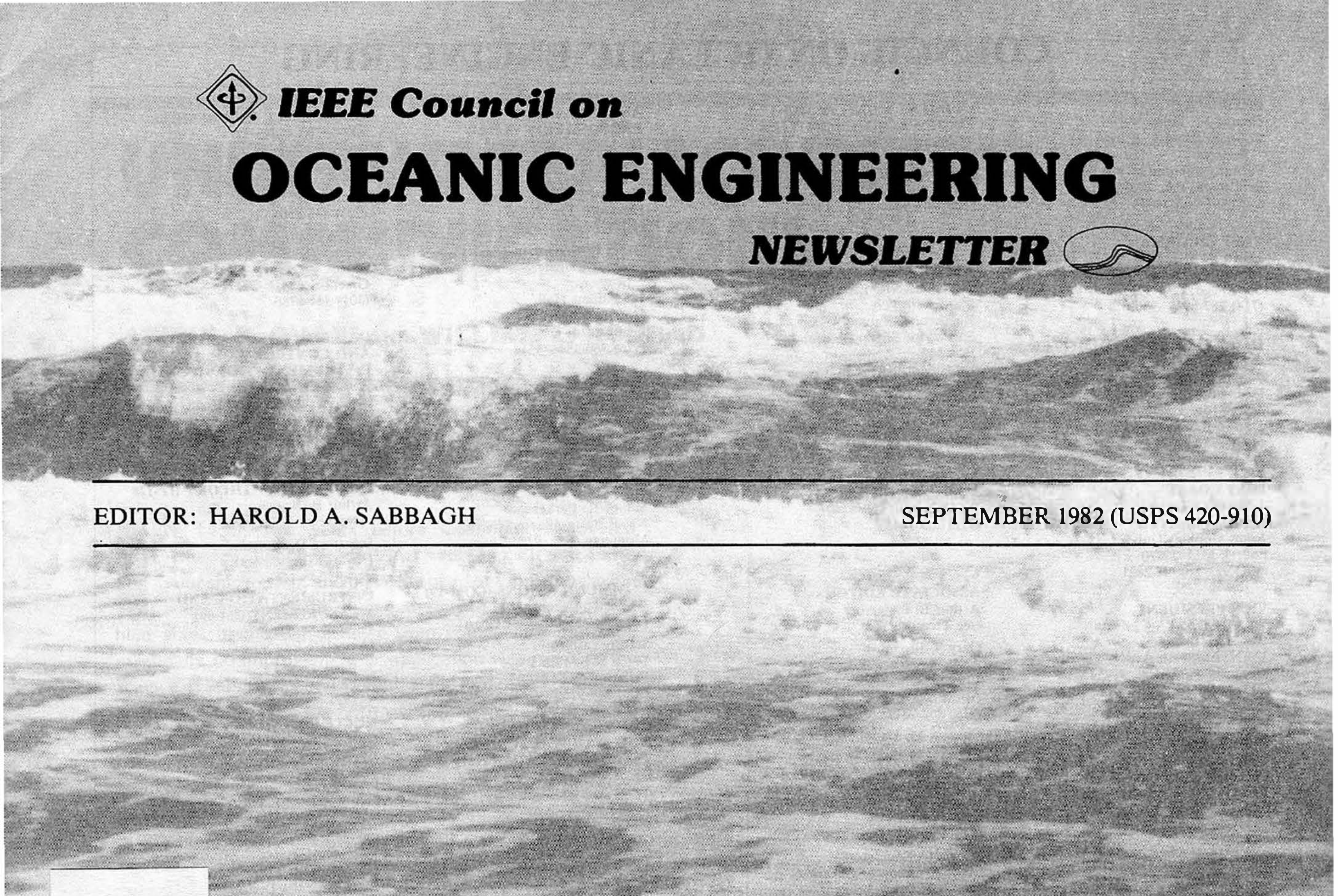

IEEE Council on

OCEANIC ENGINEERING

NEWSLETTER

EDITOR: HAROLD A. SABBAGH

SEPTEMBER 1982 (USPS 420-910)

COUNCIL ON OCEANIC ENGINEERING

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UNDERWATER ACOUSTIC COMMUNICATIONS

AZIZUL H. QUAZI AND WILLIAM L. KONRAD

A study of problems that might limit range and data rate.

IN 1490, two years before Columbus discovered America, Leonardo da Vinci wrote [1]: "If you cause your ship to stop, and place the head of a long tube in the water and place the outer extremity to your ear, you will hear ships at a great distance from you." Since that time essentially no improvement or application was made in the science of underwater sound until, at the turn of this century, a submarine bell and a fog horn were simultaneously sounded to determine distance offshore by measuring the interval between their airborne and waterborne arrivals [2]. Although embryonic underwater echo detection schemes emerged prior to World War I, World War II ushered in the "modern age" of underwater sound exploitation. But even then the water medium was used primarily for sound navigation and ranging (sonar).

The underwater telephone, developed in 1945 at the Naval Underwater Sound Laboratory (now Naval Underwater Systems Center, NUSC), was the first application of underwater voice communications. The underwater telephone was developed to communicate with submerged submarines and employed the upper sideband of an 8.3-kHz suppressed carrier. From this first operational system, military underwater acoustic communications have moved toward lower frequencies that permit transmission over longer ranges.

The absorption of electromagnetic energy in a conductive medium like sea water is extremely high, about $45\sqrt{f}$ dB per kilometer, where f is frequency in Hertz. High absorption restricts the use of electromagnetic waves in sea water, but the absorption of sound over most frequencies of interest is about three orders of magnitude lower. Figure 1 gives the absorption of sound in sea water as a function of frequency.

Aside from the obvious military uses, there are several ways underwater acoustic communications are commercially applied. An underwater telephone similar to the military UQC is in use for communicating with small submersibles engaged in pipe and powerline survey and inspection, archaeological search and offshore oil work. Smaller higher frequency systems are in use for ship-to-diver and diver-to-diver voice communications. Another important application

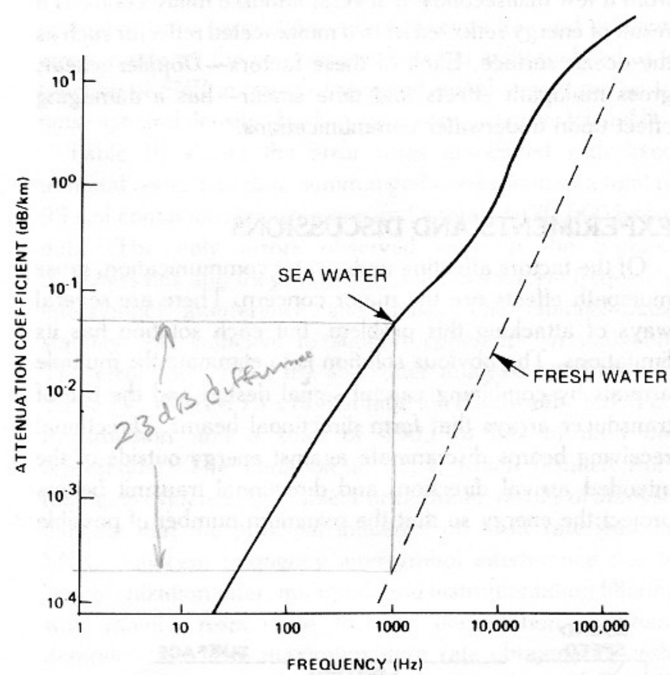


Fig. 1. Absorption of sound in sea water as a function of frequency.

is for telemetry systems to command oil and gas wellhead operations and for remote control of subsea pipeline valves.

In this paper, we share our experiences in communicating via data, voice and pictures in fresh water and sea water. The objectives of these communication experiments were to determine the maximum data rate for an undersea acoustic communication channel and discover associated problems that might limit range and data rate. Also, we wanted to evaluate the quality of voice and picture transmissions and relate them to the general characteristics of the channel.

SOUND PROPAGATION IN SEA WATER

The sea is far from the ideal sound-propagating medium [2-12]: its vertical velocity gradient (Figs. 2, 3 and 4) causes the beam to be refracted, sometimes in a way that prevents reception in certain locations known as shadow zones. Also, the signal is subject to random fluctuating Doppler shifts and spread because of surface and internal wave motion. However, the most serious problem in underwater sound transmission is the temporal distortion that occurs as a result of multipath in many modes of transmission (Figs. 2, 3 and 4). Closely spaced multipath distortion (time smear) also occurs because of forward scattering in the medium. This scattering is the result of thermal microstructure, i.e., small volumes of water at different temperatures.

Because of the random nature of these propagation effects, their magnitudes can only be described by a coefficient of variation for amplitude fluctuations and rms values for phase fluctuations. Under some conditions, usually at longer ranges, these multipath arrivals may be separated by several seconds. A time smear on a single burst or pulse can range from a few milliseconds to several hundred milliseconds as a result of energy reflected from a multifaceted reflector such as the ocean surface. Each of these factors—Doppler smear, gross multipath effects and time smear—has a damaging effect upon underwater communications.

EXPERIMENTS AND DISCUSSIONS

Of the factors affecting underwater communication, gross multipath effects are the major concern. There are several ways of attacking this problem, but each solution has its limitations. The obvious solution is to eliminate the multiple arrivals by combining careful signal design and the use of transducer arrays that form directional beams. Directional receiving beams discriminate against energy outside of the intended arrival direction, and directional transmit beams project the energy so that the minimum number of possible

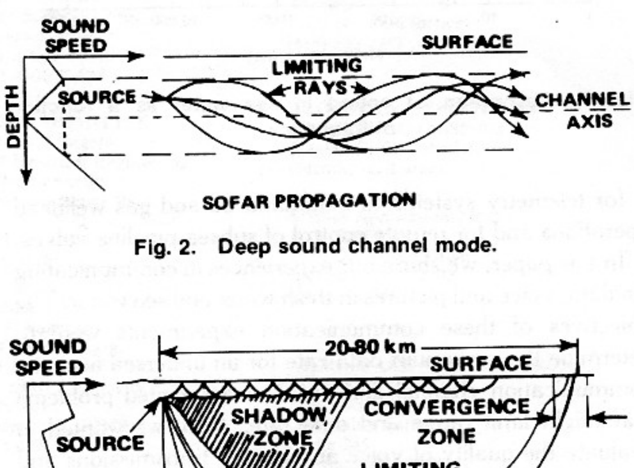


Fig. 2. Deep sound channel mode.

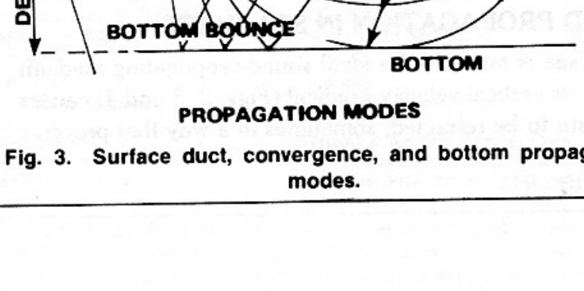


Fig. 3. Surface duct, convergence, and bottom propagation modes.

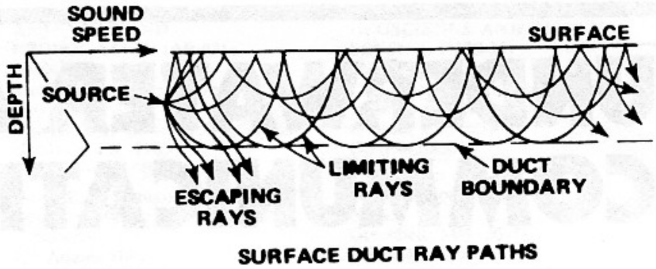


Fig. 4. Surface-duct mode.

propagation paths are excited. In certain cases, the latter can help a great deal in overcoming the multipath problem. However, the conventional acoustic source usually radiates sidelobes that, though of lower levels than the main beam, may still cause multiple arrivals. An exception to this occurs when parametric acoustic sources are used. A parametric source is capable of radiating a narrow beam with very low sidelobe levels.

Before describing several experiments that utilize the parametric source, a short description of this new technology is in order. This source capitalizes on the nonlinearity of the medium to generate energy at the difference of two or more high primary frequencies fed to a projector [13]. Medium nonlinearity results because the velocity is a function of the instantaneous pressure of the acoustic wave. The difference frequency energy is generated in a relatively long virtual endfire array in the water column in front of the projector where the interaction between the primary frequencies takes place. The effect of the endfire array with its essentially exponential shading (i.e., taper) is to reduce the sidelobe levels to more than 40 dB below the main lobe level. Furthermore, because the beamwidth is dependent on the length of the virtual array and not directly on the projector size, a narrow beam can be produced by a physically small transducer. The efficiency of the parametric radiator is relatively low (ranging from 0.01 to 5 percent); nevertheless, it is feasible to generate source levels useful not only for communications but also for echo-ranging applications [14,15].

A comparison of a conventional (i.e., direct radiation) source and a parametric source is shown in Figs. 5(a) and (b), respectively. Figure 5(a) is the pattern radiated by a 25-cm-diameter projector at a frequency of 25 kHz; it exhibits the usual pattern. Contrast this with (b) where the same 25-cm aperture is excited by two primary frequencies of 240 and 265 kHz. The 25-kHz difference-frequency energy generated in the long virtual array with its exponential taper is radiated in a much narrower "sidelobeless" pattern. Except for internal element size, which is dictated by the frequency of operation, the conventional and parametric projectors are physically identical.

Data Transmission

We conducted several controlled experiments, some in fresh water at Lake Seneca (in upstate New York) with fixed

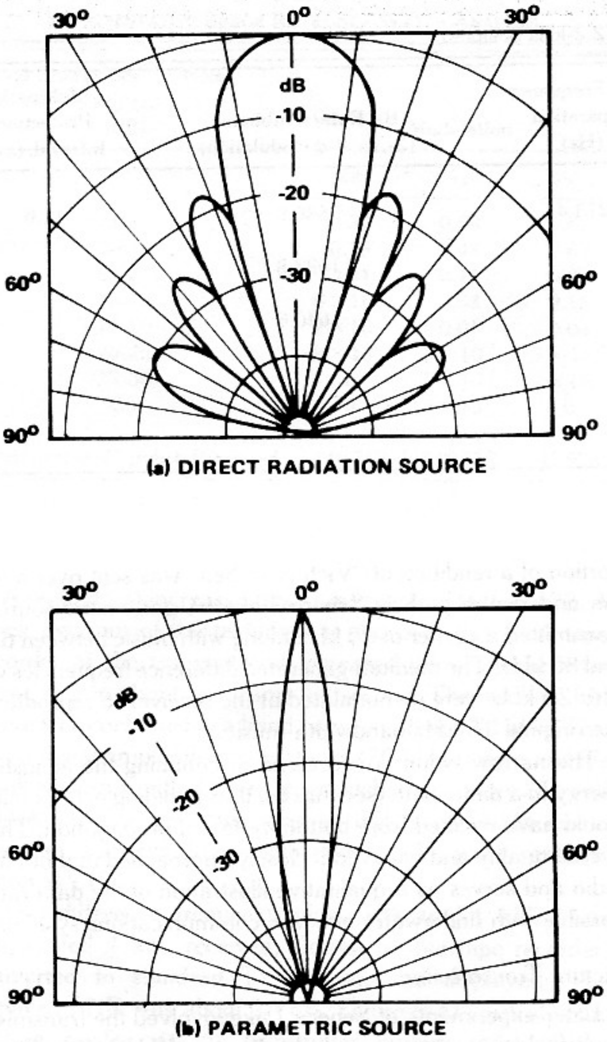


Fig. 5. Transducer beam patterns for (a) direct and (b) parametric sources.

transmission and reception platforms and the other at sea between moving platforms. These experiments were conducted with readily available equipments from NUSC and Sperry Research Center, Sudbury, MA [16,17]. Propagation conditions approximated those of a controlled ideal environment without multipath. Consequently, the measured data rates represent upper bounds on the channel capacity for a practical oceanic environment. Direct-path propagation was achieved between two test platforms separated by 4 km through the use of a parametric source, as shown in Fig. 6. A standard multitone format shown in Table I was transmitted. The frequency hopping sequence includes eight tones that extend over a 2.2-kHz bandwidth channel. Two tones are transmitted simultaneously and the hopping sequence is repeated every 4 bauds. Each baud duration is 3.66 ms. With independent phase shift keying (PSK) modulations of the two tones, 2, 4 or 6 bits per baud gives rates of 546.6, 1093.8, or 1640.6 bits per second per channel. The multipath protection is 3 bauds or 11.0 ms.

The format employed frequency hopping, M-ary frequency shift keying (MFSK) and 2-, 4- and 8-multiple phase shift keying (MPSK) modulation. The format was replicated in each of four contiguous 2.2-kHz data channels that provided a total bandwidth of 8.8 kHz. A consequence of the frequency hopping employed in the format is a "dead time" between repetitions at a given frequency. The interval protects against intersymbol interference caused by time dispersion arising from multipath.

Data modulation of the format was accomplished by differential encoding of the phase. The maximum data rate of the formats is shown in Table II to be 6.6 kbits/s and 4.9 kbits/s for the static and mobile tests, respectively.

Time and frequency synchronization is established directly from a wideband modulated waveform, and individual tone phases are demodulated by replica correlation [17]. Transmitted data symbol decisions are made on the basis of tone-for-tone differential phase. Tone signal-to-noise ratio (SNR) is estimated from correlation output magnitudes, and decision errors made by the receiver are detected and tabulated as a function of SNR in terms of received signal energy per bit to noise spectral density (E_b/N_0), as shown in Tables III and IV.

Table III shows the error rates associated with fixed terminal tests. The data summarized correspond to a total of 95 s of continuous transmission and a total of 420,000 bits of data. The only errors observed were in the 8-phase transmissions and they were attributed to adjacent frequency intersymbol interference and noise. The channel-phase stability was sufficient to support coherent demodulation. The error rates from the sea-water analysis are shown in Table IV, where 173 s of real-time full bandwidth (8.8 kHz) transmission and a total of 490,000 bits of data are represented. The variation in SNR, which resulted from fading, is evident in this table. Furthermore, results of analysis indicate that the principal influence on error rate was the SNR. Adjacent frequency intersymbol interference due to synchronization jitter, multipath and instrumentation filtering was mainly responsible for the degradation in phase demodulation. The maximum data rate obtained in fresh-water experiments in the 8.8-kHz band (with an SNR of 32 dB) is 6.6 kbits/s, which corresponds to about 7 percent of channel capacity.

No evidence of insufficient channel phase stability was

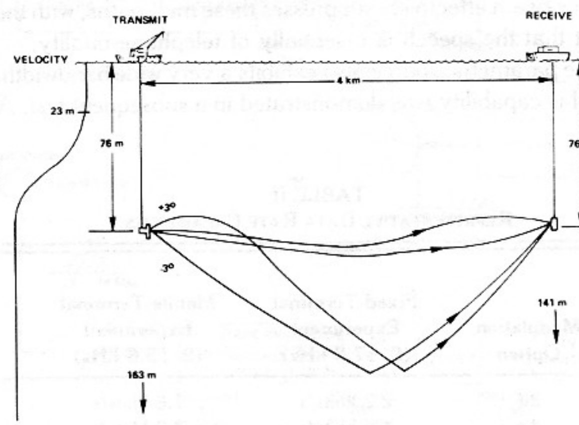
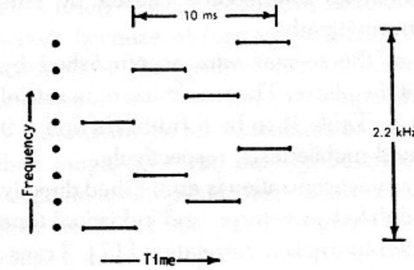


Fig. 6. Seneca Lake test geometry with ray paths.

TABLE I

Modulation Options for 2.2-kHz Subband

Subband Hopping Pattern	Symbol Duration (ms)	Tone Frequency Separation (Hz)	Bit Rate/s/subband (2-, 4-, 8-ϕ modulation)	Multipath Protection Interval, (ms)
	3.66	273.4	546.9	11.0
			1093.8	
			1640.6	

observed in any of the data analyses. The channel clearly supported 2- and 4-phase modulations, aside from some fading that was encountered. The 8-phase reception allowed only a tentative conclusion of inadequate stability at low SNR.

Voice Transmission

As stated earlier, a straightforward means of minimizing the effects of multipath is to eliminate or reduce the unwanted paths by using a narrow-beam source. A comparison of speech transmitted by the conventional omnidirectional UQC underwater telephone source with the narrow-beam parametric source has been made. The test was conducted on Long Island Sound in water approximately 30 m deep. Each transmission was made over the same 2-km path length and placed the voice on the upper sideband of a 8.3-kHz carrier so that energy in the 8.3- to 11-kHz band was propagated. In the case of the parametric source, a carrier at 170 kHz and speech at 178.3 to 181 kHz was fed into the projector.

The improvement using the narrow beam is dramatic. The broad-beam source is difficult if not impossible to understand while the narrow-beam transmission is "arm-chair copy." The broad-beam transmission is severely distorted by several, almost equal, amplitude multipath arrivals. The time spread between these arrivals is about 0.1 to 0.3 s. The parametric narrow beam effectively suppresses these multipaths, with the result that the speech is essentially of telephone quality.

The parametric source also exhibits a very wide bandwidth, and this capability was demonstrated in a subsequent test. A portion of a rendition of "Victory at Sea" was sent over a 4-km underwater path in Seneca Lake. A parametric source transmitted a carrier of 60 kHz along with music between 65 and 80 kHz. The medium-generated difference frequencies of 5 to 20 kHz were demodulated at the receiver to reproduce the original 15-kHz-bandwidth music.

The narrow beam is successful in confining the acoustic energy to a direct path (see Fig. 6), thus avoiding echoes that would have resulted from bottom-reflected propagation. The overall quality and bandwidth closely approached that of FM radio and serves as a qualitative illustration of the data rate possible with underwater acoustic communications systems.

Picture Transmission

Later experiments at Seneca Lake involved the transmission of television pictures over the 4-km path [18]. Television is sensitive to gross multipath distortions ("ghosts") and also is a convenient means of demonstrating high-data-rate transmission. The ray paths were essentially the same as those in Fig. 6.

The result of our first attempt to transmit television acoustically over a water path is shown in Figs. 7(a) and (b), where (a) is the transmitted picture and (b) is the received picture. The 256 × 256-pixel fixed picture was transmitted at a rate of 1 frame in 35 s. A parametric source was again used with the FM video in a difference frequency band from 11.2 to 12.3 kHz.

TABLE II

Representative Data Rate Capabilities

Modulation Option	Fixed-Terminal Experiment (9–17.8 kHz)	Mobile-Terminal Experiment (9–15.6 kHz)
2ϕ	2.2 kbits/s	1.6 kbits/s
4ϕ	4.4 kbits/s	3.3 kbits/s
8ϕ	6.6 kbits/s	4.9 kbits/s

TABLE III

Representative Error Rates; Fixed Terminal

Signal energy per Bit/Noise Spectral Density (E_b/N_o) (dB)	Modulation		
	2ϕ	4ϕ	8ϕ
25-30	—	0	9×10^{-4}
30	0	0	0
Total Number of Symbols Processed	64 464	70 608	70 608

TABLE IV
REPRESENTATIVE ERROR RATES SEA-WATER ANALYSIS

Signal Energy per Bit/Noise Spectral Density (E_b/N_o) (dB)	Modulation		
	2ϕ	4ϕ	8ϕ
<0	0.37	0.68	0.67
0-5	0.16	0.44	0.67
5-10	0.04	0.11	0.32
10-15	6×10^{-3}	0.03	0.15
15-20	2×10^{-3}	0.01	0.04
20-25	9×13^{-5}	3×10^{-4}	7×10^{-3}
25-30	0	2×10^{-5}	2×10^{-3}
>30	0	4×10^{-5}	0
Total Number of Symbols Processed	119712	119712	42976

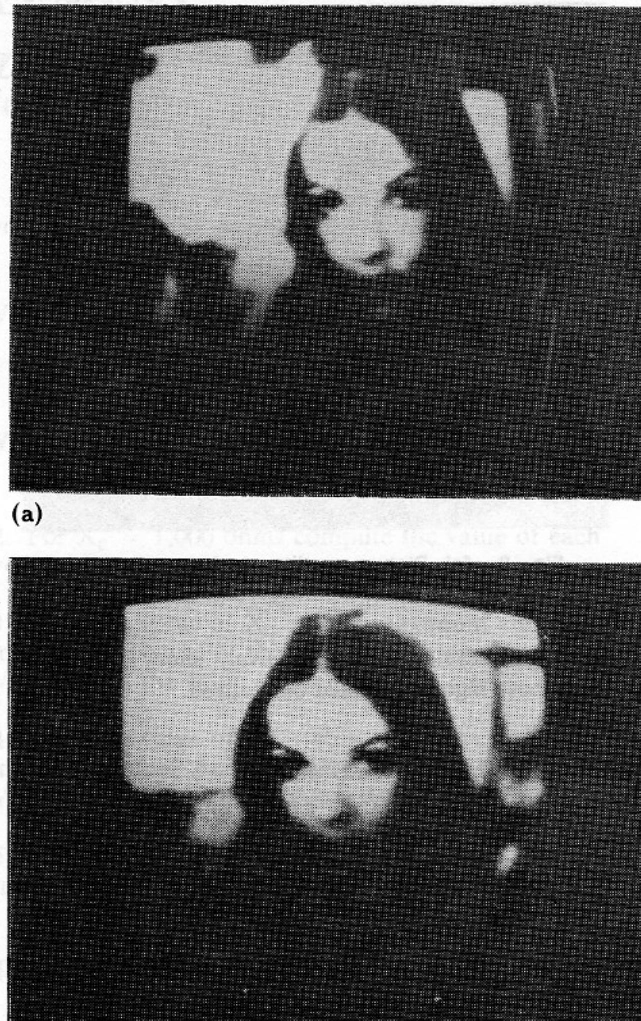


Fig. 7. Parametric underwater television transmission: (a) transmitted picture 256 lines, frame time 35s, video bandwidth 1100 Hz FM, primary frequencies, carrier 60 kHz, signal 61.2–62.3 kHz; (b) received picture, range 4 km.

A second test increased this frame rate by a factor of 32. A block diagram of the technique is shown in Fig. 8. A tape recorder at the transmit end increased the scan converter frame rate to about one frame per second. The resulting FM signal was contained in a band between 38 and 74 kHz. This video signal amplitude-modulated a 220-kHz carrier, and the result was transmitted as an upper sideband between 258 and 294 kHz. The projector used in this test was 25 cm in diameter and was driven with about 2-kW peak envelope power (PEP).

The difference frequency video (38 to 74 kHz) was propagated 4 km, received, slowed by the tape recorder, converted to standard TV format, and displayed. The received SNR was about 20 dB. Figure 9(a) illustrates the picture quality at the transmitter output; most of the degradation is the result of the scan converter. Figure 9(b) is the reconstructed picture on the receiver monitor. Assuming that the 256 × 256 pixel picture exhibits 4 gray shades, the data rate achieved here is about 130,000 bits/s.

The television transmission provides a somewhat more quantitative illustration of the data rate possible with underwater acoustics. The complete suppression of ghosts is the combined result of the narrow beamwidth and the "capture" characteristics of frequency modulation. Although multipath does not occur, some distortion, primarily in the form of dropout, still takes place because of phase cancellation due to time smear on the order of a half period of the acoustic frequencies. For example, a half period at 50 kHz is 10 μs and corresponds to an acoustic half wavelength of 1.5 cm. The effect of these dropouts, which are not present in Fig. 9(a) can be seen in Fig. 9(b) as breaks in the contour lines. Fortunately, the effect of this time smear on overall picture quality is not very damaging.

It should be noted that the lower absorption of the fresh water (Fig. 1) of the lake allows transmission of such wide bandwidth signals. The greater absorption of sea water would substantially limit the transmission range of signals containing such high frequencies. However, for applications such as an unmanned, untethered submersible-to-surface acoustic

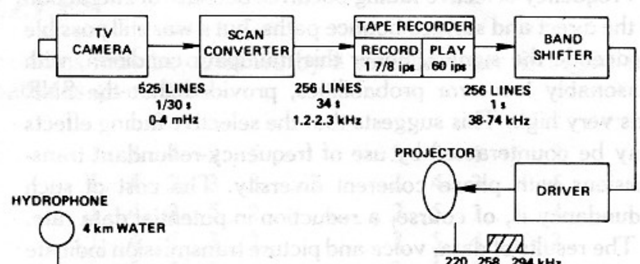


Fig. 8. High data rate television.

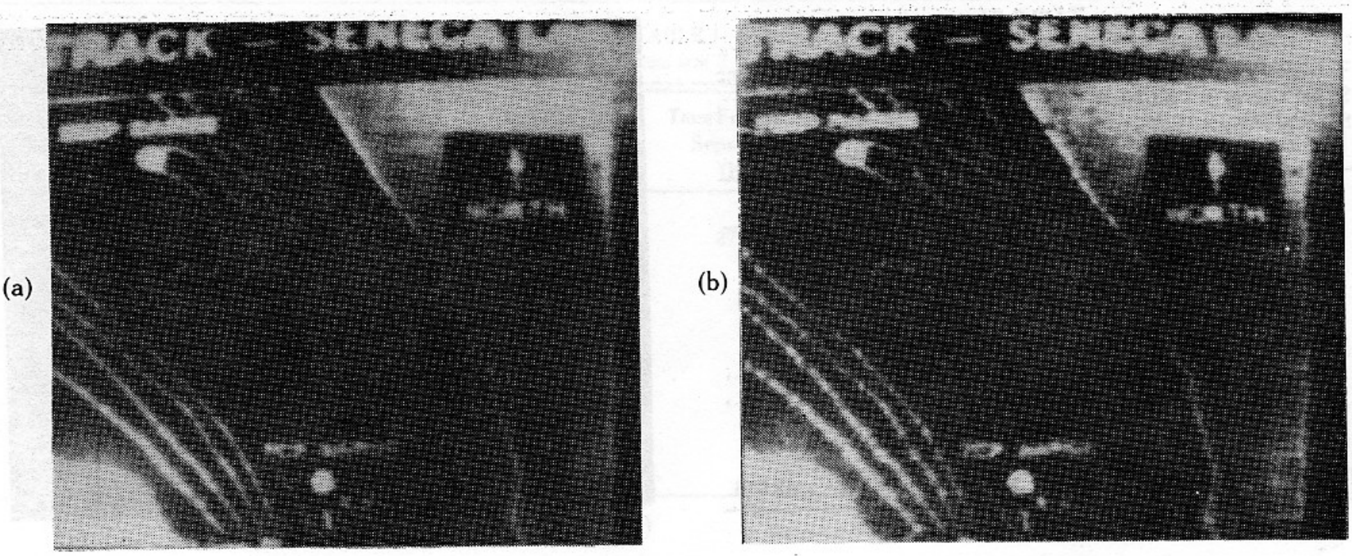


Fig. 9. (a) Picture quality as transmitted into the water. (b) Reconstructed picture on the receiver monitor.

television transmission, where relatively short ranges are involved, these high rates could be realized.

SUMMARY AND CONCLUSIONS

In the data analysis of the MFSK and MPSK, it was generally observed that the underwater channel provides sufficient coherence to support data rates of kilobits per second, in the direct path cases, to ranges of about 4 km. Multiple differential phase-modulated signals were demodulated correctly at rates in excess of kilobits per second for both the fixed and moving-platform tests. The principal determinant of error rate was the SNR at the receiver. Typically E/N_o (total energy/noise spectral density) levels of 20 dB or more corresponded to bit error rates of 10^{-3} or less. Time and frequency synchronization were secondary issues.

Two chief contributors to E/N_o reduction were broadband fading and frequency-selective fading. Broadband fading was the result of errors in projector aiming. The resolution of this deficiency requires precise control of main-beam steering at the transmitter.

Frequency-selective fading occurred because of interaction of the direct and surface-bounce paths, but it was still possible to decode the signals, under this multipath condition, with reasonably low-error probabilities, provided that the SNR was very high. This suggests that the selective fading effects may be counteracted by use of frequency-redundant transmissions with phase coherent diversity. The cost of such redundancy is, of course, a reduction in potential data rate.

The results of data, voice and picture transmission indicate that data rates well in excess of a kilobit per second over short ranges ($\leq$10 km) are possible. As data rates are increased, however, the greater bandwidth requirement will meet with increasing absorption. Therefore, a tradeoff between communication range and data rate is necessary.

Future research should include consideration of the tradeoffs necessary to achieve reliable two-way communications in realistic multipath environments at different ranges.

ACKNOWLEDGMENT

The authors wish to thank Dr. Mark Moffett, of NUSC, for his critical review and positive criticism of this paper.

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(Continued on page 12)

'TIS A PUZZLEMENT

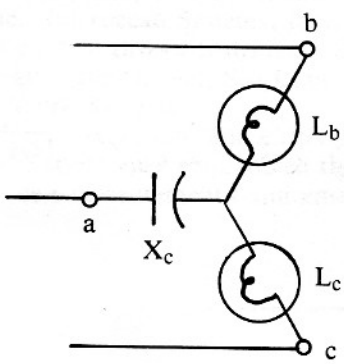
NEW PUZZLES

Puzzlement Editor: George V. Mueller, 2229 Indian Trail, West Lafayette, IN 47906

PHASE SEQUENCE INDICATOR

A common method for determining the phase sequence of the line voltages of a 3-phase 3-wire system is to connect two lamps and a capacitor in star to the system as shown. The lamps have unequal brilliance. If lamp L_b is brighter than lamp L_c, the voltage from line a to line b leads in phase position the voltage from line b to line c. If lamp L_c is brighter than lamp L_b, the phase sequence is the reverse of the above.

For the purposes of this problem assume that the resistance of each lamp is constant at 1,000 ohms, that the voltage between each pair of lines is 100 volts and that the reactance of the capacitor is X_c ohms. By varying the capacitance the value of X_c can be varied.



1. Prove that for one sequence of voltages the lamp voltages are given by the equations

$$V_b = 100\frac{\sqrt{10^6 + \sqrt{3}\cdot 10^3X_c + X_c^2}}{\sqrt{10^6 + 4X_c^2}}$$

$$V_c = 100\frac{\sqrt{10^6 + \sqrt{3}\cdot 10^3X_c + X_c^2}}{\sqrt{10^6 + 4X_c^2}}$$

2. For $X_c = 1{,}000$ ohms compute the value of each voltage.

3. For what value of X_c is V_b a maximum and what is the maximum value? For this value of X_c what is the value of V_c? What is the value of the ratio of V_b to V_c?

4. For what value of X_c is V_c a minimum and what is the minimum value? For this value of X_c what is the value of V_b? What is the ratio of V_b to V_c?

5. For what value of X_c is the ratio of V_b to V_c a maximum and what is the maximum ratio?

RIGHT TRIANGLES

Determine three right triangles with integral sides, each having an area of 840 square units.

One integral-sided right triangle with sides of 20, 21 and 29 units and another with sides of 12, 35 and 37 units each have an area of 210 square units. Prove that there is no other integral-sided right triangle with that same area.

PAST PUZZLES

Solution: Drilling Patterns

Submitted by Dr. John Costas, General Electric Company, Syracuse, NY

Given two identical square boards, similar to chessboards, having N rows and N columns. These boards are clamped together and N square-centered holes are drilled through them such that only one hole appears in any row or any column. Choose a drilling pattern such that any x and y position shift will produce at most one hole alignment. Determine all valid drilling patterns for N = 5.

Solution:

There are 40 valid drilling patterns of which 20 are listed below in row position in column order. The remaining 20 patterns may be obtained by a reverse-order listing of the patterns given here.

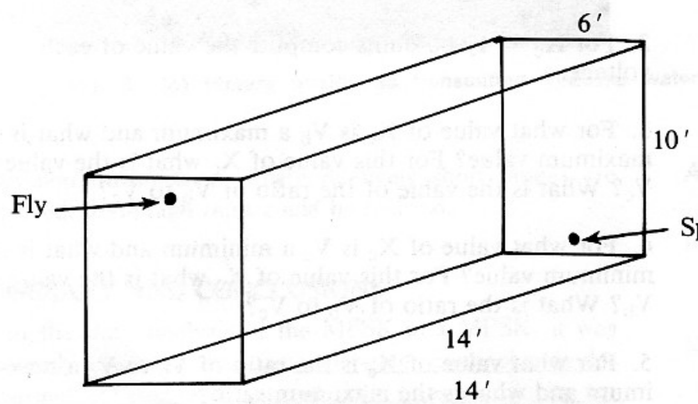
1	3	4	2	5	2	4	1	5	3
1	4	2	3	5	2	4	3	1	5
1	4	3	5	2	2	5	1	3	4
1	4	5	3	2	2	5	4	1	3
1	5	3	2	4	3	1	2	5	4
1	5	4	2	3	3	1	5	2	4
2	1	4	5	3	3	4	2	1	5
2	1	5	3	4	3	5	2	1	4
2	3	1	5	4	4	1	3	2	5
2	3	5	1	4	4	3	1	2	5

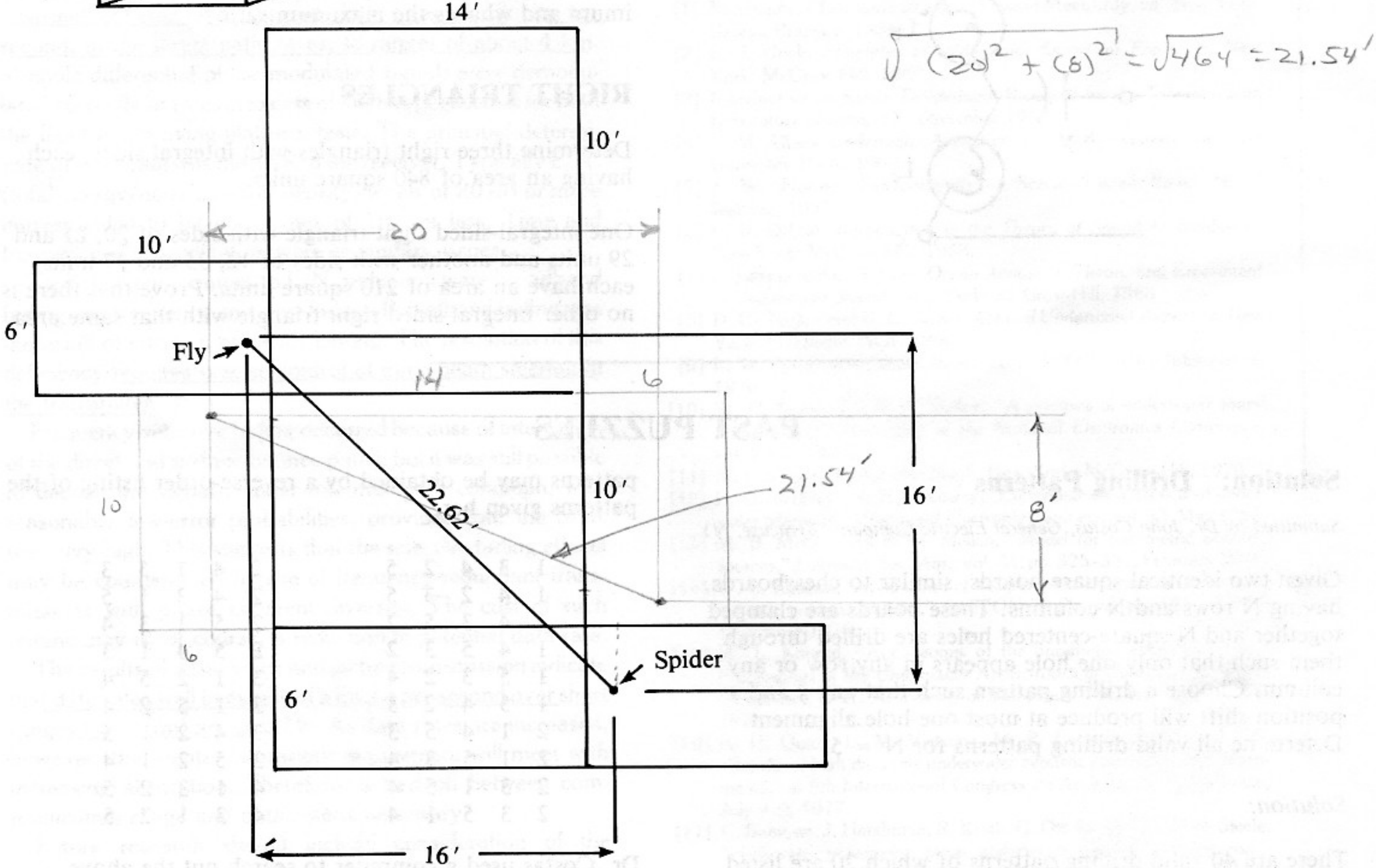
Dr. Costas used a computer to search out the above patterns.

Solution: Spider and Fly

Submitted by Arthur Levin, 2229 Willette Ave., Los Angeles, CA

In a rectangular room, 6′ × 14′ × 10′ high a spider is at the center of an end wall 12″ up from the floor. A fly is at the center of the opposite wall 12″ down from the ceiling. To determine the shortest distance the spider can travel on the room surfaces to reach the fly, draw the opened up view of the room as shown. Then it can be seen that the shortest distance between the two points is $\sqrt{2} \cdot 16 = 22.62$ ft.





Solution: Party Hat Colors

Submitted by Charles A. Lawton, Springfield, OH

The first man sees the hats on the second and third men. Both cannot be red or he would know that his hat was blue.

The second man sees the hats on the first and third men. He knows from what the first man said that both he and the third man cannot both have red hats. If the third man had on a red hat the second man would have known his hat was blue. Therefore the third man (the blind one) knew that his hat is blue.

Solution: Perfect Numbers

Submitted by Arthur Levin, 2229 Willette Ave., Los Angeles, CA

A number is perfect if it is equal to the sum of all its divisors, except itself. Six and 28 are perfect numbers. Another is 496.

IEEE SECOND WORKING CONFERENCE ON CURRENT MEASUREMENT

On January 19, 20, and 21 the Current Measurement Technology Committee of the IEEE Council on Oceanic Engineering convened the Second Working Conference on Current Measurement at Hilton Head, South Carolina. The objective of the conference was to encourage continued and focused technical exchange among those in the community who are interested and concerned about the measurement of ocean currents. The theme of the Conference was "Quality of Current Measurements—How Can I Collect Data of Sufficient Certainty to Satisfy My Needs?" More than 125 registrants gathered to hear presentations on Eulerian, Lagrangian, profiling and developing measurement techniques by 19 recognized experts in the ocean community. A unique feature of the conference was a special panel session of 11 current measurement instrument manufacturers. The session stimulated lively panel/audience interactive discussion on the differing viewpoints of the issues and problems surrounding instrument development, testing, manufacturing and use. The manufacturer's panel was chaired by William Coburn of EG&G Sea-Link and included representatives from Aanderaa Instruments, AMETEK/Straza Division, Benthos, Inc., ENDECO, Inc., General Oceanics, Inc., Interocean Systems, Inc., Marsh-McBirney, Inc., Neil Brown Instrument Systems, Inc., Sippican Ocean Systems, Inc., Sea-Data Corporation and Deep Ocean Work Systems.

The Eulerian presentations and ensuing discussions throughout the conference emphasized that the understanding of one's measurement requirements is a fundamental prerequisite to the proper design of a measurement program and selection of an instrument and/or system. A weak link in this process, however, continues to be the lack of adequate performance information needed to make that judgment. This is primarily because of the difficulty in characterizing the broadband performance of Eulerian devices.

Representatives of the Lagrangian community were optimistic and stressed the positive aspects of this technique. That is, a great deal of spatial structure of the ocean currents can be observed by using Lagrangian methods and the cost of doing so is relatively small. There is, however, a growing burden to assimilate and unravel the sometimes complex measurement results. Presentations describing innovative profiling and developing remote techniques hinted at what the future holds for current measurement and underscored the importance of understanding the comparability of data from these and the more "conventional" methods.

Most of those at the meeting felt that progress has been slow since the 1978 conference in Delaware but that the Current Measurement Technology Committee, by sponsoring conferences like this one, is providing the communication link that is essential to ensuring cooperative efforts in the community.

The target date for publication of the proceedings is June 1982. For further information contact the Conference Chairman, William E. Woodward at NOAA, OTES/TE-1, 6010 Executive Blvd., Rockville, MD 20852; (301) 443-8444.

CORRESPONDENCE

Mr. Harold Sabbagh
Analytics, Inc.
2634 Round Hill Lane
Bloomington, IN 47401

Dear Mr. Sabbagh:

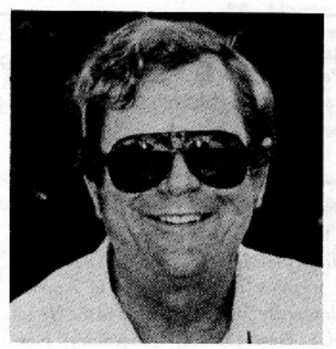
I'm an avid fan of your "Tis a Puzzlement" column and wonder if you have a collection of them you could send me. I have the Sept-Jan '81 issues. If you don't have a collection, do you have the June issue? I also enjoy the "Of Ocean Interest Column."

Sincerely yours,

Herbert Antman

Herbert Antman
35 Jayson Avenue
Great Neck, NY 11021

AWARDS



Congratulations to Robert C. Spindel for receiving the A. B. Wood Medal and Prize for 1981 from Britain's Institute of Acoustics. The award was presented to Dr. Spindel for "his extensive and distinguished research work" in ocean sound propagation.

Bob, who is an Associate Scientist with the Woods Hole Oceanographic Institution's Ocean Engineering Department, serves as an associate editor of the *IEEE Journal of Oceanic Engineering*.

Why an IEEE IRA?

Donald D. King, Chairman
Individual Benefits and Services Committee

Since the first of the year, banks and other financial institutions have put on a tremendous campaign to sell IRA's (Individual Retirement Accounts). In March, the IEEE joined in with a sponsored program. Why was this done, and how does the new IRA program compare with other member benefits?

Pensions have been an important issue for IEEE members for years. The Individual Benefits and Services Committee was alert to this member interest and had examined various alternatives in depth. The tax law changes effective January 1, 1982 then made it feasible to offer a Retirement Investment Program to members. The announcement was delayed by legal and administrative arrangements until March. Under the previous law, self employed persons, or employees not covered by a pension plan, could obtain Keogh or IRA plans respectively. The 1982 law extends IRA eligibility to all wage earners, whether covered by pension plans or not. This means that virtually all IEEE members are potential beneficiaries. Universal eligibility is an important factor, which has been a criterion for other IEEE member benefits. Basically, member benefits should be quantitatively available to all, and qualitatively worthwhile.

There are many types of IRA's available to the public and the choice to be made is a matter of personal financial planning. The particular plans offered under the IEEE Program are designed to offer a selection of mutual funds. Thereby, members have the opportunity to choose a plan to suit their needs, and also to make changes in the future, whenever they wish. The two large mutual fund organizations involved were selected by the IB&S Committee on the basis of the service they agreed to offer especially to IEEE members, and on their past record of performance.

Of course, no one can predict future financial results. However, the performance of the mutual funds in the program will be monitored, just as the performance of Life and Medical Insurance carriers is monitored by the IB&S Committee and its consultants. The combination of this regular review by IEEE members, flexible choice of mutual funds, and convenient, low cost administration is unique among the many publicly advertised plans available. As with other member benefits, there is no financial burden or responsibility involved for the IEEE. Only the numbers of participating members bring leverage for group advantages. These are more pronounced in the established Group Insurance Programs than in the IRA/KEOGH offering. However, the new IEEE Retirement Investment Program represents good value and convenience to members, and should become a key part of individual benefits.

(*Continued from page 8*)

[18] W. L. Konrad, "Very high data rate television using the parametric acoustic source," (Abstract) Paper XI, 100th Meeting of Acoust. Soc. Am., *J. Acoust. Soc. Am.*, *Supplement 1*, vol. 68, Fall 1980.

Azizul H. Quazi was born in Rahimpur, Bangladesh. He received his B.S. in electrical engineering (1956) from the University of Dacca, Bangladesh, and his Ph.D. in engineering (1963) from the Munich Technical University, Germany. He then became a staff member at the Institute of Applied Electronics at the Munich Technical University. In 1965, he joined the Naval Underwater Systems Center (NUSC), New London Laboratory, New London, CT. He taught graduate school at the University of Rhode Island, Kingston, RI, the University of Connecticut, Avery Point, CT, and the Hartford Graduate Center, Hartford, CT. At present he is teaching at the University of New Haven.

Dr. Quazi is a team leader in NUSC's System Technology and Integration Division and is engaged in the problems of acoustic communications, signal processing, sonar systems analysis, and development of advanced sonar systems concepts. He was responsible for the RDT&E long range low frequency advanced communication system and for the high data rate communication project (HIDAR).

Dr. Quazi has published and presented more than 50 papers in nationally and internationally recognized professional journals and symposiums. He is a member of IEEE and ASA and listed in American Men and Women of Science and Who's Who in Technology Today.

William L. Konrad has been engaged in nonlinear underwater acoustics for the past 12 years, at the AVCO Corporation and the Raytheon Company. In 1970 he joined the Underwater Systems Center as Head of the Nonlinear Acoustics Group, where he is responsible for the exploitation of nonlinear acoustic techniques for Navy sonar systems. He is the author of many papers on nonlinear acoustic applications and holds 12 patents in acoustic and electronic devices. Mr. Konrad is a Fellow in the Acoustical Society of America and a member of the IEEE. He received his B.S. degree in Electrical Engineering from Carnegie Mellon University. ■

1983 OFFSHORE TECHNOLOGY CONFERENCE
ABSTRACT SUBMISSION FORM

Deadline for Receipt — September 15, 1982

Note: All information requested on the abstract submission form must be included in order to be considered by the OTC Program Committee. Specific details regarding the nature of the work will be given priority consideration by the Program Committee.

GUIDELINES FOR AUTHORS

All Sponsoring Societies of the Offshore Technology Conference will participate in developing the technical program for the 1983 Conference. The Program Chairman for the Conference Technical Program Committee is Captain Don R. Wells.

Individuals interested in submitting an abstract or manuscript for consideration by the 1983 Conference Program Committee should review carefully the material included in this document. Specifically, potential authors should note that **a manuscript will be required for inclusion in the Proceedings Volumes for each paper accepted for the 1983 Conference Program.**

The OTC Program Committee will evaluate papers solely on the basis of information supplied on this form. Authors must provide specific information on the paper proposal in each of the areas of the abstract section.

OTC provides complimentary registration **only** for presenting authors who register on special author registration cards. OTC assumes no obligation for any other expenses incurred by authors for travel, lodging, food, or other incidential expenses.

SUBMITTAL OF PAPERS

Solicitation of technical papers for the 1983 Conference will be made primarily with this Abstract Submission Form. The form contains space for the abstract that must be included for all proposed papers. This system permits the selection of papers for the program before manuscripts are written. Additional copies of this form will be supplied by the OTC Headquarters Office on request.

ABSTRACT: An abstract, containing 200-300 words, must be provided. Develop the abstract by addressing the major aspects of the paper as described below:

Description of the Paper: Summarize the scope and nature of the work upon which the paper will be based. Note the relative emphasis of components such as field data, laboratory data, design, analysis, field operations, research or system development. Note difference from other past or current related work being done in this area. If the paper is a review paper, carefully state the extent of the coverage.

Application: Describe the possible application of knowledge provided in this paper to a particular area of offshore resource development and recovery. If the paper is a review paper, carefully state the extent of the coverage.

Results, Observations, Conclusions: Describe results to be presented in the paper and state specific conclusions of work. Describe how these differ from results or conclusions of previous work in the same or similar subject. If the paper describes hardware, or operation of a system, or describes an event, state specific new information revealed. Also state whether or not results of field data, laboratory test data or calculated computer work will be included in the paper.

Significance of Subject Matter: Briefly state the most significant aspect of the subject matter.

Subject Categories are listed below. Please indicate by number the most appropriate Primary and Secondary Category designation on the abstract form where indicated.

1. Marine Geology & Geochemistry
2. Exploration & Production Geology
3. Geophysical Interpretation
4. Geophysical Data Gathering & Data Processing
5. Seafloor Surveying & Mapping
6. Foundations & Soil-Structure Interaction
7. Earthquake Prediction & Effects
8. Oceanography & Meteorology
9. Wind & Wave Loading Forces
10. Offshore Platform Concepts
11. Structural Engineering, Design, and Analysis
12. Platform Construction & Installation
13. Engineering Materials for Offshore Applications
14. Corrosion & Corrosion Control
15. Welding & Fatigue
16. Wire & Synthetic Rope
17. Mobile Offshore Drilling Units
18. Construction, Support & Service Vehicles
19. Position Control & Stabilization of Vessels
20. Mooring & Anchoring
21. Navigation Systems
22. Communication & Telemetry
23. Offshore Data Collection, Instrumentation & Transmission
24. Power & Power Support Systems
25. Drilling, Production & Completion Technology
26. Field Development
27. Subsea Production Facilities
28. Marine Riser Systems
29. Offshore Pipelines
30. Manned & Unmanned Submersible Systems
31. Diving, Salvage, & Repair Operations
32. Arctic Logistics
33. Ice Mechanics
34. Ocean Transportation & Marine Terminals
35. Marine Mining, Ocean Minerals & Energy Sources
36. Offshore Islands & Breakwaters
37. Offshore Processing
38. Safety & Fire Prevention
39. Environmental Quality Considerations
40. Marine Bioresources

(please continue on reverse side)

RETURN FORMS TO: PROGRAM DEPARTMENT, OFFSHORE TECHNOLOGY CONFERENCE
6200 N. Central Expressway, Drawer 64705, Dallas, TX 75206

EVALUATION OF ABSTRACTS BY THE 1983 PROGRAM COMMITTEE

The following criteria will be observed by the Offshore Technology Conference Program Committee in selecting papers for the 1983 Conference.

1. The paper must not have had prior extensive publication or circulation. Publication in trade periodicals or other professional and technical journals will be considered extensive publication.

2. The paper should contain new knowledge or experience in some field of offshore resource and environment.

3. The paper must be technically correct and should be of interest to a reasonable number of people working in the field of offshore resources and environment. It may be theoretical or may present the results of laboratory studies, and it may state or analyze a problem. The paper may also be a review-type paper, but must be of significant value to the technical field.

4. The paper may present information about equipment and tools to be used in offshore technology. Such papers must show the definite applications and limitations of such equipment and should avoid undue commercialism and the extensive use of trade names.

5. **The paper proposal should have necessary clearance before submittal to OTC Headquarters. Prospective authors should provide information on any clearance problems when the paper proposal is submitted.**

Although theoretical papers will be selected in various fields, application papers presenting solutions to problems are also desired. Program time is limited, so the Program Committee will emphasize the quality of the contribution and its value in the field of offshore technology.

A WORD ABOUT COMMERCIALISM . . .

The OTC Program Committee has a stated policy against use of commercial trade names or language that is **commercial** in tone in paper titles and text. Use of such terms will result in **careful scrutiny** by the Program Committee in evaluating abstract submission forms, and the presence of **commercialism** in the text of papers submitted for the *Proceedings* Volume is cause for removal of the paper from the program.

COPYRIGHT

In accordance with the Copyright Law, the Offshore Technology Conference must receive and maintain on file a copy of the Transfer of Copyright Form, signed by all authors of papers to be presented at the OTC.

PREPARATION OF MANUSCRIPTS OF ACCEPTED PAPERS

Authors of papers selected for the 1983 OTC program will be notified by mail in late-November 1982.

Authors offering papers for the program should fully understand that a manuscript will be required for each technical paper selected for the 1983 Conference. If selected, the manuscript will be printed in the *Proceedings* Volumes to be sold at the Conference. The maximum desirable length for any paper is about 7,000 words.

Complete instructions on preparation of manuscripts and slides will be sent to authors of accepted papers. There are two options for preparing manuscripts:

Option 1 — **Deadline January 16, 1983.** Author provides complete manuscript and illustrations to OTC Headquarters, and the final typing and printing is done by the OTC Staff.

Option 2 — **Deadline February 15, 1983.** Author types final copy of his manuscript on special forms provided by the OTC Office, then sends typed forms and loose illustrations to OTC Headquarters Office. The OTC Staff completes the layout and printing of the paper.

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6200 N. CENTRAL EXPRESSWAY P.O. DRAWER 64705
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OFFICIAL ABSTRACT SUBMISSION FORM FOR PAPER PROPOSALS

MAY 2-5, 1983

HOUSTON, TEXAS

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DESCRIPTION:

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RESULTS:

SIGNIFICANCE OF SUBJECT MATTER:

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