and describe the ocean in an effort to learn more about the sea, the land beneath the

eering

By LCDR TRACY C. TUCKER, CEC, USN

What it is . . . and what it isn't . . . and the CEC/Seabee role in it.

sea, the life in the waters, and the chemical composition and physical behavior of the water masses.

The oceanographer's goal is an increased understanding of all aspects of the ocean. The ocean engineer, on the other hand, is concerned with more than simply studying the oceans. He designs and builds systems for the constructive utilization of the oceans for the good of mankind.

So an ocean engineer is concerned with systems for fulfilling some need of mankind. But isn't this what all engineering is about? How then does ocean engineering differ from those traditional engineering fields with which we are so familiar? To answer this question we return to an earlier statement that the ocean engineer is concerned with systems for overcoming the *problems* of meeting man's *needs* in the ocean environment. The key word now is *problems*. The ocean environment creates engineering problems which are not found on land.

What Are The Problems?

One of the problems is pressure. For every foot of depth below the ocean's surface, the pressure increases nearly 0.5 pounds per square inch. At a depth of only 300 feet, the pressure is ten times atmospheric pressure. Equipment and men which are placed in the ocean must either be able to operate at the high pressures encountered there or be enclosed in a pressure-resistant housing.

Another problem is temperature. In many areas, just a few hundred feet below the ocean surface, the temperature is only a few degrees above freezing. The cold environment has an adverse effect on the performance of man and is often detrimental to hardware.

Visibility and communications are major problems underwater. Because water is such a poor conductor of electromagnetic radiation, neither light nor radio waves travels far below the surface. Suspended particulate matter compounds the light transmission problem and often reduces visibility to a few tens of feet (or in some cases inches).

Simply determining where one is located is frequently a major undertaking at sea. Out of sight of land there are few natural benchmarks, and the precise navigation required for many ocean operations (within a few tens of meters) must be achieved by radionavigation, satellite, or acoustic systems.

Unlike the surface of the earth, the surface of the sea is never at rest. The constant motion of waves and currents imposes a heavy load on bottom resting structures as well as floating platforms which operate in the ocean.

Regardless of whether he is concerned with systems for food or mineral recovery, transportation, recreation, or national defense, the ocean engineer must cope with these and other problems created by the ocean environment. He must have a body of technology for dealing with these problems.

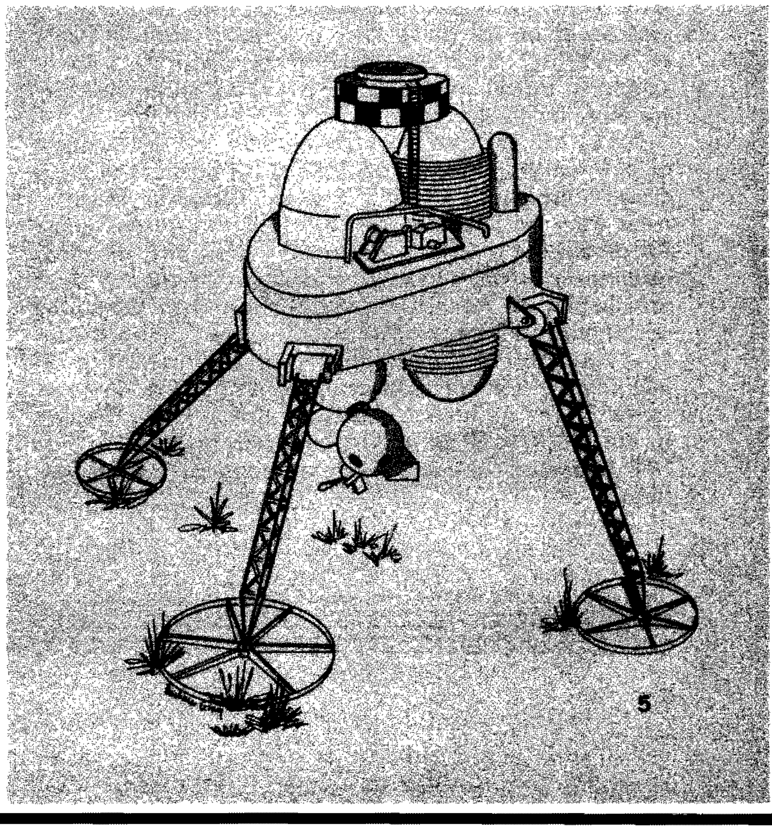
These technology areas, such as power sources, materials and structures, diver technology, and life support — to name but a few, are common to many activities in the ocean. The technology required to design and construct an offshore platform is essentially the same whether the platform is to be used for oceanographic research, petroleum recovery, or military surveillance.

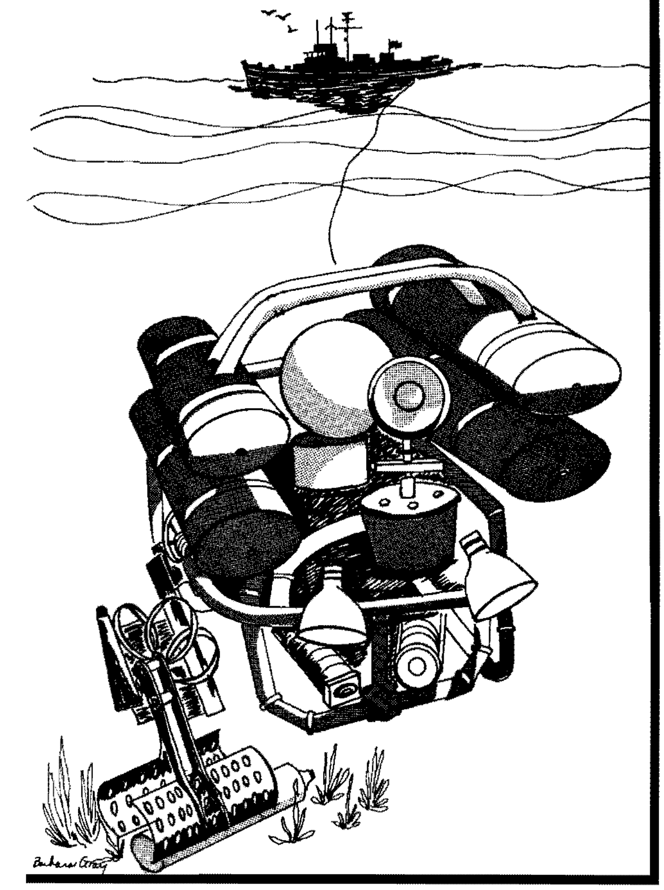
Systems for precise navigation at sea might be used for almost any ocean work system, regardless of the task. A fuel cell power source for a submersible vehicle might also be used for an underwater habitat which supports petroleum recovery operations. Knowledge of the behavior of materials in seawater is applicable to any endeavor in the ocean whether it is military, industrial, or scientific. The physics and physiology of diving is the same whether the diver is an oceanographer, a salvage diver, or a Seabee underwater construction diver.

A NAVFAC Responsibility

Thus it is that regardless of which of man's needs an ocean engineer is trying to fufill — national security, resource recovery, research transportation, or recreation — the technology for dealing with the problems of the ocean environment is basically the same. This body of technology — the know-how and the hardware — is ocean engineering.

The questions might be asked (and have in fact been asked of the author on many occasions),"Why are we in the Civil Engineer Corps concerned with ocean engineering? Why does the Naval Facilities Engineering Command (NAVFAC) support a large program of ocean engineering research at the Naval Civil Engineering Laboratory (NCEL)? Why do we send CEC officers to postgraduate





A CEC/Seabee Venture

The CEC officer's involvement with ocean engineering is not limited to duty assignments with NAVFAC headquarters or field divisions. Seabees are rapidly becoming more active in this field also. In addition to constructing tactical and logistic bases ashore, the Seabees have an underwater construction mission.

To meet the increasing requirements for underwater construction, an underwater construction team has recently been formed at Davisville, and another is being formed at Port Hueneme. When complete, these teams will be headed by CEC officers-in-charge and staffed with Seabees skilled in diving and underwater construction. Seabee divers have already been involved in a variety of underwater construction tasks ranging from the emplacement of the underwater habitats and structures, cable laying, and the evaluation of underwater tools at NCEL.

The tempo of ocean engineering activity within the CEC is increasing. As more underwater construction is required in support of Navy missions, more CEC officers assigned to NAVFAC or Seabee billets can expect to become directly or peripherally involved in ocean engineering.

school for special training in ocean engineering? What business do we have in the ocean? Aren't we primarily concerned with facilities? Isn't our responsibility limited to the shore establishment?"

The answer to these questions is simple, but it comes as a surprise to many CEC officers. Yes, we are primarily concerned with facilities, but not just with facilities on dry land.

NAVFAC has also been assigned the entire life cycle responsibility for fixed surface and subsurface ocean facilities (by NAVMAT NOTICE 5460 of 3 May 1966).

The responsibility for facilities does not end at the water's edge. If it is a fixed facility on land, on the ocean surface, or on the ocean floor it is under the cognizance of NAVFAC. This responsibility for ocean facilities is simply a logical extension of NAVFAC's responsibility for shore facilities.

NAVFAC has also been tasked with the development of new and improved capabilities in the ocean. The Deep Ocean Technology (DOT) Project, Technical Development Plan 46-36X, assigns NAVFAC the responsibility for developing a seafloor engineering capability. (Seafloor engineering is the construction and maintenance of fixed installations on the ocean floor, together with supporting operations.) A great deal of work has been conducted for NAVFAC by NCEL in developing this capability. In addition to seafloor enginering, NAVFAC is also responsible for the development of nuclear power systems in the range of 2 to 10 kilowatts (electric) and 100 to 500 kilowatts (electric) for ocean engineering applications.

Valuable technical reports are published periodically by the Naval Civil Engineering Laboratory concerning techniques and tests for Ocean Engineers, examples of which are indicated below.

TR-661 AN EVALUATION OF DEEP OCEAN RESEARCH VEHICLES
—J. B. Ciani

Summary of experience of specific submersibles for a variety of deep ocean engineering tasks, including evaluation of visibility, mobility, manipulator effectiveness.

TR-662 HOT WATER HEATING SYSTEM FOR DIVERS
—Dr. S. C. Garg

Investigation of hot water heater equipment, diver suits, hose and equipment related to diver warmth at extreme depths. Refinement and further testing necessary before widespread acceptance.

TR-653 DIVER PERFORMANCE USING HAND TOOLS AND HAND-HELD PNEUMATIC TOOLS
—F. B. Barnett and John Quirk

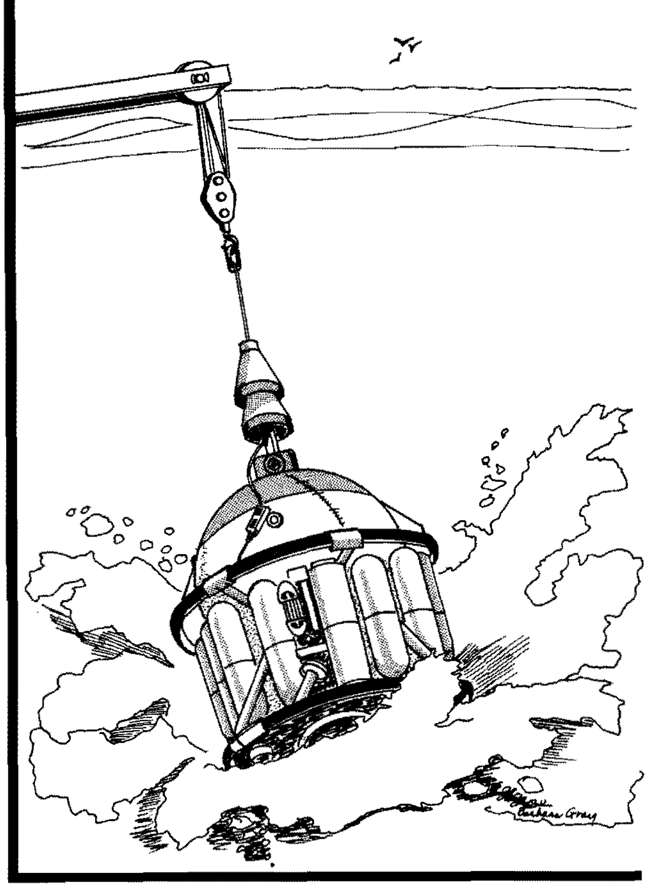
Tethering equipment results in approximately doubled applied force in underwater tool manipulation. A work platform permitting "leaning into" the job needs more investigation. Various types and kinds of tools tested.

To meet the requirement for indoctrination of both CEC officers and civilian engineers in the field of ocean engineering, CECOS has developed a two-week short course, *Ocean Engineering*, which is currently presented three times each year. The course, which was developed in-house by CECOS with assistance by NCEL*, is designed for graduate engineers who have had little or no experience working in the ocean environment.

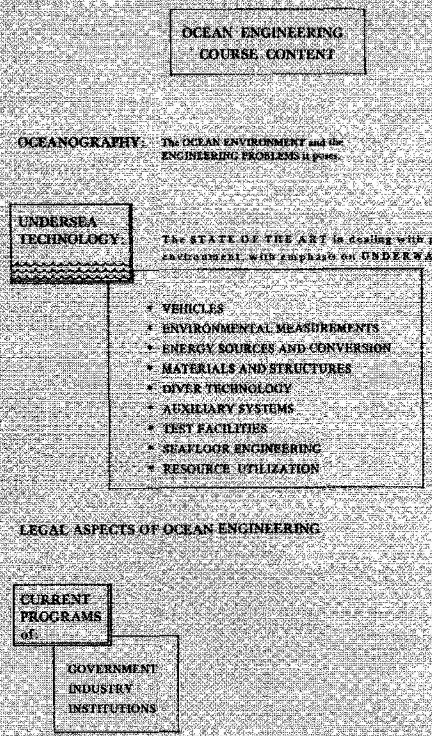
Since ocean engineering is primarily concerned with overcoming problems which are peculiar to the ocean environment, about 20% of the course is an introduction to oceanography, with emphasis on those aspects of the environment which are of particular significance to ocean construction.

Most of the course (about 70%) is a survey of the state-of-the-art in the various technologies necessary to overcome the problems created by the ocean environment. Such topics as energy sources, materials and structures, seafloor engineering, work systems, habitats, underwater lighting and television, navigation and positioning, manipulator systems, life support systems, diver technology, and test facilities are reviewed.

Emphasis is placed on the problems which are basic to each technology area and on concepts involved in the solution of these problems. In addition to current capabilities and limitations, the course surveys current development work which will lead to future capabilities.



The Ocean Engineering course structure which has recently been established at the U. S. Naval Schools, Civil Engineer Corps Officers (CECOS), is presented below.



While primary emphasis is placed on underwater technology, some coverage is given to legal aspects of ocean engineering and the significant current ocean programs of government, industry, and institutions.

The two-week course length does not permit in-depth coverage of any one topic — nor is that the purpose of the course. It is designed to introduce the engineer to the field of ocean engineering, to give him some of the basics upon which he can build by additional study and experience.

Toward this end, students are furnished an extensive bibliography of selected readings in each of the technology areas to facilitate further study in areas of particular interest after leaving CECOS.

Officers and civilian engineers interested in applying for the course should refer to CECOS NOTICE 1500 of 13 April 1970.

The steady trend towards more interest and activity in the oceans is readily apparent. The prospects for direct involvement in ocean engineering work are constantly increasing not only for CEC officers but also for civilian engineers both in and out of government service.

It is therefore fitting that every engineer endeavor to more fully understand the problems of this environment and the state-of-the-art in dealing with these problems.

* Valuable contributions to the course were also made by LCDR N. T. Monney, CEC, USN, assigned to the Office of the Deputy Chief of Naval Material (Development).