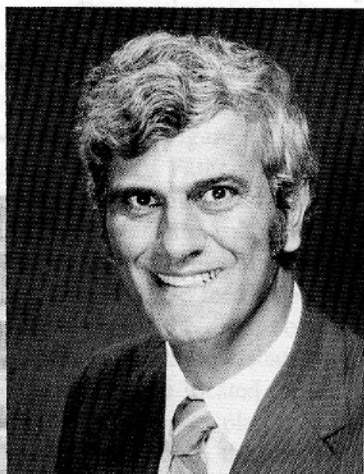
IEEE

OCEANIC ENGINEERING SOCIETY

NEWSLETTER

VOLUME XX NUMBER 1

EDITOR: HAROLD A. SABBAGH SPRING 1986 (USPS 420-910)



Harold A. Sabbagh
Editor

Anthony I. Eller
President

PRESIDENT'S COMMENTS

This is my first opportunity to address the membership at large of the IEEE Oceanic Engineering Society as President, and I wish to take this opportunity to summarize my views of the state of the Society and where I think we should be heading.

Ours is a new and healthy Society that has weathered the difficult transition period from Council to Society and is now emerging as one of the leading professional associations dealing with the application of science and engineering in the ocean at a highly technical level. Special credit for the good health that our Society has inherited goes to two people: First, to Stanley Chamberlain, our past President who guided the Society through the transition years with a policy that promoted individual involvement, the creation of Society chapters to promote regional involvement, and the creation of a base of Technical Committees to promote specialized technical involvement; and to Stanley Ehrlich, Editor of the Journal of Oceanic Engineering, who has helped through his leadership to build the Journal into one of international scope and recognition.

My own goals for the next two years are to further develop our sense of technical identity through expansion of the menu of technical conferences. Your ideas how to do this are welcome, and as a plan develops, it will be presented through this column.

Anthony I. Eller
President

IEEE Oceanic Engineering Society Newsletter is published quarterly by the Oceanic Engineering Society of the Institute of Electrical and Electronics Engineers, Inc. Headquarters: 345 East 47th Street, NY 10017. Sent automatically and without additional cost to each member of the Oceanic Engineering Society. Printed in U.S.A. Second-class postage paid at New York, NY and at additional mailing offices. Postmaster: Send address changes to IEEE OCEANIC ENGINEERING SOCIETY NEWSLETTER, IEEE, 445 Hoes Lane, Piscataway, NJ 08854.

FROM THE TECHNOLOGY EDITOR

Economical Winch Assembly Technique

INTRODUCTION

Winches are an important utility that provide the research oceanographers the ability to extent his senses into the ocean depths. The body of this paper is a picture review of a method to manufacture a style of winch that can be used with a single layer of instrumentated faired cable. Winches, like any form of research equipment, reflect the character of their application and construction budgets. For this reason, it is important to be able to economically adjust the design of a winch to fit the load, cable lengths, and type of power drive. The winch described here is manufactured primarily from aluminum alloys for light weight and resistance to salt water corrosion.

WINCH ASSEMBLY

The winch, as shown in Figure 1, was designed to be used with a single layer of Fathom Oceanology Ltd. faired cable for marine research. Storage dimensions of the winch drum are: 54.25 inch diameter and a 60 inch width. The cheeks of the drum extend 8 inches beyond the drum diameter dimensions. A cable feed-through hole is located on the power drive end of the drum so that the cable can be directed to holes in the hollow shaft for instrumental needs. Two access parts are located on the shaft to the inside of the drum center support plates. A hole is drilled in the cheek of the drum to attach the support member of the instrument cable. A plastic extrusion contoured to mate with the radius of the fairing nosepieces can be bonded to the winch drum surface. The extrusion will circle around the drum, similar to a LEBUS groove, and can function to protect the shape of the nosepiece and guide the lay of the fairings. By proper separation of the extrusion wraps around the drum it is possible to pay cable in and out without a separate fair-lead mechanism.

A three inch segment of the drum shaft extends beyond the drum base supports, either side, where additional hardware can be mounted to facilitate outputting signals, or pump water samples via electric/hydraulic sliprings from the special cable while the drum is still rotating. The drum shaft is manufactured from 3 inch outside diameter steel tubing with a half inch wall thickness.

Power to the drum is via an 84 tooth steel sprocket using number RS-80-roller chain. The sprocket is bolted to the drum flange in four places and secured to the shaft with four countersunk set screws. A 28 tooth sprocket is keyed to the output shaft of an 36:1 planetary gearbox on the winch base. The total gear reduction from the sprockets and gearbox is 108. A range of speed reductions up to 180 is possible by replacing the smaller sprocket. Before making this change, however, the roller chain specifications need to be reviewed for the winch line pull and speed factors. The planetary gearbox is driven by a Sperry Vickers hydraulic motor coupled through a hydraulic safety brake. The brake is off when there is at least 200 psi of fluid pressure. Any failure of the hydraulic system causes the brake to lock up the drum movement. Another safety brake is incorporated into the chain drive system. In case the chain parts for any reason, a chain idler arm will activate a mechanical wedge lock on the drive flange of the drum.

The gearbox/chain drive combination was chosen to allow a convenient conversion of drive power source and the possibility of deployed cable retrieval when all drive power is lost. With the 108 gear reduction to the drum, it is possible to remove the hydraulic motor and with an adaptor fixture be able to retrieve the cable. The fixture provided with this winch has a hex to spline shaft that directly mates to the hydraulic brake assembly or gearbox. For instance if the cable load was 600 pounds, it would require a torque capability of 150 inch-pounds to move the cable. This torque level can be achieved with a heavy-duty electric drill motor or even manual power through a ratchet paw. Admittedly, this method takes longer but it does offer the possibility of cable retrieval.

Another fallback state in this system is in the supply source. If the electric motor/hydraulic pump fails, a separate hydraulic source with the capability of 1100 psi and 18 gallons per minute will keep the winch functional. Most research vessels have this level of auxiliary hydraulic power available for A-frame operation etc.

The hydraulic power source for the winch is done with a 10-horsepower direct drive electric motor to a Sperry Vickers hydraulic pump. At 1800 rpm the pump will deliver 19 gallons per minute. An electric servo actuator is used to provide the pintle (shaft for volume control of hydraulic fluid being pumped) motion control on the pump. The actuator requires a 4 volt d.c. signal for maximum fluid delivery from the pump. A +4 volt signal will cause maximum drum rotation in one direction and a −4 volt signal a maximum speed in the reverse. A proportional voltage will, under specific line pull, provide a proportional drum speed. This system provides very gradual and gentle starts. The winch power train has the capacity to vertically hoist a 1200 pound load at approximately 160 feet per minute.

The electric motor, hydraulic pump, servo actuator and hydraulic fluid reservoir have been mechanically packaged into one unit so that it can be easily removed from the winch base. This feature enables the power unit to be remotely located to the winch base for better environmental use situations. Up to 50 feet of separation can be accommodated with the use of 1 inch diameter hydraulic supply hose between pump and motor. Alternate types of power transmissions can also be easily accommodated. Electric motor drives directly coupled to the planetary gearbox have been used for drum speeds up to 4 rpm.

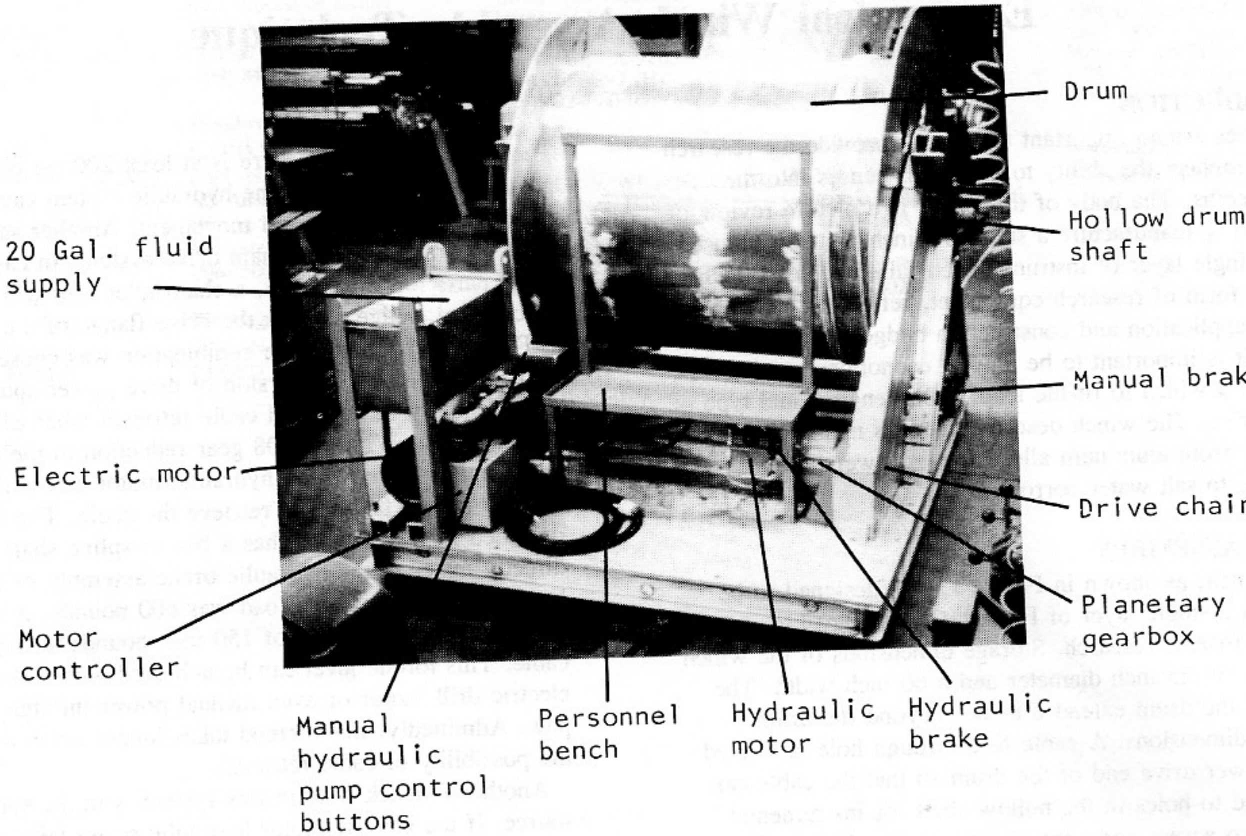


FIGURE 1. Rear view of the winch.

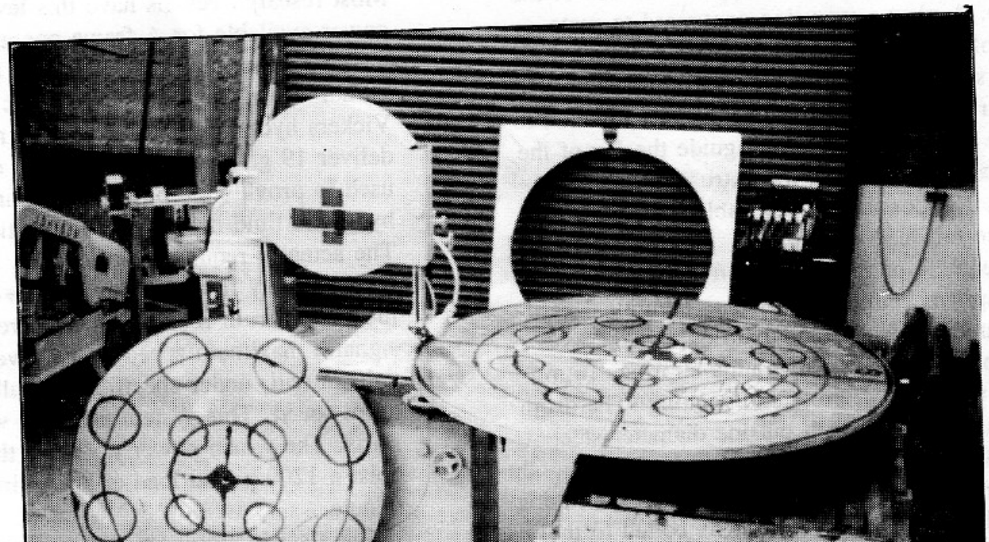


FIGURE 2. Set up for cutting out winch discs.

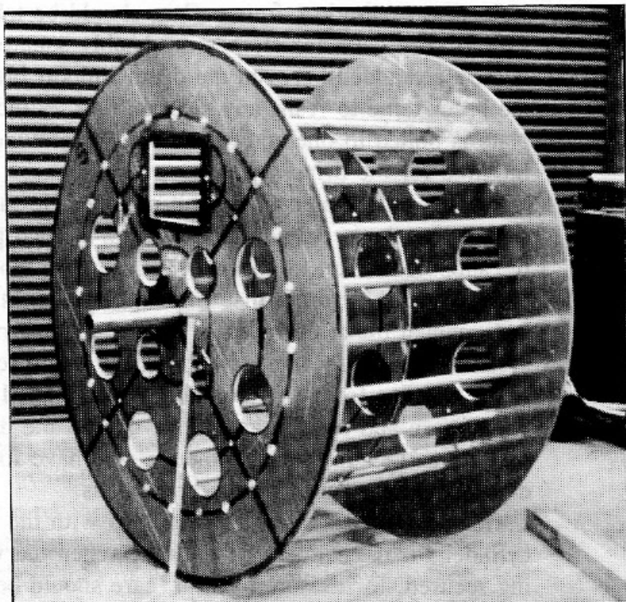


FIGURE 3.
Winch drum skeleton

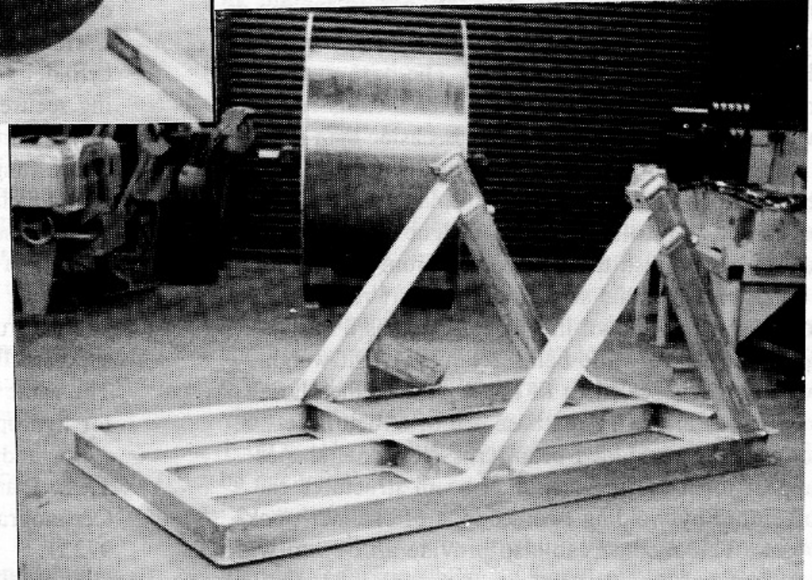


FIGURE 4.
Winch base and furnished drum

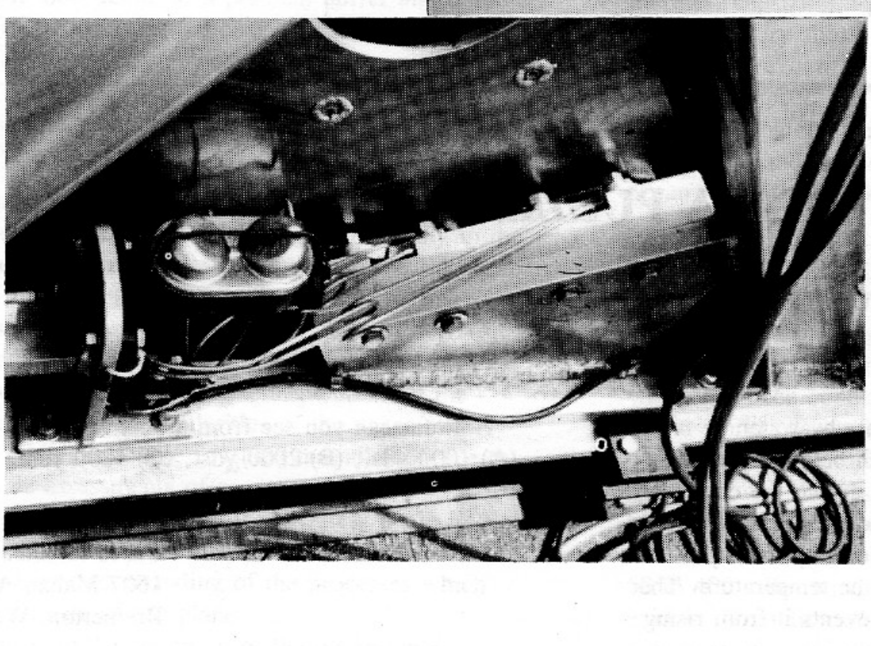


FIGURE 5.
Manual brake assembly on the winch base

The sequence of winch drum and base construction is as shown in the following figures. After layout the drum side plates (½ inch thick), and the center support plates (¼ inch thick) are cut circular with a metal band saw (Figure 2). This procedure can produce a round disc that is true to ±0.0625 inches. The discs are then ganged together and all holes drilled with a radial arm drill. Twenty four holes in the discs serve as sockets for the 1.25 inch spacer rods that form the drum support structure. The rods are machined with a shoulder on them to provide precise spacing between the drum plates. When the shaft, center rod support discs, and spacer rods have been clamped together, a metal inert gas (MIG) welder is used to secure the ends of the rods to the discs (Figure 3). Welds are also made at a few locations between some of the rods and the center support discs. Experience has shown that the side plates on drum shells constructed in this manner can run out of true by ±0.125 inches. It is important to have the side discs run as true as possible because, as explained later, they are part of the drum manual disc brake system. The next stage of the drum assembly is to have a ¼ inch thick skins rolled to place over the support rods. This step is easier than it sounds. After the skin is rolled, cut it into two half (c-shaped) sections that can be put into place more easily. Use a banding clamp to snug the shell tight to the support rods and weld and finish the cut seams. From the inside, weld at some locations the skin to the support rods. The final drum assembly, shown in Figure 4, forms a very rigid support structure while being relatively light weight.

The winch base is scaled to fit the drum and the chosen drive system. Materials for the base are of structural I-beam stock. If the standard I-beam cross sectional shapes do not appear to fit the application, I-beam structures can be manufactured by welding two sections of channel stock back to back. This method can also provide an I-beam with a much thicker web.

All of the base components can be cut to size on a metal cut off saw. As shown in Figure 4, the drum supports are welded to a base box frame. Care should be taken in this step to keep base box frames reasonably square. Corner gussets are added between the drum support brackets and the base frame to resist any side shift. A ¾ inch aluminum plate is bolted to one end of the base to provide a mounting area for the drive system.

Bearing pillow blocks are bolt mounted through the drum support brackets. An adjustment screw is incorporated into the support bracket to provide the means to move the pillow blocks for drum disc running adjustment.

A manual brake designed to be independent of the power system, makes use of one of the drum side discs. Two brake calipers from an automobile are mounted to the winch base and used to act on the disc of the drum for braking action. In this case the calipers have four independent pistons that push on the brake pads.

This assembly is shown in Figure 5 with the master cylinder for the calipers on the left. When the winch is being secured, for use on a vessel, care should be taken not to warp the base. If the base is warped, it will cause the drum flange used for the manual brake to run out of true. The winch base is rigid enough to remain true when sitting on most surfaces. If it is apparent that any corner or end of the winch base is not sitting flat, shims should be added under the base before solidly securing the unit.

This drum and base assembly technique has been used successfully to fabricate winches for faired cable systems. The same concept should be extendable to storage drums for hydrophone cables, etc.

For additional information, contact: Roderick Mesecar, Tech. Planning and Development Group, College of Oceanography, Oregon State University, Corvallis, Oregon 97331.

'TIS A PUZZLEMENT

LAST QUARTER'S PUZZLE

In The Trenches

Last quarter's puzzle was to explain why water temperature rises with increasing depth below 10,000 feet in depth. The water temperature rises due to the compression of the sea water. Even though the deeper water is slightly warmer, it is more dense since the pressure has a greater effect upon density than does the temperature. The greater density of the deeper water prevents it from rising.

THIS QUARTER'S PUZZLE

As Far As The Eye Can See

How far can you see from a boat in open water?
(A) 1000 yds., (B) 2000 yds., (C) 4000 yds., (D) 8000 yds.

Puzzlement Editor: David Holinberger
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MARINE SCIENTIFIC RESEARCH AS A NEW AREA OF TENSION BETWEEN STATES

Reprinted from OCEANS '85 Conference Record

V. V. Zdorovenin

United Nations*

ABSTRACT

Advances in marine scientific research (MSR) have created a deceptive illusion on the part of many coastal States of the availability of the ocean's wealth and have caused, in the recent past, an accelerating trend in asserting claims to national maritime jurisdiction over vast areas considered for thousands of years as the high seas. Marine science, having pointed out the resource potential of the world ocean to mankind, now finds itself in a paradoxical situation whereby many phenomena within its scope have now become virtually alienated from it as a result of the drastic curtailment of the freedom of MSR in marginal sea/ocean areas. What concerns marine scientists even more is that the process of adopting decisions on MSR is increasingly politicized and marine science itself sometimes becomes an instrument for achieving political results. This is exemplified by a case history of the thwarted plans of the USSR Academy of Sciences to conduct MSR in the South-West Pacific. A special role can and must be played by international organizations. Not only is their co-ordinating and organizational assistance important in this connection, but their action as a political buffer and possible moderator of conflicting national interests acquires particular prominence.

INTRODUCTION

For millenia mankind looked upon the seas as an alien, unknowable and unmanageable element and it is only in the last few decades that new understanding of the world ocean emerged as a result of advances in the field of marine sciences. First, the general picture of the ocean floor structure was elucidated in some detail that gave strong impetus to study and exploration of the mineral potential of the oceans. Second, the main regularities of the water mass structure and circulation were revealed that allowed one to make reasonable assessments of ocean energy and biological resources. And finally, the progress made in the study of the interaction of the ocean and the atmosphere resulted in a better understanding of the processes which determine the climate of our planet.

These advances in the cognition of the ocean have created a deceptive illusion of the availability of its wealth and caused in the recent past a mounting process of claims of national maritime jurisdiction over vast areas considered for thousands of years as high seas. Available data indicate that 90 nations have already claimed authority of one sort or another over a 200-mile offshore zone. Thirteen States among them claim a 200-mile territorial sea, 56 States assert varying degrees of authority over an area they call an economic zone, and 26 States claim an exclusive fishing zone.[2] However, these claims to jurisdiction and sovereignty over immense water areas and their floor do not realistically reflect exploitation potentialities of the States. Only a handful of technologically advanced nations are undertaking the first steps in mastering the ocean depths and even for them, the question is not of managing the ocean but merely of withstanding this hostile environment and coping with the difficulties it creates for man. The ocean itself as a natural force still stands fast as a most vigorous defender of the philosophical thesis advanced in 1609 by H. Grotius who enunciated that the sea could not be occupied; it was by nature intended to be free to all i.e., *mare liberum.* From time to time the ocean asserts its unrestrained power by crushing the most advanced submarines, capsizing huge anchored platforms and drowning modern luxury ships, thus ultimately stopping man in his marine endeavours. Mankind has just started mastering "the inner space" of the Earth, rewards are believed to be enormous, the challenge is immense and not yet fathomed to its depth and only the ever expanding study of the world ocean will let man take its wealth.

THE MARINE SCIENCE PARADOX

Almost all that is now known about living and non-living resources of the ocean came from marine science research which has been conducted by a few States in various parts of the world ocean. Elucidation of the circumcontinental distribution of the main mineral and biological resources of the ocean was the basic achievement of these studies. It was discovered that practically all sea oil and gas reserves and 90 per cent of fish stock are contained within the belt 50 to 400 miles wide which borders the continents. The evident diminution of natural resources on land and alluring prospects of conquering the offshore wealth have pushed the coastal States to claim sovereign and exclusive rights

*The views expressed herein are those of the author and do not necessarily reflect the views of the United Nations.

within a wide zone beyond the territorial sea over many types of activities, including marine scientific research, thus heavily upsetting the progress of fundamental science which views the world ocean as a single natural historical body. For example, it is impossible to study such a unique phenomenon as the Pacific orogenic belt without systematic geological-geophysical investigations in the margin of the Pacific Ocean, but the restrictions imposed by the Pacific coastal States upon marine geological and geophysical research in their offshore areas may seriously hamper or even make impossible the solution of this fundamentally important scientific problem.

World marine science has so far completed only the first, ''heroic'' stage of acquisition, accumulation and generalization of prime information. But, having pointed out the potential wealth of the world ocean to mankind, it found itself in a paradoxical situation when the phenomena it studies were virtually alienated from it be the efforts of many coastal States. It is quite evident that any further progress in the exploration and exploitation of the resources of the ocean would be impossible without prior advances of science; however, the majority of coastal States, in their pursuit of exclusive rights over offshore resources, have created grave impediments for the development of marine sciences. This could potentially lead to new forms of tension and disputes between States.

Very few technologically advanced nations are capable of carrying out large scale marine scientific research. Actually, world ocean science is represented only by such States as Australia, Canada, France, Federal Republic of Germany, Great Britain, Japan, New Zealand, the US and the USSR, and among them, the technical capabilities of the US and the USSR surpass those of other countries taken altogether. The assertion of offshore jurisdiction over scientific research is instigated primarily by developing nations, a fact which was particularly evident at the Third United Nations Conference on the Law of the Sea (UNCLOS). Lack of high technology, investment potential and qualified personnel in developing States for efficient participation in the use of the ocean has put those countries in an unfavourable position. In this context, one of their main problems now is to find ways and means to prevent them from being precluded from the exploitation of marine resources, this being a real possibility. Their alarm is reflected in the zeal with which they came out at the UNCLOS sessions in favour of claiming resource sovereignty in offshore areas. Under the pressure of their mounting requests, delegations from the ''researching States'' were gradually forced to agree on a regime under which the freedom of marine scientific research in the 200-mile exclusive economic zone and on the continental shelf would be for all practical purposes eliminated. Thus, the question of the freedom of marine science has become one of the questions of the general socio-economic confrontation of developed and developing nations. At the same time, new issues of a purely political nature are becoming already evident in this context.

MARINE SCIENCE, THE LOS CONVENTION AND EMERGING POLITICAL TENDENCIES

The urge to limit the freedom of marine scientific research is reflected in various articles of the Convention on the Law of the Sea. It will enter into force when it is ratified by 60 States but the impact of its drafting on the establishment of new rules of customary law of the sea has already been considerable. The provisions contained in the Convention, including those on marine science, can be viewed as an adequate prediction of the ocean law of the near future.

The main characteristic feature of the Convention's provisions dealing with marine scientific research in the exclusive economic zone (EEZ)* and on the continental shelf** is the establishment of a so-called ''consent regime'' which stipulates a complex procedure for requesting the consent of the coastal State for the purpose of carrying out a scientific project.

In order to obtain such consent a research applicant must submit a detailed proposal at least six months prior to the expected commencement of the project and official channels must be used for this purpose. It is implied in Article 246 of the Convention that the coastal State must grant its consent ''in normal circumstances'', although ''normal circumstances'' are not defined. It is only at the insistence of the US delegation at one of the last UNCLOS sessions that a new paragraph to Article 246 was added providing that ''normal circumstances may exist in spite of the absence of diplomatic relations between the coastal State and the research State''. At the same time, the right of the coastal State to withhold its consent is secured by the same Article 246 in a very wide and undefined range of circumstances: if the proposed project is ''of direct significance'' for the exploration and exploitation of natural resources; if the project ''involves drilling into the continental shelf, the use of explosives or the introduction of harmful substances into the marine environment''; if the project proposal contains ''inaccurate information''; if the research proposer has ''outstanding obligations'' from a previous research project. There are also other provisions in the Convention which ensure and enhance the jurisdiction of the coastal State over marine scientific research in the EEZ and on the continental shelf.

In their struggle for retaining the freedom of marine scientific research, scientists through sympathetic delegations have succeeded in including in the Convention some modest provisions from which the most significant is the provision concerninng the so-called ''implied consent'' according to which consent by a coastal State will be implied where it fails to act on a research proposal within four months of submission of the proposal.

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*Up to 200 miles from the baselines from which the breadth of the territorial sea is measured.

**At least up to 200 miles or, under specified circumstances, out to 350 miles from the baselines from which the breadth of territorial sea is measured.

Recent moves of the coastal States to control and prohibit marine scientific research in offshore areas have tended to confirm misgivings on the part of scientists who fear that rights of coastal States could be exercised on the basis of reasoning of a non-scientific, technical or economic nature.

There is a new tendency now on the part of coastal States to equate the legal status of research vessels to that of military ships or introduce new restrictive status. Some States have established a port call regime for research vessels which is even more restrictive than that for military ships. Some other States demand that research vessels submit their navigational data while entering and passing through a State's EEZ which is contrary to the principle of free navigation through the EEZ. This not only hampers marine research but also inflicts moral damage upon marine science.

The existing legal provisions and those embodied in the Convention and also the procedural frameworks used by coastal States are such that they always leave open to the coastal State ways and means of circumventing or preventing marine science research that might be incompatible with their national policies or international relations. Statesmen perceive marine science within the context of many political and economic interests which in some instances clash dramatically with the interests of marine scientists.

A CASE HISTORY

A case of purely political treatment of marine scientific research is represented by the story of the proposal of the USSR Academy of Sciences to carry out geological-geophysical studies in the South-Western Pacific. From the geological point of view, this is a unique area where one can find almost all types of the Earth's crust. However, the region is almost completely covered by 200-mile zones of island States with no space for free scientific research.

On the other hand, there is a special regional international organization acting here which is affiliated with the UN system and whose main purpose is to promote marine geological and geophysical research. This is the so-called Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) which works within the organizational framework of the UN Economic and Social Commission for Asia and the Pacific (ESCAP). This Committee is composed of the following South Pacific States: the Cook Islands, Fiji, Kiribati, Vanuatu, New Zealand, Papua New Guinea, Samoa, the Solomon Islands and the Kingdom of Tonga. At the annual session of CCOP/SOPAC in 1979 these States had requested the Soviet Government to provide non-reimbursable scientific aid to the countries of the region by conducting geological and geophysical studies in the CCOP/SOPAC area. In response to this request the USSR Academy of Sciences allocated the necessary funds and planned a cruise, the main objectives of which were to provide the countries of the region with scientific information pertaining to sea-bed mineral potential and to train their personnel in the techniques of marine research. At the next annual session of CCOP/SOPAC in 1980, the Soviet Academy came up with an offer to conduct this cruise in the South-West Pacific on board the Soviet research vessel "Callisto" in co-ordination with the programmes of CCOP/SOPAC and in co-operation with the Committee. As it was put in the official record of the session, the CCOP/SOPAC "was pleased to accept the Soviet proposal". The generosity of the Soviet offer which was the equivalent of 1.5 million US dollars was also noted in the report of the Committee.

A special working group had been established by CCOP/SOPAC which designated areas for cooperative research, formulated scientific objectives and outlined the organizational framework of the cruise. Specifically, the implementation of some national projects of Vanuatu and the Solomon Islands in the waters adjacent to these island States was suggested by this working group. The USSR Academy of Sciences accepted all those proposals and, through official governmental channels, submitted full information on planned research to the governments of CCOP/SOPAC member States.

Meanwhile, however, a message was sent to the USSR through ESCAP channels and that message made it quite clear that in spite of the warm welcome given to the proposed cruise by the representatives of the member states in the Committee, the governments of these countries now rejected this idea. The Government of the Solomon Islands stated specifically that it would "not allow Russian vessels into Solomon Islands' waters while Russian military forces remain in Afghanistan", and that "in the circumstances the Solomon Islands Government will not be responsible for any difficulties which could be encountered by the Russian vessel should the "Callisto" cruise continue and no facilities will be allowed in Solomon ports for replenishment of water, food, fuel, etc...". It is worth emphasizing here that the so-called "Solomon Islands waters" were suggested for research by the working group of CCOP/SOPAC and not by Soviet scientists, in other words, Soviet scientists were invited there by Solomon Islands' representatives. Finally, in August 1981, the Heads of Governments of the South Pacific countries adopted a special resolution on this subject at the Twelfth South Pacific Forum. They siad in it: "The Forum discussed the concerns expressed by the Government of the Solomon Islands that the USSR intended to proceed with a marine survey cruise in Solomon Islands and Vanuatu waters, contrary to the expressed stand of the Solomon Islands Government. The Forum expressed its support for the Solomon Islands' position not to allow the Soviet vessel "Callisto" to conduct a geophysical and oceanographic survey and research in Solomon Islands' waters as part of the CCOP/SOPAC programme, and for the Solomon Islands' decision not to accord the Soviet vessel assistance facilities. The Forum further welcomed the acceptable alternative offer made by the Governments of Australia, New Zealand and the United States to undertake a geophysical and oceanographic survey in the South Pacific in close collaboration with CCOP/SOPAC".

The representatives of the member states at the 1981 session of CCOP/SOPAC were instructed by their Governments to cancel their own request for scientific research.

In their response Soviet scientists stated that "any attempts to create an atmosphere of political confrontation within the Committee, and moreover to discriminate against purely scientific work on a political basis, infact, contradict the goals and the objectives of the Committee's activities. Such attempts can only complicate further promotion of scientific co-operation and that, in the first place, will harm the interests of the countries of the South Pacific".

While the political circumstances surrounding this incident were quite special, it clearly illustrates that the freedom to carry out marine scientific research can be seriously reduced as a result of political attitudes of coastal States asserting claims to jurisdiction over wide areas of the world oceans and the sea-bed. The presence of the "alternative offer" by Australia, New Zealand and the U.S. in this particular case shows that the interests of third parties were involved, which provides grounds for a conclusion that not only the process of adopting decisions on marine scientific research is politicized but marine science itself can become an instrument for achieving political results.

CONCLUDING REMARKS

The new "consent regime" eliminates some 37 per cent of the ocean from free marine research activities, which would include about 80 per cent of the scientifically most interesting areas. What is very important in this new climate is that research nations and other coastal nations will need to cooperate in multilateral and bilateral arrangements for promoting and planning marine scientific research. A special role can and must be played by international organizations. Not only their coordinating and organizational assistance is important in this connexion, but their action as a political buffer and moderator of conflicting national interests acquires particular prominence.

So far, international ocean organizations have received relatively little support from developed States in terms of funding, national legislation or acceptance of strong regulatory powers on the part of the organization.[1] Under new changing conditions, however, several forces may work to increase the interest of the developed States in ocean organizations. One of the main factors in this connexion would be the potential available through international bodies for increased access rights in the economic zones of other States.

For developing countries, a geographical location may be a strong factor so far as interests in organizational participation is concerned. The inadequacy of unilateral or even bilateral actions will become increasingly evident particularly with respect to semi-enclosed seas and other restricted water areas, as in the Western Pacific, and developing countries fronting a common semi-enclosed water body could be expected to support certain regional institutions. Existing examples of such institutions acting as regional co-ordinators of marine scientific research are two intergovernmental committees which work under the auspices of the UN Economic and Social Commission for Asia and the Pacific. One of them is the above-mentioned CCOP/SOPAC, and the second, a similar committee (CCOP), acts in the offshore areas of Southeast Asia. The member states of these committees tend to view their activity as essential for the development of their economic potential and actively support these organizations. At the same time, as we have seen in the case of the CCOP/SOPAC, political leverage multiplied by regionalism and applied to marine scientific research can be extremely damaging to marine science and may have grave repercussions for international scientific and political relations.

What is becoming evident is that while international organizations are expected to play a greater co-ordinating and intermediary role in marine scientific research under new realities of the marine order, they must at the same time make greater effort in order to protect marine science and international scientific co-operation from politization and political abuse.

ACKNOWLEDGEMENTS

I would like to express my appreciation to my former colleagues and opponents for the experience I received while participating with them at the CCOP/SOPAC sessions.

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OF OCEANIC INTEREST

Undersea Vehicles — The Military Side

Reprinted from SEA TECHNOLOGY, January 1986

By Frank Busby, Director, Busby Associates, Inc.

With OPEC rumblings of a price war and some oil industry analysts predicting $20/barrel, this is a year when the prudent would much prefer to review rather than forecast the future of commercial undersea vehicles. Besides, the commercial arena — particularly as concerns ROVs — is so well covered in trade journals and conference transactions that another review and prediction on this subject seems unnecessary at the moment. Instead — and in view of the military's stony silence for the past several years — it might be instructive to review a market segment that is the equivalent of the commercial segment and probably exceeds it in dollars, if not in fanfare.

Manned Vehicles

Military involvement with manned submersibles has pretty much been marking time since the late 1970s. Aside from upgrading *Sea Cliff* and *Turtle* to 6000- and 3000-meter depths, respectively, and improving the capabilities of their existing fleet of five vehicles *(DSRV-1, -2,* and the *NR-1),* the U.S. Navy has not progressed beyond their 1971 inventory of dedicated manned vehicles. Other navies of the free world have followed a somewhat similar path. The Canadian Armed Forces supports the diver lockout submersible *SDL-1* (launched in 1970 and subjected to extensive modification in 1984) and the hybrid vehicle *Smart ADS,* launched in 1982, which can be operated as a remotely operated vehicle or a one-man submersible. The French Navy operates *Griffon* (a 600-meter submersible) and *Licorne* (a 300-meter diver lockout vehicle). The French Navy also has access to the recently launched 6000-meter *Nautile* and the 1970-launched, 3000-meter Cyana, although both vehicles, like the U.S. *Alvin,* are operated by a non-military activity. Other navies, such as Sweden's, the United Kingdom's, Japan's and the PRC's have developed or support submersibles for submarine rescue.

For one who cut his teeth on manned submersibles, it is a sad but real fact of life that the untethered, manned submersible, although a superb specialist and deepwater investigator, has been reduced to a cameo role in the military sector.

Tethered, Free-Swimming ROVs

The military sector was the first to commit significant funds and effort to ROVs. The first major activity in this area took place at the Naval Ocean Systems Center (then the Naval Electronics Laboratory) beginning in the early 1960s with the tethered, free-swimming vehicle *CURV. CURV* was launched in 1965, and the following year was instrumental in retrieving a lost U.S. hydrogen bomb in some 600 meters of water off the coast of Spain. Although the H-bomb retrieval received a great deal of recognition for *CURV,* the undersea vehicle community was more interested in manned vehicles at the time.

And from 1966 until the early 70s the tethered free-swimming ROV was a solution looking for a problem.

With the advent of the first commercial appearance of an ROV in 1974 (Hydro Products' *RCV-125,* later designated *RCV-225),* and the subsequent boom in ROV production and application in the offshore oil and gas market, the military applications of ROVs were, from a news standpoint, virtually ignored. The U.S. Navy and other navies continued improving their prototypes and developing other vehicles, but only in batches of one or two; not on the production line assembly of commercial vehicles.

Indeed, some of the commercial manufacturers made their debuts into this field by development of military vehicles, two such companies being Hydro Products and Ametek/Straza Division.

Military applications of ROVs in the 70s closely paralleled those of the manned submersibles: inspection of hardware, sunken vessels and downed aircraft; survey of sites and routes; search/identification/retrieval and retrieval assistance; and, while not of pressing U.S. interest then, other navies began fitting ROVs into mine neutralization applications. This later application is discussed more fully below, for it developed into the single most widespread market for today's military ROVs.

The military, without exception, does not tout its ROV capabilities as does the commercial operator, but the commercial ROV manufacturer must, if he is to survive and expand, make known his track record. From such sources the following Navies fall into the ranks of ROV operators: U.S., Canada, U.K., France, Italy, Japan, Sweden, South Korea, Thailand, Nigeria, Israel, Egypt, Belgium, the Netherlands, Malaysia, Yugoslavia, West Germany and Norway. This roll call is undoubtedly minimal, and the notation of the manufacturer's production lists of "Clients Unspecified" probably shelters a number of other naval members. The Soviet Union acknowledges having made at least one 1500-meter ROV, and it is safe to assume that it has made others.

The uses to which these various navies apply their ROVs is not much different than industrial applications. Most of these were listed above, and may also include rescue assistance and diver assistance. Some of their operations, however, tend to make international headlines when, and if, they are successful. One such operation took place in 1982 when a Soviet submarine was bottomed for several days in Swedish waters offshore Karlskrona. The Swedish Navy, at that time the owner of at least four *Sea Owl* ROVs, had the capability to inspect and videotape at its leisure the details of this submarine with not too much more difficulty than did the residents of California recently watch the comings and goings of a semilandlocked whale.

It is difficult to provide an exact count of the numbers of ROVs that the various world navies use for what can be termed general purposes. An estimate of perhaps 30 to 40 does not seem exorbitant and, with the advent of the Low-Cost ROV (see *Sea Technology*, December 1985, page 10) this number can be expected to increase significantly.

The major area in which ROVs have found a home in the military is in mine inspection and neutralization. Beginning in 1973 the French firm Societe ECA of Meudon began production of a mine neutralization ROV called *PAP 104*. U.S. ROV manufacturers and their foreign counterparts hardly noticed this vehicle until about 1979 when the firm announced the sale of some 120 vehicles throughout the world. By 1981 the count had risen to 160 and today has reached somewhere between 230 and 250 with sales to six European navies and Australia, and a combat-proven record in the Falklands where it reportedly went through thousands of missions. Also by 1981 the cat was out of the bag and virtually every major ROV manufacturer joined the chase. The rewards were considerable as the per-system cost of *PAP* is in the neighborhood of $350,000.

Whereas Societe ECA has the field to itself until about 1981, today they are meeting some stiff competition from established firms and from newly created partnerships that now foresee what the French saw over a decade ago. The mine neutralization vehicle list of today is impressive. Below are listed some of the vehicles and their manufacturers who offer an alternative to *PAP:*

- *MNS* (Mine Neutralization System) — Nine vehicles being produced for the U.S. Navy at a cost of about $30 million by Hydro Products.
- *ADROV* (Advanced Development ROV) — Prototype being developed by Hydro Products for the U.S. Navy's Explosive Ordnance Disposal Technology Center.
- *MIN* (Mine Identification and Neutralization) — Constructed by the SMIN Consortium of Italy on behalf of the Italian Navy.
- *Minnow* — Operational prototype constructed by Marconi Underwater Systems in the U.K.
- *Pinguin B3* — Built by the West German firm Messerschmitt-Bolkow-Blohm GmbH (MBB) to address that country's mine identification/neutralization programs.
- *Sea Eagle* — Constructed by the Swedish firm SUTEC. The Royal Swedish Navy reportedly operates several of these vehicles.
- *UTAS-280* — Constructed by Teksea S.A. of Switzerland.
- *Trailblazer* — Constructed by International Submarine International, Ltd., of Canada and its associates Fairey Systems, U.K., and Underwater Systems of Australia.
- *Pluto* — Some 14 of these vehicles have been built for various navies by the Italian firm Gay-Marine.
- *MiniRover* — A low-cost ROV built by Deep Sea Systems International and purchased by the U.S. Navy's Explosive Ordnance Disposal Technology Center.
- *MicROV* — Constructed by OSEL (Offshore Systems Engineering Ltd.) and GEC Avionics of the U.K.

Many of the above will be contenders for the Royal Navy's tender to build upwards of 16 ROVs for mine inspection (RCIV — Remote Control Inspection Vehicle) and neutralization (ICMDS — Internally Controlled Mine Destruction System).

Emulating the French penetration into the mine neutralization vehicle field, the Lockheed Marine Group has quietly gone about the business of developing a low cost system to neutralize naval underwater mines. The project is under the aegis of the U.S. Naval Air Systems Command. This past summer Lockheed received a $5.2 million contract from design through testing of this wire guided, helicopter-deployed vehicle that will augment existing airborne mine countermeasures capabilities (see *Sea Technology*, September 1985, page 61). The contract calls for delivery of 100 test models and two remote control consoles. The technical predecessor to these test vehicles was called LENS (Low-Cost Expendable Neutralization System) and was begun in 1983.

Some appreciation for the military impact on the tethered, free-swimming ROV count can be gained by considering that of a total of 740 ROVS developed, 315 were for military applications. This does not take into account the 100 LENS-type vehicles or the tenders out for additional mine identification/neutralization vehicles.

Towed Vehicles

The U.S. Navy has long been active in the field of deep (6000-meter) towed ROVs. In 1960 the Marine Physical Laboratory, Scripps Institution of Oceanography, developed the Deep Tow under the direction of Dr. Fred N. Spiess and with funding from the U.S. Navy. Some 25 years later, and after numerous modifications and upgrading, Deep Tow is still operating. Other towed vehicles were developed by U.S. Naval activities in the interim: Teleprobe by the Naval Oceanographic Office and DOSS (Deep Ocean Search System) by the Naval Research Laboratory. More recently the Royal Navy has entered this field with TUMS (Towed Unmanned Submersible) and the U.S. Navy's Submarine Development Group One took delivery on the STSS (Surface Towed Search System). These vehicles were developed for search/survey/location/identification and large-area reconnaissance.

Not too many of the world navies report development of towed vehicles. Development had proceeded under relatively low visibility until the discovery of the *R.M.S. Titanic* last September. The identifying vehicle used by the Woods Hole Oceanographic Institution in this memorable find was the towed vehicle ARGO, whose development is being funded by the U.S. Navy. The vehicle from which the remarkable still photographs were taken was ANGUS, another U.S. Navy funded effort. That such a capability exists will no doubt open the eyes of other navies to another aspect of ROVs.

Untethered (Autonomous) Vehicles

Here we enter the dark world of ROVs where virtually nothing has been heard publicly from the military of any country for several years, if at all. Some 23 programs in this arena can be identified from the open press. Of these, 14 are supported by the military. At present most untethered or autonomous ROVs are primarily developmental vehicles that are identifying the problems and technological pitfalls that must be hurdled to make this approach a practical and effective alternative to cable-connected vehicles.

Autonomous ROVs have been used by the U.S. Navy since the early 1960s but, similar to towed vehicles, their numbers were limited to a handful. More recently, due in large part to the advent of the microprocessor, this type vehicle has seen a greater emphasis by the military. Since the autonomous vehicle is, by nature, designed to operate at distances beyond visible range of its support craft or station, it can conduct missions covertly and/or under ice. This capability is of obvious interest to the military. Consequently, many of the applications of the autonomous vehicle and its performance/design specifications are classified.

Untethered vehicles currently operate in one of two modes. One is pre-programmed, or autonomous, in that a task is given to the vehicle's microcomputer, which directs the vehicle in terms of its depth, course, speed, what data to collect and when to return. All of these functions are carried out without surface intervention.

A second operating mode consists of controlling the vehicle's course, depth and dive duration via an acoustic link to the surface. Currently, most data collected is recorded in the vehicle and reviewed when the vehicle is retrieved. Ideally, many applications would require that the date be telemetered to the surface in real-time as the mission progresses.

The applications of untethered ROVs by the military are varied and include search, identification, survey, broad area reconnaissance, mine countermeasures, mid-water tracking and serving as a model for submarine hydrodynamics studies. Given the capability of a long-range, high payload, ''intelligent'' and covert untethered ROV, the mind fairly boggles at the military possibilities.

One application for this capability has been developed, somewhat surprisingly, by the Swiss firm Teksea of Lugano. The purpose of the vehicle, called *Telmine,* is to destroy ships, platforms, dams, docks, etc. *Telmine* has a maximum depth of 150 meters and an effective range of up to 500 kilometers. The vehicle is installed on the bottom where it awaits an acoustic activation signal from the shsore, a ship or an aircraft. Once the signal is received, the vehicle self-releases from its anchoring base and ascends to the surface. At the surface an antenna is deployed which can receive radio signals that contain course commands. At 500 meters distance from the target, the vehicle increases its positive buoyancy and emerges to the point where a TV camera atop the vehicle extends above the water's surface. At this point, the target is acquired on TV and guided from there to the target where it explodes on contact or by proximity.

Gaseby Dynamics of the U.K. is currently developing an expendable intelligent decoy and has prototype systems under test. Mounted in magazines on a surface vessel, as many as six of these vehicles can be deployed into the water if the presence of acoustic torpedoes is suspected. Against a passive seeker it would automatically begin a seduction or distraction program, while against an active seeker it would store the sonic transmission then retransmit it with added doppler and time diference to seduce it also. (*Military Technology,* Vol. IX, No. 11, 1985.) Likewise such decoys can be launched from submarines or aircraft.

Researching into the future, the European-based Scicon Company has conceptually developed *SPUR* (Scicon's Patroling Underwater Robot). The full-scale vehicle would be between 10 and 11 meters long with a 1.8 meter cross section. Normal propulsion would be by an oxygen/hydrogen fuel cell and higher attack speeds of up to 50 knots may be obtained from either a closed-cycle engine or batteries. At cruising speed the vehicle would have an action radius of 1850 kilometers, and endurance of two months and, for certain applications, be capable of diving to 6000 meters. *SPUR* would be under shore control and artificial intelligence would be used to assist functions which *SPUR* would need to perform autonomously, expecially in the fields of tactical decision-making (e.g., route planning, target classification, attack maneuvers, and communications routines). Scicon foresees such roles for *SPUR* as mine countermeasures (using manipulators), vessel destruction via torpedoes, wrap-around wire system deployment directed against a ship's propellors, and, as a last resort, an intelligent mobile mine. The company further envisions ''wolf packs'' of *SPUR*s deployed in a patrol line to create barriers up to 370 kilometers long.

Future Military Trends

Space does not permit a detailed discussion of all the trends that might take place in the military with regard to ROVs, but the two areas discussed above, mine neutralization and autonomous ROVs, stand out as two with the greatest potential for future development.

There is no question that ROVs in the mine neutralization field will become more dexterous, maneuverable and sophisticated. With incorporation of microprocessors into the system they seem likely to also become more intelligent. The future of mine warfare seems also assured, as mines of almost any design can place a country on alert within a moment's notice, witness the recent Red Sea mining event. There is, however, another option that was brought about by the advent of the Low-Cost ROV (LCROV).

The debut of the LCROV, which costs from $25,000 to $50,000 complete, has given some members of the mine neutralization community cause to reflect. This reflection is centered around the philosophy of an expendable mine neutralization ROV, much like the current Lockheed vehicle for Naval Air Systems Command. Considering that there is a fairly good chance that the ROV, regardless of sophistication, might very well activate the object it is inspecting, perhaps it might be more cost-effective to simply go with the LCROV and accept the loss.

Another aspect of consideration is the deployment problem. The MNS vehicle typically weighs over 1000 kilograms, a weight that requires a ship of moderate size that can accommodate the launch/retrieval system necessary to handle the vehicle. The result is that the mine-sweeping vessel must be dedicated to the task of operating one vehicle at a time.

The argument has been advanced that with a LCROV, which weighs less than 20 kilograms and can be powered by 12-volt batteries, it would be possible to carry on several mine inspection operations concurrently from nothing larger than a 4- to 6-meter outboard powerboat. Another problem with the large, massive systems is the time and requirements they take to respond to an emergency situation. Although air-transportable, the complete MNS suite weighs in excess of several tons, particularly if a launch/retrieval system must accompany the vehicle. An LCROV can be carried in as few as two cases as excess baggage. Lead acid batteries, if necessary, can be found almost anywhere in the civilized world, and the 20-kilogram vehicle can be launched/retrieved by almost any healthy adult male or female.

The autonomous vehicle seems likely to receive considerable attention from the military. At least 20 years ago the subject of an untethered vehicle arose, and beginning in the mid-70s serious efforts were applied to its development. In the late 1970s and early 1980s, coincident with the burgeoning of the microprocessor, the autonomous field took on a new complexion. Prior to the microprocessor or microcomputer, the main task was simply to get the vehicle to work as scheduled. With the microprocessor the task became one of increasing its working capabilities. This field now, in 1986, holds the potential for future development as did the tethered ROV in 1975. The recent use of drone aircraft by Israel to locate and assess the efficiency of Syrian missiles — as well as the sophistication of the terrain-following cruise missile — are but two examples where the application of autonomous vehicles have achieved success in the military. The potential for undersea applications are equally as widespread and no less achievable.

Advancing the State of Ocean Science

Reprinted from SEA TECHNOLOGY, January 1986

By RAdm. John B. Mooney, Jr., USN
Chief of Naval Research

The accomplishments of basic research are, by definition, not usually apparent to the casual observer or the hopeful industrialist. We nibble away at the scientifically unknown with the knowledge that dramatic breakthroughs occur only infrequently.

The objective of the Office of Naval Research, on a year-to-year basis, is to advance the state of science in areas of interest to the Department of the Navy by attempting to discover or understand the basic processes above, in, on, and under the world's oceans. These processes include physical, chemical, and biological oceanography; atmospheric science; underwater acoustics and optics; and seafloor geology and geophysics. Much of our work relates to antisubmarine warfare, both acoustic and nonacoustic. Other areas of naval interest include surface, air, and mine warfare and surveillance.

The 1984 initiatives by the Secretary of the Navy and Chief of Naval Operations made 1985 a particularly active year in our community. ONR is now funding four new Secretary of the Navy chairs in oceanography, whose incumbents — Walter Munk, (Scripps Institution of Oceanography), Carl Wunsch, (Massachusetts Institute of Technology), Jim O'Brien, (Florida State University), and Bob Ballard, (Woods Hole Oceanographic Institution) — represent the cream of America's scientific crop. A new oceanographic research ship appears close to reality and progress has been made in plans to modernize and replace our current research fleet.

Last year also saw increased emphasis on graduate oceanographic education within the Navy, with Ensign Christine Holderied becoming the first student to enter the Joint Woods Hole-Massachusetts Institution of Technology master's degree program in oceanography. At the same time, ONR expanded its fellowship program for Ph.D. candidates, selecting seven top university graduates, including one from the U.S. Naval Academy, for its Secretary of the Navy Oceanography Fellowship program.

Funding for environmental sciences in the contract research program for 1985 was $56.5 million and productivity continues to be high. Our scientific accomplishments for Fiscal Year 1985 cover a wide spectrum of disciplines and are probably best listed by the scientific area in which they occurred.

Without question, the most glamorous accomplishment in the history of the Ocean Technology Program was the recent discovery of the *R.M.S. Titanic* during sea trials of the ARGO undersea search system. The combination of optical and acoustic sensors on this towed system provides an unmatched operational undersea search capability that was used on its first science cruise in December 1985 on the East Pacific Rise. Another accomplishment that received international attention was the "vortex foil" concept for minimizing maintenance dredging requirements in harbors. This development uses the turbulence generated from specially designed foils in tidal or river currents to promote erosion and suspension of sediments in navigation channels. Inquiries have been received from around the world about this approach to sediment management, and it is likely to be used by the commmercial as well as the military sectors.

Finally, work has been initiated to establish the feasibility of starting and maintaining electric arcs and chemical flames in the ocean depths from 1,000 to 6,000 meters. This science will lead the way for the thermal deep ocean work systems of the future.

A major accomplishment of the Research Ship Management Program was completion of the upgrade of the *RV Moana Wave* in concert with the National Science Foundation. Improvements to the ship included a 9-meter midbody stretch, a 2-meter stern extension, and installation of a two-level deckhouse. As the ship was relatively small overall, and too noisy for a multibeam echo sounder installation, scientists at the University of Hawaii have installed a Sea MARC side scan sonar in a towed fish. This system has remarkable capabilities to define morphological characteristics of the sea floor, such as outcrops, seamounts and erosion patterns.

The Physical Oceanography Program is concerned with understanding ocean processes and phenomena so they may be more effectively incorporated in future ocean numerical models. A ventilation model was developed to explain the formation of mode waters, such as the 18°C water in the Sargasso Sea, which will lead to a better understanding of the thermohaline component of ocean circulation. The confluence of the Brazilian and Falkland currents was characterized by an observational program using ships, drifting buoys, satellite sensors and oceanographic moorings. Measurements of internal waves under the arctic ice sheet found lower amplitudes and a flatter spectrum form than predicted by Drs. Munk and Christopher Garrett of Dalhousie University in Canada in 1975.

The Coastal Sciences Program is closely associated with the shallow water problems of the Marine Corps. The existence of 10 kilometer wavelength edge waves that are the source of low frequency motions in the nearshore zone was confirmed. A theory of coastal trapped waves to sea floor and beach processes was demonstrated. The feasibility of using an electromagnetic sounder to depths of 300 meters was proven. This sounder meets the International Hydrographic Bureau's accuracy standards.

A new capability for computing tides and currents, including compensation for earth tide motions, in shallow water regions such as the New York bight was developed. The first comprehensive experiment to describe the oceanography of the sea straits with accompanying atmospheric forcing was begun at Gibraltar.

The first interdisciplinary bioluminescence experiment conducted at sea, which involved physical oceanography, ocean optics and oceanic biology, demonstrated the validity of a new ocean prediction bioluminescence model. A 100kHz to 5MHz sonar was used to detail the distribution of small plankton and nekton at an ocean thermal front. Sonar classification was primarily by scattering size. Detailed species identification was by standard net tows.

Hydrogen peroxide distribution was modeled and observed in well-lit tropical waters. The presence of peroxide sea water causes fundamental perturbations in trace chemical distributions and modes of reactivity with consequences for man's impact on the upper ocean. An *in situ* chemical anaylzer carried by DSV *Alvin* promises a CTD-like revolution in chemical sampling and analysis for many chemical species and nutrients in seawater.

In the area of marine meteorology, ONR participated in the pilot phase of the international humidity exchange experiment at the ocean surface (HEXOS). This North Sea experiment will define the underlying physics of the bulk moisture transfer co-efficients between the ocean and the overlying atmosphere. In a water tank, ONR investigators simulated realistic thermal convection in the marine planetary boundary layer. This work will ultimately uncover the physics of convection within the layer.

In atmospheric physics, a cloud chamber, supported by ONR with the Army and Air Force, was completed. This chamber will be used to study water droplet formation in clouds and fogs. In other work, a study of the buildup of static electricity in hovering helicopters identified the engine exhaust as the principal charging source.

Pertaining to arctic research accomplishments, ONR completed marginal ice zone experiments during the winter in the Bering Sea and during the summer in the northern Greenland Sea. Initial results provide an indication of the impact of the marginal ice zone on the planetary boundary layer, specifically: wind speeds, roll convection cells, oceanographic jets upwelling along the ice edge and acoustic conditions. Acoustic studies established the fact that large sparse arrays can be processed by high-resolution techniques, thereby maximizing the likelihood to isolate individual ambient sound sources for both spectral characteristics and frequency of occurrence in time and space.

In marine geology and geophysics, good correlation was established between band-passed *Seasat* altimetry data and shipboard measurements of gravity and seismics. Fine scale undulations found in the *Seasat* data reflect minor or buried fracture zones. Specral analysis of seamount bottom topography indicates a nonstationary, anisotropic, red noise process. Initial testing of an airborne gravity measurement system has demonstrated accuracies that show promise of achieving required levels for operational naval measurement programs. Multibeam echo sounders have been installed on three academic research vessels: *RV Washington* (Scripps Institution of Oceanography), *RV Conrad* (Lamont-Doherty Geological Observatory), and *RV Atlantis II* (Woods Hole Oceanographic Institution). Additionally, software was developed to incorporate the ship's precise position, making multibeam systems effective survey instruments as well as research instruments for marine geological research.

There were also accomplishments in remote sensing and surveillance. Using space data from available satellite altimeters, scientists were able to map features of mesoscale ocean topography, thus opening the door for future synoptic ocean surface mapping. Furthermore, the

Coastal Zone Color Scanner was demonstrated to be quite effective in detecting mesoscale ocean features in cases where other sensors (particularly infrared) might not be effective.

In regards to synthetic aperture radar (SAR), a major field experiment using the NOSC Tower in San Diego was completed. A number of theories for SAR imagery have been developed as a result of this and other associated work. Additionally, the importance of non-Bragg scattering in radar remote sensing in general was determined, and in other work it was verified that the dominant scattering mechanism for multiyear ice is volume scatter in the winter and surface scatter in the summer.

Although funding levels are not expected to increase significantly over the next few years, new research initiatives have been approved to start in 1986 and 1987 and are funded for five years. In 1986, our SAR research option will investigate the physics of radar imaging of the sea surface with an eye toward improving SAR's application prospects. The new Heavy Weather at Sea research option is designed to improve our understanding of the rapid cyclogenesis occurring in the North Atlantic, which can have disastrous effects on naval operations and shipping in general.

The Real Time Synoptic Ocean Prediction option will develop a realtime prediction capability for synoptic ocean phenomena. The Coastal Transition Zone initiative is designed to help understand ocean dynamics in regions influenced by the adjacent coastal boundaries. The Real-Time Environmental Arctic Monitoring and Modeling program is directed toward real-time monitoring and modeling of the arctic environment and acoustic conditions.

Finally, we have just begun a program called Extreme Environmental Habitat, which will asist in understanding the mechanisms of bacterial function and growth in inhospitable environments, such as extreme heat, high concentration of salt of toxic chemicals, or anaerobic conditions.

In 1987, programs are funded to cover major new research on factors controlling tropical cyclone motion, a study of the marine microlayer, and a study of marine biosurfaces for solutions to marine corrosion problems. On the drawing board of 1988 and beyond, we see initiatives designed to improve our understanding of ocean waves and our ability to study them using sensing methods. We also forecast an increased emphasis on energy transport mechanisms at the sea floor/water interface, and hope to fund a study of acoustic transients that would ultimately lead to improving our anti-submarine warfare capability.

ELECTRICAL PERSONALITIES

KARL FRIEDRICH GAUSS (1777-1855)

The science of electricity owes to Gauss the exact mathematical formulation of the magnetic field. Gauss was a natural mathematical genius whose mind functioned in a manner peculiar to such intense, concentrated and penetrating thinking and it was fortunate for the evolution of electrical science that at an early stage in its development, this fine mind turned to the resolution of its intricate problems.

Gauss was born in the humblest surroundings in Braunschweig, Germany. His unusual ability to solve complex mathematical problems at a very early age won for him the patronage of Ferdinand, Duke of Brunswick. At eighteen Gauss had already evolved the method of "least squares", a device of great practical value to the surveyor and to the statistician. Another popular aid to the statistician, the rule of normal distribution of errors with its accompanying curve shaped like a bell, is familiar to all who handle variance and probability. Gauss was nineteen when he discovered and proved the law of quadratic reciprocity. However, these accomplishments brought him little gain until at 25 he applied his mathematical principles in astronomy to the determination of the orbits of a family of asteroids — Vesta, Ceres, Pallas, and dozens of others. He invented the heliograph, an instrument of important military use, in which signals, in code, can be transmitted by reflecting sunlight from a mirror to an observer.

In electrical science Gauss is best known for his application of rigorous mathematical analysis principally to the field of terrestrial magnetism, a field that has become of increasing importance as the lanes of commerce multiplied over the surface of the globe. His first memoir on a theory describing the earth's magnetism, "Intensitas vis magneticae terrestris", was published in 1833. In it Gauss used measurements in absolute units to describe electric and magnetic quantities for the first time. He stated, "For the complete determination of the magnetic force of the earth in a given place, three elements are required: the declination, or the angle between the plane in which the magnet lies and a meridian; the inclination of its direction to the horizontal plane; and in the third place, the intensity." He thereafter showed how it was possible to separate the earth's magnetic field into two components — one originating inside the earth and the other orginating in regions outside the earth's crust. He was joined shortly thereafter by another keen investigator, Welhelm Weber (1804-1891), who had been appointed to the professorship in physics at Goettingen at Gauss' recommendation, and together they erected there in 1833 a magnetic observatory free from iron, as was previously suggested by both Humboldt and Arago. Here magnetic observations covering several years were made. These observations were published for the years 1827 to 1840 and contained such data as the declination at Goettingen, the intensity of the terrestrial magnetism in absolute terms, the variation of magnetic declination. There also was published data on the location and shift of magnetic poles and the axes and magnet movement of the earth. Included in their publications were also charts showing the isomagnetic lines covering the known areas. Here also were centered the activities of an association formed by Gauss and Weber, called the 'Magnetischer Verein', in which other investigators made observations and contributed their data. Here was developed a sensitive declination instrument and the "magnetometer" which consisted of a magnet suspended by two wires (bifilar suspension), the deflection of the magnet being measured by the reflection of a beam of light from a mirror attached to the magnet upon a graduated arc. With this instrument the horizontal component of the earth's magnetic force was measured. At first this society was composed almost entirely of Germans, but later observers from many parts of Europe, extending as far south as Sicily, contributed their data taken on fixed termdays. Gauss analyzed the data and prepared two important memoirs as a result; one on a general theory of the earth's magnetism, the second of forces attracting in accordance with the inverse square of the intervening distance. With the magnetometer, Gauss first determined the intensity of the earth's field as indicated by the motion of a magnet suspended horizontally. The period of oscillation of the magnet in the earth's field was first measured and then the angle thru which the needle of a magnetometer was deflected by the same magnet when placed a measured distance away. Both method and instrument are substantially those in use today. Gauss' connection with the observatory at Goettingen began in 1807 and continued until his death, a period of nearly 50 years.

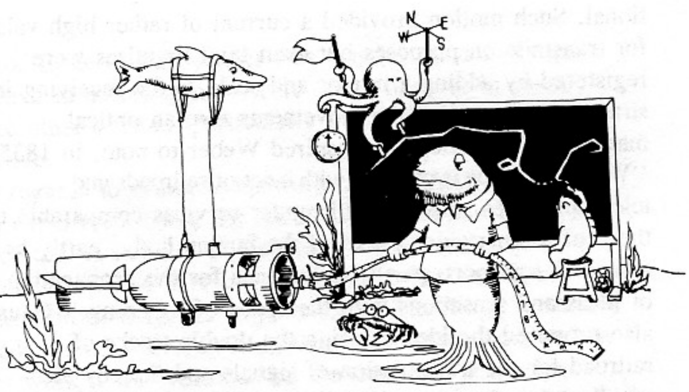
In order to communicate quickly between the iron-free magnetic observatory and the astronomical observatory also in Goettingen, Gauss and Weber connected the two observatories with an electrical telegraph. This is one of the earliest uses (1834) of electric telegraphy. It consisted of a line of some 15,000 feet of wire and over this line impulses were generated in the circuit by magnetoelectric currents. Noting the discovery of Faraday of induced electric currents, Gauss and Weber arranged a large permanent magnet around which they placed a coil having 7,000 turns of fine wire. Handles were attached to the coil and these enabled the operator to move the coil up and down on the magnet or to remove it entirely. Because a motion in one direction would cause the current to flow in one direction, a reverser was added to keep the current flow unidirectional. Such motion provided a current of rather high value for transmission purposes but even faint impulses were registered by adding a mirror and scale to the receiving instrument and reading the movements thru an optical magnifier. This telegraph inspired Weber to note, in 1835, "When the globe is covered with a net of railroads and telegraph wires, this net will render services comparable to those of the nervous system of the human body, partly as a means of transport, partly as a means for the propagation of ideas and sensations with the speed of lightning." Gauss also proposed the idea of using the double tracks of a railroad for the transmission of signals and thereby electrically tying the network together. Steinheil tried to introduce this system on the Nuernberg-Fuerth line, but faulty insulation caused the project to fail.

Gauss' application of "absolute" units of length, mass, and time to magnetic fields prompted Weber to do the same to electrical fields. Weber thereby determined, using the magnetic effects of an electric current, that this current will exert unit force at unit distance on one of Gauss' unit magnetic poles situated at right angles to the wire. In 1849 Weber began his investigations of electromotive force and of current and therewith evolved their units of measure. Having thus determined units of current and electromotive force, Weber, by Ohm's law, determined the unit of resistance.

For his contributions to our knowledge of terrestrial magnetism the International Congress of Electricians designated the value of intensity of a magnetic field by the term 'gauss'. A popularization of the term "degauss" occurred in World War II when measures were taken by the allied forces to neutralize the external magnetic field of a naval vessel and thereby to avoid triggering the magnetic mines set by the Germans. These mines were energized by the magnetic field of the steel hulls of ships not degaussed.

Gauss possessed the unusual power of devising dynamical models and drawing on analogies to demonstrate obscure physical relationships, particularly those in electrical science. Steeped in the severe discipline of mathematical thought he adhered to the practices of Archimedes and Newton in presenting for publication only completed works, simple and definitive, but omitting the steps by which his conclusions had been arrived at, a trait he had developed since boyhood. His contributions to mathematics, astronomy, geodesy, and electricity place him among the giants of the sciences.

Reprinted from *Instrumentation and Measusrement Society Newsletter, April/May 1985*



CURRENT MEASUREMENT TECHNOLOGY COMMITTEE NEWS AND INFORMATION

A primary objective of the Current Measurement Technology Committee (CMTC) of the Oceanic Engineering Society (OES) is to provide a focus for information exchange and promote cooperation and coordination among those in the marine community involved in current measurement. To this end, this column has been established as a regular feature of the *OES Newsletter* and everyone is encouraged to participate by submitting news items and information about active or planned current measurement efforts to Bill Woodward (301) 443-8444 or Jerry Appell (301) 443-8026 for publication in the column. This will be an effective forum only if everybody participates, so let's hear from you.

IEEE Third Working Conference on Current Measurement

Oceanographers, researchers and manufacturers of oceanographic instruments recently converged for a 3-day forum at the Airlie Conference Center in Airlie, Virginia. The IEEE Third Working Conference on Current Measurement was convened by the Institute of Electrical and Electronic Engineers, Oceanic Engineering Society, Current Measurement Technology Committee, on January 22, 23, and 24, 1986. The objective of the conference was to encourage continued and focused technical exchange among those in the community who are interested and concerned about the measurement of ocean currents. The theme of the Conference was "How far have we progressed in our ability to make current measurement; Have the traditional methods improved; Are the new methods any better; How well do they or should they compare?" One hundred twenty registrants gathered to hear presentations on both conventional and new technology. The conference included a special 1-day session devoted exclusively to acoustic Doppler current profiling techniques. This session was followed by a panel of five acoustic Dopper experts which stimulated lively panel/audience interactive discussion of the differing viewpoints on the issues and problems surrounding the development, testing, manufacturing and use of this technology.

Participants came from the four corners of the United States, the Netherlands, Norway, England, Belgium, South Africa, and Canada. Fifty percent of the conventional technology session papers reported on field intercomparisons among a variety of instruments while the new technology session reported on current measurements from motional electric fields, space-time acoustic scintillation analysis and shallow water. These presentations identified several promising large scale measurement techniques while underscoring the importance of understanding the comparability of data from these and the more "conventional" methods.

Most of those at the meeting felt that although progress has been slow, we as a community are converging on a consensus concerning instrument performance capability and that field intercomparisons, while they do play a major role in performance assessment, can at times result in more questions than answers. It was also agreed that the Current Measurement Technology Committee, by sponsoring conferences like this one, is providing the communication link that is essential to ensuring cooperative efforts in the community.

The target date for publication of the proceedings is April 1986. For further information contact the Conference Chairman, William E. Woodward, at NOAA/NOS, 301-443-8444.

Standard Times

The Standards Subcommittee of the CMTC is interested in continuing our quest for guidelines or "standards" in the following areas: Standards for tow tanks, flumes and other calibration facilities; Standard procedures for current meter calibration and testing; Guidelines for comparison experiments; and Standard presentation of current meter specifications in manufacturer's data sheets. Interest in these topics at the Third Working Conference on Current Measurement in Airlie, VA was high. It is important that we do not let our interest die until the next conference. Active participation by the oceanographic community is necessary if we are to reach our goal.

A framework for testing Eulerian current meters has been presented by Appell, Mooney, and Woodward[1]. The International Organization for Standardization (ISO) defines some of the minimum requirements for a standard tow tank[2]. Current meter users, as well as researchers actively involved with calibration and evaluation, should be familiar with both of these documents.

Response to our survey of current meter calibration facilities was a bit disheartening. We would like to try again. We are interested in compiling a list of these facilities and their capabilities. Information on physical dimensions, speed range, oscillation capability, availability to outside users, costs, person to contact, etc., is requested. Please send the information to W. Terry, 201 Smith Bldg., Woods Hole Oceanographic Institution, Woods Hole, MA 02543.

Your comments and suggestions are welcome. Please send them to Bill Terry at the above address, or via Telemail, Omnet address W. TERRY.

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[1] APPELL, G. F., et al., (1983). "A Framework for the Laboratory Testing of Eulerian Current Measuring Devices", IEEE, J. Oceanic Eng., OE-8, 8 pp.

[2] International Organization for Standardization (ISO), (1976). "Liquid flow measurement in open channels — Calibration of rotating-element current mentes is straight open tanks.", Ref. No. ISO 3455-1976 (E), ISO, 1 Rue de Varembe, CH-1211, Geneva 20, Switzerland, 8pp.

ANNOUNCEMENTS AND CALLS FOR PAPERS

To: Presidents, IEEE Societies
Chairmen, IEEE Society Award Committees

From: IEEE Awards Board — Dr. Sol Triebwasser, Chairman

You have no doubt seen the call for nominations for IEEE awards in the December 1985 edition of THE INSTITUTE.

We would like to make an important request of you and the members of your Society to consider and submit candidates for the various awards. You may, of course, nominate any suitably qualified candidate for the different awards, but we feel that the Society officers have a particular responsibility to consider the important accomplishments by members of their own Society and to bring such accomplishments to the attention of the Awards Board by arranging for nominations of these members for appropriate awards. Diligence in discharging this responsibility will help the Awards Board greatly in its selection process.

A copy of the Awards brochure, ''IEEE AWARDS GUIDE — An Invitation to Nominate'', and a listing of Major Medal recipients for the past ten years, together with their citations, are enclosed. These will facilitate your participation in this very important IEEE function. Please use the attached order sheet (Q-28) to request the award nomination forms needed from the Staff Secretary of the Awards Board at IEEE Headquarters.

The date schedule for receipt of nominations for the various awards is:

Field Awards	— before April 1, 1986
Medal of Honor	— before July 1, 1986
Major Annual Medals	— before July 1, 1986
IEEE Service Award	— before July 1, 1986
Prize Paper Awards	— before July 1, 1986

If you do not already have one, it is hoped that you will appoint a local committee to select candidates for nomination. We suggest that the IEEE AWARDS GUIDE be studied carefully to ascertain that each nominee fulfills the requirements of the specific award for which a nomination is submitted. Similarly, the furnishing of complete information describing a nominee's accomplishments is of substantial advantage to the nominee.

We shall be looking forward to you much needed participation in the IEEE Awards Program. It is up to you to see that qualified people receive proper recognition for their outstanding achievements.

SPECIAL ISSUE ON *SCATTERING* (THEORY AND EXPERIMENT)

A special issue of the IEEE Journal of Oceanic Engineering, scheduled for publication in April 1987, will be devoted to theoretical and/or experimental studies of the interaction of acoustic and electromagnetic waves with single or multiple scatters or materials, with a view toward applications for sensors, transducers, and radiation-absorbing substances. Topics of special interest may include, but are not limited to, the following:

DIRECT CLASSICAL SCATTERING

1) Low and high-frequency methods
2) Resonance frequencies & hybrid methods
3) Target-scattering within waveguides
4) Rough surface scattering (sonar/radar)
5) Variational methods
6) Numerical and matrix methods
7) Porous and composite media
8) Radar/sonar cross-section reduction

CLASSICAL INVERSE SCATTERING

9) Exact/approximate methods
10) Computational methods/algorithms
11) Remote sensing/tomography
12) Classification and identification
13) Inhomogeneous layered media
14) Non-linear evolution eqs. & solutions
15) Target imaging/spectral analysis
16) Target characteristics

All the above pertain to acoustic or electromagnetic waves in theoretical or experimental cases. Prospective authors should prepare their manuscripts in accordance with the ''Information for Authors'' published in the back cover of any recent issue of the IEEE Journal of Oceanic Engineering and forward the completed text by the firm deadline of July 15, 1986, to:

Dr. G. C. Gaunaurd, Guest Editor
Naval Surface Weapons Center
White Oak, Code R-43
Silver Spring, MD 20902-5000
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SPECIAL ISSUE ON UNDERWATER ACOUSTIC SIGNAL PROCESSING

A special issue of the IEEE Journal of Oceanic Engineering, scheduled for publication in January 1987, will be devoted to theoretical and/or experimental developments in underwater acoustic signal processing. Topics may include, but are not limited to, the following:

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4) Detection
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9) Robust Detection, etc.
10) Statistical Signal Processing
11) Spectral Analysis
12) Higher Order Spectral Estimation

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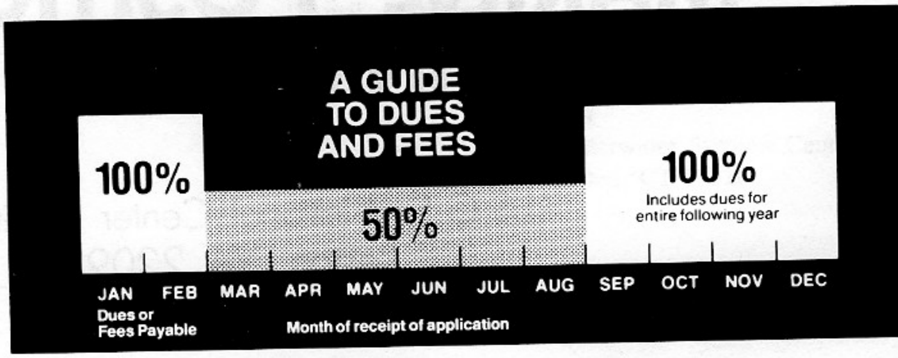

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