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The Diver in Oceanography

Precise undersea charting and techniques for independent navigation of submersible craft are in serious need of development.

Abstract: *Man's interest in the sea floor is growing with new demands for more detailed information about the continental shelf and coastal waters throughout the world. The ability of the human being to make logical decisions on the spot, and to manipulate equipment with his hands causes the diver to be indispensable. A scuba diver is weightless, and can move about with remarkable agility and freedom. The development of improved underwater cameras, rapid and accurate mapping techniques, and a dependable navigation system are some of the problems encountered in present day underwater exploration. These are a few of the ways that science and engineering can aid the underwater researcher and explorer in his quest for knowledge, which will aid man to live and work beneath the surface of the oceans.*

Today we are at the beginning of an exciting, new human exploratory venture—our conquest of inner space, the watery ocean frontier. This unexplored inner space makes up over two-thirds of our planet. Our continental shelf, the rim of the land beneath the sea, is less than a thousand feet deep and incomparably more accessible to us than the surface of any planet. This shallow sea floor has a greater surface area than the entire surface of the moon, and it is within our reach for the acquisition of food and minerals.

Much has been said about the ocean as a great reservoir of minerals and food but very little has been said about the importance of the ocean to science itself. Yet there can be few scientists today who are not very strongly aware of the important role the ocean plays in the development of their respective field, no matter how unrelated the sea may seem to be from their actual work. Compared to the land, the sea is a more natural environment for life, thus, biologists and medical researchers can study marine organisms in their comparative simplicity to reach an understanding of the more complex mechanisms of human beings. The geologist can study the floor of the sea to better understand the origin and structure of the earth.

Much of the history of the earth is found in deep sea sediments, i.e., a tremendous amount of information has been gathered through

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* Presented at the Annual Convention of the American Society of Photogrammetry in Washington, D. C., March 1967 as one of several papers on underwater photography, all contained in this issue.

chemical and biological analysis of deep sea cores. If there were no seas, our weather would be vastly different; the air circulation of the entire world is tied in with the ocean. The ocean is a great reservoir of water and energy.

There is no need to mention the importance of the ocean as a means of defense. A large part of the scientific and engineering effort in the ocean today is directed towards solving some of the problems of submarine communication, submarine detection and submarine destruction.

How can the diver fit into this picture? It is obvious that the diver can aid the scientist; however, science can also aid the diver. Oceanographic science has many instruments of varying degrees of sophistication, thanks to engineering technology. Underwater cameras, underwater television, unmanned submarine vehicles, a whole new array of manned research vehicles, many types of mechanical, acoustical, and electronic sensing devices—all of these are being used to pierce the sea and to reveal its secrets.

Divers are frequently required to install, to position properly or to align scientific instruments, to perform routine maintenance and upkeep on underwater instruments in cases where it is not practical to pull the equipment off the bottom or out of the water, to inspect underwater installations for damage, and to perform many other tasks involving the installation and upkeep of equipment.

The ability of the human being to make decisions on the spot and to manipulate things with his hands makes it highly desirable to have divers at work with the scientists, or to go one step further and have diver-scientists collecting data and perform underwater investigations.

Some of the latest concepts in gathering naval intelligence employ instrumentation which is connected to shore-based monitoring stations by cables. In recent years oceanographic data collection systems have been designed wherein hard-line telemetering of information has been the most expedient manner of transmitting data to shore facilities. The requirements for these types of systems appear to be on the increase. Use of this system requires laying cables over shorelines which are varied in topographic features, biological communities, currents, and response to wave action. These characteristics can best be documented by visual and photographic records made by personnel trained in the marine sciences. This type of information would be extremely difficult, if not impossible, to collect from a surface platform, and a diver with no training in the marine sciences may not recognize features which would be of salient importance. Thus it becomes necessary that technical personnel collect data in order to have a more meaningful collection and an eventual interpretation of the data.

In other words, to achieve maximum results the diver should be a scientist or the scientist should be a diver, and it is generally easier, or at least it takes less time, to train a scientist to be a diver. This is the procedure followed by the Naval Oceanographic Office. Scientists who wish to qualify as divers are required to complete satisfactorily the training course offered at the Naval Underwater Swimmer School, Key West, Florida. On completion of this course they are then ready to continue their study of the ocean without being restricted to the old conventional surface platform techniques.

Naval Oceanographic also employs a few non-scientific divers. This type of diver achieves his greatest value to science not in observation but in the engineering support of science—placing and servicing various underwater arrays of instruments, such as remotely controlled underwater television and listening stations; the operation of underwater vehicles and sleds to take continuous motion picture records while moving across areas of the sea floor in which the scientist is interested; marking and measuring sedentary organisms on the bottom of the sea in an effort to measure their growth rate; measuring the amount of sediment in channels to determine the rate of sediment deposition; and many other varied types of underseas work.

The important thing about the scuba diver is that he is not bound by gravity; he is weightless, free, and can move with remarkable agility and freedom of action. This makes him indispensable to engineering operations and scientific research. This will be increasingly evident in the future with the rapidly accelerting explorations of the ocean. The principal limitation in this development will be the length of time and depth at which divers will be able to work, and the tools and equipment he will have to work with. This is where science and engineering must help the diver. Many problems must be overcome before significant exploration of the underwater world can begin. Man must be able to use his senses and his manual dexterity for extended periods at considerable depths.

Much progress has been made by Cousteau, Link, and the U. S. Navy *Sealab* under Captain Bond. They are proving that man can live and work for long periods at great depths. Others are conducting experiments in liquid breathing. Dogs, mice, rats, and even cats, have been able to survive while breathing submerged in oxygenated liquids under pressure. Hampsters have also been kept alive underwater by surrounding them with a membrane which extracts oxygen from the water and releases carbon dioxide into it.

STILL ANOTHER PHASE of research and development remains which must progress at the same pace—that of precise area charting and photogrammetry underwater. In order to explore fully, and to develop and understand the seas of our planet, man and machine must be able to travel independently and at will over the bottom. As with land travel, he must have complete and accurate maps of its geography to prevent him from wandering about aimlessly. We must have a means of producing precise, accurate charts of the sea floor, charts which will reveal details and bottom features which are impossible to obtain using existing sonar techniqes.

Sonar is merely an accurate electronic depth sounding device. Would our terrestrial map makers be content with a few varied lines of radar contacts along the earth's surface from which to make their maps? The number of scientists who have the opportunity to dive or ride in a submersible to study the ocean floor are few indeed. Could the scientists who have studied the terrestrial portions of the globe have done so much if they had been unable to see the surface of the land? Now that man can live underwater for long periods of time, and cover great distances using propulsion devices, he has this advantage of being able to see the area under examination and thereby adjust his observation points in such a manner that the more essential features are accurately portrayed.

Just as terrestrial map making has evolved from simple sketches to extremely accurate high-speed aerial surveys, so must our sonar "sketches" evolve into extremely accurate high-speed underwater surveys. By adapting basic aerial photogrammetric principles to an undersea environment, many of the methods and procedures that took years to perfect on land could be transferred and applied immediately to undersea work. From the processed data of a survey of this kind, scientists would have color photographic mosaics of wide expanses of the oceans floor; extremely accurate photogrammetric maps showing the contours of hills, valleys, ridges and trenches; and stereo-pairs that would enable him to see the floor of the ocean in three dimensions. This photographic record would produce extremely valuable, environmental intelligence information for a significant number of critical nearshore areas of the world, and reveal many secrets to scientists and military alike.

MANY OTHER PROBLEMS remain to be solved—problems including turbidity, light scattering, and light absorption, to mention but a few. Science and engineering are already hard at work in most of these areas and will eventually overcome these obstacles. At present, most of the cameras and equipment used by divers consist of surface equipment which has been modified or improved so as to make it suitable for underwater use. Some advances have been made recently in this area, but there is room for much improvement. The underwater camera is an important tool for the diver. This instrument, used in recording the environment, is extremely valuable in almost every phase of oceanographic diver surveys.

It is possible at this time to gather information and photograph small areas of the bottom using conventional methods, but it requires long hours of underwater work with support from a surface vessel if the information is to be complete and accurate. The method to be used in each case depends upon the scope of the operation, the accuracy required, the number of personnel, equipment and instruments available. Some of the very general considerations that are important in the execution of this type operation are: conduction of a detailed bathymetric survey of the bottom using electronic depth recorders, performance of a visual reconnaissance, noting points of interest, outstanding features, composition of the bottom, marine life, etc.

With information collected from the bathymetric and visual survey, a decision must then be made as to the areas to be photographed, and the type of photographs that will best depict bottom features. It is easy to understand that a survey of this type can become very involved and time consuming. The same area, however, might be covered using high speed undersea vehicles equipped with specially designed photogrammetric camera systems in a fraction of the time normally required, and produce data having a much greater degree of accuracy than is possible to obtain at the present time.

WE HAVE A NEW frontier to explore under the sea and as with any frontier, we must make maps and charts to guide the generations who will follow us. Many serious and industrious underwater men are ready to explore and chart this new frontier. But they cannot proceed without the proper tools, and these can only be supplied by the land-based researchers and manufacturers. Men have already begun to live in the ocean in spite of our relative neglect of it. However, if they are going to explore this underwater world well, then modern technology must be prepared to aid them in all possible ways.

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spooled for still or motion picture cameras. They could be, however, and I am sure we would be willing to submit samples to anyone who is in a position to conduct some tests and supply us with the results. There might also be some advantage to high-speed films that are senstiive to the blue and green only. It seems that there is not much point to panchromatic sensitivity if no red light is present. Also, there might be some advantage to use films with thinner bases. Such films are made for aerial photography. A thinner base means that a camera can hold almost twice as much film as it can hold with a film with a standard thickness ordinarily used for motion pictures. To summarize black-and-white photography I would say, therefore, that we might consider a film sensitive to the blue and green, having a high contrast, and on a thin base.

Now let's speculate a little bit on color films. First of all, it seems that a definite advantage would result from using a color negative film rather than a color reversal film. For example, with a film such as Kodacolor, when making the prints one can use correction filters to restore the color balance. Because with a reversal film no color except blue and green exist at 25 feet, with a negative film one can make prints that are pretty good even if photographed down to about 30 feet. As with the black-and-white films, it seems that some advantage might occur from using a higher contrast film. Again, the aerial type films might be worth trying; also thinner base films might be worthwhile so that more film can be put in a camera. On color films, however, maybe we can go even further and state that there would be an advantage to some type of *special* color film, possibly one in which the red sensitivity is higher than it is with standard films. We are not considering making such a film at this time but it seems worthy of discussion.

This has been a very brief presentation only because so little can be said on the subject. We would welcome any thoughts and ideas that you may have.