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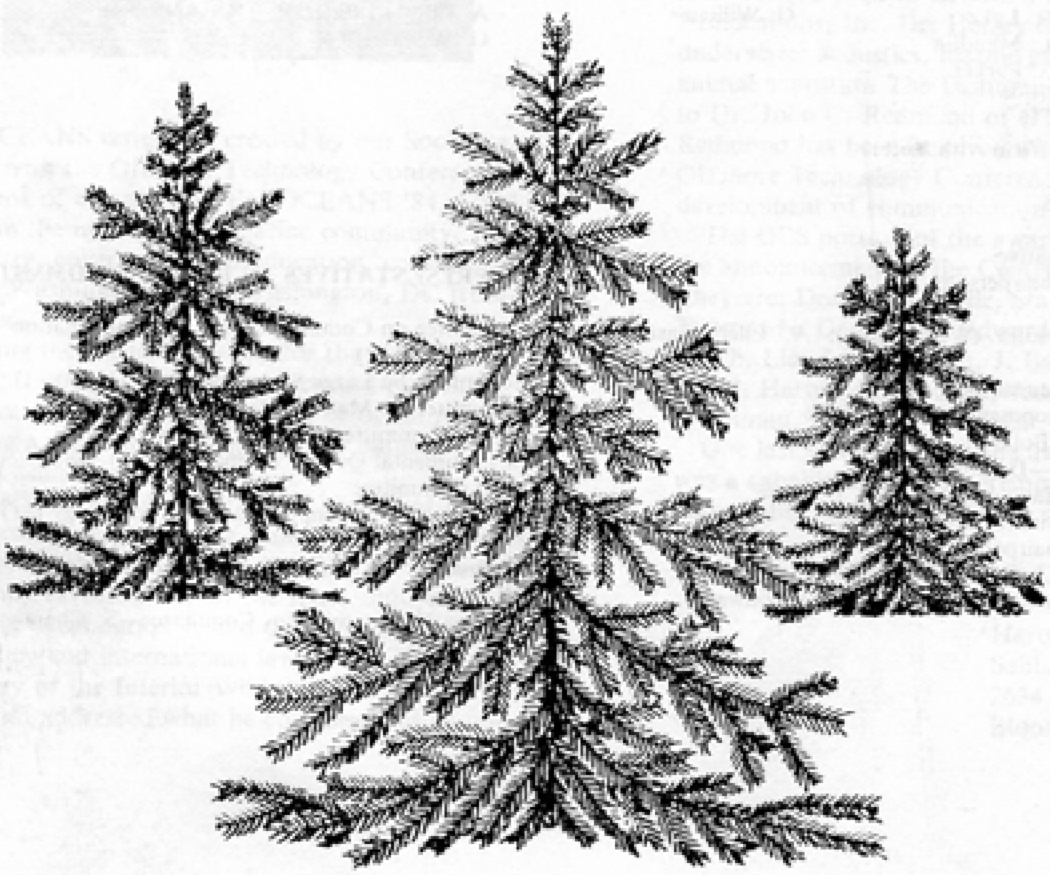

Season's Greetings

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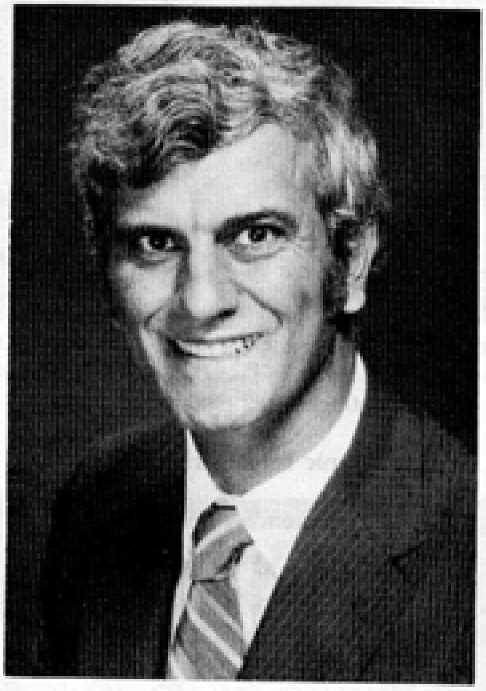
EDITOR'S COMMENTS



The OCEANS series was created by our Society and remains, with the Offshore Technology Conference, a cornerstone of our activity. For OCEANS '84, 1,500 experts from the international marine community, representing industry, government and education, convened at the Sheraton Washington Hotel, Washington, DC from 10-12 September.

Adopting the theme "Designs for the Future", the purpose of this international conference and exposition was to enhance the orderly development of ocean resources by promoting a productive partnership of industry, government and academia.

OCEANS '84 focussed on a wide variety of topics, including ocean energy, marine transportation, fisheries development, pollution, waste disposal, food, undersea vehicles (my favorite), use of the space shuttle and satellites in oceanography, and discussions on national ocean policy and international law.

Secretary of the Interior William Clark was the featured speaker and addressed what he considered to be one of the highest priorities of his Department, namely, the orderly development and protection of the resources in the 200-mile Exclusive Economic Zone (EEZ) that was enacted by President Reagan's Proclamation of 10 March 1983.

Over 300 policy and technical papers, representing significant contributions from universities, governments, laboratories and private industries, world-wide, were presented.

The conference exhibit area featured some 150 demonstrations of the latest state-of-the-art marine products, services and systems.

At the President's Awards Luncheon, that was held on Wednesday, 12 September, Secretary of the Navy, John F. Lehman, Jr., described the Naval recovery program that is a part of the "change in national policy" that has become manifest during the Reagan administration. The high-point of the Luncheon, however, is always the awards ceremonies. Our Distinguished Technical Achievement Award went to Dr. John Brackett Hersey of Applied Applications, Inc. Dr. Hersey is a published authority on underwater acoustics, marine geophysics and underwater animal acoustics. The Distinguished Service Award went to Dr. John C. Redmond of GTE Communications. Dr. Redmond has been involved with the early planning of the Offshore Technology Conference and research and development of communication products.

The OES portion of the awards ceremony ended with the announcement of the Centennial Medal recipients. They are: Donald M. Bolle, Stanley G. Chamberlain, Thomas N. Dauphinee, Edward W. Early, Stanley L. Erlich, Lloyd Z. Maudlin, J. Barry Oakes, John C. Redmond, Harold A. Sabbagh, Joseph R. Vadus, David E. Weissman, Arthur S. Westneat, Jr., Glen N. Williams.

One last recollection of the awards luncheon; Joe Vadus was a capable master of ceremonies, but the lad will never make it big on Broadway if he doesn't loosen up a bit.

Harold A. Sabbagh
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OCEANS '84 HIGHLIGHTS

John Brackett Hersey

Distinguished Technical Achievement Award

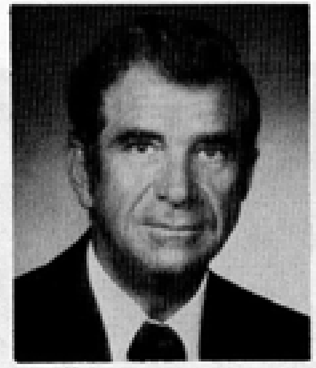
Oceanic Engineering Society

September 12, 1984

Dr. John Brackett Hersey received his first degrees in Physics from Princeton University and was awarded the Ph.D. degree by Lehigh University in 1943. For the greater part of his career he was affiliated with the Woods Hole Oceanographic Institution where shortly before leaving he had attained the rank of Senior Scientist and was head of the Department of Geology and Geophysics. He spent the next thirteen years at the Office of Naval Research where his principal duties were those of Deputy Assistant Oceanographer and Special Assistant to the Assistant Secretary for Research and Development. He currently serves as Senior Staff Scientist and consultant to Science Applications, Inc. He served with distinction in the Navy during the Second World War. During his extensive career he has published over fifty science journal articles covering broad areas of investigation in physical oceanography, sound scattering by marine animals, marine geology, and various applications of underwater acoustics to the study of the oceans and the sediments and rock on the ocean floor. He has also contributed major chapters to texts on underwater acoustics, marine geophysics, marine animal acoustics, and oceanographic instrumentation. His advice has been sought by a number of national institutions and he has served on major review committees for the Navy, the National Science Foundation, and the National Academy of Sciences.

He has received recognition through election to Fellow of the Acoustical Society of America, Geological Society of America, and the Royal Astronomical Society. He was further recognized by being awarded the Fleming Medal in 1964 and the Distinguished Civilian Service Medal in 1970.

We recognize Dr. John B. Hersey today through the award of the Oceanic Engineering Society's Distinguished Technical Achievement Award in recognition of his outstanding technical and scientific achievement across broad reaches of oceanography.



John C. Redmond

Distinguished Service Award

Oceanic Engineering Society

September 12, 1984

Dr. John C. Redmond received his engineering degree from the University of North Dakota in 1955 and subsequently received the Ph.D. degree in Geophysics from the Pennsylvania State University in 1962. For a very substantial part of his career he held a number of positions with the General Dynamics Corporation where he rose to the position of Corporate Director of Research and Development. Subsequent to that he was Vice-President of Engineering and General Manager of the Digital Systems Division of Stromberg-Carlson Corporation which is a subsidiary of General Dynamics Corporation. More recently he joined GTE as Vice-President — Research and Development of GTE Communication Systems Corporation, a major component of General Telephone and Electronics, and has direct responsibility for the development of domestic communications system products and for research and development of world-wide communications research and products developments.

Throughout his career he has given generously of his time to serve in a number of capacities within the Institute of Electrical and Electronics Engineers. He served on the Administrative Committee of the Geoscience and Remote Sensing Society and was President of that Society. He was recognized also by the IEEE and named Outstanding Lecturer.

He was also one of the early participants of the IEEE's Oceanic Coordinating Committee which later became the Council of Oceanic Engineering and is now the Oceanic Engineering Society. While President of the Geoscience Electronics and a member of OCC, he was involved in the early planning of the Offshore Technology Conference which has since developed into the largest world conference of technology relating to offshore engineering. He has served as a member of the Executive Committee of the Offshore Technology Conference from 1972 to 1984.

The IEEE's Oceanic Engineering Society recognizes Dr. John C. Redmond for his long and distinguished service in advancing the interests of the IEEE and its members in the oceanic engineering field through awarding him its Distinguished Service Award.

OES President Stan Chamberlain (l) presenting Brackett Hersey with the Distinguished Technical Achievement Award.

Stan Chamberlain (l) presenting John Redmond with the Distinguished Service Award.

Recipients of the IEEE Centennial Medal. Front row (l to r): Ed Early, Lloyd Maudlin, Dave Weissman, J. Barry Oakes, Tim Dauphinee, John Redmond, Stan Ehrlich; back row (l to r): Joe Vadus, Don Bolle, Hal Sabbagh, Stan Chamberlain, Art Westnest, Glenn Williams.

Banquet speaker, Dr. John Craven.

Foreground to rear: Gilbert L. Maton, Pres. of the Marine Technology Society, RADM John B. Mooney, COMO John R. Seesholtz, Stan Chamberlain, OES President. RADM Mooney and COMO Seesholtz were co-chairmen of OCEANS '84.

Left to right: Gil Maton, ADM James Gracey, Commandant, US Coast Guard, Stan Chamberlain, and Joe Vadus, Master of Ceremonies of the Awards Luncheon.

Secretary of the Interior,
The Honorable William P. Clark.

The Honorable John F. Lehman, Secretary of the Navy.

SONOBUOYS—PART I HISTORICAL DEVELOPMENT THRU WWII

Reprinted from the IEEE AESS Newsletter, September 1984

INTRODUCTION

This article concerns a technology that may have more impact on the survival of the Free World than the technologies of Nuclear War. We are inundated, and understandably so, with debates on MX missiles, B-1 bombers, Super-Carriers, Pershing Missiles, Trident Submarines, and so on, all components of a Nuclear War. The debate may be futile. Atomic War is World destructive. Neither the United States nor Russia can possibly want, or win, such a mutually destructive military show-down. It is more likely that they will continue this confrontation with "neither may dare" preparedness, like two angry gorillas beating their chests and baring their teeth, but avoiding mortal combat. If not, there will be no winners, the arguments will have been wasted, our World will be over.

It would seem more likely that both Nations, each realizing the senselessness of Atomic War, will if it comes to War, try to hold it to "conventional" war where there can be survivors and so-called winners. If so (and this is our only hope if War comes), we must be prepared with our Allies overseas to win such a War. The required key to such a victory has been evident for Centuries of Wars but was most clearly shown in both War 1 and War 2: Mastery of the Seas. Mastery of the Seas, Freedom of the Seas, depends upon our being able to keep the shipping bridges across the Oceans open for the transport of the tools of War and the two-way logistics of our National survival.

In both those Wars we nearly lost that control of the seas to submarines. In both we finally and narrowly defeated the U-boats. Our own submarines (and mining) destroyed the essential Japanese shipping lifeline and brought Japan to her defeat. The atomic bombs, in retrospect, were just a final spectacular curtain at the end of the drama. The lesson of the past, inadequately remembered, is more germane than ever: the side that cannot defeat submarines will lose the War.

Russia and the Allies each now possess a great overkill deterrent atomic strength. One upsetting area in which Russia has overwhelming strength is in its ready force of deadly submarines. Germany at her peak never had over fifty, surface operating, U-boats at sea and these were without any real Naval force to protect them from the enormous Allied Naval might. Russia now has over 300 submarines, many new and most of modern technology. Some have alarming performance. It also now has a modern, massive, formidable Navy to work with the submarines, protect and enhance them. Their submarine force alone, heavily atomic powered, frightening in quantity, also possesses quality, making each Russian atomic submarine many, many times more dangerous than War 2 types.

Our anti-submarine problem is therefore tremendous and, despite too frequent Navy or Defense Department propaganda reassurances to the contrary, is far from solved. Since War 2 we have, however, developed one really new ASW ace, the new and ever more promising capability of aircraft against submarines. This capability largely rests upon ubiquitous little devices called sonobuoys. The story of this technology should be known. Hopefully this article will help.

If one were to ask many leaders of the Navy their opinions of what technological developments had changed the face of Naval warfare, one would get many answers. These would include (in no priority order), radar, aircraft, the submarines, radio, the transistor, computers, and so on. Strangely, the chances are very high that no one would even think of mentioning the sonobuoy, even though it changed the way the Navy fights submarines. The sonobuoy, unknown at the start of World War 2, is now considered indispensible in anti-submarine warfare (ASW).

What is a sonobuoy? If you will look in Websters Third International Dictionary (Unabridged) you will find, defined in immediate and most appropriate sequence, two closely associated words:

"son-o-buoy . . . a buoy equipped with a hydrophone for detecting underwater sounds and an automatic radio transmitter for transmitting the sounds and developed as a submarine detector to be dropped by parachute from aircraft for transmitting the coded sounds of submerged submarines to air and surface craft.

son-of-a-bitch . . . Bastard 7—sometines considered vulgar; sometimes used interjectionally to express surprise or keen disappointment"

Webster, in addition to poor grammar, was inaccurate. The sounds are not coded, they are the natural sounds made by a submarine or other underwater sound sources. Webster's definition of the second "word" should have truthfully and aptly included: a term 'affectionately' applied to sonobuoys by those, who with infinite faith, perception, and skill, have now caused sonobuoys to be sworn "by" and not "at"!

ANTISUBMARINE WARFARE BACKGROUND

A brief historical background of antisubmarine warfare is essential as a prelude to discussion of ASW and Sonobuoy technology.

In both War 1 and War 2 the Allied Nations were nearly defeated by German submarines. War 1 witnessed the birth of submarine warfare when a small number of German U-boats (undersea boats) almost caused German victory. War 2 was again almost a catastrophy for the Allies. Some 2028 ships, of 5000 tons average, were sunk by a relatively small force of German submarines. Britain alone lost over 30,000 men on those ships. At peak periods there were only about 50 U-boats causing this slaughter. To meet the submarine menace required about 25 warships and 100 aircraft for each U-boat, and about 100 Allied sailors for each U-boat sailor. This havoc was created by submarines that were not true submersibles. They were surface operating vessels that could submerge for limited times. Their sinkings were generally done while surfaced at periscope depth.

In War 1 there was no real ASW technology. The frigates and destroyers caught the U-boats on the surface. There was no sonar as we know it today. Aircraft depended almost solely on visual sightings which caused submarines to submerge, spoiling their attacks, but not effectively destroying them.

Aircraft were first used in ASW in War 1. Those first crude airplanes, just a few years out of the Wright Brothers' cradle, were quickly recognized for their observation capability against submarines that spent most of their time on the surface. From the beginning, submarines did not like to be seen by aircraft. Even if the aircraft could not effectively attack, it could and did notify ships that could. This observation feature also caused hundreds of BLIMPS (a forgotten technology today) to be widely used in War 1 for ASW, even operating off ships. But aircraft then had only one good submarine sensor: the human eyeball. A few aircraft had radio equipment (wireless in those days) that did detect submarine radio transmissions but this simply alerted that there submarines around somewhere.

The technology of ASW had been nurtured between War 1 and War 2. This was largely applied to surface vessels such as destroyers (DD) and frigates (FF). The developments, mostly in echo-ranging equipments, were independently pursued in the United States, France and Great Britain. Germain concentrated on underwater listening systems for her U-boats and in that, far excelled anything done here or in England. No nation placed much emphasis on aircraft for ASW purposes.

The British Naval Command was unrealistically convinced that their ship sonars (ASDICS) were masters over submarines. Apparently that is why Britain consented and allowed Hitler to violate the Naval treaties and build submarines right prior to War 2. England thought the submarine menace was licked with ASDIC. That mistaken high Naval policy also was applied to their Naval construction priorities. (These beliefs and policies have a familiar ring today.) They built battleships and neglected ASW ships such as destroyers and frigates. No country did any real development work towards applying aircraft to anti-submarine warfare. Therefore, War 2 started with no real airborne ASW technology. Until about 1942, three years into War 2, the major ASW platforms were destroyers and frigates using echo-ranging sonars, depth charges, and early radar technology.

The U-boats largely closed the convoys on the surface. The ship echo-ranging sonars had very short ranges against submarines on the surface. Those sonars were also not good enough under many operational conditions against submerged submarines. The British scientists had known this but their Navy officials did not listen carefully. Radar started to be applied to the detection of the surfaced U-boats. The British Navy grimly, tenaciously and bravely fought a one-sided battle until America joined in the Battle for the Atlantic, using destroyers against the surface loving U-boat.

When War 2 started in 1939, about the only improvement in the ASW capability of aircraft was that they had achieved medium range, reliable flight, respectable endurance and payload. Radar had been invented but it was not until about two years later (1941) that crude radar was being installed in aircraft. Great improvements had been made in communications, navigation, and operations. Aircraft Carriers were already part of our arsenal. The United States had vastly improved BLIMPS. Aircraft sensors to detect submerged submarines had not yet been developed. Even so, since the submarines were still largely surface operating boats, aircraft were very valuable for spotting submarines and spoiling their attacks on convoy ships. Unfortunately, the aircraft of early War 2 did not have the endurance or range to cover the mid-Atlantic ocean. The mid-Atlantic gap nearly did us in.

Airborne ASW technology was only born in the latter part of War 2. Submarines still feared and hated aircraft because they could surprise a surfaced U-boat, drop depth charges and, later in the War, the homing acoustic torpedo. While radar was a fine technical tool it was not, as has been claimed, the all important breakthrough in ASW. The main reason we defeated the U-boats in War 2 was because they ''talked'' too much! German submarines, by strict operational doctrine, were required to communicate by radio with their shore-based Command in occupied France. They received and supplied shipping information and received battle instructions in very secure spurt codes allowing them to form ''wolf packs''. The British had captured a German U-boat intact (U-110, 9 May 1941) with the coding machines, and the codes (Ultra/ENIGMA) used for submarine operations, without the German High Command's knowledge. The Allies thus often knew how the U-boats were disposed and what they were up to. Furthermore, the Allied ships and shore stations took instant cross bearings on the U-boat transmissions by using high-frequency direction finders (HFDF), popularly known as HUFFDUFF. The Germans did not believe fast DFing was possible. This priceless information revealed where the U-boats were. There have been few instances in the history of War where one side had such superb intelligence information to use against the enemy (McClelland at Antietam in the Civil War found General Lee's battle plans). Despite this strategic intelligence miracle, and the massive Allied ASW forces, the few in number, crude, surface dependent German submarines very nearly won the War for Germany.

HISTORY OF SONOBUOY DEVELOPMENT

The American scientific and engineering community realized well before our involvement in War 2 that we had better get prepared. Vannever Bush, of MIT, and others persuaded Roosevelt that the technical brains should gear-up for action. The Office of Scientific Research and Development (OSRD) was established. Representatives of this neophyte body, separate from any organized military research organization, visited England to obtain first hand knowledge of what that beleaguered Nation thought was needed. Britain was so preoccupied with survival that she could not possibly devote adequate attention to the application of high technology to the War effort. England had ideas, based upon her military needs and the lessons she was bitterly learning, but did not have the resources to carry them out. Britain welcomed the potential American scientific effort and did all possible to educate the green American visitors with what they thought was needed in the way of developments. That cooperation continued and increased all through the War and still does today. The American civilian teams returned from England with many concepts which introduced them into the strange world of military science. Among these, and this will be focused on in this paper, was the urgent need for much better antisubmarine technology in all its many aspects. England was already losing its valiant fight to keep its Atlantic lifelines open.

One of these ideas was to become the foundation of airborne antisubmarine warfare. At that time, 1940, the convoys supplying Britain were being increasingly attacked by German submarines. These U-boats were starting to operate in ''wolf packs''. Having intercepted a convoy the U-boats, operating on the surface, would gather and often close the inadequately defended convoy from astern, and proceed to carry out a coordinated attack. This was frequently done at night, upsetting the planners in Britain who, despite War 1 experience, incredibly did not think submarines could operate at night! The German submarine tactics of attacking from the rear made the British believe that a device was needed which would remotely detect the submarines as they gathered and approached the convoy from the rear. They proposed that buoys equipped with hydrophones (underwater microphones) be dropped from the stern of the convoy ships. These special buoys would be equipped with radio transmitters which would relay their submarine detections to the convoy alerting them of the imminent attack. They called these proposed devices ''radio sonobuoys''. Thus the concept of today's sonobuoys was British. The British did not develop their brainchild.

OSRD had established War Research laboratories at various Universities. Harvard, Columbia, University of California had embryonic antisubmarine warfare labs established in the Spring of 1941, well before United States got into the War. These Labs literally knew nothing about Naval warfare. They had money, brains, ''learning fever'', and freedom to innovate. They, quite apart from official Navy laboratories, were cutting their teeth in very strange technology. They gladly accepted British suggestions concerning new ideas, ideas that were not always welcomed by the Navy laboratories. Among these was the concept of the sonobuoy. This was assigned to the new Columbia University, Division of War Research, Laboratory (CUDWR) at New London, Connecticut.

This OSRD lab awarded a contract to RCA Camden on 23 June 1941 for the development of such a ship launched radio sonobuoy. The contract was also supposed to consider developing this buoy into an aircraft launched unit. The writer had the extreme good fortune to be the person assigned to monitor the RCA ship launched sonobuoy development, an assignment that changed my life and the way the Navy fights submarines. RCA did a remarkable job in quick reaction development. Within three months, 12 September 1941, they were ready for testing the first models (Figure 1) at sea including the development of an FM receiver. The RCA effort was headed by Ken Chittick. Dr. Harry Olsen, the great acoustics scientist at RCA designed the hydrophone. The engineering put into this first-of-its-kind-buoy, and its receiver, was novel and ingenious.

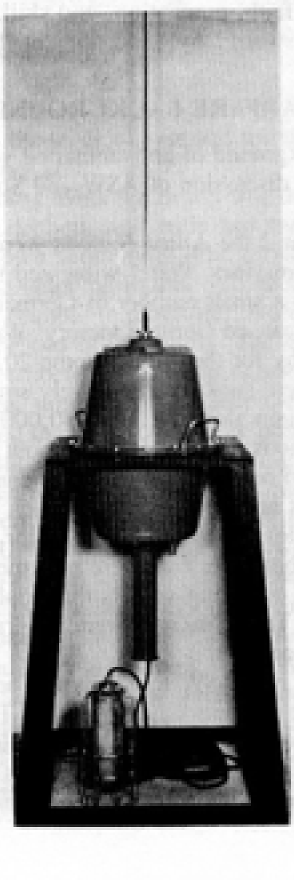


Figure 1-A

Figure 1-B

RCA chose wide-band FM at about 70 megahertz, and an output of around 10 watts, radiated from a whip antenna. This enabled a line of sight range to a ship of about 15 miles. A 400 volt "B" battery powered the unit and understandably discouraged careless fingers during tune-up. The unit weighed about 60 pounds and had a life of about ten hours. The hydrophone was simply an automobile radio eliptical cone loudspeaker encased in a waterproof rubber boot and suspended about 30 feet beneath the surface. This was hardly a design one would expect from the eminent acoustician Harry Olsen, but this was one of his first attempts at hydrophone acoustics. It worked reasonably well. The FM receiver was, it is believed, the first FM receiver to utilize automatic frequency control (AFC). It needed that considering the poor frequency stability of the buoys reactance modulated transmitter.

The buoys did what all developmental buoys have done initially and embarrassingly ever since; i.e., they leaked, they were noisy, and they sank. But they did work well enough to prove the concept of sonobuoys. They could detect underwater sounds at good distances and radio that detection to a ship.

It was thought by the naive civilians that such a demonstration of a remarkable new concept would have the Navy rushing to accept it. But the hide bound (and desk bound) traditional Navy officials, with fixations that only ships echo ranging equipment was good for ASW, very quickly decided that the whole idea was not worth further priority development.

Sonobuoys just did not appeal to them. Columbia University was told the Navy had no further interest in the idea. The development priority was downgraded. The few engineers who had been associated with the tests had great faith in the idea. Despite an order to stop work, the units were discreetly cleaned up, debugged of obvious problems such as noise and leaks, and put aside. This clandestine refurbishing was "civil" disobedience at its best. The RCA buoys were stored away (fortunately not thrown away), with reluctance and keen disappointment.

At that time, early 1942, the Navy was using BLIMPS in coastal waters for ASW patrols. These beautiful, and now neglected, airships were also testing and using a newly developed short range, submerged submarine, sensor, the Magnetic Anomaly Detector (MAD) which sensed the disturbance created in the Earth's magnetic field by any large ferrous body. Many developers had tried to make such a unit including the British, MIT, and others, but all had failed to achieve the required sensitivity. Victor Vacquier, of Gulf Oil Research, using saturable core technology, had succeeded where all others failed and his development had been first assigned to Columbia University, New London Lab for intensive ASW develop- ment and application engineering. The first MAD equipments were, within months (like many OSRD projects), operating i Lakehurst BLIMPS and were making detections daily. The problem was that they were most often detecting sunken ship and old wrecks. The BLIMPS were depth charging old banana boats and getting rather discouraged about their new and sensitive (about 600 feet in those days) MAD sensor. Some Staff officers from Admiral Rosendahl's airship Command at Lakehurst came directly to New London early in February 1942 and asked what could be done to enable the BLIMP to distinguish between a MAD detected live, moving, submerge submarine and a submerged, stationary wreck.

Two ideas were suggested. One was to tow a passive hydrophone and listen for the sounds of a moving submarine. The other was to try the RCA ship-launched sonobuoys. The RCA units had been debugged and were ready to demonstrate. The BLIMP officers eagerly asked for tests of both concepts. The 'towed hydrophone' was tried but towing noise problems postponed development. Sonobuoys were about to be given another chance, this time by an eager, unorthodox ASW organization, Navy Air from Admiral Rosendahl's BLIMP command at Lakehurst.

This meeting between Navy operators and civilian engineers agreed that a test should be made at the earliest possibl time. The Lakehurst people got official blessing at a meeting in Washington on 21 February 1942, and in a letter from Admiral Furer on 26 February asking OSRD to have such tests performed. The work already underway at New London thus got legalized.

New London was ready, thanks to the RCA buoy modifica- tions that had been made. Arrangements for the test were completed and the test was made on 7 March 1942. The BLIMP K-5, operated with the submarine S-20 in waters south of New London. A launch placed two RCA ship buoys in the water and the submarine ran a prearranged course designed to enable correct evaluation of detection and tracking results. The writer was running the receiver and plots aboard the K-5. The BLIMP received the transmissions easily within a five mile circle of the area and the submerged submarine's underwater sounds wee easily detectable up to three miles. This rather innocuous test was in fact epochal in significance. It was the first time in the history of Naval science that an aircraft in flight had detected a completely submerged submarine by acoustical detection from a sonobuoy.

There was one other most significant aspect of this test. The sonobuoys had been used to verify that a magnetic detection by MAD was caused by a moving submarine. The tests changed the concept of a sonobuoy from being an auxiliary follow-up to the MAD and made the MAD an auxiliary to the sonobuoy. The sonobuoy, in that first test, laid claim to being the prime submarine detector available to aircraft. A new and revolutionary Naval science had been born.

That flight really initiated the technology of sonobuoy engineering. The RCA units were not in any way suitable for use from aircraft. A complete redesign was needed. The team at the Columbia University Laboratory was ready to accept the challenge. We were starting from zero. This naivete was an asset because there was no established technical prejudice. W had no restrictions. Nothing resembling an airborne sonobuoy and its strange requirements had ever been designed before. The team was not contaminated by the conventional shipboard cast-iron and heavy bronze Naval engineering practices. Perhaps the most significant and impacting attitude was that, as patriotic neophytes, they believed designs for expendable equipment should be simple and economical, characteristics uncommon to most military equipments.

With War fever pervading the all-out procurement rush in getting this Country prepared, money for Defense meant little. But there were material shortages in many areas. The civilian community was hit hard with rationing. All automobile production for civilian use was understandably stopped. People were asked to surrender their aluminum pots and pans, car bumpers, etc. for needed recycling in the all-out War Industry production. The public without question believed the publicity. The rather naive sonobuoy engineers, unlike most other military designers, honored the publicity and made every effort to avoid use of critical materials. The engineering design discipline of sonobuoys, from the very beginning, has been cost conscious to a degree still unique in military design and procurements.

The fact that a never-before development was being undertaken really did not complicate the design problem. A sonobuoy, the RCA ship launched unit, had already been developed and it had detected a real live submarine. All that was needed now was to repackage it into a form suitable for aircraft launching. Talk about being naive! Nobody really knew anything about underwater acoustics, the ambient noises of the sea, the acoustic spectra of the submarine and so on. Therefore these vital bits of knowledge essential to proper design did not then exist to bother the designers. Ignorance truly can be bliss.

The "newness" of the project, the total lack of previous design guidance, and the belief that strategic materials must not be used, fostered innovation. Innovation is design fun. Fun instills enthusiasm. These elements gave the program a wonderful starting climate. It did not take anything but enthusiasm and imagination to design the first airborne sonobuoys. The recipe was probably 10% good thinking and 90% mistakes. A poet (Pien?) rather well stated this when he wrote, "The road to wisdom? Well, it's plain and simple to express: to err, and err, and err again, but less, and less, and less". That has been the vital spirit of sonobuoy engineering.

The engineers, having witnessed vertical "spar" buoys stability in heavy seas, decided that such a cylindrical, vertical shape was sensible. This shape also had "bomb" like flight ballistics. It was a shape of strength. Watertight sealing problems were eased. Furthermore, the tubular shape could be simply fabricated out of many materials. Paper was one such material. It was not in short supply since the Pentagon had not yet diverted paper to become their basic output. So the first buoys were wound paper cylinders about 5 inches in diameter and three feet long. That shape and size selection must have been good. It is still standard for "A" size sonobuoys. The electronics design was simply an FM reactance modulated transmitter lifted out of a handbook. Low drain filament vacuum tubes were used, four in the first models, but five in the final design. The electronics assembly was simply mounted on circular steel discs stacked in a frame that fit snugly inside and reinforced the ¼ inch thick paper tube made by SONOCO Products in Mystic, Conn. Water tight integrity was obtained by wooden discs above and below the common electronics and battery chamber. The lower one was nailed in and sealed by pouring a flexible pitch onto it. The top wooden seal was held on by wood screws and sealed by an adhesive tape.

Tuning of the FM transmitter to any one of six different RF frequencies was effected by holes drilled through the top wooden deck which then were sealed with corks and cement. The paper tube was painted with "glyptal" to keep it watertight for a few hours. The buoy was designed to sink after a few hours, so it would go off the air, and also not be captured. The sink time was controlled by drilling a hole in the lower wooden disc and filling it with a predictable water soluble product called "carbowax." The battery pack was simply assembled flashlight cells which powered the unit for several hours. The buoys intended for dropping manually from BLIMPS used a plain steel rod antenna attached manually just before launching. The later airplane launched buoys used a stored, self-erecting antenna. The RF output was about one-half watt, at 60 to 72 megahertz, which gave radio ranges out to line of sight of the aircraft. The buoy was designed to utilize the existing RCA FM receiver. The hydrophone was a rugged unique, nickel magneto-striction unit, designed by a wonderful, unforgetable Bell lab scientist named Al Thuras. This was about the only use of critical material in the design. The illustrations of the first units show the basic simplicity of the design. They also indicate the controlling attempt to avoid strategic materials.

The first development units were tested by dropping from high bridges at New London and Middletown, Connecticut. During one of these tests the writer was apprehended by the FCC for operating radio equipment without a license. This was a serious matter, especially during the War when the air was heavily monitored for clandestine transmissions. The mystery of how the FCC could pick up a one watt, 70 megahertz, short range signal in the middle of the Connecticut River was solved when we found out that a house on the riv bank about a thousand feet away was an FCC monitoring post. The World's worst spot had been accidentally chosen f this supposedly secret sonobuoy test! The crime was forgive when explanations made during the grilling were understood

Very early in the learning process the engineers realized that a sonobuoy, even though an electronic device, was even more a mechanical engineering challenge. This was demonstrated in design of descent retardation for buoys to be used from airplanes instead of from BLIMPS. Incidentally, the ai plane sonobuoys were for the U.S. Army, not for the Navy' Many ideas were suggested and argued. The variety of concepts was so great that it was finally decided to have all the engineers assemble dummy models of their pet ideas and ha a drop contest from an airplane. The winner was supposed become the best retardation device. About sixteen different dummy buoys were assembled. Parachutes, kite tails, drag discs, etc. were all represented. Never before or since has such a variety of junk been thrown out of an airplane. Sixte different buoys floated down. All sixteen came down perfectly! There was no clear cut winner. However, a valuable lesson was learned. Never, never, trust a statistical sample 'one'! Eventually after many more tests, with many failure simple parachute was chosen as the best compromise desig While the writer may have the honors for developing the fi airborne sonobuoy, my wife made the first parachutes. All War 2 production sonobuoys had parachute retardation.

The design problems experienced in arriving at solutions that were simple, reliable, produceable, and low in cost, taught the engineers the value of a design philosophy attrib uted to William B. Stout, of FORD TRIMOTOR aircraft fame. These three 'ungrammatical' principles were:

1. Simplicate. What you don't put on can't give you no trouble
2. Add more lightness
3. Don't invent "rubber gloves" to correct leaky writin pens

These cardinal rules apply to almost all engineering. It takes engineering maturity to practice these. It takes clear thinking to recognize "rubber gloving". The engineers who pioneered sonobuoys became, through bitter experience and many trials, devout practitioners of these sensible, but difficult, engineering disciplines.

The encouraging tests of the first crude buoys from BLIMPS did not at first cause the Navy to exhibit any excitement about this new technology. The interest was furnished by the Army Air Corps! At that time (1942) the Army had a "Sea Search Group" under a Colonel Dolan operating out of Langley Field, Virginia. Colonel Dolan was a sparkling, gung-ho officer. The fierce German U-boat campaign along our Eastern Seaboard was keeping him busy on ASW flights. He heard about the BLIMP buoys and came to New London to find out about this submarine sensor. Buoys were quickly altered from BLIMP units for a test to help Colonel Dolan. They were first dropped on July 18, 1942 from an Army B-18 bomber. All either disintegrated in the air or on impact with the water. A fast redesign and rebuilding was instituted and on July 25, 1942 (how's that for quick reaction!) the first successful airplane launches were accomplished. In August 1942 Colonel Dolan expended sonobuoys in actual off-shore operations against U-boats. The success he believed he had caused the Army to order 6410 buoys in late 1942. The Navy contented itself with ordering only 1800 units. The Navy then staked out a claim and asserted a new proprietory interest in sonobuoys. Colonel Dolan, bless him, of the Army Air Corps, may have been responsible for providing impetus in getting Navy acceptance of sonobuoys.

The sonobuoys first went to War for the U.S. Navy (flying modified Army B-24 Liberators) in early 1943 with Fleet Air Wing 7 operating first out of Argentina, Newfoundland and then under RAF Coastal Command out of Dunkeswell, Devon, England. Buoys also were heavily utilized by the "Jeep Carriers", merchant ships converted with flight decks to become small, low cost, aircraft Carriers (CVE's). The first use of sonobuoys against a German U-boat was by a Canadian RCAF Lockheed "HUDSON" bomber operating out of Iceland in 1943. A civilian Columbia University employee, Walter Clearwaters, now an Associate Technical Director at the Naval Underwater Systems Center, (NUSC) New London, was there. While he was introducing the Canadian crew to sonobuoys they ran across a U-boat on the surface. Clearwaters dropped a pattern of sonobuoys around the U-boat. Despite heavy and damaging anti-aircraft fire from the surfaced U-boat, the RCAF plane made a perfect attack straddle on the submarine with depth charges. Clearwaters made magnetic "wire-recordings" from the sonobuoys of the submarine sinking and breaking up, positive vertification of a kill. Sonobuoys were subsequently successfully used by the small CVE Carriers in many kills of U-boats.

The buoys could only detect the presence of a submarine in a large area and ascertain its speed by propeller noise count. The aircraft knew the U-boat had limited submerged endurance. It would keep close monitoring of a large area with a pattern of buoys. The aircraft then at proper detection either dropped a homing torpedo or patiently waited for the submarine to eventually surface. Buoys were also used to tell when the first limited range acoustic homing torpedoes (Mark 24 Mine, called FIDO, a Harvard University design) should be dropped. The presence of submarine propellor cavitation noise on the sonobuoy indicated that the MK 24 acoustic torpedo dropped near that buoy should be able to home-in on the sub.

Sonobuoys were used in action all over the World. The writer was in on two attacks, one in 1943 near Guadalcanal in the South Pacific, and another in 1944 during the Invasion in the English Channel. Many civilian engineers from the New London sonobuoy team served either abroad the small Carriers (CVE), or with land-based ASW patrol squadrons. One, Russ Lewis (of USNUSL), got a good swim when the CVE BLOCK ISLAND got torpedoed. Civilians participated willingly on attacks on U-boats. Raymond Murphy, also of CUDWR, was on U-boat kill while flying off the CVE USS BOGUE. They received no official recognition for this selfless service. The Navy ordered some 59,700 CRT-1A sonobuoys during War 2 (Figure 2). Those crude first sonobuoys played a proud essential first part in the birth of Airborne Antisubmarine Warfare.

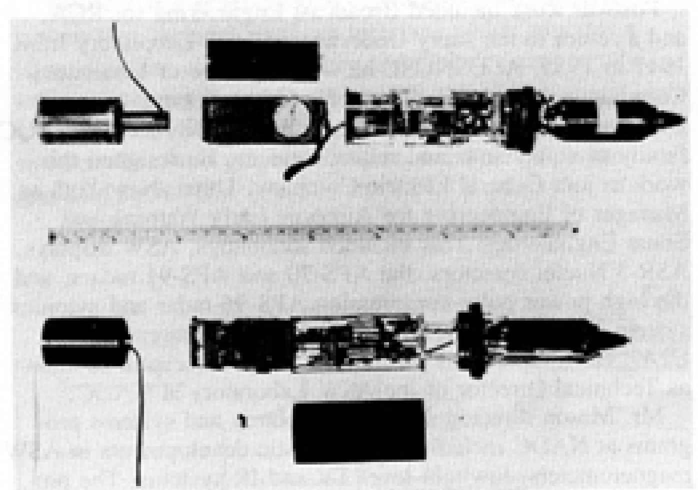


Figure 2. CRT-1 Sonobuoy

The sonobuoy designers at New London, early in the design of the omni-directional first sonobuoys, realized that a directional buoy that would provide bearings would be a major step forward. Such a design was initiated and developed. This was the World's first directional sonobuoy, the AN/CRT-4. This was operationally evaluated at Ft. Lauderdale during 1945 and accepted for Fleet use. It was put into production and many were ordered. The end of the War precluded operational introduction during War 2. This type sonobuoy will be discussed later.

(Part two of this article will appear in the next issue of this newsletter.)

ABOUT THE AUTHOR

Russell I. Mason retired as Technical Director of the U.S. Naval Air Development Center (NADC) at Warminster, Pennsylvania in 1975. He received his undergraduate education at Northeastern University and has subsequently taken many additional engineering and management courses.

His pertinent professional experience started with RCA in the Sound Motion Picture field. This was followed by successive positions with Public Service Corporation of New Jersey. He then became a charter member of the Columbia University Division of War Research Laboratory being established at the Navy Underwater Sound Laboratory in 1941 before Pearl Harbor. This work comprised R and D in ship, submarine, and airborne antisubmarine warfare (ASW) during all of World War 2. In this work Mr. Mason pioneered airborne ASW and the development of the World's first airborne sonobuoys. This also included wartime assignments for the Office of Scientific Research and Development in England and other war zones introducing the new sonobuoys in war operations.

Postwar work included Broadcast Engineering for RCA, and a return to the Navy Underwater Sound Laboratory from 1947 to 1955. At USNUSL he was in charge of Underwater Communications developments for Ships, Submarines, and Underwater Swimmers (UDT) resulting in the successful UQC family of equipments and related devices. He resigned this work to join General Electric Company, Utica, New York as Manager of Engineering for Airborne Early Warning and Sonar Engineering. This included sonobuoys, ASW displays, ASR-3 Nuclei detectors, the APS-70 and APS-91 radars, and the high-power pulse compression APS-96 radar and avionics system associated with the Grumman W2F-1 aircraft (now E2A). He resigned this position in 1960 to accept a position as Technical Director of the ASW Laboratory at NADC.

Mr. Mason directed all ASW sonobuoy and systems programs at NADC including non-acoustic developments in ASW magnetometers, lowlight level TV and IR systems. The program included the pioneering "ANEW" ASW system work which resulted in the Lockheed P3C ORION, the 53A VIKING, and the Sikorsky/IBM LAMPS 3, aircraft computerized ASW systems. Most of today's modern sonobuoys were initiated or introduced during this time.

He has served on many Navy ASW panels and committees and received many commendations. He has been granted sixteen patents including the original airborne sonobuoys. On retirement from NADC in 1975 he was given the highest Navy civilian honor, the U.S. Navy Distinguished Civilian Award. The National Security Industrial Association (NSIA) named him the 1981 recipient of the "Admiral Charles Martell Award for Technical Excellence in ASW". He now resides in Glens Falls, New York and is writing a book on "The Technology of Airborne ASW", as well as consulting to Industry.

CORRESPONDENCE

923 Harriman St.
Great Falls, VA 22066
October 8, 1984

Dear Dean Bolle:

I can scarcely believe it is nearly a month since the Oceanic Engineering Society Awards luncheon when the IEEE awarded me their Technical Excellence Award. I felt deeply honored and, of course, I was very pleased to receive this award. I was, and am, most appreciative of the many personal courtesies to Mrs. Hersey and myself at the awards luncheon. I thank you and your Society for all of this recognition.

I enjoyed very much meeting you and learning the great things about Lehigh. I hope that I may have the opportunity to visit you at Lehigh and see the fine things that are developing there.

I enclosed a fairly recent photograph, as you requested. I regret this is so late in being sent. It is *not* a passport picture, as I'm afraid it appears to be. I hope it will serve your purposes — if not please let me know and I'll try again!

Again, thank you very much for your kindness in the events leading up to and during the Oceans '84 awards luncheon.

Sincerely yours,

Brackett Hersey
Lehigh '43 (PhD)

P.S. I look forward to a future visit to Lehigh — probably not this Fall, but possibly next Spring.

RESULTS OF THE ADCOM ELECTION BALLOT

As you know, a ballot for the election of four IEEE Oceanic Engineering Society Administrative Committee members was issued on September 14, 1984. The ballots returned have been counted, and the following candidates have been elected for a three-year term beginning on January 1, 1985:

Rui J. P. de Figueiredo
J. David Irwin
Michael D. Serotta
William E. Woodward

We wish the newly elected AdCom members success and thank all nominees for their willingness to serve and for permitting their names to be included on the ballot.

FROM THE TECHNOLOGY EDITOR

A Data Compression Algorithm For Use With Personal Computers

Abstract

The design flexibility offered by microcomputers (*µC*) makes them a prime candidate to improve the operation of existing sensor measurement systems. This paper will focus on one unique application of *µC* technology to compress the number of data points needed to characterize the temperature profile from an expendable temperature (XBT) probe. However, while the following comments relate to the experience with a digital XBT system, it should be remembered that the same principles appear valid for a variety of measurement system applications.

Introduction

The use of expendable probes, as temperature profilers, in the oceanographic research and operational data gathering community is well established. Directed and volunteer shipboard personnel participate in releasing thousands of probes in programs with a requirement to:

- provide a message format for (radio) transmission of synoptic bathy-thermograph (XBT) data for oceanographic forecasting.
- provide the National Oceanographic Data Center (NODC) with information for XBT analog and digital processing.

Associates and users of this data are participants in a broad suite of national research programs and the National Weather Service. The message, known as bathy-message, is most commonly derived from encoding a strip chart after the expendable probe has been deployed. This message format follows specifications of the World Meteorological Organization (WMO) (1), and it is used internationally by interested agencies. In compliance with these specifications, four bathy-messages are transmitted daily at six-hour intervals. The procedure to acquire, extract, and maintain the quality of data from these observations is noted to be labor-intensive, which thereby limits the effectiveness of how and when the data can be applied.

The procedure for developing the synoptic bathy-message requires the operator to visually select key data points from the temperature profile on the strip chart. The bathy-message is then sent by CW or teletype radio-message, by agreement, to the nearest shore-based data collecting receiver station for re-transmission. Often by other means, to a designated data center for integration into synoptic weather and ocean thermostructure maps. The data center may not be the final depot.

Any of the aforementioned steps in the preparation and delivery of data is a potential source of error. Up to forty percent of the bathy-messages are estimated to contain operator and data transmission errors that nullify the data value.

To accomplish data dissemination specified by WMO, the original temperature profile strip charts are sent, after the vessels dock, by mail service, or a similar conveyance, to a data center for processing. Converting the strip charts to a digital-tape format is generally done on a manually operated electronic digitizer. The accuracy of this method for producing the digitized data is good; however, the operation is production-limited.

Figure 1 is a general block diagram of a digital XBT system that includes a *µC*, an interface which contains a signal digitizer, control circuitry and probe current supply, and an operating system written in "BASIC." The operating program will graph and prompt messages, control this interface, and prepare bathy-messages in the format specified by WMO.

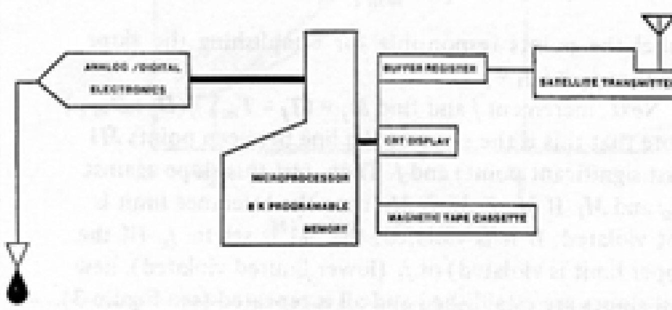


Figure 1 XBT DIGITAL RECORDING AND DISPLAY SYSTEM

The Bathy-Message Algorithm (BMA)

To achieve the WHM bathy-message format requires a form of data compression in which 160 data points from the XBT probe temperature profile are reduced to approximately 20 significant points.

The BMA is relatively compact, requiring about 30 lines of "BASIC" code and about 700 bytes of memory. The mean-processing time is about 15 minutes although under special circumstances (near surface wire break) up to 45 minutes may be needed. The BMA is adapted from one developed at White Sands Missile Range (2) for real-time reduction of radiosonde data. The real-time capability of the algorithm is not used, but it is significantly faster and uses less memory than most other schemes we investigated.

The BMA functions by assuming an initial "tolerance limit." Next, the number of points required to approximate the data to that tolerance is determined. The tolerance is then adjusted according to whether there are too few or too many points. The entire procedure is then repeated until 19 to 21 points result (in this application). If more than 20 of these iterations have occurred, then 10 to 25 points will be accepted and a bathy-message determined. If more than 30 iterations have occurred, then a message is outputed on the display screen indicating that the bathy-message cannot be determined.

To begin an explanation of the BMA, assume two arrays of digitizer-quantity points, D_j and Q_j, and $j = 1$ to Rs, representing depth and temperature. Since these points are in digitizer units, they must be converted to depth and temperature before use. Assume a tolerance (TOL), which is arbitrarily specified initially and iteratively changed in successive trials. Assume that $M1$ is the index (value of j) of the last signficant point ($M1 = 1$ at the start of each iteration with a new tolerance). Then compute T_{m1} (temperature) and D_{m1} (depth) from the digitized case values. For $j = M1 + 1$, find T_j and D_j. As shown in Figure 2, compute a pair of slope limits, M_u and M_l (upper and lower), with the following equations:

$$M_u = \frac{T_j + \text{TOL} - T_{m1}}{D_j - D_{m1}} \quad \text{and}$$

$$M_l = \frac{T_j - \text{TOL} - T_{m1}}{D_j - D_{m1}}$$

Label the points responsible for establishing the slope limits as $j_u = j$; $j_l = j$.

Next, increment j and find $M_j = (T_j - T_{m1})/(D_j - D_{m1})$. Note that this is the slope of the line between points $M1$ (last significant point) and j. Then, test this slope against M_u and M_l. If $M_u \geqslant M_j \geqslant M_l$, then the tolerance limit is not violated. If it is violated, the $M1$ is set to j_u (if the upper limit is violated) or j_l (lower limited violated), new test slopes are established and all is repeated (see Figure 3).

If the test slopes are not violated, then another set of tests is carried out. A new set of trial limit slopes are computed using points $M1$ and j. If either of these new trails results in a tighter limit, then the corresponding limit slope and labels are changed (see Figure 4). Note that both limit lines could be altered during this step.

When the modification of the limits slopes is completed, if not all data points have been tested (i.e., $j < Rs$), the j is incremented and the tests are repeated for the new point.

When all points have been tested, the number of significant points is compared to the desired number of points. Twenty-three to 25 points is the desired number. But four of these points in the actual bathy-message label 100 meter crossings (100 m, 200 m, 300 m, and 400 m) so the actual number of data points is 19 to 21, with a target of 20. A new tolerance is now estimated with the goal of bringing the number of significant points closer to 20. The scheme used to estimate the new tolerance is based on the reationship between the number of significant points and the tolerance (see Figure 5).

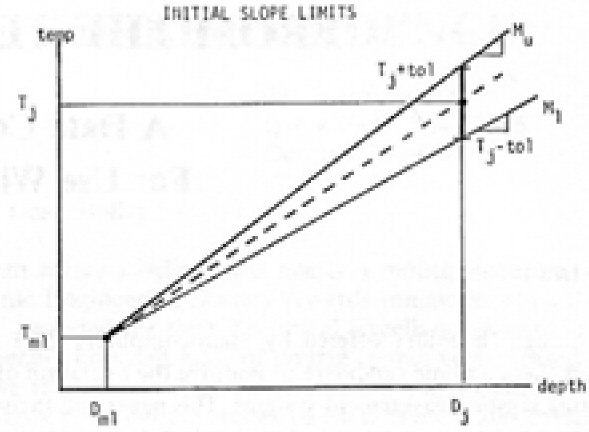
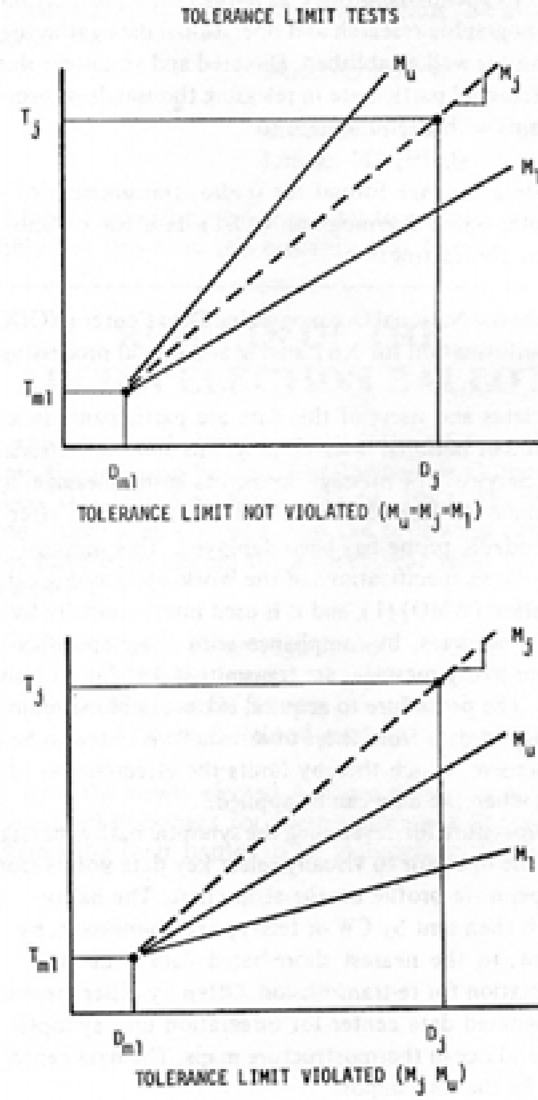


Figure 2

Figure 3



The graph in Figure 5 is based on three observations concerning the number of significant points (Ns). First, if the tolerance is smaller than some values, TOL_{min}, all points will be significant points; a tolerance smaller than TOL_{min} cannot result in an increase in the number of points. The second observation is that if the tolerance is increased from TOL_{min}, the number of significant points can decrease or stay the same; no tolerance increase can result in an increasing number of points. Thus, Ns is a monotonically decreasing function of TOL. Finally, as TOL is made larger, the number of significant points decreases until there are only two: the first and last points. Further increases in TOL cannot result in a decreased number of points when TOL exceeds TOL_{max}.

These three observations provide enough information for the programmer to estimate a new set of TOL values which will provide an appropriate number of significant points. There are two "known" points on this curve, TOL_{Min}, Rs and TOL_{max}, 2. There are no local maxima or minima between these points since Ns is monotonic. If a value TOL results in Ns significant points, then using TOL, Ns, and the known end point, which is on the opposite side of $Ns = 20$, define a line L_1 or L_2 on Figure 5 and determine where this line crosses $Ns = 20$. If TOL is the current tolerance and Ns is the current number of significant points, TOL' is a new tolerance value, and Ns' is a new (estimated) number of significant points, then the equations for L_1 and L_2 are given by the following equations:

$$L_1: (Ns > 21) \quad Ns' = 2 + (Ns-2)\,\frac{TOL_{max} - TOL'}{TOL_{max} - TOL}\text{, and}$$

$$L_2: (Ns < 19) \quad Ns' = Rs + (Ns - Rs)\,\frac{TOL' - TOL_{min}}{TOL - TOL_{min}}.$$

In each case, TOL' is found by setting $Ns' = 20$, the desired number of significant points. The resulting value is then used at the tolerance in the next iteration. When $Ns' = 20$, TOL' is given by the following equations:

$$(Ns > 21) \quad TOL' = TOL_{max} - (TOL_{max} - TOL)\,\frac{2}{Ns - 2}\text{, and}$$

$$(Ns < 19) \quad TOL' = TOL_{min} + (TOL - TOL_{min})\,\frac{20 - Rs}{Ns - Rs}.$$

The data compression routine is convergent for linear, concave, and convex functions.

However one problem with this routine is that TOL_{max} and TOL_{min} are not constants. In fact, their values vary from data set to data set, and therefore values must be picked which represent reasonable values. The chosen values also limit, in each direction, the maximum and minimum attainable values to TOL. Thus, TOL_{max} must be large enough and TOL_{min} must be small enough to accommodate all expected data. The values $TOL_{max} = 2$ and $TOL_{min} = .05$ have been found to suffice for extremes of data well beyond the expected range for this application.

Figure 4

NEW LIMIT LINES

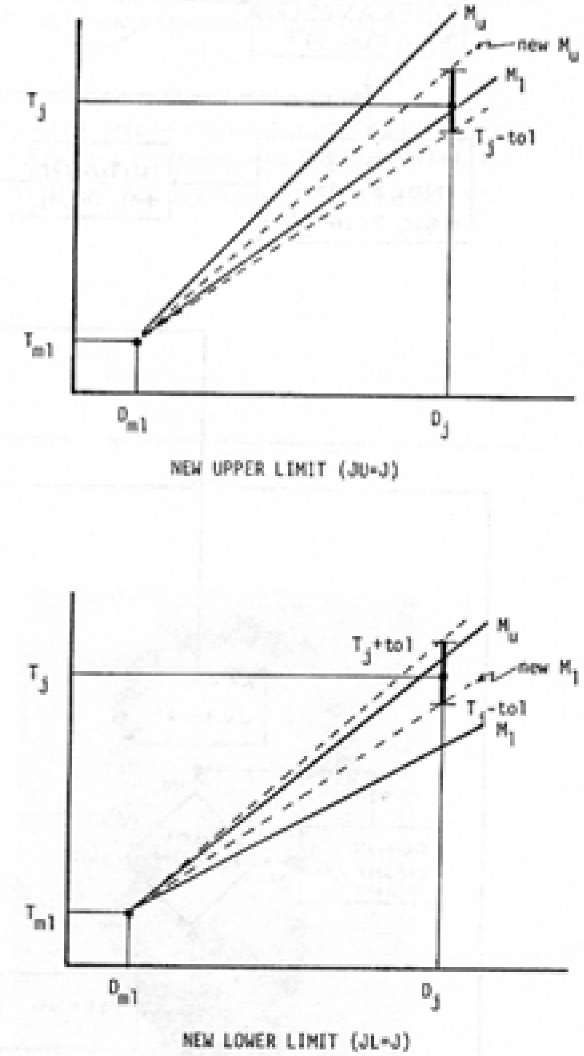
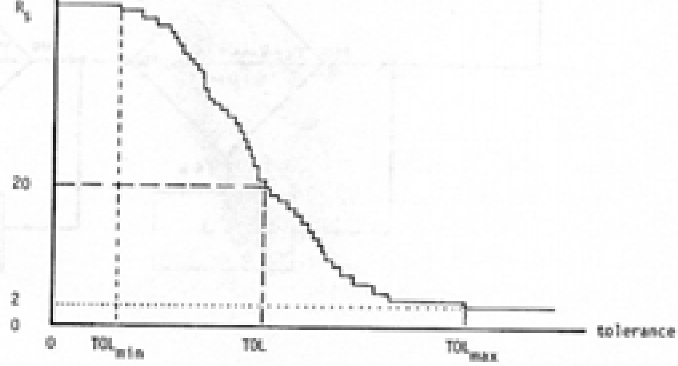


Figure 5

NUMBER OF SIGNIFICANT POINTS VS TOLERANCE VALUE



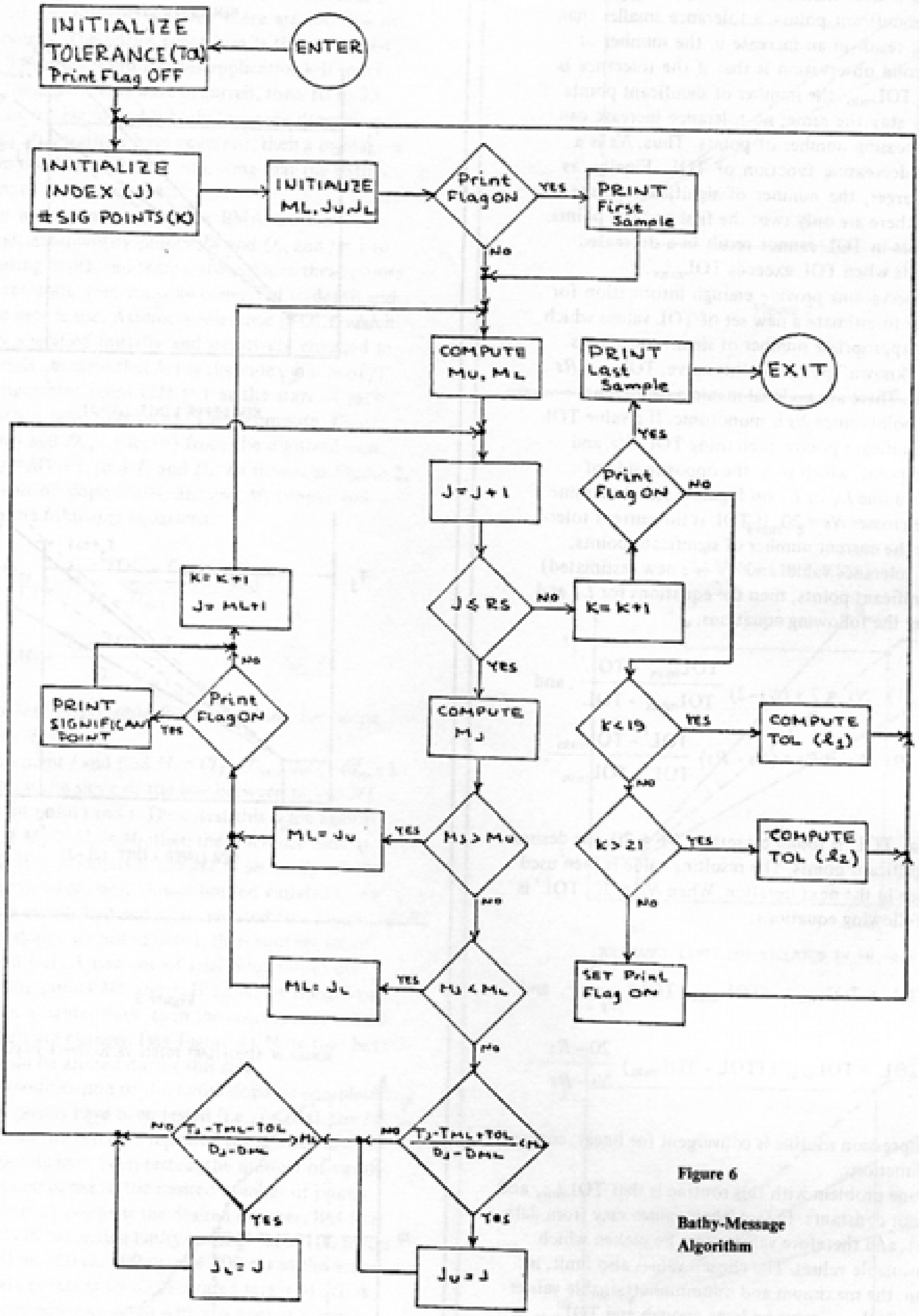


Figure 6

Bathy-Message Algorithm

The complete bathy-message algorithm is shown in the flowchart in Figure 6. The flowchart is simplified by omitting the decision which alters the number of acceptable data points when the number of iterations becomes large.

Again, it should be remembered that this data compression scheme is not limited to expendable probe applications. It can be readily implemented on any μC with a floating point arithmetic capability. The algorithm shown here is particularly adapted to the situation where data is already stored. But in real-time operation, the only data (other than significant points) which needs storage is that between the smallest values of j_u or j_l and the current data point since these points may be needed when a new line is started. In real-time operation, of course, the iterative selection of the tolerance for a specific number of points is not appropriate.

References

(1) *Instructions for Preparing the Bathythermograph Log*, Feb. 1972, U.S. Dept. of Commerce, Nat. Oceanic and Atmospheric Admin., Nat. Weather Service, Office of Meteorological Operations, Silver Spring, MD.

(2) Merrill, M. Don & Don R. Veazey, "Linearization for Compact Storage of Digitized Analog Data," *IEEE 1977 Region & Conference Record*, (IEEE Cat. No. 77CH1206–2 Reg 6; Library of Congress No. 72-92043).

FOR FURTHER INFORMATION, CONTACT:

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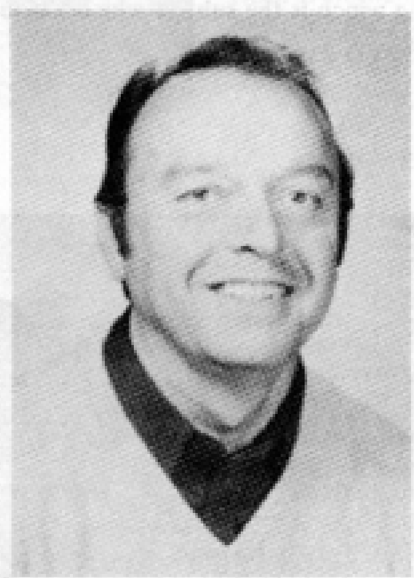

Rod Mesecar is head of the Technical Planning and Development Group, School of Oceanography at Oregon State University. He has B.S., M.S., and E.E. degrees in electrical engineering and a Ph.D. in physical oceanography from OSU. Since 1965, his interest has been in applying engineering technology to all disciplines of oceanography.

James Wagner is a member of the Technical Planning and Development group at OSU. He has a B.S. (physics) and a M.S.E.E. from OSU and a Ph.D. in electrical engineering from Colorado State University. His interests include analog and digital circuit design, filter synthesis, and interdisciplinary applications of electronics. He was formerly a design engineer at Tektronix and is currently working on in situ digital instrumentation systems.

A Light Weight Free Standing Profiling Winch for Use on the Arctic Sea Ice

In response to several scientific programs to be carried out in the Canadian High Arctic (such as the North West Passage Transport Research and Development, and other work near or on the Continental Shelf), it was necessary to perform multiple CTD profiles and collect water samples to a depth of approximately 500m. The usual aircraft for Arctic operations is a DeHavilland Twin Otter, and while this is an excellent machine, it is limited by its requirement for a smooth snow-covered landing strip. The obvious answer was the helicopter. This created its own set of problems, such as available storage space and weight restrictions. In response to these problems the members of the Frozen Sea Research Group miniaturized our CTD electronics recording package, reduced the size and weight of the ice drilling package, provided heated storage for the water samples and designed and built a light weight CTD profiling winch. The design and development of a light weight free standing winch is the subject which I would like to address here.

As it is nearly impossible to find a completely smooth flat area on the ice it was necessary to design a free standing winch, one which would be high enough off the ice to easily handle the CTD "fish" and allow water collection bottles to be easily snapped onto and removed from the winch wire. Other considerations such as handling size, weight, spooling and drive power were to be packaged into a single unit that could be easily deployed from a Bell 206 helicopter with a maximum crew of two. To conserve weight it was decided to use the electric auger motor to also provide power for the winch. This means that the motor must be easily attached to the winch without modification. "U.R. Finbore" ice augers were purchased and a socket square drive adapter was welded to the top flight section. Black and Decker model 1405, Type 1, electric drills were purchased, the drill chucks removed and a square stub drive suited to the augers was fitted on the drill motor.

Now for the winch as shown in Figure 1 —

Figure 1.


Figure 2.

In preparation for the CTD operation it is necessary to drill two holes in the sea ice. Power for the drilling motor is supplied by a Honda 1500 watt generator. One hole is drilled about 2' deep and the other hole about 2' away from the first is drilled through the sea ice (usually the ice is from 6' to 8' thick). See Figure 2. A winch support pole is mounted in the first hole with the winch overhanging the second hole. This natural angle allows the winch to spool well, rewinding fairly evenly on its own. However a handle is provided allowing the winch to be swung back and forth to guide the spooling. The electric drill motor is "plugged" into the back end of the winch with the stub square drive engaging a socket chain drive, which in turn drives the drum. The brake lever provides two functions. First applying a band brake for the drum when pushed down and as a throttle for the winch motor when lifted up. A short rod connecting the brake lever and the electronics motor controller provides this function. Reversing of the drill motor is accomplished by turning a reversing collar (built in) on the motor itself. For noiseless profiling downwards (depending on the weight of the "fish") the motor can be removed and free fall speed controlled just with the brake. A hand crank is provided for emergency rewind should the power fail. The winch wire is a 1/8" single conductor, double armored "Ameragraph" cable joining the "fish" to a two contact slip-ring assembly. (One ring connects the centre conductor and the other goes to the shielded jacket.) Slip-ring contact is through spring-loaded braided wire contacts and these in turn are hard wired to the electronics package in the helicopter. As mentioned before, power for all of this is provided by a standard 1500 watt Honda generator.

The entire CTD and winch package stores nicely into a Bell 206 helicopter. The winch weighs about 80 lbs. complete with wire and is an easy lift from the helicopter seat to the pole stand. It is usually best to have two people prepare the site (drill the hole, erect the winch, etc.), then while one operates the electronics from inside the helicopter he can communicate with the winch operator by means of a sound-powered microphone headset. Water samples are collected in a modified Niskin bottle and stored in a well insulated heated box in the helicopter until returning to the base where they are processed. With a little practice the entire procedure can take less than half an hour per site (depending on the profiling depth), enabling 10 to 12 profiles per day be easily accomplished.

Photo Credits: R. A. Lake, F.S.R.G.

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Dennis Richards is a member of the Frozen Sea Research Group where group efforts are primarily in the Canadian High Arctic. A machinist by trade, his primary function is the designing and building of electro/mechanical equipment for the Frozen Sea Research Group.

Al Koppel is responsible for the electronic design of the winch. He has been in government Research and Development for 11 years. Previously in industry, and university departments of Zoology and Physics.

THE INVENTIONS AND TRAGEDY OF MAJOR EDWIN ARMSTRONG

by David Kuraher, ***Student***
Capitol Institute of Technology

In concurrence with the 100th anniversary of the founding of the I.E.E.E. parent organizations, the U.S. Post Office is issuing stamps honoring the electrical and electronic engineering profession. The stamps honor four men. Among the four is Edwin Howard Armstrong, considered to be the last of the great inventors. Little known by most of the general public, his inventions have had a great impact on our modern daily lives.

Born in New York City in 1890, his family soon moved to Yonkers, NY located just to the north of the city. The house at 1032 Warburton Avenue was the scene of his early radio experiments. As a fourteenth birthday present, his father presented him with *The Boy's Book of Inventions*. In its pages was the story of Marconi's wireless experiments. The story inspired the young boy to improve radio reception, and during his high school years, he flew antenna kites and erected a 125-foot pole in his back yard. He had the complete support of his family. Upon graduation, his father bought him a motorcycle which he used to commute to Columbia University in upper Manhattan.

His interest in radio led him to the study of electrical engineering. Preoccupation with improving radio reception finally bore fruit during his junior year in 1912. The triode detector had previously been invented by Lee deForrest in 1906, but its operation was not completely understood at the time. It was thought to be simply another way of detecting radio signals like the "cats whisker" or crystal detector. Armstrong experimented with feeding a small portion of the output power back to the input. By carefully controlling the amount of feedback, he obtained a tremendous increase in the received signal. Not only did this turn the triode into a far superior detector, but it proved it could amplify signals as well. A third benefit was the feedback oscillator. Gone was the cat's whisker. Gone was the spark gap transmitter. Here now was a device that for the first time could amplify signals. A giant leap forward in the state-of-the-art in 1912, and by a student still in his junior year!

Naturally, he wanted to protect his invention by obtaining a patent. The family was well off and could have easily afforded the $150 filing fee. His father, not fully aware of the implications, and fearing his son would terminate his studies, withheld the money until his graduation in June of 1913. Lee deForrest challenged his patent. The challenge worked its way up to the U.S. Supreme Court. Because of the filing delay and deForrest's own patents, the court was forced to rule against Armstrong. The scientific community has always credited him with these inventions.

After graduation, Armstrong became an instructor and remained with Columbia University until joining the Army Signal Corp during World War I. Rising to the rank of Major, he used the title throughout the rest of his life.

During the service, Major Armstrong pioneered another leap forward, the invention of the super-heterodyne circuit. Now, in 1919, was a way to amplify and separate signals. Every radio and television receiver in the world today employs this principle. The invention brought him into contact with Brig. General David Sarnoff (later president of RCA) and Sarnoff's secretary, Marion McInis (later to become his wife.)

After the Great War he returned to Columbia. Financed with royalties from some minor inventions, he set upon the task of eliminating static from radio reception. The two methods of impressing intelligence on a radio wave are to vary the power or the frequency. In 1922 the two systems were analyzed mathematically. It was proven that with any then-known detection system, FM was far inferior to AM. AM was "in" and FM forgotten until Armstrong re-examined the possibilities.

In 1935, the Major secured four patents which became the cornerstone for FM. On November 5, 1935, the first demonstration of the system was presented before the Institute of Radio Engineers (parent organization of the I.E.E.E.) in New York City. Broadcasting from a ham radio operator's living room in Yonkers, the assemblage heard a supernaturally clear voice announce, "This is amateur station W2AG at Yonkers, NY operating on Frequency Modulation at 2½ meters." The audience was stunned. The voice, that of Randy Runyon, (an old friend of Armstrong) described the low power distance of 17 miles, wavelength and modulation method.

Everything the textbooks claimed wouldn't work had just been challenged although, "If you build a better mouse trap, the world doesn't necessarily beat a path to your door," said Armstrong.

For the next two years RCA, via David Sarnoff, gave Armstrong experimental broadcast privileges in the Empire State Building. In 1937, with the claim that RCA needed the space for T.V. development, he was asked to leave. With greater determination, he built his own tower in Alpine, NJ. Programs from WQXR in New York were experimentally broadcast to the public in the summer of 1939. World War II brought a halt to both FM and T.V. development. The Major devoted himself to military research but resumed promotion of FM after the war.

Although overshadowed by T.V., FM started to grow and soon became an obvious threat to the major networks. A series of detrimental federal regulations (no doubt encouraged by the networks) stymied further growth. Meanwhile many companies in allied fields were blatently ignoring Armstrong's patent rights. A series of

Reprinted with permission THE CIRCUIT, *publication of Capitol Institute of Technology, August 1983.*

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Legal expenses mounted and expiring patent rights luced his income. Meanwhile, his health at age 63 gan to deteriorate and he was close to a nervous eakdown. Both financially and emotionally the RCA t was a matter of survival.

His wife Marion begged him to withdraw and retire, as totally alien to his strong-willed nature. After a avy argument on Thanksgiving Eve, both sick and artbroken, she went to live with her sister. Her health rsened and she was advised by her doctors not to return to the stressful situation. The Christmas holidays came and went and Armstrong was alone. They had never had children.

Sometime on Sunday night, January 31, 1954, Armstrong wrote a letter to Marion expressing his deep regret for having hurt her. His body was found the next morning in the courtyard of their apartment building.

After the Major's death, Marion continued the fight. She did win over RCA and with the funds from the settlement, continued the other suits. In 1967, with the final victory over Motorola, all 21 suits originally filed were won.

The house on Warburton Avenue was declared an historical landmark of the City of Yonkers. Along with Armstrong's memory, it was allowed to deteriorate. Last year, the abandoned structure was torched by vandals. The Alpine tower still stands, used for other purposes—perhaps the only memorial to its creator. The true measure of greatness, however, is not the memorials. Greatness in one's lifetime is the value of the legacy left behind. The honor of being pictured on a commemorative stamp that Major Armstrong is about to receive is surely well deserved and long overdue.

COOPERATION, FOR TECHNOLOGICAL PROGRESS, BETWEEN PRIVATE INDUSTRY AND THE GOVERNMENT'S NATIONAL LABORATORIES*

HYMAN OLKEN

Olken Publications, Livermore, California

For decades we have been building national laboratories to perrm their missions for R&D in our Government programs for efense, space, and atomic energy. These laboratories have grown include extraordinary facilities and manpower for research and evelopment. Those laboratories have also, over the years, proced a vast output of new technology as a by-product of their &D programs. But these Government R&D facilities and these ge resources of new Government-produced technology have en carried on almost totally independent of the private industry ctor. However, in the last several years we were suddenly wakened to the fact that we are rapidly losing ground in the race r high-tech industry against Japan, Germany, and other instrial nations. Therefore, a sudden hue and cry have arisen to rness the great research facilities in our National Laboratories, and their huge output of new technology, to benefit the technological growth of our private industry sector (Ref. 1).

There is one great measure that private industry and the National Laboratories could start to cooperate on at once to provide technological help to industry. That is the conversion of Government-produced technology into profitable commercial products on a large scale.

Much of this Government-produced technology has already flowed out to industry for decades. However, compared to the vast amount of such technology available, the amount that has been spun off to private industry is only a trickle (Ref. 2). There are four major reasons for this and they could all be corrected by better cooperation between the National Laboratories and private industry.

*Condensed from paper, under this title, published in PROCEEDINGS 1983 IEEE nference on Engineering Management, held at Dayton, Ohio, November 7-9, 1983.

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CAUSES OF STUNTED TECHNOLOGY TRANSFER

1. **Scarcity of Commercial Sense in Engineers.** The first and by far the greatest reason for the failure of private industry to cash in on the huge treasure of Government-produced technology is the fact that engineers, as a class, have very little commercial sense. That is, they can not look at a new technology development and accurately appraise its future commercial prospects.

A striking example of this is afforded by the case of the quadrupole mass spectrometer, invented a number of years ago by a scientist (Mr. Richard Post) in the course of his work at the Lawrence Livermore National Laboratory. The mass spectrometer is an instrument which analyzes a stream of gas into the chemical elements it is composed of. This requires a very powerful magnetic field which makes a stream of ionized gas particles flowing past it to spread out into bands of gas molecules, each band containing gas particles of the same chemical element.

At the time Post made his invention, the magnet used in a mass spectrometer was huge — even the size of a room. Post's device uses a different principle. Instead of a powerful magnetic field to cause the separation of different chemical elements, he uses a cage formed of four electrode rods, each rod at one corner of a rectangular cage. A high frequency electrical voltage is applied to two diagonally opposite pairs of rods. Then, when atoms of a gas flow axially through the cage, they will be deflected by the voltages applied to the electrode rods that form the cage.

It is easily possible to adjust the frequency of the applied voltage so it resonates with the atoms of a particular chemical element. Then the atoms of only that one chemical element will pass all the way through the cage. Others will be deflected off to the side. Thus, the atoms of a single chemical element can be separated out from the total gas flow. This mass spectrometer uses no huge magnets. In fact, the whole machine can be mounted on a desk top.

When Post invented this machine he submitted it to the AEC (now the DOE) to patent, as employees are required to do in AEC or DOE laboratories. But the patent department of the AEC did not think this device would be useful, hence was not worth the cost of patenting. They rejected it and released it to him to get a patent on it himself. He did not think it had good commercial possibilities, so declined to take out his own patent on it.

Because of its convenient size and low cost it is universally used where gas flows have to be chemically analyzed, particularly in vacuum equipment for manufacture of microelectronics. It has huge commercial possibilities, particularly for application in high vacuum equipment, where it is used to detect leaks in the vacuum system.

This is one good example that engineers rarely have a good enough commercial sense to appraise the commercial possibilities of a new technological development in its infancy. Such a "commercial sense" could and should be developed. It can be done by practice in writing up histories of widely adopted lines of technology development.

In short, the capability of private industry's engineers for picking up golden nuggets of new technology, in the great mass of by-product technology created in the National Laboratories, could be increased by orders of magnitude if the National Laboratories will cooperate by having their chains of successive developments in a particular line of technology written up so the engineers in private industry can easily spot them and can realize, from the context of the chain, their commercial potential.

2. **Failure of National Laboratories to Write Up Technology Developments They Create.** The second greatest cause of Government-produced technology being lost to private industry is the fact that a great deal of the technology created in Government R&D programs is never written up. Hence, if there is no record of it, a valuable technology development is totally lost — not only to private industry, but to everyone else as well.

Of course the Government R&D agencies do require reports on all projects they fund, as part of the R&D contract. But the primary concern to those agencies is the research results to be obtained under the contract, not the technology that often has to be evolved to achieve those research results. For example, the DOE programs to achieve nuclear fusion by inertial principles requires fantastic developments in the technology of high power lasers, their power supplies, and their optical systems. But the DOE primarily wants reports on whether the inertial fusion process is feasible. The technology developed in the course of achieving these or other research results is usually of less or no interest to those R&D agencies. So, even when they require reports on the technology produced, they are not very stringent about producing them.

Furthermore, another reason that much valuable technology produced in the National Laboratories does not get written up is the fact that the writing up of technological developments so they can be communicated to practical users is such a costly process. It takes at least one man-day per page to produce a publishable report or article. So the engineer who completes a valuable technological development does not want to take extra days or weeks from his regular work to write it up. And since the write up is often not mandated as part of the research contract, he just goes off onto another development job and the technology he developed does not get written up.

The write up of technology developments in National Laboratories is basically done by the engineers or scientists who made them. However, because of the time load this imposes, the National Laboratories also have technical writing staffs to do much of that work. Essentially, it is the lack of adequate technical writing staffs that causes most of the loss of valuable technology.

3. **Failure to Make Technology Write Ups Accessible to Private Industry.** The common failure of engineers to perceive the commercial value of technological developments, and the common failure to write up those developments, are not the only great factors in causing the loss of valuable Government-produced technology to private industry. Another great factor is that, even where appropriate write ups have been produced, the engineers in private industry are, to a large extent, barred from using them. This happens because the engineers from private industry are banned from using the technical libraries of the National Laboratories.

When National Laboratories have produced good technology, they write it up and present it at technical conference meetings. These valuable technology items can then easily be found in the Proceedings of those conferences. For example, the Conference on the Technology and Industrial Application of Accelerators is a gold mine of valuable technology that could be profitably applied in industry.

The proceedings of these conferences are huge volumes and very costly — about 50 or 60 dollars a piece, so that individuals and public libraries can not afford to buy them. But the technical libraries of the National Laboratories all need and collect them. So the best way to acquaint people in private industry with the technology created in the National Laboratories is to give them access to those libraries. However, most of those laboratories exclude the public from their libraries, mainly on the grounds that to admit the public to them would impair their "security".

4. **Failure to Organize Information to Permit Spin-Offs.** Finally, one other great factor that keeps private industry from profiting from the vast stores of valuable technology created in Government R&D programs is that the storage of the material describing all this valuable technology, in the laboratories where it is produced, is chaotic.

A great variety of material is required on each technology developed if it is to be transferred to private industry. This material includes design studies, specifications, drawings, manuals, test reports, etc. In short, to effect technology transfer economically one must have all the design and production material needed to make that technology development possible in the laboratory where it was created. The essence of doing technology transfer economically is to be able to do it without having to reinvent the wheel.

Even where all these materials — drawings, specifications, manuals, etc. — have been produced in a National Laboratory, they are produced in different departments of the laboratory, by different groups within its staff. As a result, to find all the material needed for the commercialization of even a simple technological development can be a vast exercise in chaos, confusion and frustration.

In my book (*Technical Communicator's HANDBOOK of Technology Transfer, Ref. 3*), I have devoted a full chapter (CH. V) to systematic ways of searching through the maze in each National Laboratory to find the technological treasures profitable to industry that lie buried in it. If one wants to acquire the technology private industry could profitably use, ability to find his way through the maze of such a laboratory is a must. The National Laboratories could and should assign members of their technical writing staffs to provide the guides needed to do that. My HANDBOOK of Technology Transfer (Ref. 3) gives a good detailed treatment of how such guides can be prepared, in a full chapter (CH. VI) devoted to that subject.

Summary

To summarize, the huge Government R&D programs generate a vast amount of technology that could be used by private industry to advance its technological progress. But the realization of this vast possibility for the technological progress of American industry requires these measures of cooperation between private industry and the National Laboratories:

1. Develop commercial sense, in the engineers of private industry, by the National Laboratories writing up histories of widely adopted technology developments produced in each Laboratory.

2. Prevent the loss of technology, through failure to write it up, by increasing the technical writing staffs of National Laboratories.

3. Give private industry access to the Laboratories' new technology by opening up the technical libraries of the National Laboratories to the public.

These are the primary areas of cooperation between the National Laboratories and private industry that could be applied immediately and would quickly make possible the technology transfer, on a large scale, that would make U.S. industry competitive with other nations in high-tech industry.

In addition, these two other measures of National Laboratory-private industry cooperation would be helpful in the long term:

1. Provide a guide, through the organizational maze in each National Laboratory, so the outsider can systematically and efficiently find all the design and production information — specs, drawings, reports, manuals, etc. — needed to make the transfer of a selected technology development quick, easy and low cost.

2. Require, as part of each R&D contract, that the technology produced to achieve the research results, as well as the results, be written up in reports that will be effective in enabling private industry to adapt that technology to commercial use.

REFERENCES

1. "Industry Finds A New Ally In the National Labs", *Business Week*, April 18, 1983, pp. 44E, 44F, 44K.

2. Samuel I. Doctors, *The Role of Federal Agencies in Technology Transfer*, The MIT Press, Cambridge, Mass., 1969, 230 pages.

3. Hyman Olken, *The Technical Communicator's HANDBOOK of Technology Transfer*, Olken Publications, 2830 Kennedy St., Livermore, Calif. 94550, 1980, 132 pages.

Hyman Olken
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BIOGRAPHY

Mr. Olken holds the Bachelor's and Master's degrees in electronic engineering from Harvard. For a number of years he was a development engineer on automatic control systems and holds several patents in that field. As reviewer of the specifications on instrumentation systems prepared by the 250 engineers in the Electronics Engineering Department of the Lawrence Livermore National Laboratory, at Livermore, Calif., he has had sixteen years of first hand experience in the evolution of new technology and its conversion to profitable new commercial products (i.e., technology transfer). He also has experience in technology transfer operations of the Federal Government through former employment in the Office of Technical Services (Department of Commerce) and has written extensively on the subject.

'TIS A PUZZLEMENT

SOLUTION TO LAST PUZZLE:

Financial Planning a Monopoly®

Last quarter's puzzle was to determine which Monopoly® properties are the best investments. The idea for this puzzle was suggested by LCDR Greg Bryant of Puget Sound Naval Shipyard. My solution is listed below. A score of 1.00 means the chance of landing on the properties is the same as it would be if probabilities of landing on all squares were equal.

Properties		Railroads	
1. Orange	1.06	1. Reading	1.15
2. Red	1.00	2. Penn.	1.08
3. Dark Blue	.97	3. B & O	1.06
4. Magenta	.94	4. Short Line	.92
5. Green/Yellow	.91	**Utilities**	
6. Light Blue	.88	1. Electric Co.	.98
7. Purple	.83	2. Waterworks	.96

Mr. David Ulmar, Jr. of Redondo Beach, CA and Mr. Laird Parker of Fort Worth, TX sent me solutions (before my copy of the OES Newsletter arrived!) which agreed with the one above except both placed the dark blue properties (Boardwalk and Park Place) near the bottom of the list. I used an iterative technique so maybe more iterations would make our answers agree. Or possibly David and Laird did not account for the "Advance to Boardwalk" cards.

For each square, I figured out where you would end up on the next roll. This is determined mostly by the dice (you are most likely to roll a seven then a six or an eight and so on), but you could roll a third consecutive double and land in jail or draw a card and be advanced to another square. Having done this you can: 1. Use a Monte Carlo technique to solve the problem; 2. Solve 40 equations in 40 unknowns (Take heart! Two-thirds of the coefficients are zero.); Or, as I did, 3. Assume an initial probability distribution over all the squares, then move each square forward one move and determine the new probability distribution. Keep iterating until the solution converges. I iterated nine times and was getting less than a 3 percent change per iteration for most squares. If you would like a detailed, square by square solution please write me at the address below and send a self addressed, stamped envelope.

Mr. Ulmar, who is the Western U.S. Monopoly Champion, also sent along the following Monopoly® trivia questions for your enjoyment. The answers are given at the end of this article.

1. Which railroad is not a railroad?

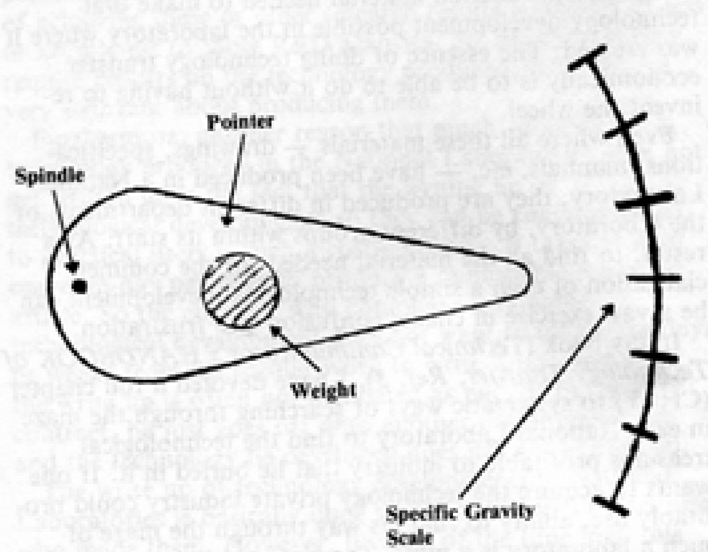
2. Which property is not in Atlantic City?

3. In 1959, six Monopoly® sets were stolen from a display case. Where did this occur?

THE NEW PUZZLE:

Hydrometer — Angling for an Answer

Several months ago my wife bought me a saltwater aquarium for my birthday. One of the accessories is a hydrometer which determines salinity indirectly by measuring specific gravity. This clever little device, which is manufactured by Sea Test, consists of a pointer which is the shape of a two dimensional ice cream cone which points to a scale indicating specific gravity (see sketch below). The pointer is made of a plastic which floats in seawater. Inserted in to the pointer is a circular weight which sinks in seawater. The pointer is supported at the ice cream end by a small spindle.

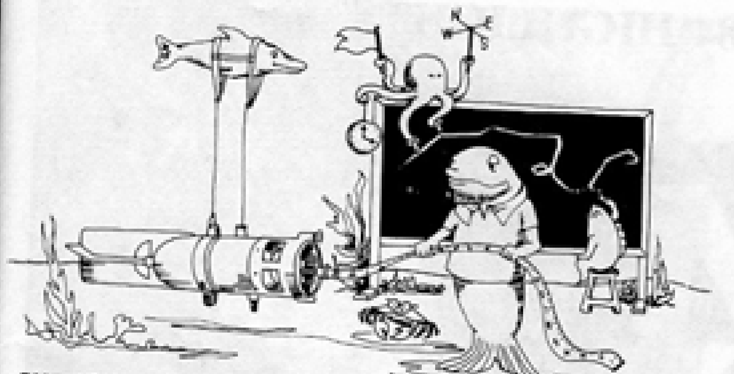


The puzzle is to determine how this device works and the relationship between the angle of the pointer and the specific gravity of the water.

Dave Hollinberger
1607 Mahan Avenue
Bremerton, WA 98310

Monopoly® Trivia Answers:

1. Short Line — it is a trolley line
2. Marvin Gardens — it is a suburb of nearby Margate
3. Moscow — at the American National Exhibit



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 everyone participates, so let's hear from you.

A technical report entitled *Fall 1983 Acoustic Doppler Profiler Measurements and Sea Truth Intercomparison Experiment at Ambrose Light, New York* has been completed by Dr. Bruce Magnell of EG&G WASC Oceanographic Services and is available in limited quantities. This report describes the results of a long term deployment of the AMETEK Straza DCP4400/300 Doppler Current Profiler conducted by NOAA and described in previous articles in this column.

For further information contact Bruce Magnell (617) 891-7204 or Jerry Appell (301) 443-8026.

A NOAA Technical Memorandum NOS 31 entitled *Measurement Comparison of United States and Soviet Calibration Facilities and Several Ocean Current Meters* by A. N. Kalvaitis and J. Solomon has just been published. For further information contact Al Kalvaitis on (301) 443-8655.

Real-Time Currents Measurements in Miami Harbor

NOAA's National Ocean Service will be installing a bottom mounted AMETEK Straza Model DCP4400 acoustic Doppler current profiler in the Government Cut channel during December 1984. This is the main shipping channel connecting Biscayne Bay and Miami with the Atlantic, and the strong currents in the channel make navigating difficult. The system will make current profile measurements in the channel and provide a real-time display for the Biscayne Bay Pilots Association as an aid to navigation.

The experiment will involve a series of measurements with conventional current meters and surface drogues to characterize the performance of the current profiler. In addition, the Biscayne Bay Pilots Association will assist in evaluating the value of the real-time measurements and in enhancing the real-time displays. For further information contact Tom Mero (301) 443-8026.

Miami Harbor Circulation Project

A comprehensive tidal circulation study of the harbor channels of the Port of Miami has been commissioned by the National Oceanic & Atmospheric Administration (NOAA). The project is under the supervision of the Estuarine and Ocean Physics Branch of the National Ocean Service (NOS), directed by Dr. Henry Frey who is the technical representative to the program. The contract was competetively awarded to the Field Services Division of General Oceanics, Inc., Miami, Florida, and it represents the first time that such a survey has been contracted for by NOS. Previously, work of this type has been performed internally by NOS.

The tidal circulation study is designed to measure the tidal characteristics of the currents to aid navigation and other activities in the harbor. Miami Harbor is the busiest cruise ship port in the world and is home to the largest passenger ship, the S.S. Norway. Tidal currents are up to 3 knots (1.54 m/s) and the complex tidal channels produce large current shears over the length of the typical commerical vessel. The large currents and heavy fouling in the area require that the moorings and instruments be carefully designed and maintained.

The project plan requires meticulous preparation and calibration of the instruments and careful documentation of all phases of field preparation and instrument performance. The field study will consist of two 15 day deployments of approximately 18 current meters at various points in the harbor.

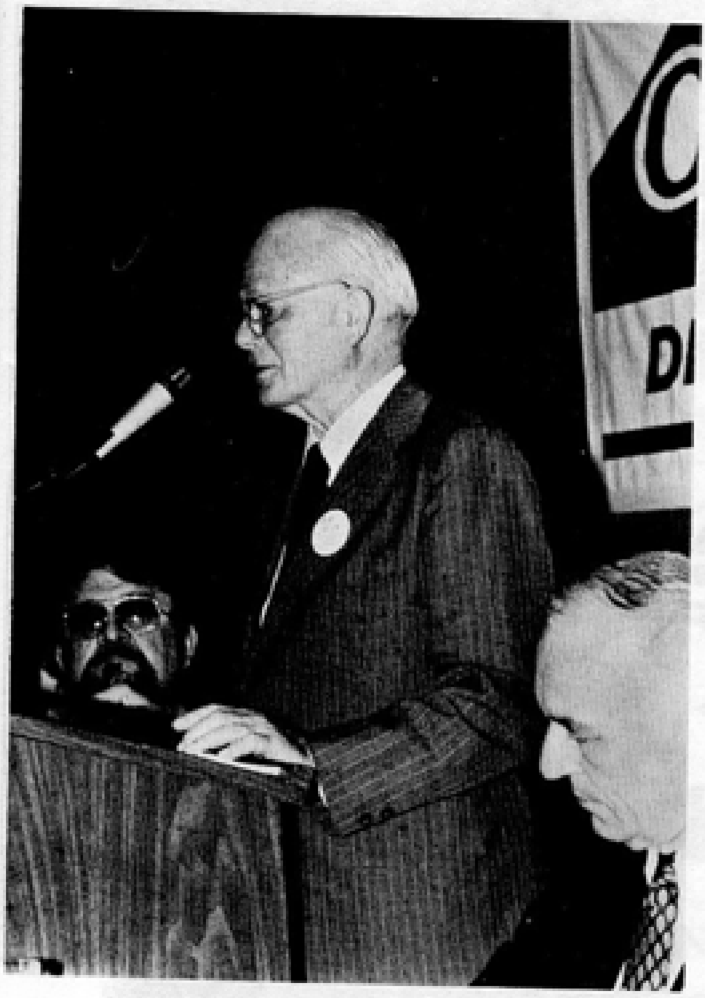
Some of the instruments will remain in the same location for the full 30 days of the study while others will be moved after the first 15 day period. Meteorological data is to be obtained from a project maintained recording meteorological package. NOS specified the locations and depths of the meters and the rotation schedules.

The current meters and meteorological station must perform perfectly to obtain the required coverage of data for all the Port channels. General Oceanics will use its Model 6011 Mk II current meter for all deployments. The Model 6011 current meter utilizes an innovative design where the speed and direction is found from the tilt and orientation of winged cylinder which forms the body of the instrument. The Model 6011, which has no external sensors to foul or to be damaged, has proven itself to be accurate and reliable in difficult, high speed and high fouling environments such as in the Mineral Management Service sponsored programs on the Blake Plateau and Florida Straits. The selection of the Model 6011 Mk II by NOS received careful review and it was required to meet stringent accuracy requirements.

General Oceanics will conduct the entire study from the preparation and calibration of the instruments, through mooring construction, deployment, recovery and data processing. The data processing on General Oceanics WICAT super-micro computer will provide NOS with specially formatted data tapes. The project will also provide NOS with a complete interactive data processing system to transform the original data into the form required by NOS's tidal analysis packages. It allows the operator to interactively modify the header and calibration information and allows multiple passes through the data files.

For further information contact Dr. Gregory Han, Program Manager at General Oceanics, Inc. 1295 NW 163 St., Miami, FL 33149 or at (305) 621-2882.

MORE OCEANS '84 HIGHLIGHTS

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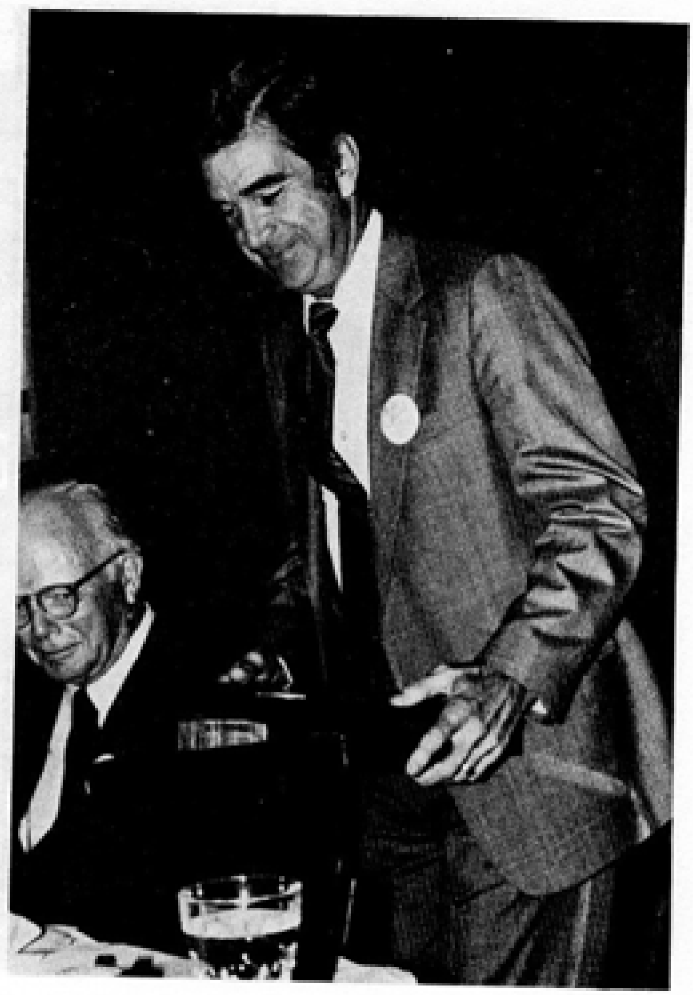


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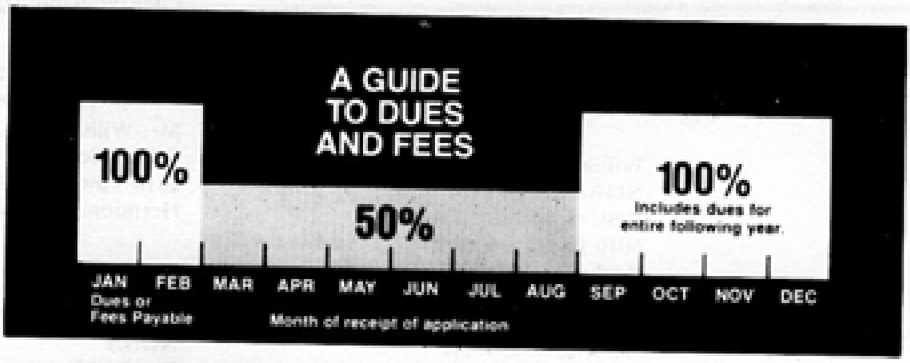

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