IEEE

OCEANIC ENGINEERING SOCIETY

NEWSLETTER

VOLUME XV NUMBER 3

EDITOR: HAROLD A. SABBAGH FALL 1984 (USPS 420-910)

EDITOR'S COMMENTS

Summer is over, and it's time to get back to work. And that includes reading your FALL issue of the OES Newsletter. We have included a potpourri of reading material that we hope will go down smoothly and ease the transition between seasons. You will note that more and more, IEEE officials are using the society newsletters as a vehicle for communicating with members. Thus, Saj Durrani, Director of Division IX, wishes you to respond to a question on election practice, and Bruno Weinschel, who is a candidate for 1985 President-Elect, has a questionnaire for guidance on interests and concerns of IEEE members. If you choose to respond to these questions, please send your answers to the appropriate person, *not to the editor of this newsletter.*

Rod Mesecar, our Technology Editor, has a couple of entries in this issue, but we are concerned about the viability of this feature because nobody is responding to Rod's request for future articles. There have been many favorable comments about the Technology feature, but we must have more papers if we are to continue it. If you have something to say, or know someone who does, please write to Rod at Oregon State University, College of Oceanography, Corvallis, OR 97331, or call (503) 754-2208.

'TIS A PUZZLEMENT is alive and well again, thanks to our new puzzle editor, Lt. David Hollinberger, 1607 Mahan Ave., Bremerton, WA 98310. Dave volunteered for the job after reading a persuasive plea for participation by President Stan Chamberlain. I'm sure that he will want input for puzzles from our readers. If you have a contribution, send it to Dave, or call him at (206) 377-9709(h), (206) 476-3008(w).

Finally, we are pleased to print our first chapter meeting notice, back in the ANNOUNCEMENTS section. Congratulations to the Central New England Chapter (I don't know if they are the first chapter to have a meeting, but they are the first to announce it in the Newsletter).

Now get back to work.

Harold A. Sabbagh
Sabbagh Associates, Inc.
2634 Round Hill Lane
Bloomington, IN 47401

OCEANIC ENGINEERING SOCIETY

ADCOM ORGANIZATION

ADCOM EXECUTIVE COMMITTEE

Office/Position	Current Holder	Term End
President	S. Chamberlain	12/84
VP/East Coast	A. Eller	12/83
VP/West Coast	L. Maudlin	12/84
Treasurer	E. Early	12/83
Secretary	C. Beckers	12/83
Jr. Past President	D. Bolle	12/84
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D. Alspach	E. Early	H. Sabbagh
W. Bacon	S. Ehrlich	R. Spindel
A. Baggeroer	A. Eller	J. Vadus
C. Beckers	F. Envant	D. Weissman
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- Publicity
- Meetings—L. Maudlin (West Coast); A. Eller (East Coast)
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- Nominations—D. Bolle
- Awards & Fellows—D. Bolle
- Constitution & Bylaws—L. Maudlin, D. Bolle
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- Current Measurements Technology—W. Woodward

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NEWSLETTER Editor—H. Sabbagh
NEWSLETTER Editor for Technology—R. Mesecar
JOE Associate Editors
- A. Baggeroer
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- R. Spindel
- G. Brown
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- A. Fung

AD Hoc Committee Chairpersons
- Education—A. Westneat

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Committee on Communications and Information Policy (CCIP)
Committee on Large Scale Systems (COLSS)—D. Alspach
Committee on Man and Radiation (COMAR)
Energy Committee (EC)—J. Vadus
Environmental Quality Comittee (EQC)—W. Bacon
R&D Committee
Society on Social Implications of Technology (SIT)—F. Envent
Professional Activities Committee for Engineers (PACE) Coordinator
Division III Nominations Committee—S. Chamberlain

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PRESIDENT'S COMMENTS

The 1984 Centennial year of the IEEE has been an interesting year for me. While history is not normally of great interest to me, a review of my roots as an electrical engineer, as an IEEE member and as a member of the IEEE Oceanic Engineering Society has intrigued me greatly this year. Since historical resumes of the first two have been well covered in Spectrum and the various IEEE Centennial publications and activities, I will comment here only on the latter, the Oceanic Engineering Society (OES).

The OES has grown out of the need for a forum for the exchange of information on the emerging applications of electrotechnology in the oceans. Dr. Ivan Coggeshall, a Past-President of the IRE (1957), has covered it well in his history entitled: "Oceanic Engineering — The Making of an IEEE Society", to appear in our Journal of Oceanic Engineering. As he points out, one of the first movements of electrical engineering seaward was in electrical communications. Submarine cables were first laid in 1856, with wireless telegraphy and transoceanic radio telephony in 1895 and 1915, respectively. In the area of navigation, wireless direction finding was invented in 1906 and the electronic fathometer in 1927.

However, it was not until 1969 that the organizational roots of OES began to take shape. This came from the IEEE Professional Groups on Geoscience and on Aerospace and Electronic Systems. A joint chapter of these Groups in the Providence R. I., Section held a specialty conference on Ocean Systems at the University of Rhode Island. This grew into the OCEANS Conference Series, which began the next year and has continued annually thereafter.

It was also in 1969 that these two IEEE Professional Groups, along with that on Communications, appointed representatives to what was called the Oceanography Coordinating Committee (OCC). The OCC sponsored the Oceans Conferences and was a cosponsor with other, non-IEEE Societies, of the Offshore Technology Conference, which has also been held annually since 1969. Other IEEE professional groups, with interest in applying their electrotechnology specialities in the ocean, also appointed representatives to the OCC. By 1977, there were 19 professional groups represented on the OCC. It had grown to the point that it became that year the Council of Oceanic Engineering (COE). The COE not only cosponsored Conferences like the OCEANS and Offshore Technology Conferences, but it published the Journal of Oceanic Engineering (begun in 1976) and the Oceanic Engineering Newsletter (begun on a continuing basis in 1973).

On January 1, 1983, another organizational milestone was achieved, when the organization moved to Society status, to become the Oceanic Engineering Society. It had become clear that a need existed for a grass roots organization of IEEE members with interest in applying electrotechnology to the ocean environment. The Oceans Conference moves to various sites around the U.S. and beyond, and has grown to become a major conference. The effort required to conduct a top drawer conference like OCEANS requires strong local leadership. IEEE is a professional Society composed of professional engineering peers and is strongly committed to active volunteer participation in conferences, publications, and other endeavors. And so, we are currently establishing local chapters, especially in geographic regions of high oceanic engineering activity.

I am pleased to report that the first OES chapter has been formed, officially on August 17, 1984. This is the Central New England Chapter. As of this date, officers have been nominated, ballots printed for election, and the first post-organizational meeting is scheduled for September 19, 1984. Activity is currently underway to form OES chapters in San Diego, Seattle, San Francisco, Houston, Southern Florida, Washington D.C., and the maritime Provinces of Canada. Those of you in one of these regions (or another one) who would like to get involved on the ground floor of chapter organization, please contact me or our Chapters Coordinator, Arthur Westneat.

Oceanic engineering is multi disciplinary and includes a broad range of electrotechnology application areas. To stimulate technical exchange in these areas, we are forming technology committees. One of these committees has been operating very successfully or several years: the Current Measurements Technology Committee. This committee is now preparing for their third workshop, has organized sessions at several OCEANS Conferences and produces a regular column in our Newsletter. Additional technology committtees are being organized in such areas as: Marine Communication and Navigation, Remote Sensing, Oceanic Data Systems, Underwater Acoustics, Arctic Instrumentation, Oceanographic Instrumentation and Data Acquisition, Ocean Energy Conversion, Data Base Systems, Modeling and Simulation, and Autonomous Underwater Vehicles. If you would like to get in on the ground floor of one of these (or another) committees, please contact me or Tony Eller, our technology committees coordinator.

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You should also have noted the addition of new entries in our OES Newsletter. I mentioned the regular column by the Current Measurements Technology Committee. We are now including brief technical papers on practical aspects of oceanic engineering that are of broad interest. Several such papers have appeared during 1984. If you would like to submit a paper in this catagory, please contact me, Hal Sabbagh, or Rod Mesecar, our Newsletter Editors.

In closing, as we celebrate the Centennial Year of the IEEE, let me reemphasize the participatory nature of the IEEE and the IEEE Oceanic Engineering Society. We have a host of activities in which you can become involved. You will benefit, and we will too, if you will consider how you can increase your participation in the various forums for technical exchange within the Oceanic Engineering Society.

Stanley S. Chamberlain

FROM THE DIRECTOR'S DESK

YOU BE THE JUDGE

S. H. Durrani, Director, Division IX

I would like to share with you a question that will be faced by the Board of Directors in its fall meeting, and ask for your verdict: What would you decide if you were the judge?

The offices of President Elect and Executive Vice President are of critical importance to the Institute and are the only two offices elected by the entire membership. Obviously the nominees must be of the highest caliber as leaders and managers within the Institute and must have a proven record of service in the organization. They must also be willing to listen to all viewpoints and resolve conflicts on emotionally charged issues.

The Institute is fortunate in having several highly dedicated people on its Boards. However, the demands of office increase exponentially along the way, and only a very few individuals possess the time, energy, and talent needed for the two top jobs. Board members, who observe them from close quarters, are in an excellent position to know who these individuals are.

According to the bylaws, the Board of Directors must submit to voting members a list of nominees for these offices. The list must include any other names placed on the ballot by petition.

Traditionally, the Board used to submit a single nominee for each office. This was so because suitably qualified candidates are very few; moreover, some of them decline to run against another highly qualified and respected colleague when it is guaranteed that one of them is going to lose.

A couple of years ago the Board departed from tradition and started naming two candidates for each top office, ostensibly to offer members a choice. However, since both candidates are selected by the same Board, they usually have very similar views of how to run the Institute. (They do not represent different "parties" with distinct programs; the choice is one of personality rather than of philosophy or approach.) Actually, a different mechanism for offering a choice already exists and is guaranteed by the IEEE constitution; if someone is unhappy with the Board's choice, he can offer another name through the petition route; it takes only about 1800 signatures to put a name on the ballot.

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A more serious drawback is the following. In case of three nominees — say all endorsed by the Board, or two endorsed by the Board and one nominated by petition — it is possible for the two "best" candidates to split the vote, thus allowing the lesser qualified candidate to win. To prevent such an outcome, it would be necessary to have a run-off when there are three or more nominees for the same office. This would add even more politics, delays, and costs to the election process, all of which is unnecessary and unsuited to a volunteer technical and professional organization. After all IEEE has no "political" authority and its officials cannot influence our lives as elected government officials can, so that the safeguards needed in one situtation are completely irrelevant in the other.

For the reasons discussed, I am fairly convinced that the endorsement of two or more nominees by the Board for these top offices is a mixed blessing, and the disadvantages far outweigh the advantages. Thus I am in favor of reverting to the traditional approach of presenting a single nominee for President-Elect and similarly a single nominee for Executive Vice President, of course with provision for petition candidates in each case.

Before casting my vote, I would like to hear from you about your preference. Your reasons will also be welcome; however, if you are pressed for time, a simple answer will do:

Single nominee or multiple nominees — what would you prefer?

Please call me at my office (301) 344-6339 or drop me a line at my home address: 17513 Lafayette Drive, Olney, Maryland 20832. Your inputs will be greatly appreciated.

Reprinted from the Los Angeles Times, Saturday, March 31, 1984

We are indebted to Walter Bacon for bringing this article to our attention.

HIGH TECHNOLOGY AIDS STUDY OF WORLD'S OCEANS

Satellites, Digital Computers, Microelectronics, Audio Systems Give Scientists a Bigger Picture

By George Alexander, *Times Science Writer*

Oceanography, for more than 200 years the realm of solitary scientists who set to sea with little more than stoppered bottles, thermometers and sample buckets to probe the vast, swirling flows that are the world's ocean currents, is rapidly becoming a "Big Science" complete with large budgets, group research teams and joint international projects.

The wind pushing this venerable science onto a new tack is high technology: sophisticated space satellites, digital computers, micro-electronics and acoustic systems that are enabling a new generation of oceanographers to see the oceans whole and entire. Their goal is to understand the dynamics of these huge bodies of water from above, on and below the surface simultaneously with changes in the overlying atmosphere.

"Oceanography for a long time has been basically a cottage industry, with people working largely alone and turning out a hand-made product — their understanding of some particular facet of the oceans," said Robert H. Stewart, who holds a joint appointment as an associate professor at the University of California's Scripps Institution of Oceanography in La Jolla and as a research scientist at Caltech's Jet Propulsion Laboratory near Pasadena.

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Making Sense of Data

Today, Stewart continued, oceanographers are expected to work together more like meteorologists: "They don't go outside and measure the weather with their own rain gauges and thermometers. They've got a global network of satellite sensors and automated (ground) stations that collect all the data they need, so that their main concern is making sense of all that information. That's the direction we oceanographers are moving toward. The older scientists are resistant to this, but the younger ones — not having known any thing else - accept it."

Indeed, the World Meteorological Organization is now planning a major scientific project for the late 1980s and early '90s, called the "world ocean circulation experiment," that should reveal how the oceans and the atmosphere interact to generate the climatic patterns — the droughts, harsh winters, scorching summers or heavy rainfall seasons — that can and do have profound effects on human societies.

Satellites will play a major, although not exclusive, role in that upcoming project. And for good reason: They are cheaper to operate than surface vessels, acquire larger quantities of data on more phenomena over broader regions in less time, are not hampered by even the worst storms, and make their findings available to scientists sitting at land-based computer facilities within minutes to at most a day or two of acquisition.

The potential of space oceanography was recognized exactly 20 years ago, when 150 scientists gathered at the Woods Hole Oceanographic Institution in Massachusetts to discuss what might be monitored from a few hundred miles up. It has emerged slowly — through weather satellites of the early 1960s carrying one or more experimental sensors to measure various oceanic characteristics to the dazzlingly successful, but unfortunately short-lived Seasat of 1978.

Several factors have converged in the past few years, however, to cause a surge in space oceanography: the disastrous El Nino ocean event of 1982-1983; the development of the American space shuttle, which can either carry satellites into orbit or fly scientific instruments in its cargo bay for a week at a time, and the realization that modern technology has the means of understanding what sorts of climatic patterns develop in different parts of the globe — and, most importantly, how and why.

Predictions Expected

By the early part of the 21st Century, Stewart and other oceanographers believe, they should be able to predict short-range climate patterns as accurately as weather forecasters now call the shots for this coming weekend's weather.

If that could be done accurately, then government, industry and even individuals might use that intervening time to get ready — by conserving water, for example, or by planting one crop rather than another, by stockpiling fuel supplies, or by shoring up vulnerable coastal facilities, well in advance of the event.

"The economic benefits (of climatic forecasting) could be very great," Stewart said. "If farmers in the Midwest (United States) knew that this summer was going to be hot and dry, or cool and wet, they could plant crops best suited to those conditions. Or if they knew that the Russians were going to be short on wheat because of a poor growing season there, or that the Argentines and the Australians were likely to raise bumper crops of wheat this year, they might decide to do things differently."

By appropriate planning, Stewart continued, American farmers could change the economic gain or loss of the nation's agricultural output by 1%.

"It doesn't sound like much," he conceded, "but 1% of a $10-billion industry amounts to $100 million. That's significant."

More than that, knowledge of future patterns could lead to unusual — even unprecedented — sociopolitical actions by nations.

"The drought in the Sahel region of Africa (in the mid-1970s), the El Nino of last winter and other disasters of recent years have cost governments dearly," Steward continued. "If a country knew that something like that was coming up and would last only a year, it might get by by calling upon other nations for food and supplies. But if it knew a climatic event was going to last a decade, then perhaps it might have to do something else — like relocating the people in the area to be affected."

All that depends, of course, on oceanography's ability to develop a sort of climatic early warning system. None are more candid about the difficulty of achieving this goal than the men and women who explore the oceans.

"The truth is," said one, "that we've really only begun to study the oceans in the past few decades."

Scientific Partnership

One of the more ambitious efforts to achieve that goal is the sky-above, sea-below partnership of JPL and Scripps. The JPL engineers are providing satellites or space shuttle-borne sensors that can detect changes as small as an inch or two in the average height of an ocean current, pick out the temperatures of large pools of water on the ocean surface, or tell which way and at what speeds the winds are blowing.

"The global perspective from space gives us a tremendous overview of what's happening across a large part of the ocean," said Moustafa Chahine, manager of JPL's Earth and space sciences division. "But surface measurements are very important in combination with remote-sensing data. When we zero in on a small, localized area of the ocean, we have to know in some detail what's going on there and that's where the surface measurements come in. They tell us if our global interpretation of the remote-sensing data is correct."

JPL is developing several oceanographic systems, some of which will be flown for just a few days in the cargo hold of the space shuttle. Others will be operated on unmanned satellites in orbit for several years. These include:

—The topography experiment (Topex) satellite, a radar altimeter-carrying spacecraft able to tell within an inch or two its exact height over an ocean more than 500 miles below. Since currents like the Gulf Stream in the Atlantic or the Kuroshio in the Pacific slide along the steeply pitched sides of elevated cells of water, this ability to make precise measurements will enable scientists to draw accurate maps of the oceans changing scene and provide some good clues as to what it's up to. JPL officials hope this project will be given a go-ahead by the U.S. space agency a year from now.

—The advanced moisture and temperature sounder, an array of 28 sensors capable of measuring the humidity and temperature at many points in a column of air extending from the ocean surface up to a height of 5,000 to 6,000 feet. It will offer insights into the heat budget of the lower atmosphere, those layers of air immediately above the ocean where so many weather disturbances originate.

—The high resolution infrared sounder, a device that can tell the temperatures on the surface of the sea despite the presence of high, thin cirrus clouds that might otherwise give misleading indicators. This is a passive device, as is the previous one, and receives only the heat radiated by the sea surface itself.

—The Navy remote ocean sensing system, a platform that will carry several instruments into orbit in the late 1980s. Among them will be a scatterometer being developed by JPL, a radar that bounces microwave pulses off choppy ocean water, catches the echoes and, by means of a computer, figures out the direction and speed of winds blowing across the water and creating the waves. Like sailing ships, ocean currents are driven along by winds.

Seasat Paved Way

Measuring such things as the height of a swath of water in the open ocean, or detecting the speeds and directions of winds, from a 150-mile-high vantage point might seem an improbable, even impossible, thing to do. But it was done by the Seasat spacecraft in 1978. Carrying a radar altimeter and several scientific instruments, Seasat was performing like clockwork — measuring the heights of oceans and collecting other data — until an electrical short-circuit knocked it out after only three months of service.

Still, the reams of valuable oceanographic information that Seasat gathered not only are useful to scientists even today but are also reassuring program planners that, from its ashes, will rise the phoenixes of Topex and the various sensors now under development at JPL.

"There are three major kinds of variation in the ocean," said Chahine, explaining how something like the relative height of a vast tract of water can be measured. "The most transient are the winds. The semi-permanent variations are the big currents and the permanent ones are the shapes of the ocean basins. If you measure the same area day after day for several years, you can filter out the effects of wind-whipped waves and be left with the other two."

Additional measurements would allow scientists to distinguish the currents — which do change course slightly from year to year even while sticking to a basic circulation pattern — from the hills, peaks, chasms and plains of the ocean bottom, which do not change that much in just a few years.

Where JPL looks at the oceans from afar, the Scripps oceanographers literally submerge themselves in their work. They record what is taking place on or below the surface with their own specialized sensors — including a seagoing version of the computerized axial tomographic scanner (CAT scanner) that medical researchers use to "see" sections of the human body, and floats that can be programmed to make their measurements at specific depths, popping to the surface periodically to transmit the information to a shore station or to a satellite passing overhead.

Oceanic rivers like the Gulf Stream off the Eastern Seaboard of the United States, the Kuroshio off Japan, or the Humboldt off the west coast of South America are frequently depicted in textbooks as being fixed in place, their tracks as invariant as freeways. "This is a misleading image," said Peter F. Worcester of Scripps, "representing an average position calculated over decades, even centuries."

But, added Walter H. Munk, associate director of Scripps' Institute of Geophysics and Planetary Physics, almost nothing is known about how these "gyres" — the oceanographers' term for the big, basin-circling flows — fluctuate in time and space. In an experiment in the Atlantic Ocean two years ago, Munk and his colleagues discovered purely by chance that the southern flank of the Gulf Stream had shifted about 60 miles farther north than any then-current charts showed it to be.

"We don't know how these gyres change," Munk said, "Is it seasonally? Or from year to year?"

1985 Experiment

Munk expects to answer this and other questions from the data to be gathered by the acoustic waves — low-frequency sounds very much like a cow's moo — that Scripps and the Massachusetts Institute of Technology in-tend to beam through a large swath of the Pacific Ocean in late 1985. The two institutions will deploy four transmitters and five receivers, each atop a 12,000- to 15,000-foot-long cable anchored to the ocean floor between the Hawaiian Islands and the North American continent and operate it for at least a year.

Light waves and other electromagnetic radiation do not penetrate the oceans very far, if at all, Munk explained. Sound waves do travel easily through long stretches of ocean (as the eerily beautiful recordings of humpback whale songs have dramatized recently), but the speed at which they pro-pagate is either accelerated or decelerated by the temperature and density of the water at different depths.

Tucked away inside beachball-sized pressure shells along with the receivers, microcomputers will note the arrival times — with an accuracy of a few thousandths of a second — of the sounds from different transmitters. Oceanographers later will use this data to reconstruct what the column of water must have looked like to shape the sound signals the way it did.

Although the average person probably regards the oceans as simply large pools of homogenous saltwater sloshing back and forth between several continents, scientists have discovered that there is a great deal of structure in these turbulent, fluid bodies.

Massive Eddies

A joint American-British oceanic experiment in the earl 1970s revealed the presence of eddies — large, irregularly shaped rings of water ranging from six to almost 100 mile in diameter and extending from the surface down to a depth of between several hundred to several thousand feet.

Some have water inside their walls warmer than that of the surrounding ocean and so ride as much two or three feet higher in the ocean; others have cooler, denser water their cores and so are more like shallow craters. Most are home to planktonic and other marine species different fro those in adjacent waters.

"These eddies are to the ocean what high- and low-pressure cells are to the atmosphere," Munk said. "They are 'weather' in the ocean and if we know how many the are, and what they're doing, we could produce 'weather maps' of the ocean that would be useful for fishermen, t Navy and climatologists."

"If you want to know what the weather is going to be like next June 24," said Robert Knox, another Scripps oceanographer, "then these kinds of 'weather maps' won't help. But if you're interested in knowing whether this coming summer is going to be cool, warm or awfully hot, then this information could be quite helpful. These eddies may have a net effect on the heat transport process in the oceans."

If there is one process oceanographers are eager to understand more fully, it is how the oceans manage their heat budgets and how they trade that heat with the atmosphere. Water is slower to gain or lose heat than air, a phenomenon familiar to everyone who has ever waited for a kettle to boil or hot coffee to cool enough to drink. But once the oceans have heat, they tend to hang onto it longer. Oceanographers like to say oceans have a longer "memory" than the atmosphere.

Because almost three-fourths of the Earth's surface is covered by water, the oceans are the major reservoir of stored heat on the planet. In fact, a column of seawater only 10 feet deep can hold the same amount of heat stored in a column of air extending from the surface up to the fringes of space — about 100 miles. That oceanic heat is released, along with water vapor, a little or a lot at a time into the air to fuel atmospheric processes.

"Hurricanes are a good example of very fast air-water interactions," said James Price, a Woods Hole oceanographer. "They form only over pools of warm water, where there's a lot of water vapor — fuel for atmospheric systems — coming off a temperatures at 27 degrees Celsius (80 degrees Fahrenheit) or higher and rapidly progress into major storm systems."

There are other air-sea interactions, slower-developing than hurricanes, which still have significant climatic effects and which are equally dependent upon water surface temperatures and available water vapor.

A Big Unknown

"It's important to know how much the ocean is heated and how much it's cooled," Stewart said. "A big unknown is evaporative cooling; it can take out as much heat as the sun puts in. Cold, dry air from Siberia can suck out a lot of heat from the North Pacific and that robs the climate engine of its fuel."

Tim Barnett, a Scripps research physicist who has been exploring sea surface temperatures for several years now, has only recently discovered an oceanic-atmospheric pattern that seems to recur on an irregular basis every several years. It includes a sea level low-presure anomaly over the Indian Ocean and the Indonesian Archipelago, a vast swath roughly 3,700 by 5,000 miles, and two high-pressure regions — one over Siberia and much of China, the other over most of the central Pacific Ocean.

The low-pressure area then starts to drift slowly to the east at a rate of about 20 to 25 miles per day, bringing with it clouds, rain, typhoons and warm surface waters. ("That's fuel the atmosphere likes to eat," he said.)

It splits into two smaller systems around Australia, while the high-pressure regions move around and behind it. In a technical paper written last year, Barnett said this low-pressure area appears to disintegrate as it runs up against Central and South America, although, he added, "there is some suggestion (it) may eventually make (its) way into the Atlantic Ocean."

Pattern Repeats

The interesting thing about this pattern is that another low-pressure anomaly pops up again over the Indian Ocean and Indonesia anywhere from one to five years after the last one. It is possible, he explained, that the low manages to roll across the Atlantic and return to its spawning grounds in the Indian Ocean where it is rejuvenated.

"It's happened this way seven times in the last 30 years," Barnett said, "so if this really does recur, maybe it's some kind of global atmospheric signal. It's hard to understand, but the phenomena associated with it — the clouds, the moisture content of the atmosphere, the long-wave (infrared) radiation — should be readily apparent to satellite sensors."

FROM THE TECHNOLOGY EDITOR
The Maximum Speed For Marine Sensor Profiling

INTRODUCTION

There was a need to know how quickly an oxygen sensor could pass through a water column and still measure the oxygen within a chosen accuracy. Since this is a general problem with profilers, with the oxygen profile being a special case because the sensor's time constant is a function of temperature, the answer has been generalized in this note.

It is important to realize that the accuracies of the readings from many standard profiling instruments for oceanography and limnology are severely reduced when the speed of profiling is not matched to the gradients in the water column. In some cases the speeds have to be surprisingly low, even for temperature and conductivity instruments, to restore the desired accuracy to the readings.

PROBLEM AND ASSUMPTIONS

All profilers, regardless of their speed of response, expressed as a time constant, will produce an error when the parameter they measure varies in time or space. This happens because a finite difference between the stimulus and the response must exist to drive the sensor for a period of time. In the application of sensors, the amplitude of this difference is important because it represents an error in the measurement.

The speed at which the profile is made is one parameter in the error equation. It is useful to know what is the maximum permissable speed for a given allowance for error.

The full analysis of this problem can be simplified if some assumptions are made about the variable being measured and the duration of the measuring time. The first assumption is that the true variations can be closely approximated by linear ramp functions. The second assumption is that the sensor spends sufficient time traversing each ramp to reach a stable signal that tracks the ramp. This is the equivalent of saying that the sensor experiences a given ramp for at least four time constants. The third assumption is that the sensor's response is close to a simple exponential response to a step function in the stimulus.

The first assumption is reasonable in many applications, such as measuring environmental parameters, since step functions (the time limit of a ramp function) are rare because of the turbulence that usually produces gradients between the boundaries of two distinct zones. The second assumption is valid because the operator, making the profile, must slow the profiling to the point that the major ramps are closely approximated. Regardless of how slowly the profile is taken there is a scale of measurements that will be missed because the ramps are too fine to be detected. In the limit, the size of the sensor and its location becomes more important than the time response of the sensor.

As to the third assumption, a large class of sensors exhibit a simple single-pole, low-pass response. Others are somewhat more complex such as having delay functions or multiple exponential (nonlinear) responses. Regardless, the dominant component can be approximated by an exponential response in the majority of sensors used in environmental measurements.

THEORY

Sensors may be represented and analysed through electrical analogues. If the sensor can be represented by a single-pole low-pass filter, as confirmed by its response to a step function, the behaviour of the sensor can be analysed for the case where it encounters a ramp function in the stimulus. A single-pole, low-pass filter can be made with the combination of a series resistor followed by a parallel capacitor between the driving voltage and the output voltage. The driving voltage in this case is a ramp:

$$v_i(t) = at$$

where a is the slope (V/s)
t is the time (s)

As well, circuit analysis shows that

$$v_i(t) = Ri(t) + \int \frac{i(t)\,dt}{C} + K$$

where R is the resistance of the series resistor (Ω)
C is the capacitance of the parallel capacitor (F)
K is the initial voltage on the capacitor (V)
i(t) is the current in the circuit (A)

The integral equation has the solution in terms of the current,

$$i(t) = aC\,(1 - e^{-t/RC})$$

since the output voltage

$$v_o(t) = v_i(t) - Ri(t)$$

then

$$v_i(t) - v_o(t) = Ri(t) = aRC(1 - e^{-t/RC})$$

The above difference of voltages is the error of the sensor because v_i is the true input analogue and v_o is the sensed analogue output.

In a profiling situation the slope variable, a, is related to three variables as

$$a = GUS$$

where G is the gradient of the variable being measured (such as °C/m or mg/L•m)
U is the speed of the profile (m/s)
S is the transfer coefficient of the sensor (such as V/°C or V•L/mg)

The product, RC, is the time constant of the circuit which is a direct analogue of the time constant, τ, of the sensor. This is the time in seconds the sensor takes to reach 63% of the final value after being stimulated by a step function.

The error of the sensor's output is

$$E = GUS\tau\,(1 - e^{-t/\tau}), \text{(volts)}$$

By dividing both sides by S the resulting equation expresses the error as a difference of the parameter being measured, that is

$$D = GU\tau\,(1 - e^{-t/\tau}), \quad (^{\circ}C \text{ or } mg/L)$$

If the sensor is given the equivalent time of four time constants to measure the ramp, the exponential term may be ignored without introducing more than 2% error in the estimate of the error.

Using this assumption and solving for U_m the maximum speed for a given error D is

$$U_m = \frac{D}{G\tau}, \ (m/s)$$

In the case of an oxygen sensor the time constant is a function of temperature. This function is specific to the membrane and electrode materials. In one case an oxygen sensor (YSI 5740) was thoroughly measured and found to follow the relationship $\tau = 10(1.45 - 0..022T)$. This is a simplification because the τ is affected by a delay function and a compound exponential response. However, for the purposes of most oxygen profiling, the simplification is adequate. T is the temperature in degrees celsius.

APPLICATION

Using the error relationship, the operator taking a profile can either estimate the error for a given speed of profiling or estimate the maximum speed at which a profile may proceed for a given error. The time constant and the gradient must be known ahead of time. The first is known from laboratory tests. The second can be obtained in two ways. A profile can be made at a constant high speed, then the gradients measured from the graph. This sets the first approximation of the maximum speeds for subsequent profiles. The number of iterations depends upon the severity of the ramp functions encountered. In another way, the profile can be taken as before, then the data processed with a correction function described in the unpublished report, "The Demonstration of a Correction Technique for Oxygen Profiles", Report ES-558 of the National Water Research Institute. The corrected data give a good estimate of the gradients which will govern the maximum speeds in the second and final profile.

Figure 1 is provided to assist the operator in choosing the profiling speeds. It is a nomogram for the general relationship. Figure 2 is the nomogram for the special relationship for a specific oxygen probe, in this case a YSI type 5740. To use Figure 1, the operator starts with the sensor's time constant (0.2 s as an example for a temperature sensor) and draws a line to the difference (error) he wishes to stay within (say 0.01°C). Where the line crosses the pivot line, a second line originates to extent to the gradient (say 1°C/m). Where the line intersects the speed axis (0.05 m/s) is the maximum speed at which the sensor should traverse that gradient zone.

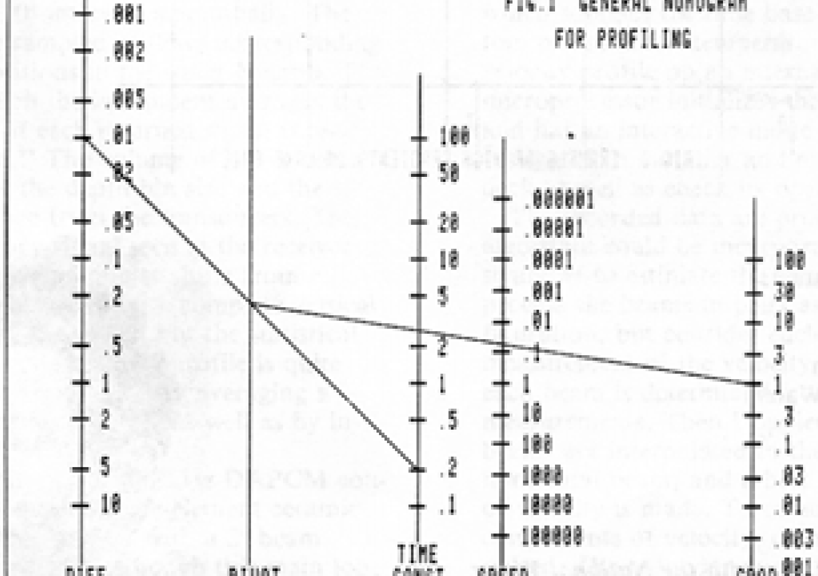
If in the example, the profile were taken at 1 m/s as is normal with field work, the error in temperature rises to 0.2°C in the thermocline. An example of high gradients at the thermocline is given in Figure 3. In this case if the profile were taken at 1 m/s the error would have been about 2°C.

In Figure 2, a temperature variable is incorporated because the oxygen sensor's time constant is dependent upon the water temperature. In this case, the operator draws a line from the start cross-line, through the lower temperature of the water in the gradient (to be conservative) to where it intersects the time constant axis. The nomogram is used from there in the same way as in Figure 1. In the example shown, the temperature is 10°C, the maximum error chosen is 0.2 mg/L and the gradient of interest is 10 mg/L•m. The maximum speed is slightly over 1 mm/s. If the minimum practical speed is 5 cm/s then the sharpest gradient must not be greater than about 0.3 mg/L•m. If that speed (5 cm/s) were used on a gradient of 3 mg/L•m the errors would exceed 2 mg/L while the sensor passed through the gradient.

The general equation can be used in many applications providing the sensor and the variables behave according to the assumptions made earlier. If the sensor behaves like an under-damped servo-system then the first approximation for τ must be used with great caution because it will underestimate the errors.

The speed selection process might be made automatic for oxygen profiling by using a microcomputer to set the winch speed while it gathers the data. The program would measure the temperature gradient as the first indication to slow down the winch because the temperature sensor's time constant is faster and temperature and oxygen features usually coincide. Once the oxygen sensor begins to sense the gradient correctly 70 seconds later (at 10°C) the winch speed can be set more correctly to complete the measurement of the feature. This may be practical enough to reduce the number of profiles to one but more knowledge must be gained in the variability of oxygen and temperature features in the profiles.

FIG.1 GENERAL NOMOGRAM FOR PROFILING



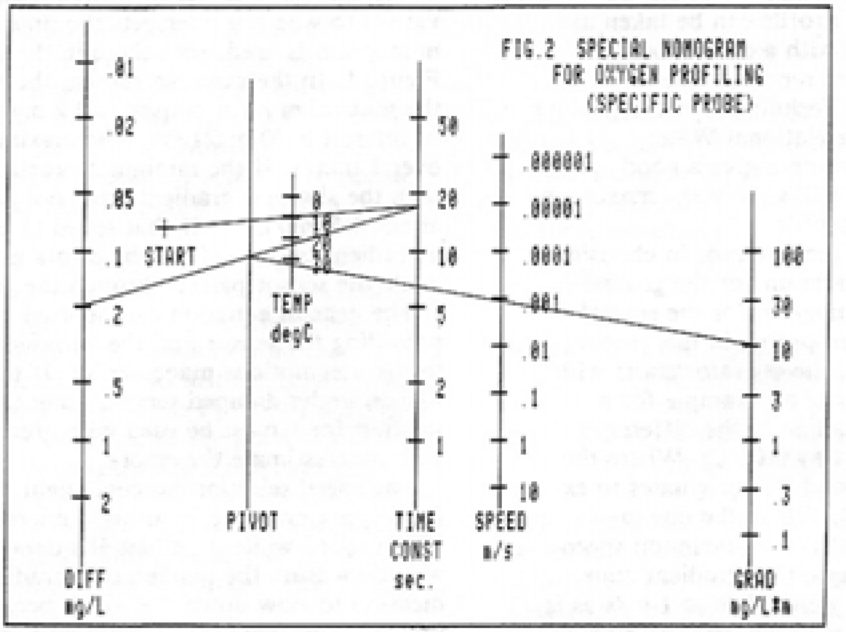


FIG.2 SPECIAL NOMOGRAM FOR OXYGEN PROFILING (SPECIFIC PROBE)

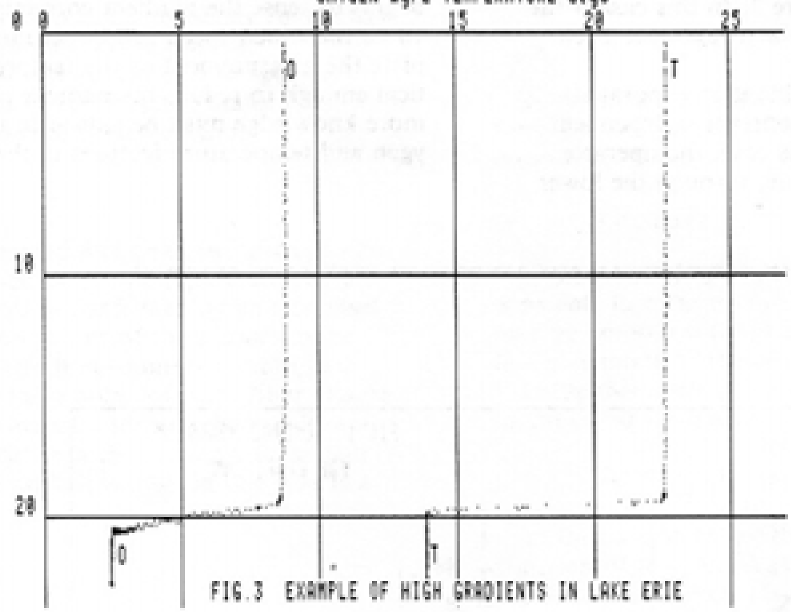


FIG.3 EXAMPLE OF HIGH GRADIENTS IN LAKE ERIE

For further information contact:

J. S. Ford, Head
Engineering Services Section
Canada Centre For Inland Waters
Box 5050
Burlington, Ontario
Canada L7R 4A6

Jerry Ford is a Project Engineer with the National Water Research Institute, Burlington, Ontario. He has a BASc in Electrical Engineering from the University of British Columbia and has worked in water-related engineering for seventeen years. His current interests are in lake monitoring systems and in river-ice instrumentation.

A Bottom-Mounted, Doppler Acoustic Profiling Current Meter

INTRODUCTION

The Physical Oceanographic Research Team at the University of New Hampshire has been working with RD Instruments of San Diego, California, in the development and testing of a self-contained, internally recording, bottom-mounted Doppler Acoustic Profiling Current Meter (DAPCM). The acoustic bottom-mounted instrument offers several advantages over a conventional mechanical current meter mooring. An acoustic instrument does not rely on moving sensing elements such as propellers or rotors which can be fouled or broken, causing loss of data. As a bottom-mounted, remote sensor, it does not distrub the flow that it is measuring, nor is it subject to contamination by mooring motion. Since the instrument is fixed in space, measurements obtained from repeated pulses can be directly averaged together, thus improving accuracy, without correcting for a moving platform. The power of this instrument is in its ability to resolve time variations in the vertical structure of the horizontal velocity field.

INSTRUMENT

The instrument (Figure 1) uses the RD Instruments model RD-DR0300 acoustic Doppler sensor mounted on a UNH bottom instrument frame containing the recorder, power, etc. Both the acoustic sensor and the bottom-mounted recorder use low power CMOS microprocessors and electronics. We currently have two models, one operating at 308 kHz and a new prototype operating at 150 kHz. The lower frequency unit should give about twice the range of the high frequency unit. The principal of operation of both units is the same.

The acoustic sensor transmits 308 kHz (150 kHz) pulses from four transducers which are oriented 30° (20°) from the vertical and at 90° intervals azimuthally. The backscattered signals are sampled at times corresponding to sequentially higher positions in the water column. The vertical distance over which the instrument averages the Doppler frequency shift of each returned signal is referred to as a "depth bin." The volume of water being sampled is determined by the depth bin size and the beam width at that distance from the transducers. The observed Doppler frequency signal seen at the receiver consists of the average of the Doppler shifts from all scatterers within the sample volume. A complete vertical profile is measured by a single pulse, but the statistical uncertainty in the single pulse velocity profile is quite large. This statistical error is reduced by averaging a number of individual profiles together as well as by increasing the bin size.

The transducer assembly of the 300 kHz DAPCM consists of the four 22cm-diameter, single-element ceramic transducers which behave as pistons with a 2° beam width (at the half-power point). Although this main lobe is oriented 30° from the vertical, there are also lower amplitude side lobes directed off axis. Because the surface is such an efficient reflector of acoustic energy, these side lobes can contaminate the near-surface measurements even though the side lobe gain is much lower. The main lobe returns at about 13% of the water column depth are contaminated by the vertical side lobe reflection from the surface which arrives simultaneously at the transducer. For the 150 kHz unit, the angle of the transducer has been reduced to 20° from the vertical, so the side lobe contamination now occurs at about 6% of the water column depth.

The orientation of the transducer assembly is monitored by a two-axis pendulum tilt sensor and a flux gate compass. These sensors are mounted to the transducer assembly, and their measurements are recorded at the end of each sample interval. The Doppler velocity is a function of the speed of sound at the transducer, which is monitored by measuring the transducer's temperature. The error introduced by estimating the sound velocity from temperature alone is negligible. The correction to the speed of sound for typical shelf bottom temperature variations is a few percent.

The microprocessor in the acoustic profiler can be programmed to adapt the sampling to the experiment. Pings can be transmitted as rapidly as twice per second or as slowly as once per hour. The length of the transmitted pulse is selected in powers of two multiples of 1.5706 ms, which is about a 1.0 m vertical distance, corresponding to the two-way distance that sound travels along a beam in 1.5706 ms. The sampled bin length can be set independently of the pulse width. An option can be selected which delays processing of the returns to allow the transducers to stop ringing and to prevent interference due to reflections from the nearby instrument frame or bottom. The number of bins in a vertical profile and the number of pulses averaged together can be selected for each experiment.

The recording system's microprocessor communicates with the acoustic profiler's microprocessor through an RS232 serial link. The recorder has a stable quartz clock which supplies the time base for the entire system. Bottom pressure and temperature are also recorded with the velocity profile on an internal cassette recorder. The microprocessor initializes the profiler before deployment and has an interactive mode which allows the investigator to initialize and monitor the instrument on deck as well as check its operation.

The recorded data are processed on land, although an algorithm could be incorporated into the sea floor instrument to estimate the velocity profiles. We do not process the beams in pairs as is done in the JANUS configuration, but consider each beam as an independent measurement of the velocity field. The orientation of each beam is determined from the tilt and direction measurements. Then Doppler frequencies from three beams are interpolated to the depths of the most horizontal beam, and a best fit to the three components of velocity is made. To estimate the three orthogonal components of velocity, data from three beams are required. The redundancy of the four beams allows an optimal determination of the velocity components at each depth to be made. If one of the beams were noisy or a transducer were damaged, good profiles could be determined from the remaining three beams. Data from two beams are sufficient to determine horizontal velocity if the vertical velocity is negligible.

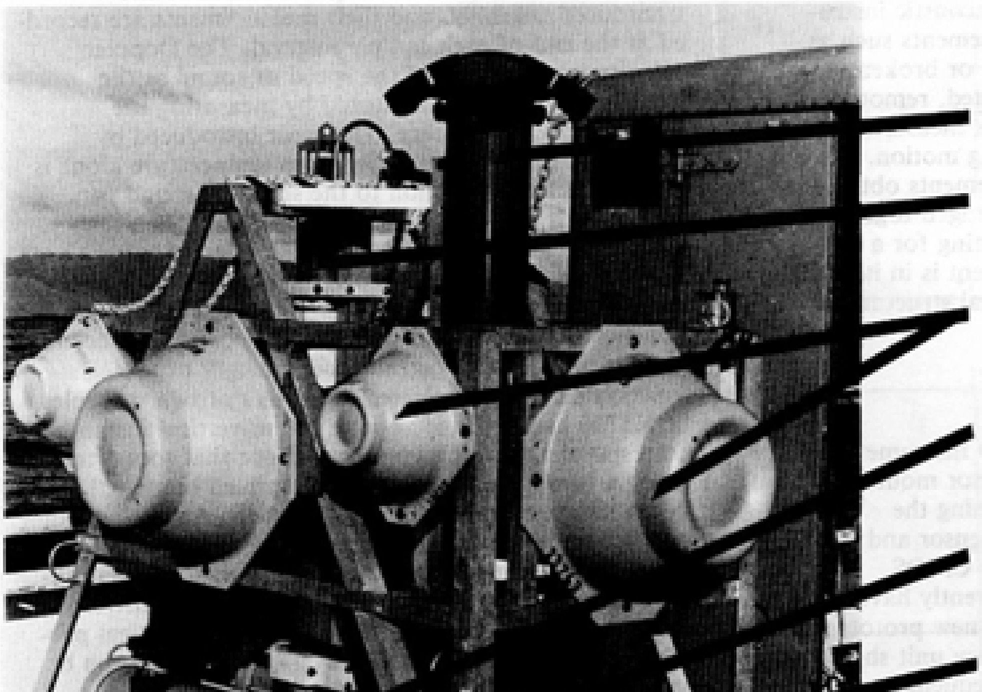


Figure 1. The Doppler Acoustic Profiling Current Meter

DEPLOYMENTS AND RESULTS

The 300 kHz instrument was deployed twice during the Coastal Ocean Dynamics Experiment (CODE) and once in the Gulf of Maine. The CODE deployment was near a standard Woods Hole Oceanographic Institution current meter mooring consisting of a subsurface and surface mooring with Vector Measuring Current Meters and Vector Averaging Current Meters. Mean differences between the DAPCM and the subsurface mooring were about 0.5 cm/sec, and rms differences were approximately 2 cm/sec. Not surprisingly, the mean and rms differences were greater between the DAPCM and the surface mooring, which, unlike the bottom-mounted instrument, is subject to mooring motion.

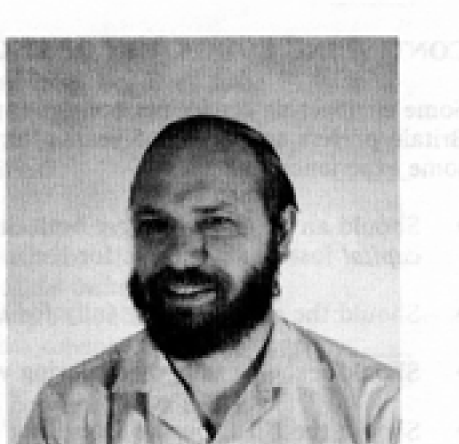
The Gulf of Maine deployment tested an improved acoustic profiler which measured the amplitude of the backscattered signal from each beam and the width of the Doppler spectrum as well as the mean Doppler frequency. A peak in the backscattered amplitude profile was observed to move upward at night and downward during the day, as would be expected from migrating biota. In the spring of 1984, both instruments were deployed in the Strait of Gibraltar for a short test to determine the vertical range of the instruments and to measure the velocity structure.

ACKNOWLEDGEMENTS

The 300 kHz instrument was developed and tested under NASA and NSF CODE funding. R. C. Beardsley and the WHOI Buoy Group provided the intercomparison moorings under NSF CODE funding. Improvement to the 300 kHz instrument and its deployment in the Gulf of Maine was supported by continuing NASA funding. The 150 kHz instrument and deployment in the Strait of Gibraltar was funded by ONR.

For further information, contact:

James D. Irish or Neal R. Pettigrew
Department of Earth Sciences, James Hall
University of New Hampshire
Durham, NH 03824
(603) 862-1718 or 862-3505



Jim Irish has been working with oceanographic instrumentation since 1966. He received a B.S. in Physics from Antioch College in 1967, and an M.S. and Ph.D. in Oceanography from Scripps in 1969 and 1971, respectively. His first work involved instrumentation for measurement of the wind generation of waves. Studies at Scripps involved deep ocean tides, internal waves and the behavior of oceanographic pressure and temperature sensors and various acoustic and heated element current meters. At the University of Washington, he studied internal waves, using moored temperature and conductivity instrumentation. At the University of New Hampshire, he has worked on the development of microprocessor-controlled, conditional sampling instrumentation measuring bottom pressure, moored temperature and conductivity, and most recently has participated in the development of the DAPCM.

Weinschel's Questionnaire For Guidance On Interests and Concerns of IEEE Members

Please Return To:
Dr. Bruno O. Weinschel
One Weinschel Lane
Gaithersburg, MD 20877

A) COMPETITIVENESS (Use only in Regions 1-6)

In some manufacturing areas we have lost both market share in imports and in the export trade. This indicates a loss of competitiveness.

		YES	NO
A-1	• Do you believe there is a need for both U.S. industry *and* the government to establish *team* relationships and take *new* initiatives to re-establish our *competitiveness* against imports and in the world trade?	____	____
A-2	• Does this require better *quality control* in depth?	____	____
A-3	• Does this require better *reliability engineering*?	____	____
A-4	• Does this require better *after-sales service*?	____	____
A-5	• Does this require better and more entrepreneurial *management*?	____	____
A-6	• Would it help if *management* would be *more knowledgeable in technology* instead of specializing in law or finance?	____	____
A-7	• Should industrial employers spend more of their own funds on *longer term civilian R&D*?	____	____
A-8	• Since this impacts both on the quality of future engineering students as well as on the quality of the general work force, should the IEEE be concerned with the *quality of pre-college science and mathematics education*?	____	____
A-9	• Should more use be made of *quality circles* and other employee participation as a means to increase innovation, productivity and quality?	____	____

B) CONTINUING EDUCATION OF ENGINEERS

Some engineering disciplines are developing quite rapidly. The average employer in the U.S. and Britain prefers an engineer 5 years after graduation. This assures that he is not out-of-date and has some experience.

		YES	NO
B-1	• Should an employer *budget* both time and funds *for maintenance of human technical capital* just as he budgets for the maintenance of capital equipment?	____	____
B-2	• Should the employer pay fully for the teaching of continuing education?	____	____
B-3	• Should teaching take place during working hours?	____	____
B-4	• Should the IEEE pursue Don King's idea to give an employer tax *credits* for the excess expenses over prior years for the continuing education of technical professionals?	____	____
B-5	• Should engineers, after an extended period with one employer be entitled to a sabbatical leave for graduate study?	____	____

C) ENGINEERING CURRICULUM

C-1	• Do you believe that engineers require additional training so that they *can communicate more effectively* both orally as well as in writing?	____	____
C-2	• The traditional teaching of engineering usually does not reflect the interdisciplinary requirements of real life engineering problems. Should the IEEE recommend more interdisciplinary teaching in engineering?	____	____

C) ENGINEERING CURRICULUM *(cont.)* YES NO

C-3 • The teaching of *manufacturing engineering*, manufacturing processes and manufacturing technology in engineering schools has been almost completely abandoned. While the teaching of engineering science is a necessary base for engineering, should the IEEE recommend the increased availability of courses in manufacturing engineering, manufacturing processes and manufacturing technology?

C-4 • The teaching of *design* in many engineering schools has been deemphasized in the last 20 years. Should the IEEE recommend that engineering schools not only teach analysis but also synthesis and design? ____ ____

D) STRUCTURE OF ENGINEERING SCHOOLS

Should the IEEE be concerned with: YES NO

D-1 • The structure of engineering education such as four-year vs. five-year programs? ____ ____

D-2 • Should the IEEE recommend a *formal internship* during or after schooling before recognizing an engineer as a professional? ____ ____

D-3 • Most engineering schools in the U.S. have *no requirements* that the *faculty* has *industrial experience.* Should the IEEE recommend that engineering faculty have or obtain industrial experience via sabbaticals to industry, exchange programs, concurrent industry employment, etc.? ____ ____

D-4 Medical doctors and lawyers have more than 4 years of college education. Doctors have a higher average income than engineers. Lawyers frequently are the policymakers in industry, government, state and federal legislatures. Most engineers stop at the bachelor degree.

• Should the IEEE recommend that the first degree should be a masters degree with a minimum of 5 years of higher education? ____ ____

D-5 • Schools of law and schools of medicine are usually separate schools within the university and have a great autonomy. Engineering faculty is usually locked into the salary scale of the university in spite of the greater earning power of an engineering professor in the market place. Should the IEEE recommend that engineering schools become *autonomous, professional engineering schools* within their universities? ____ ____

D-6 • The doctor's degree in engineering is usually awarded for basic research leading to *new knowledge.* In some other countries, including West Germany, the doctor of engineering is also awarded for excellence in *industrial design* or for the solution of *industrial problems.* Should the IEEE recommend that doctors degrees for engineers should not be restricted to basic research but also be awarded for industrial problem solving or design? ____ ____

D-7 • Faculty tenure is usually awarded for research. Should tenure also be given for a prolonged period of excellent teaching? ____ ____

E) UNDERUTILIZATION

Good engineers are always in short supply; it is important to best utilize the available talent. Utilization in this context emphasizes the *portion of time spent in professional tasks* vs. time spent on subprofessional tasks which can be delegated to clerks — e.g., following up late purchase orders, making Xerox copies — or to technicians who perform simple tests, wiring, etc. etc.

SUPPORT

Can we improve engineering utilization by recommending that most engineers have qualified and sufficient YES NO

E-1 • subprofessional support facilities and personnel? ____ ____

E) UNDERUTILIZATION — SUPPORT *(cont.)*

		YES	NO
	This would include but not be limited to the services of		
E-2	• library research?	___	___
E-3	• computation?	___	___
E-4	• drafting?	___	___
E-5	• clerical services?	___	___
E-6	• purchasing services?	___	___
E-7	• machine shop services?	___	___
E-8	• programming?	___	___
	Should engineers be supported by having available		
E-9	• personal computers?	___	___
E-10	• intelligent terminals?	___	___
E-11	• CAD/CAM?	___	___

EDUCATION AND TRAINING

		YES	NO
E-12	• Should an employer have a long-term human resource plan for engineering personnel (training, continuing education, logistics of replacement, growth and technology change)?	___	___
E-13	• A definite career plan for each engineer?	___	___
E-14	• Do you believe that the employers should assist those older engineers who are interested in upgrading to the current state of the art?	___	___
E-15	• Do you believe that employers should rotate engineers in order to expose them to challenging job assignments thereby preventing over-specialization and obsolescence?	___	___
	Do you believe there is a shortage of electrical engineers		
E-16	• generally (most fields and geographies)?	___	___
E-17	• in specific mini specialties (e.g., microwave, electrical power)? Please specify ________	___	___
E-18	• in specific mini geographies (e.g., California? Please specify ________	___	___

F) INVOLVEMENT OF ENGINEERS IN POLICY

		YES	NO
F-1	• Should engineers play a greater role in the top management of industry? If so, how? ________	___	___
F-2	• Should engineers play a greater role in the top management of government? If so, how? ________	___	___
F-3	• Should an employer have a strategic plan? If so, how? ________	___	___
F-4	• Should engineers participate in the formulation of an employer's strategic plan? If so, how? ________	___	___

G) **LEGISLATION**

In the area of legislation, is it in the interest of the IEEE members for the IEEE to be concerned with: **YES** **NO**

G-1 • patent legislation? ____ ____

G-2 • anti-trust legislation on joint research? ____ ____

G-3 • the portability of pensions by expanding IRA limits? ____ ____

G-4 • since the availability of venture capital depends on tax structure, the maximum rate of the capital gains tax? ____ ____

• Other? (specify) ________________________________

H) **POLITICS** (Only for Regions 1-6) **YES** **NO**

H-1 • The National Science Foundation spends about *10%* of its $1.5 billion budget *on engineering* research at universities. The law requires that the NSF support *both science and engineering*. Should the IEEE attempt to increase the portion for engineering research at NSF? ____ ____

H-2 • Should the IEEE continue to be active in those political areas which have a direct impact upon the job security and job satisfaction of engineers? ____ ____

Should the IEEE be concerned with the *implementation of federal laws or regulations* impacting on the work of its members in the area of:

H-3 • *Quality* of *Measurement Standards* by the National Bureau of Standards? ____ ____

H-4 • *Export Licenses; Technology Transfer;* as governed by the applicable federal laws, such as the Export Control Act of the Commerce Department or ITAR of the State Department or DOD security regulations? ____ ____

H-5 • Technical *qualifications*, minimum *salary* relative to average domestic salaries, governing the issuance of *work permits* for *alien engineers* or alien engineering students or graduates of U.S. engineering schools (in contrast to legal immigrants)? ____ ____

H-6 • Should the IEEE be concerned with the proportion of government R&D support between defense and non-defense? ____ ____

I) **INVOLVEMENT IN IMPROVING THE GENERAL WELFARE**

Should the IEEE become more active in those political areas which require the expertise of its members in order to improve the quality of life in the area of **YES** **NO**

I-1 • pollution regulation? ____ ____

I-2 • development of alternate sources of energy? ____ ____

I-3 • increased use of mass transportation? ____ ____

I-4 • improved utilization of natural resources? ____ ____

I-5 • improvement of health delivery services? ____ ____

I-6 • communications policy? ____ ____

I-7 • improvement and application of verification methods supporting the enforcement of mutual agreements on limitation of mass destruction weapons? ____ ____

ELECTRICAL PERSONALITIES

Reprinted from Instrumentation and Measurement Society Newsletter, April 1984

Benjamin Franklin

(1706-1790)

Franklin's interest in electrical phenomena was aroused when he attended a lecture presented by Dr. Spencer of London, in Boston between 1744 and 1746. Franklin was 40, soon to retire from a successful career as a printer. He immediately purchased all of the lecturer's electrical equipment and began to experiment. The generator of Franklin's day was a glass sphere or cylinder rotated by a crank, and against which a leather, felt, or cloth cushion, sometimes impregnated with a mercury amalgam, would be pressed. An electric charge so generated would be drawn to a metal bar or chain suspended by silk strands and transferred to the metal rod projecting thru the cover of a Leyden jar. From his experiments Franklin concluded that the peculiar property of charged bodies to attract and repel one another was not a manifestation of two different kinds of electricity as believed by the electricians before him, but the transfer of electric fluid from one body to another. With this conclusion Franklin provided a complete understanding of the operation of all forms of condensers and charged bodies. He analyzed the charge in a Leyden jar and found that it always charged positive on one metallic coat and negative on the other (the very terms "positive," "negative," "plus," and "minus" were his permanent contributions to our electrical vocabulary) and explained the principle of electrostatic induction. He claimed that although opposite in sign, the charges were of equal magnitude and proceeded to demonstrate this by suspending a pith ball equidistant between two wires connected, one each, to the two surfaces of a Leydon jar. The ball oscillated from wire to wire until the charges had equalized and the pith ball hung limp between them. He devised the "Franklin Pane" which consisted simply of a thin sheet of glass on either side of which were fixed thin metal sheets (a parallel plate condenser), and showed that it was the glass that held the charge. He also discovered that charges reside on the outside of a charged hollow conductor, that when one body contains more than its normal quantity of the electric fluid, a wire connecting it to a neutral or negatively charged body permits the charge to become uniformly distributed between them. If not connected, but placed sufficiently close together, the charge passes between such bodies in the form of a spark.

To Peter Collinson of the Royal Society he communicated his observations and theories about lightning, which were basically that electric charges were raised from the sea and from the land by evaporation. These gathered in clouds of differing charges which, as they approached one another, discharged with a display of thunder and lightning. Therefore, contended Franklin, the action of an electric machine and lightning were similar. He enumerated the similarities thus: (1) the resulting light and sound are similar, and both phenomena are practically instantaneous; (2) the spark, like lightning, is able to set bodies on fire; (3) both can kill live creatures (Franklin killed a hen by the discharge of several Leyden jars); (4) both do mechanical damage and have a smell like burnt sulphur (this led to the discovery of ozone); (5) lightning and electricity follow the same conductors and both pass most readily to sharp points; (6) both are able to destroy magnetism, or even to reverse the polarity of a magnet; and (7) both are able to melt metals.

Finally, as a result of both theoretical analysis and observations of experiments, Franklin concluded that a sharp pointed object, especially if grounded, was more prone to draft off an electric charge than was a dull, rounded one. Coupling this conclusion with his understanding of the nature of lightning, Franklin conceived the notion of drawing off a lightning charge by means of a tall rod, the top of which terminated in a point and the bottom set in the ground. This became the lightning rod which served not only as a great benefaction in eliminating the hazard of destructive lightning strokes; it also helped popularize Franklin's name on both sides of the Atlantic. The King of France sent a special letter to the Royal Society complimenting Mr. Franklin on his valuable contribution.

To confirm the electrical nature of lightning experimentally, Franklin made his famous kite experiment in June 1752. This he described in a letter to Collinson dated October 1, 1752. A kite of cedar ribs was covered with a thin silk handkerchief to which a sharp pointed wire was added at the top and the usual tail at its bottom. Franklin then added a silk ribbon to the bottom of the twine and at this juncture fastened a key. In flying the kite in a storm, the experimenter stood in the shelter of a door so as not to wet the silk ribbon. he noted that when the thunderclouds cross over the kite "the pointed wire will draw the electric fire from them,, and the kite, with all the twine, will be electrified and the loose filaments of the twine will stand out every way and be attracted by the approaching finger." He noted: "At this key the phial may be charged, and from electric fire thus obtained, spirits may be kindled, and all the other electrical experiments be performed." He later discovered that thunderclouds may be charged either positively or negatively. De Romas, a French experimenter, repeated Franklin's experiments and succeeded in drawing a spark from the clouds eight inches long. Dalibard (who translated Franklin's book into French) set up a pointed rod at Marly, near Paris, following Franklin's instructions. Here his deputy drew sparks during a thunderstorm in May 1752. The idea spread to England and other nations on the Continent. In 1753, a Prof. Richmann of St. Petersburg was killed by a charge that was brought down an improperly terminated rod; this unfortunate result thus made him the first martyr to the new electrical science. The lightning rod idea expanded in Franklin's mind so that he asked "May not the knowledge of this power of points be of use to mankind, in preserving houses, churches, ships, etc., from the stroke of lightning, by directing us to fix on the highest part of these edifices, upright rods of iron made sharp as a needle, and gilt to prevent rusting, and from the foot of these rods a wire down the outside of the building into the ground, or down round one of the shrouds of a ship, and down her side till it reaches the water?''

With the publication of his book ''Experiment and Observations on Electricity, made at Philadelphia in America'' in London, 1751, his reputation grew rapidly in Europe. This book was reprinted five times in English in his lifetime and in several editions in French, Italian and German. On his visits to England and France he became one of the most popular men of his time. He received a doctorate from Oxford, was elected Fellow and Manager of the Royal Society of London and was chosen one of the eight foreign members of the Royal Academy of Sciences of France, the only American to be so elected for the next hundred years.

The enthusiasm which Franklin displayed in his electrical research is well demonstrated in his third letter to Collinson. In it Franklin sums up by describing an event to celebrate that fruitful year, 1747, ''in a party of pleasure on the banks of the Skuylkil a turkey is to be killed...for dinner by the electrical shock, and roasted by the electrical jack before a fire kindled by the electrified bottle; when the healths of all the famous electricians in England, Holland, France, and Germany are to be drank in electrified bumpers, under the discharge of guns from the electrical battery.''

ANNOUNCEMENTS AND CALLS FOR PAPERS

MEETING NOTICE

Central New England Chapter — Oceanic Engineering Society

The first official meeting of the CNE chapter — OES shall be held Wednesday, September 19, 1984 beginning at 5:30 P.M. at the Sheraton-Mansfield Inn, Mansfield, Mass. An ambitious program is planned with representatives from industry, Woods Hole Oceanographic Inst., and academia to discuss the interaction of those three bodies and involvement of members of the OES. A brief business meeting and buffet dinner is planned. Come meet with other members of this new chapter in an informal atmosphere. For information on cost and reservations please contact Bruce Ambuter (617-548-8700), Michael Serotta (401-847-9680) or Stephen Ivkovich (401-847-8000).

SPECIAL ISSUE ON BEAMFORMING

In July 1985 a special issue of the IEEE Journal of Oceanic Engineering will be devoted to beamforming, covering both the electromagnetic and the acoustic case, with empahsis on the latter. Among the topics to be covered are comparative analysis of electromagnetic and acoustic beamforming, image formation, arrays, side lobe reduction, interpolation and adaptive beamforming, as well as modern beamforming techniques inclusive of, but not limited to, frequency domain approaches, maximum likelihood methods, and maximum entropy processes.

GUEST EDITORS

Dr. Mario D. Grossi Raytheon Company Submarine Signal Division P.O. Box 360 Portsmouth, RI 02871	Prof. Giorgio Tacconi University of Genova Department of Engineering, Biophysics and Electronics (DIBE) Via all'Opera Pia 11 a 16145 Genova, Italy

ISSUE MONTH: JULY 1985

SUBMISSION DEADLINE:

October 15, 1984

Prospective authors should prepare their manuscripts in the manner prescribed on the back cover of the IEEE Journal of Oceanic Engineering and submit them at any time up to the deadline to either of the Guest Editors.

SPECIAL ISSUE ON ADVANCES IN ELECTROMAGNETIC REMOTE SENSING OF THE OCEANS

Papers are invited that present new observations, technologies and scientific results related to studies of the ocean from air and space platforms. Active and passive remote sensing at all electromagnetic and optical frequencies are of interest. Recent advances in technology, theoretical interpretations and modeling, and applications are sought. In addition, activities that directly support air and space measurements and operations are also encouraged.

GUEST EDITORS

Prof. David E. Weissman Department of Engineering Hofstra University Hempstead, NY 11550	Prof. Adrian K. Fung Remote Sensing Laboratory University of Kansas Center for Research, Inc. Lawrence, KS 66045

ISSUE MONTH: SEPTEMBER 1985

SUBMISSION DEADLINE:

December 15, 1984

Prospective authors should prepare their manuscripts in the manner prescribed on the back cover of the IEEE Journal of Oceanic Engineering and submit them at any time up to the deadline to either of the Guest Editors.

Announcements and Calls for Papers continued on pag

'TIS A PUZZLEMENT

Since there is no puzzle from last quarter to solve, I am going to take a few lines to introduce myself and reintroduce this column.

I've long enjoyed puzzles and problems and find them an excellent way to keep the brain cells alive and sharp. Since there are limits to my time, imagination and talents, I encourage you to write when you have ideas for new puzzles, a solution to an old one, a gripe or a compliment. This will greatly improve the quality of this column, provide you with recognition as the excellent puzzler you are and help me avoid "puzzle editor burnout."

THIS QUARTER'S PUZZLE

This quarter's puzzle is simple to state, challenging to set up and tedious to actually solve. Therefore, just aim for figuring out in detail how to solve the problem. That will be enough.

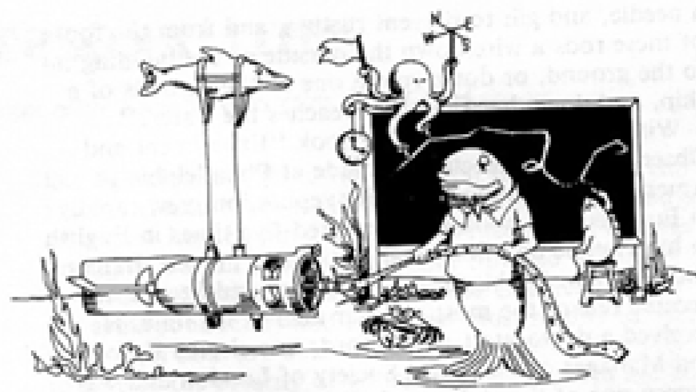
The Puzzle: In the game of Monopoly™, what are the best properties to buy and which are the worst? This requires determining the probability of landing on the various squares on the board, which would be simple if it was not for Community Chest, Chance and going to jail on the third consecutive double.

While I don't expect you to solve this problem, I still hope a few hard live puzzlers with some time on their hands will. In five years of playing Monopoly™ with my wife, I've only won one game. I need help badly!

Dave Hollinberger
1607 Mahan Avenue
Bremerton, WA 98310

BIOGRAPHY OF DAVE HOLLINBERGER, PUZZLEMENT EDITOR

I grew up in Belleville, Illinois. My high school years found me on the math team, the school newspaper and a TV quiz bowl team. Vanderbilt University in Nashville, Tennessee provided me with a scholarship and the opportunity to earn a Bachelor degree in Electrical and Biomedical Engineering in 1978. After graduating, I joined the U.S. Navy and was assigned to the Division of Naval Reactors in Washington, D.C. There, I worked as a project engineer on the nuclear propulsion plant in the TRIDENT submarines. In 1983, I left D.C. for submarine training in Connecticut and on board USS Nathanael Greene. I reported to Puget Sound Naval Shipyard in February and am in training to become a nuclear ship superintendent for submarine overhauls. My wife, Susan, and I have a two-year old son, Drew, and are expecting our second child in September. In addition to IEEE, I am a member of Tau Beta Pi and the American Society of Naval Engineers.



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.

A joint NOAA/Navy 30 day cruise is planned for October 1984 aboard the NOAA ship MACARTHUR off the U.S. West Coast from Seattle to Northern California in the Exclusive Economic Zone (EEZ) Area. The cruise plan includes routine XBT/CTD mapping in support of circulation modeling augmented by deployment of Sippican Expendable Current Profilers (XCP), to measure vertical profiles of relative horizontal currents. Chris Mooers of the U.S. Navy Postgraduate School will lead the XBT/CTD efforts while Tom Sanford of the University of Washington's Applied Physics Laboratory will be responsible for the XCP deployments.

For further information contact: Bill Woodward, (301) 443-8444.

As part of an experiment to evaluate the concept of combining numerical hydrodynamic models for short term forecasting with real-time monitoring of water levels and currents, NOAA's National Ocean Service (NOS) will deploy a bottom mounted upward looking Remote Acoustic Doppler System (RADS) in approximately 12m of water in Delaware Bay, in mid-August. The velocity data will be used in the assessment of the forecasting skill of a numerical circulation model, being employed in the forecasting mode using real-time data inputs for the first time.

The RADS sensor is a Rowe-Deines Inc. (RDI) Model RD-VM 1200 1.2MHz acoustic Doppler current profiler. The sensor and processing electronics will be deployed on a bottom-sitting sled, to minimize vulnerability to deep draft vessels. The RADS will be connected via underwater cable to transmitting equipment on Brandywine Shoals Lighthouse. Microcomputers and RF telemetry equipment located on the lighthouse will be used to format the data stream for transmission to Lewes, Delaware, where the data will be sent by telephone line to NOS headquarters in Rockville, Maryland for display in real-time, along with the numerical model forecast.

The quality of the RADS data will be corroborated by means of an EG&G Vector Measuring Current Meter (VMCM) anchored near the RADS, and also cable connected to the Brandywine Shoals Lighthouse for real-time operation.

In addition, an intensive "sea truth" intercomparison experiment is planned for a two week period beginning September 17. The Coastal Ocean Dynamics Applications Radar (CODAR) will also be operated to measure surface current in Delaware Bay during this time period.

The general, though tentative, plan for the "sea truth" experiment includes four moorings; one supporting Grundy current meters, a second with Aanderaa current meters, the third with an EG&G VMCM and Marsh-McBirney electromagnetic current meter, and the last supporting three Neil Brown Three-Axis "Smart" Acoustic Current Meters (SACM's). Two Aanderaa pressure gages will also be installed to monitor water level at the site.

The Delaware Bay "sea truth" experiment is the third in a series of NOS evaluations of remote acoustic Doppler current profilers. The first involved the Ametek-Straza DCP 4400/300 in Chesapeake Bay in August 1982, and the second, the Ametek-Straza deployed in New York harbor in the autumn of 1983. The results of these experiments have been described by Mero et al (1) for the Chesapeake Bay deployments, and by EG&G (2) for the New York harbor deployments.

1. Mero, T. N., G. F. Appell, and D. L. Porter, "Sea Truth Experiments on Acoustic Doppler Profiling Systems." Proceedings of Oceans 83

2. EG&G Corporation, Washington Analytical Services Center, (B. Magnell, Principal Author) "The Fall 1983 Sea Truth Experiment, Ambrose Light New York, October 19 through November 9, 1983." (In preparation)

For further information contact Bob Williams, (301) 443-8939

Horizon Marine, Inc., of Marion, MA, has commenced a joint industry program, "Ocean Response to a Hurricane," with a consortium of oil companies participating. Horizon will measure the ocean currents in front of, in, and in the wake of a Gulf of Mexico hurricane in 1984, using the expendable current profiler (XCP).

Further information regarding the program can be obained by contacting Andrew J. Santos, Jr., Program Manager, Horizon Marine, Inc., 13 Marconi Lane, Marion, MA 02738, (617) 748-1860.

NOAA's National Ocean Service is in the midst of a major project to improve NOAA predictions of currents and water levels in Delaware Bay and the Delaware River using a numerical model with both historical and real-time data as input. Traditionally, NOAA predictions of tides and currents have been based on analyses of the astronomic tide producing forces and of extensive historical records of water movement dynamics. However, these predictions can be seriously affected by forces which are difficult to predict, such as severe weather and heavy fresets. To account for these parameters, the National Ocean Service has deployed a number of real-time sensing systems at key locations in Delaware Bay and Delaware River, including an RD Instruments, Inc., remote acoustic Doppler system (RADS) to measure currents from near bottom to near surface, a NOAA-developed Coastal Ocean Dynamics Radar (CODAR) for surface currents, four Sutron AQUATRAK and four Progress Electronics water level systems, and a meteorological data buoy from the Applied Physics Lab of Johns Hopkins University. These data will be augmented by National Weather Service meteorological data and U.S. Geological Survey river flow data. The model being used in the project is a subset of the three-dimensional Mellor-Blumberg estuarine model developed at Princeton University. The goal of the project is to develop a model that could be used to improve predictions of water movement dynamics not only in Delaware Bay and River, but also in Chesapeake Bay and other key estuaries in the United States.

For further information, contact: R. Patchen (301) 443-8501.

Announcements and Calls for Papers continued from page

OCEAN ACOUSTIC REMOTE SENSING

In October 1985, a special issue of the IEEE Journal of Oceanic Engineering will be devoted to ocean acoustic remote sensing. Among the topics to be covered are acoustic monitoring and assessment of fish stocks, ocean acoustic tomography, acoustic monitoring of pollution and acoustic current velocity profiling. Papers on these or other ocean acoustic remote sensing topics are invited.

Prospective authors should prepare their manuscript in the manner described on the back cover of the IEEE Journal of Oceanic Engineering and submit them by January 15, 1985 to the guest editor:

Dr. John E. Ehrenberg
BioSonics Inc.
4520 Union Bay Place N.E.
Seattle, Washington 98105

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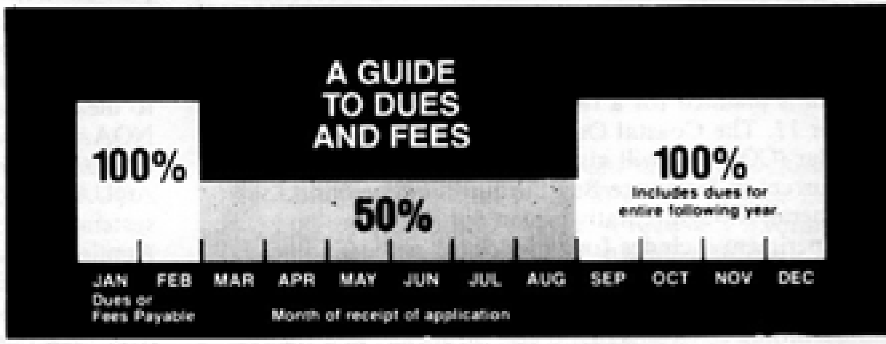

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22-5

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ADVISORY COMMITTEE MEMBERS

Dr. William C. Boicourt
UMCEES
Horn Point Lab
Box 775
Cambridge, MD 21613

Mr. Edward C. Brainard II
Environmental Devices Corporation
Tower Building
Marion, MA 02738

Mr. William L. Coburn
EG&G Sea-Link Systems
2818 Towerview Road
Herndon, VA 22071

Dr. David Halpern
NOAA
Pacific Marine Environmental Lab
7600 Sand Point Way, N.E.
Seattle, WA 98115

Mr. Earl G. LeDet
The Johns Hopkins University
Applied Physics Lab
Johns Hopkins Road
Laurel, MD 20707

Dr. Bruce A. Magnell
EG&G Environmental Consultants Div.
300 Bear Hill Road
Waltham, MA 02154

Mr. Geoffrey K. Morrison
Neil Brown Instrument Systems, Inc.
P.O. Box 498
1140 Route 28A
Cataumet, MA 02534

Dr. David G. Mountain
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Woods Hole, MA 02543