



IEEE

OCEANIC ENGINEERING SOCIETY

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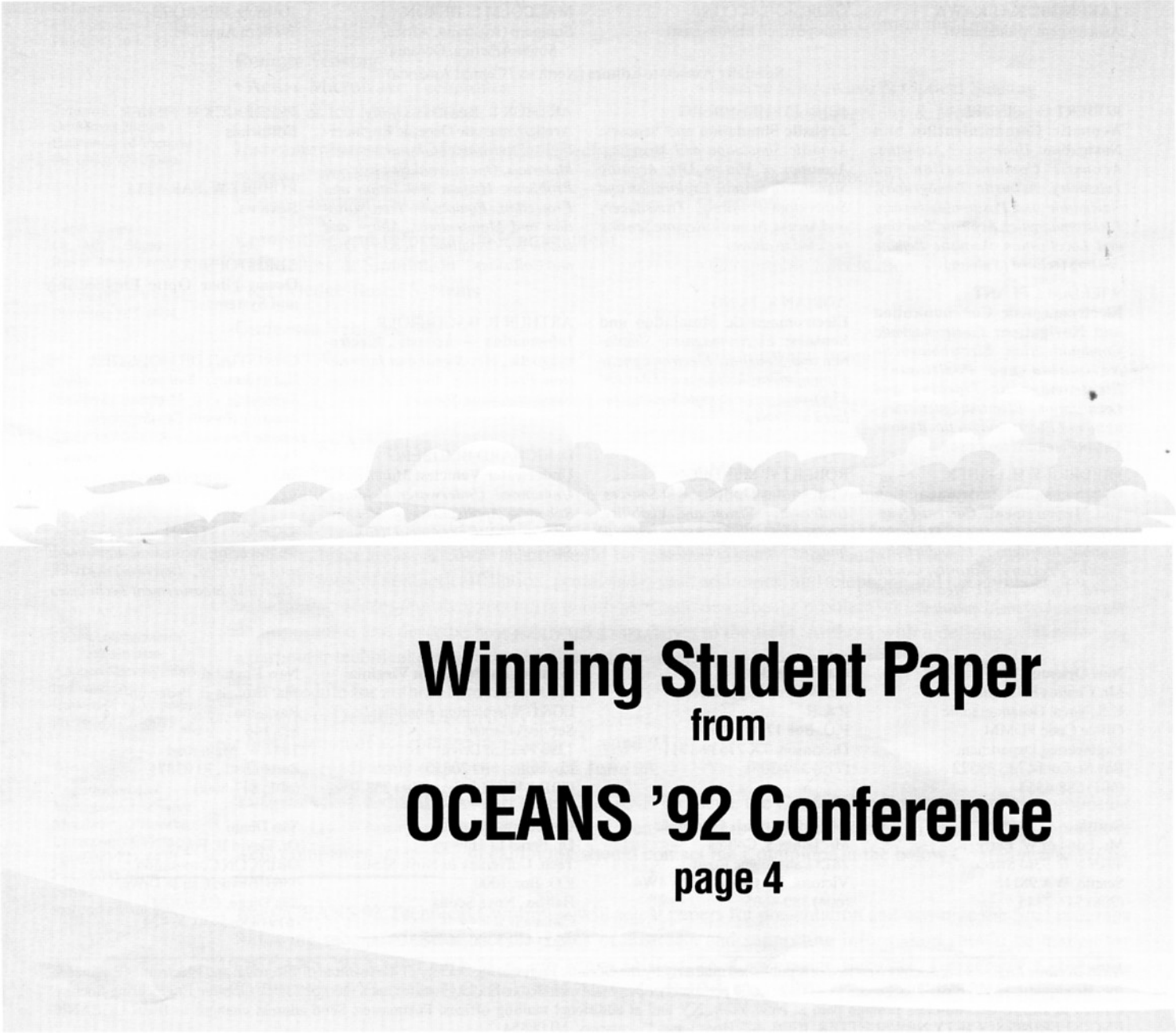


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EDITOR: FREDERICK H. MALTZ

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Winning Student Paper
from
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Journal of Oceanic Engineering Editor
WILLIAM M. CAREY
Defense Advanced Research Projects Agency
Arlington, VA 22203-1714
Editorial Office:
79 Whipoorwill Road
Old Lyme, CT 06371
(203) 434-6394
Fax (203) 434-6394

Newsletter Editor
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OCEANS '93

ENGINEERING IN HARMONY WITH THE OCEAN
18-21 October 1993



The Victoria Conference Centre, Victoria, Canada

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The theme for Oceans 93, ENGINEERING IN HARMONY WITH THE OCEAN, emphasizes the benefits of technology which is tailored to the ocean environment. As always, the IEEE emphasis on high-technology content and high quality in the technical program will guide the development of the technical program. Proposed technical sessions at OCEANS 93 will emphasize the following topics:

Underwater Acoustics

- Transducers and Arrays
- Source localization
- Matched Field Processing
- Boundary Effects & Propagation
- Air-Sea Acoustics
- Bottom Imaging & Detection
- Sonar Signal Processing
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- Bathymetry
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Remote Sensing

- Active Microwave Techniques
- Ocean & Ice Measurements
- Passive Microwave & Optical Sensing
- Satellite Oceanography & Meteorology

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- Polar Environment
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- Currents

Computing and Information Management

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Undersea Vehicles

- Positioning
- Obstacle Avoidance
- Robotics
- Stability and Imaging
- Power Sources
- Hardware/Software Architecture

Technology Advances

- Power Sources
- Navigation
- Materials
- Non-Acoustic communications

Prospective authors should submit titles and abstracts (300 to 500-words) for 20-minute talks in these or related subject areas. A cover sheet should be attached showing title, author(s) name(s) [designate one author as point of contact], affiliation, postal and e-mail addresses, and telephone and fax numbers. It would be helpful in addressing abstracts fairly if authors would describe the problem which was addressed, indicate its importance and describe how this work contributes to the field. Authors with a definite preference for a particular technical session should please so request.

The schedule for authors is:

- Abstracts Deadline - **1 February 93**
- Notification of acceptance to authors - **1 April 93**
- Camera-ready copy (6 pages max) - **15 June 93.**

Tutorials and Exhibits: As part of an OCEANS 93 focus, the Conference Committee solicits proposals for half-day (4 hour) tutorials in technology areas related to those highlighted in this Call for papers. As well, companies interested in exhibiting should contact the Committee at the below Conference Services address.

The OCEANS 93 Technical Committee will select papers for presentation and organize the final program following receipt of abstracts. Six copies of abstracts and supporting information should be mailed to: **OCEANS '93 CONFERENCE, c/o Mary O'Rourke, Conference Services, University Extension, University of Victoria, P.O. Box 3030, Victoria, British Columbia, Canada, V8W 3N6.**

High Frequency Radar Measurements of Coastal Ocean Surface Currents

Daniel M. Fernandez
October 27, 1992

Abstract

This study demonstrates the application of high frequency (HF) radar to the long-term examination of ocean variability. High frequency radar has been shown capable of measuring radially directed surface current speeds over several hundred square kilometer areas of the ocean as well as of estimating the wind direction and wind speed over these areas. Ground-based high frequency radar (such as the one used in this study) may provide regular, long-term coverage of coastal ocean areas of this size. Since ocean current measurements within the uppermost meter of the ocean are very difficult with other techniques (such as drifters, current meters, or acoustic Doppler current profilers), and since these ocean surface currents are of vital interest to biological and physical oceanographers, the use of high frequency radar for this application is advisable. Using a pulse Doppler radar system and an eight-element phased array, radial current velocities as a function of both range and angle may be measured. Such a system was used extensively on the California coast about 15 miles south of Monterey from July, 1989 until August, 1992. The operation was automated through the use of a Macintosh computer, which permits hourly sampling of the instrument for at times months of uninterrupted data collection. Analysis of the measured currents reveals the expected tidal frequencies, and high correlation exists between tidally filtered data, winds measured at sea, and sea surface temperatures measured at the shore. This is strong evidence for the technology's potential as an indicator of upwelling/relaxation conditions and, on a larger scale, as an earth-based remote sensing tool for coastal oceanic circulation.

Introduction

It is well known that coherent backscatter from the ocean surface occurs when high frequency radio waves (3 MHz to 30 MHz) interact with ocean waves of one half the radio wavelength (which is 10 to 100 m). This interaction yields a returned signal whose Doppler shift is proportional to the radial velocity of ocean gravity waves of half the radar wavelength, both approaching toward and receding from the radar. This radial wave velocity may then be determined by multiplying the Doppler shift by the proper factor, namely one half the radar wavelength. Subtracting the known still water phase velocity of these gravity waves from the measured velocity allows the depth-weighted, near-surface radial ocean current upon which the waves ride to be deduced. Since ocean waves of the proper wavelength exist in all ocean patches observed by the radar and since these waves may travel either

toward or away from the radar, the frequency spectrum of the signal received always shows two peaks, one associated with resonant waves approaching the radar and the other associated with resonant waves receding from the radar. The shift of each of these peaks from the still water phase velocity should be similar, since both the approaching and receding waves occur on the same patch of ocean and thus ride on ocean currents that have similar speeds. The height of the peaks represents the relative amplitude of the ocean waves both approaching and receding from the radar, thus yielding the ocean wave directional spectrum sampled at the wave number observed as a function of look angle. Since the relative amplitude of the ocean waves in a given direction is a function of wind direction and to a lesser extent the wind speed, the ratios between the height of the Bragg peaks in the frequency spectrum may also be used to infer such wind parameters as direction and speed.

Experimental Setup and Procedure

The system itself consists of a four-frequency radar (of which two frequencies were used in this experiment), assorted amplifiers and filters, a control box, a 250 Mbyte tape recording medium, a modem interface, a switched phased array containing 8 small loops, two transmitting whip antennas, and a Macintosh computer. The radar is a pulse Doppler type, meaning that it extracts the Doppler frequency shift for the purpose of detecting moving targets, which are in this instance ocean waves. It transmits 50 μ s gaussian-shaped pulses at each frequency it operates at (in this case 21.77 MHz and 13.38 MHz), which results in a 7.5 km range resolution. The radar samples the signals from each receive antenna independently and converts the data received at the carrier frequency to in-phase and quadrature data at audio frequency. The signal region of interest in this audio data is only 2 Hz wide, since the doppler shift observed is less than 1 Hz for the ocean waves of interest (2 Hz allows both the approaching and receding peaks to be seen). In order to distinguish between the approaching and receding waves, it is necessary to have complex time data, or else the resulting frequency spectrum will exhibit identical approaching and receding Bragg peaks. The fact that signals are received and stored independently from each antenna allows *aposteriori* steering of the array's main beam. The angular resolution of the phased array is 15° at 21.77 MHz and 18° at 13.38 MHz. The entire operation was automated via a Macintosh computer enabling hourly data collection runs of about 8.6 minutes' duration. I checked the status routinely through the modem interface. The system was located at the Granite Canyon Marine Laboratory, 36°25.9'N, 121°55.0'W which is about 15 miles south of Monterey and overlooks the narrow shelf of the California Pacific Ocean.

Power Spectrum of Complex Signal Received

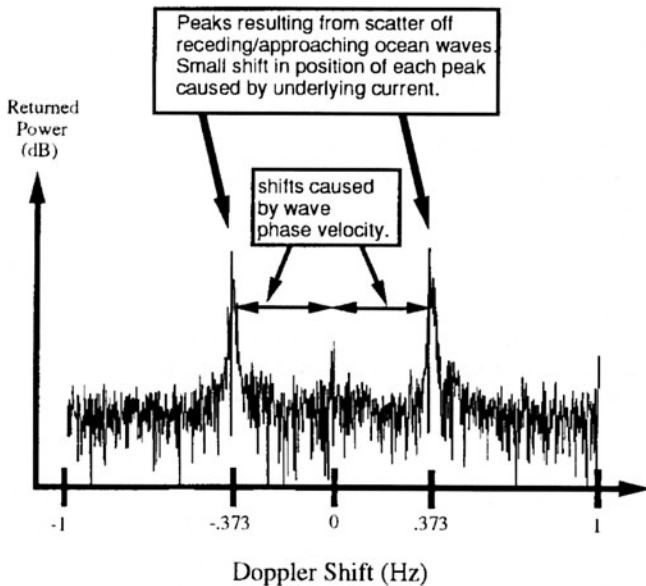


Figure 1.

Amplitude Spectrum of Ocean Surface Currents from 7/20/90 - 9/20/90

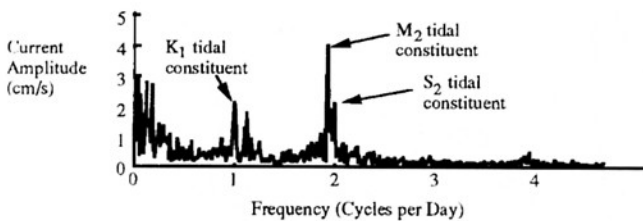


Figure 2.

Filtered and Unfiltered Ocean Current Data from 13 km, 227° from True North

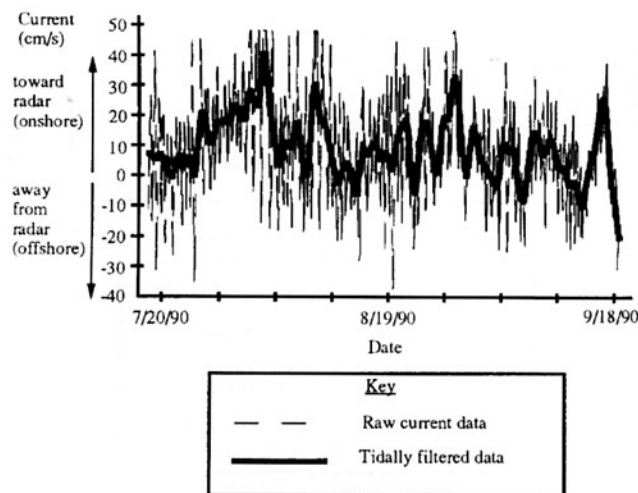


Figure 3.

Data Processing

In order to compute the radial ocean surface currents, it is necessary to form the frequency spectrum for data of each of the 8 receiving elements. I accomplished this using a complex fast-fourier transform on the real and quadrature data, of which 1024 samples were collected from each antenna during each data run. This procedure results in the dual peak spectrum discussed previously (Figure 1). The spectra from each antenna were then coherently added together after the phase was adjusted in order to steer the main beam direction and compensate for cable lengths. I decided to use the approaching Bragg peak of each angle's spectrum to estimate the currents for all the data presented, since it generally had a higher signal-to-noise ratio. The centroid of the upper peak was estimated (in Hz), and from it the stillwater Doppler shift was subtracted. The result, when scaled by half the radar wavelength, is the estimate of the surface current in the ocean patch ± 4 cm/s.

Tidal Identification Using Radar Current Measurements

For this study, I examined only data from 13.38 MHz since generally there was less interference at this frequency. My first step in the analysis of the actual ocean current data was to form a time series from this data at a given range bin and angle. I selected a range bin centered at about 13 km from shore and an angle 30° south of the radar broadside, or 227° from true North. This angle was selected because it is closest to alongshore and showed the strongest tidal components. Since data collected between July 20, 1990 and September 20, 1990 exhibited no gaps of more than 3 hours, I used this range of data for this analysis. A fast-fourier transform of the ocean current data from this time period exhibits many of the tidal constituents that were to be expected (Figure 2). In order better to estimate the strength and phase of each constituent, I fitted sinusoidal components of the known constituent frequency to the data and obtained the estimated strength of the constituents M_2 (5.4 cm/s), S_2 (2.9 cm/s), and K_1 (2.8 cm/s).

In a previous study of tidal currents in this region, the M_2 component was the only component whose currents were calculated using the Laplace Tidal Equations with friction included. Battisti and Clarke obtained alongshore components of about 2-8 cm/s (Battisti and Clarke, 1981). Therefore, my own measurements of the M_2 constituent are within the expected range.

Long Term Analysis

Tides, interesting as they are, complicate long-term observations in that they wipe out observations of slower variations, which may occur on scales of days or even weeks. In order to get a better picture of these slower variations, I low pass filtered the ocean current data to remove the high frequency tidal "noise." The filter chosen was the PL64, a symmetric, 128-point temporal filter developed by C. Flagg and R. Beardsley (Rosenfeld, personal communications). The resulting time series is a much smoother function (Figure 3).

Interpretation of long-term ocean circulation requires an understanding of the relationship between the driving force of the wind, the movement of coastal water, and the change in

Low Pass Filtered Radial Surface Currents and Sea Surface Temperature vs Time

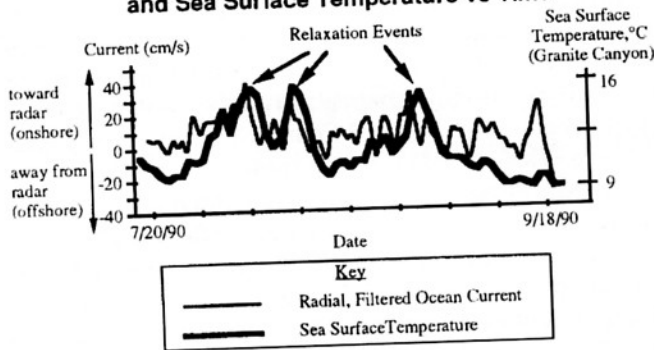


Figure 4.

the local sea surface temperature. In the Northern Hemisphere, a force such as the wind acting on a body of water in the open ocean produces a net flow 90° from the wind direction as a result of the Coriolis effect. Near a coastline, conservation of mass requires that cooler, subsurface water replace the coastal surface water when it is driven offshore by the wind/Coriolis forces. Along the California coast, this situation is called upwelling and it results when a strong northwest wind is blowing nearly parallel to the coast for a long enough time.

Additionally, near the coast, continuity requires some flow in the direction of the wind as well. The result is a net surface flow to the south southwest and a decrease in the temperature of the near coastal water during an upwelling event.

Observation of the filtered radial surface currents during the period of time from July 20, 1990 to September 20, 1990 illustrates excellent correlation between the magnitude and direction of the 227° directed current and the sea surface temperature measured at Granite Canyon (Figure 4). Whenever there is a large degree of offshore transport, the sea surface temperature is seen to decrease. The opposite effect is seen when the currents are predominantly shoreward and the sea surface temperature increases. This is termed relaxation.

The radar look direction may be steered $\pm 30^\circ$ from the radar broadside permitting a swath of observation from 227° to 287° from true North. Using measurements from five angles in this range and assuming a uniform, nondivergent flow in the radar swath region, I used least mean squares to estimate the strength and angle of a steady current at each range location. Since the residual for each fit is small, the assumption of a uniform current is satisfactory. The estimated uniform currents may be plotted in "stick figure" vector format, which provides a better idea of what is actually occurring in the local circulation pattern than do radial measurements alone.

Least Mean Square Fitted, Tidally Detrended Current Vectors, Winds*, and Sea Surface Temperature vs Time

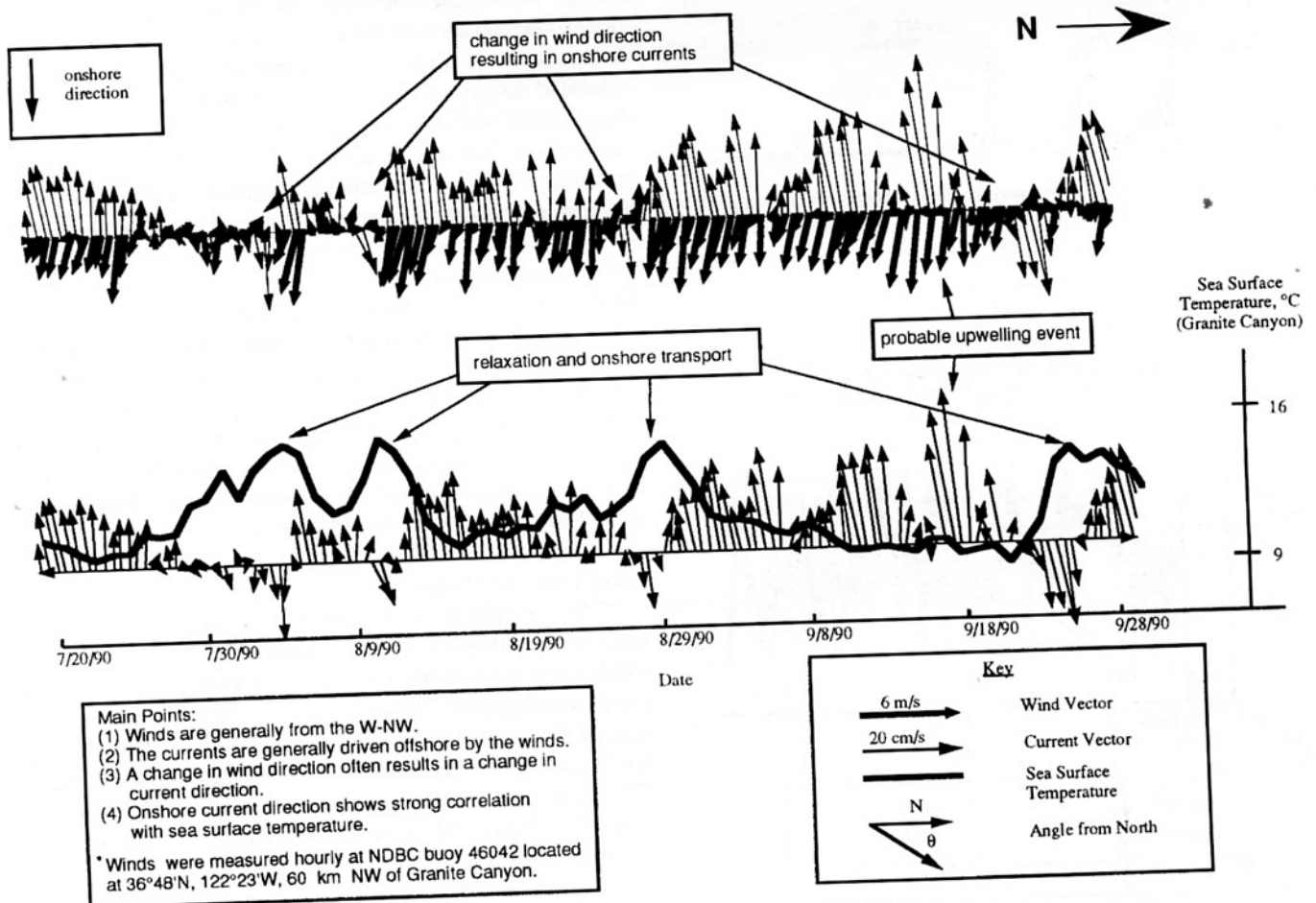


Figure 5.

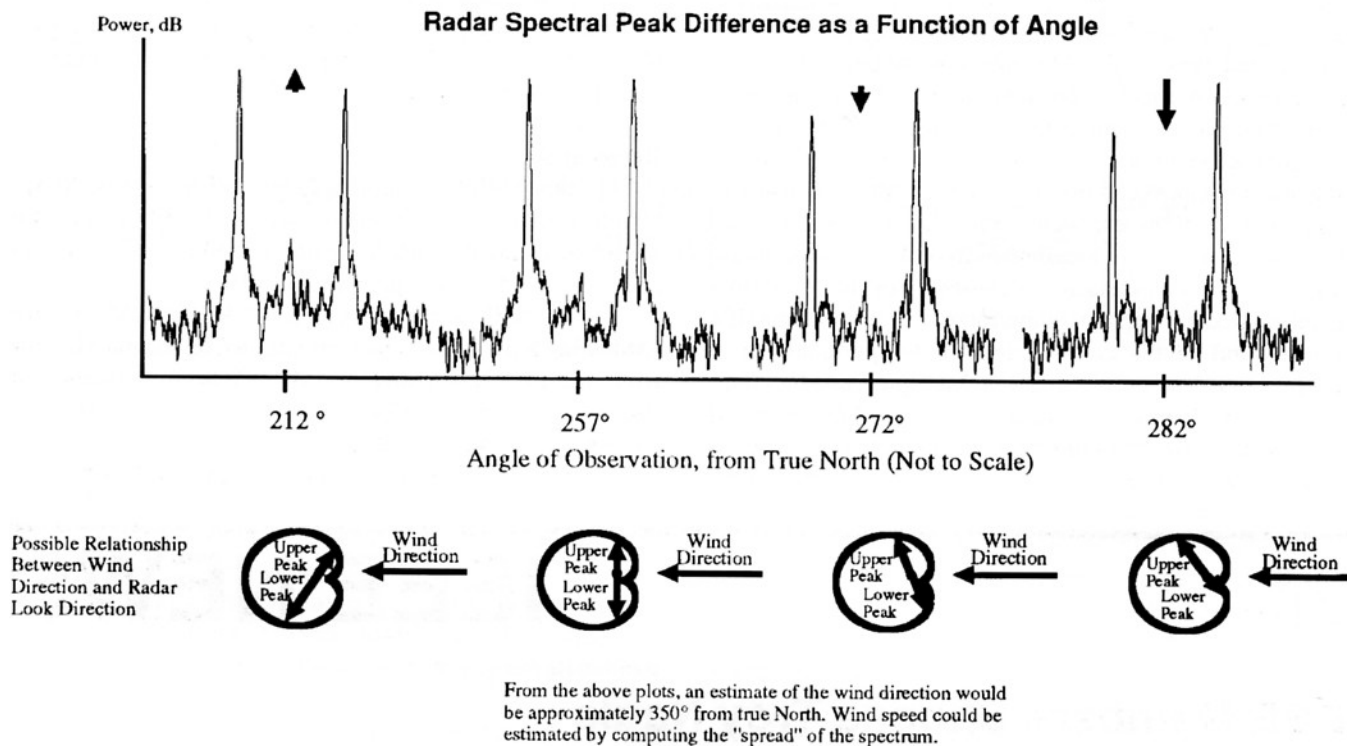


Figure 6.

I plotted the stick figure current vectors at 13 km range along with wind measurements made from buoy 46042, located 60 km to the northwest of Granite Canyon, and sea surface temperatures measured at Granite Canyon. Points of interest include the fact that the winds were generally blowing from the northwest during the entire time of observation (summer 1990). These winds generally forced currents offshore. However, during intervals in which the wind either let up or significantly changed direction, fitted current vectors became onshore or else northerly directed. Sea surface temperatures also generally followed the pattern of warming when the northwest wind component lessened in intensity and ocean currents became more onshore (Figure 5). These observations prove the radar system's facility in monitoring long term oceanic phenomena.

Radar-Inferred Wind Measurements

As mentioned earlier, in addition to measuring the ocean currents, high frequency radar has the capability of estimating the wind speed and direction. The ratio of the two Bragg peaks indicates the ratio of wave height of resonant waves traveling in two opposite directions. When this ratio is 1, or 0 dB, the waves traveling opposite to one another are of the same height and (assuming the wind has been blowing in a constant direction for several hours), the wind is blowing 90° from the radar look direction, regardless of wind speed. Using the Munk spectrum for wave distribution in the presence of a wind, given a Bragg peak ratio of 1, one may infer the wind direction with 180° ambiguity. This ambiguity is seen in skywave radio estimates of wind direction (Barnum et. al., 1977). It is resolved in our case because we measure the ratio of the peaks at 5 angles and can thus assume the wind to be blowing from the direction in which the approaching Bragg peak exceeds the

Angular Distribution of 11-Meter Ocean Wave Energy as a Function of Wind Speed and Angle from Wind Direction

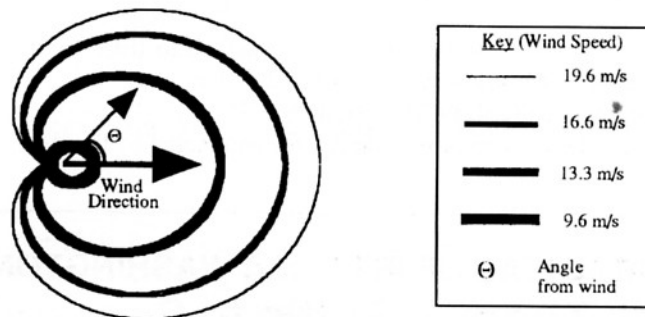


Figure 7.

receding Bragg peak (Figure 6). If the ratio between the peaks is not 1, then the Munk spectrum implies that a number of different wind directions or wind speeds could exist (assuming a saturated sea at the resonant ocean wavelength) (Figure 7). Thus, non-unity Bragg peak ratios are a function not only of wind direction, but of wind speed as well. However, given the wind direction, which may be found uniquely by using the point where the peak ratios are 1, the wind speed may then be roughly estimated by measuring the "spreading" of the peak ratios as a function of angle (in a stronger wind, the peak ratios vary less as a function of angle).

Conclusion

I have demonstrated that high frequency radar can be a very useful tool in coastal ocean remote sensing. Several important

results were revealed in this paper. The first is that radar-derived estimates of the M_2 tidal constituent's southwest (227°) ocean current component fall in the range predicted by theory. Additionally, radar data allows long-term observations of coastal ocean circulation if the higher frequency tidal constituents are removed. Low pass filtered radar estimates of ocean currents show excellent correlation with shore-based sea surface temperature measurements and buoy wind measurements. This correlation demonstrates the system's capability in detecting upwelling/relaxation phenomena. If a uniform wind field is assumed, high frequency radar can be used to estimate the wind direction. Multiple look directions in the region allow better estimates of the wind direction and eliminate the 180° ambiguity present in skywave radar estimates of the wind direction. Wind speed may also be es-

timated if a saturated sea and steady wind over the region observed are assumed for at least a period of several hours.

This research was supported by NASA.

References

- [1] Barnum, J. R., Maresca, J. W., and Serebreny, S. M., "High-Resolution mapping of oceanic wind fields with skywave radar," *IEEE Transactions on Antennas and Propagation*, AP-25, 1, pp. 128-132, 1977.
- [2] Battisti, D. S. and Clarke, A. J., "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M_2 Tide off the Atlantic and Pacific Coasts of the United States," *Journal of Physical Oceanography*, 12, 1, pp. 8-16, January, 1982.
- [3] Rosenfeld, personal communications, April, 1991.



IEEE NEWS

IEEE Members Choose Troy Nagle as 1993 President-Elect

NEW YORK, Nov. 9 — H. Troy Nagle, a professor of electrical and computer engineering at North Carolina State University in Raleigh, has been elected 1993 President-elect of The Institute of Electrical and Electronics Engineers, Inc. (IEEE). Nagle will assume the presidency of the IEEE on Jan. 1, 1994.

Of the 234,584 ballots that were mailed to IEEE voting members, 47,482 valid ballots (20.2%) were returned. This compares with 21.4% in 1991, and 20.7% in 1990.

Nagle was one of two candidates nominated by the IEEE

Board of Directors for the office of president-elect. The other was Edward C. Bertnolli, professor of electrical engineering at North Dakota State University in Fargo.

Of the 50,304 members who voted, 25,168 (50.03%) selected Nagle. Bertnolli received 24,700 votes (49.10%), while write-in candidates received 436 (0.87%).

Nagle, who joined the IEEE in 1966, was named an IEEE fellow in 1983. He served on the Board of Directors from 1987-90, and was Vice President - Technical Activities, 1989-90.

NEW HEAD OF IEEE-USA WASHINGTON OFFICE W. Thomas Suttle to Succeed Leo C. Fanning as Staff Director, Professional Activities

WASHINGTON, Nov. 6 — W. Thomas Suttle has been named staff director for professional activities of The Institute of Electrical and Electronics Engineers, Inc. (IEEE), effective January 1.

As staff director, Suttle will head the Washington, D.C., office of the world's largest technical professional organization. The IEEE has a worldwide membership of more than 320,000 electrical and electronics engineers and computer scientists. Its United States Activities' unit — IEEE-USA — is responsible for promoting the professional careers and technology policy interests of the 250,000 IEEE members who live and work in the United States.

Suttle succeeds Leo C. Fanning, who had held the post for the past 13 of his 17 years with the IEEE. Fanning, who is

retiring, was a school teacher and held technical education posts with the U.S. Agency for International Development and Westinghouse Learning Corporation. A former Peace Corps official, Fanning was executive director of the American Occupational Therapy Association before joining the IEEE in 1976.

Suttle is an honors graduate of The University of the South at Sewanee, Tenn., and holds a masters degree in international studies from The School of Advanced International Studies (SAIS) of The Johns Hopkins University. He served as an intelligence officer with the U.S. Air Force from 1971-73. Suttle joined the IEEE in 1977 and has held a variety of staff management positions. He is currently serving as associate staff director of professional activities.



Ask*IEEE, Comprehensive New Document Delivery Service, Offers Researchers Speed and Economy

NEW YORK, Nov. 16 — The Institute of Electrical and Electronics Engineers, Inc. (IEEE) has announced its entry into the document delivery business with a new service that will enable researchers from around the world to obtain scientific and technical articles rapidly via phone, fax, e-mail and online requests.

Specializing in electrotechnology and computer science information, but offering ready access to information of any kind, the new service, known as Ask*IEEE, is the first such venture by a leading primary publisher into document delivery. Starting Jan. 1, 1993, Ask*IEEE will provide journals, magazines and conference proceedings from all publishers on an article-by-article basis.

To assure the fastest and most efficient service, the IEEE has joined forces with Dynamic Information Corp. of Burlingame, Cal., a pioneer in the document delivery business. The IEEE has established a toll-free telephone number, 1-800-949-IEEE (or 415-259-5040 for callers from outside the U.S. and Canada) which links customers directly with Ask*IEEE.

Due to the IEEE's immense core collection, Ask*IEEE will offer several key benefits, according to Phyllis Hall, IEEE Director of Publishing Services. "Compared to other docu-

ment delivery services, we aim to be faster, less expensive and more comprehensive," she said. "Ask*IEEE will offer wider coverage than data base-specific collections."

Hall noted that Ask*IEEE provides researchers with one-stop shopping. One invoice and a simple price will cover all fees, including copyrights. "All a customer has to do is pick up the telephone anywhere in the world — or contact us via the Internet or Dialog's DialOrder or other e-mail systems — and have his or her credit card handy."

The IEEE accounts for an estimated one-quarter of the world's published literature in computing, electronics and electrical engineering. The Institute holds more than 300 technical conferences around the world each year, and with more than 320,000 members in approximately 150 countries, is the world's largest technical society.

Rates for articles from the IEEE collection are \$10 for IEEE members, and \$12 for others. Orders for IEEE items received by noon Pacific time are shipped the same day at no added cost. Articles from the non-IEEE collections will cost slightly more. Delivery will be made by any method a customer chooses: fax, e-mail via Ariel fax, overnight express, or U.S. Postal Service. Rush service is available for an extra charge.

IEEE-USA Seeks Award Nominations for Technology Journalism Efforts

WASHINGTON, Nov. 13 — Nominations are being solicited to recognize outstanding journalistic efforts that contribute to the enhancement and expansion of public understanding of the engineering profession.

Entries may be either a single printed article or broadcast or a series of presentations that appeared during 1992. All efforts will be judged on their individual quality in portraying subjects, themes or incidents leading to a better public understanding of how engineering professionals are adding to the nation's social, economic and cultural life.

Winning journalists will be honored by the United States Activities' unit of The Institute of Electrical and Electronics Engineers, Inc. (IEEE-USA).

The IEEE is the world's largest technical professional society, with a worldwide membership of more than 320,000 electrical and electronics engineers and computer scientists. IEEE-USA is responsible for promoting the professional careers and technology policy interests of the 250,000 IEEE members who live and work in the United States.

One or more awards will be given by the United States

Activities Board of the IEEE for distinguished literary contributions furthering public understanding of the profession. Nominations can be submitted by any U.S. member of the IEEE or by the publisher, author, radio or television station responsible for the effort.

The nomination must include: complete identification of the print or broadcast piece, with place and date of publication or location and time presented; and a 300-500 word summary of the entry and why it meets the objectives in an outstanding way. In addition, a copy of the printed articles or tapes or transcripts must be included for use by the judging panel.

Nominations and supporting materials should be sent to: Awards and Recognition Committee, IEEE-USA, 1828 L Street, N.W., Washington, DC 20036. Entry deadline is March 30, 1993.

Further information concerning the award for literary contributions can be obtained from William R. Anderson in the IEEE-USA Office: telephone, 202-785-0017; fax, 202-785-0835.

LEGISLATIVE ALERT – IEEE-USA

Support The Private Pension Reform Act! Write to Your U. S. Senators in Washington Today

At a time when *some members of Congress are calling for another study* of the nation's private pension system and the creation of another national Commission to make recommendations for increasing the level and security of private retirement savings, *others have already introduced legislation* that will substantially improve the effectiveness and reliability of private pensions as a source of retirement income for our increasingly mobile American workforce.

In 1991 Representative Sam Gibbons (DEL), the ranking Democrat on the powerful House Ways & Means Committee, introduced *The Pension Coverage and Portability Improvement Act* (H.A. 2390). This bill, which has been referred jointly to the Ways & Means and Education and Labor Committees, enjoys bipartisan support in the House of Representatives. Among its current cosponsors are George Brown (D-CA), Phil Crane (R-IL), Bill Hughes (D-NJ), Marcy Kaptur (D-OH) and James Walsh (R-NY).

And earlier this month, Senators Brook Adams (D-WA) and Howard M. Metzenbaum (D-OH) introduced similar legislation in the United States Senate. S. 3184, *The Private Pension Reform Act - Retirement 2000* includes provisions that will improve pension portability from traditional defined benefit plans and set the stage for a five year transition to a comprehensive minimum benefit pension system. Like H.R. 2390, S. 3184 is based on retirement income policy recommendations developed by IEEE-USA and is designed to increase savings for retirement and to expand the pool of capital available for productive investment in our nation's economy.

Read on for *more information* on this important legislation and *how you can help* to ensure that it gets the attention it deserves from your own United States Senators.

HIGHLIGHTS OF S.3184 - THE PRIVATE PENSION REFORM ACT - RETIREMENT 2000

Sponsored by Senators Brook Adams (D-WA) and Howard M. Metzenbaum (D-OH)

Purposes: To improve the portability of earned pension benefits when workers change jobs, expand pension coverage and provide for a transition to a comprehensive, minimum benefit pension system in order to ensure individual economic security in retirement and increase savings for productive investment in the nation's economy.

Portable Pension Plans: Title I will enable terminating employees to transfer earned pension benefits to portable pension plans or to rollover IRAs upon separation from service.

- Qualified plans will be required and individuals will be permitted to establish and maintain portable plans that can accept transfers from other qualified plans.
- Portability will be accomplished at the election of terminating employees by means of direct trustee to trustee transfers of earned benefits from qualified plans to portable plans.
- Portable plans must offer a range of choices among investment options and permit beneficiaries to control the disposition of the accumulated assets in their accounts.

- Portable plans must provide for distributions to retirees or their beneficiaries in standard stream of payments forms and must ensure spousal protections with respect to benefit distributions.

Minimum Benefit Pension System: Title II provides for an incremental transition to a minimum benefit pension system under which private employers will be required to establish and maintain pension plans that meet minimum contribution and benefit accrual requirements.

- After one year of service, all employees will earn a vested right to a pension benefit.
- When Title II is fully phased in, all employers will be expected to contribute a minimum of 3 percent of each employee's compensation to a defined contribution plan or the amount needed to produce an equivalent benefit in a defined benefit plan.
- The integration of earned pension benefits with Social Security benefits will be prohibited.
- The transition from the existing voluntary private pension system to the comprehensive, minimum benefit system will begin years and be completed 7 years from enactment of this legislation.

YOUR SENATORS NEED TO HEAR FROM YOU ABOUT THIS IMPORTANT NEW BILL

Concerned engineers and scientists should communicate their support for The Private Pension

Reform Act - Retirement 2000 proposal to their own Senators in Washington at once.

SUGGESTED LETTER OF SUPPORT FOR S.3184

Senator _____
United States Senate
Washington, DC 20510

Dear Senator _____

I am writing as a constituent and a member of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) to call your attention to a bill that offers practical solutions to problems that currently limit the effectiveness of private pensions as a reliable source of retirement income for increasingly mobile American workers.

The Private Pension Reform Act - Retirement 2000 (S. 3184), sponsored by Senators Brock Adams and Howard M. Metzenbaum, includes provisions that will ensure greater retirement security for individual Americans and, at the same time, substantially increase the pool of private savings needed for productive investment in the nation's economy.

Title I of S. 3184 will improve pension portability by permitting vested employees who change or lose

their jobs to transfer their earned benefits to rollover IRAs or to other portable plans upon separation from service.

Title II of the bill provides for an incremental transition to a comprehensive minimum benefit pension system. Such a system will substantially increase coverage, reduce vesting requirements and establish the kinds of benefit accrual and contribution standards needed to ensure that plan participants receive an adequate benefit when they retire.

I urge you to support this important legislative proposal.

Sincerely,

Your Name and Address

Inquiries about S. 3184 as well as copies of your correspondence with your Senators should be directed to Vin O'Neill in IEEE-USA's Washington Office, 1828 L Street NW, Suite 1202, Washington, DC 20036 (202/785-0017).

United States Senators — 102nd Congress — 1991-1992

ALABAMA

Howell Heflin (D)
Richard C. Shelby (D)

ALASKA

Ted Stevens (R)
Frank H. Murkowski (R)

ARIZONA

Dennis DeConcini (D)
John McCain (R)

ARKANSAS

Dale Bumpers (D)
David Pryor (D)

CALIFORNIA

Alan Cranston (D)
John Seymour (R)

COLORADO

Tim Wirth (D)
Hank Brown (R)

CONNECTICUT

Christopher J. Dodd (D)
Joseph I. Lieberman (D)

DELAWARE

William V. Roth Jr. (R)
Joseph R. Biden Jr. (D)

FLORIDA

Bob Graham (D)
Connie Mack (R)

GEORGIA

Sam Nunn (D)
Wyche Fowler Jr. (D)

HAWAII

Daniel K. Inouye (D)
Daniel K. Akaka (D)

IDAHO

Steve Symms (R)
Larry E. Craig (R)

ILLINOIS

Alan J. Dixon (D)
Paul Simon (D)

INDIANA

Richard G. Lugar (R)
Daniel R. Coats (R)

IOWA

Charles E. Grassley (R)
Tom Harkin (D)

KANSAS

Bob Dole (R)
Nancy Landon Kassebaum (R)

KENTUCKY

Wendell H. Ford (D)
Mitch McConnell (R)

LOUISIANA

J. Bennett Johnston (D)
John B. Breaux (D)

MAINE

William S. Cohen (R)
George J. Mitchell (D)

MARYLAND

Paul S. Sarbanes (D)
Barbara A. Mikulski (D)

MASSACHUSETTS

Edward M. Kennedy (D)
John Kerry (D)

MICHIGAN

Donald W. Riegle Jr. (D)
Carl Levin (D)

MINNESOTA

Dave Durenberger (R)
Paul Wellstone (D)

MISSISSIPPI

Thad Cochran (R)
Trent Lott (R)

MISSOURI

John C. Danforth (R)
Christopher S. Bond (R)

MONTANA

Max Baucus (D)
Conrad Burns (R)

NEBRASKA

Jim Exon (D)
Bob Kerrey (D)

NEVADA

Harry Reid (D)
Richard H. Bryan (D)

NEW HAMPSHIRE

Warren B. Rudman (R)
Robert C. Smith (R)

NEW JERSEY

Bill Bradley (D)
Frank R. Lautenberg (D)

NEW MEXICO

Pete V. Domenici (R)
Jeff Bingaman (D)

NEW YORK

Daniel Patrick Moynihan (D)
Alfonse M. D'Amato (R)

NORTH CAROLINA

Jesse Helms (R)
Terry Sanford (D)

NORTH DAKOTA

Quentin N. Burdick (D)
Kent Conrad (D)

OHIO

John Glenn (D)
Howard M. Metzenbaum (D)

OKLAHOMA

David L. Boren (D)
Don Nickles (R)

OREGON

Mark O. Hatfield (R)
Bob Packwood (R)

PENNSYLVANIA

Arlen Specter (R)
Harris L. Wofford Jr. (D)

RHODE ISLAND

Clairborne Pell (D)
John H. Chafee (R)

SOUTH CAROLINA

Strom Thurmond (R)
Ernest F. Hollings (D)

SOUTH DAKOTA

Larry Pressler (R)
Tom Daschle (D)

TENNESSEE

Jim Sasser (D)
Al Gore (D)

TEXAS

Lloyd Bentsen (D)
Phil Gramm (R)

UTAH

Jake Garn (R)
Orrin G. Hatch (R)

VERMONT

Patrick J. Leahy (D)
James M. Jeffords (R)

VIRGINIA

John W. Warner (R)
Charles S. Robb (D)

WASHINGTON

Brock Adams (D)
Slade Gorton (R)

WEST VIRGINIA

Robert C. Byrd (D)
John D. Rockefeller IV (D)

WISCONSIN

Bob Kasten (R)
Herb Kohl (D)

WYOMING

Malcolm Wallop (R)
Alan K. Simpson (R)

Highlights from the TAB Administration Council Meeting

October 3, 1992

The second meeting of the 1992 TAB Administration Council (TABAC) was held on October 3, 1992 at The Conrad Hilton Hotel, Cancun, Mexico. The following actions were taken:

TAB Entitlement. In consonance with the action taken by TAB during its August, 1992 meeting to change the method used to calculate TAB's entitlement by replacing the 10.3% of member dues with a per member allocation, TABAC endorsed proposed revisions to IEEE Bylaw 310.2(3)(e), reflecting this

change, for recommendation of approval by the IEEE Board of Directors.

Intersocietal Committees. Since under the new TAB structure intersocietal publications are monitored by the TAB Periodicals Council, TABAC opposed the proposed assignment of newly formed Intersocietal Publications Committees to Divisions. The TAB Secretary was directed to prepare a Motion to TAB requesting that the concept of Intersocietal Committee assignments to Divisions be dissolved and that such Committees be assigned to the TAB Periodicals Council.

Technical Meetings As requested by the TAB Technical Meetings Council, TABAC agreed with a recommended policy change requiring that IEEE members pay no more than the sponsoring organization's members at meetings in which IEEE is a Technical Co-Sponsor or Cooperating entity. However, before proceeding further with IEEE policy revisions, the TAB Technical Meetings Council was requested to look further into its proposal regarding the acquisition terms for purchasing conference proceedings from meetings in which IEEE is a Technical Co-Sponsor.

Assistance to Scientists and Engineers in the former Soviet Union. Further to TAB's action encouraging societies to take steps to create specific mechanisms for assisting scientists and engineers in the former Soviet Union and Eastern Europe, TABAC passed a resolution recommending to the IEEE Executive Committee that IEEE work with the National Science Foundation (NSF) to help them formulate a plan to support engineers and scientists in the republics of the former Soviet Union. Further, that the IEEE Executive Committee consider having IEEE take a lead role in the plan.

1993 Strategic and Operating Plan. TABAC endorsed, and recommended to TAB, a 1993 TAB Strategic and Operating Plan consisting of seven (7) objectives and fifteen (15) goals.

Proposed Addition to IEEE Policy Statement 15.3 — Preparation of Entity Position Statements. In an effort to avoid having Entity Position Statements misconstrued as IEEE positions or positions of other IEEE entities, TABAC endorsed a proposed addition to IEEE Policy Statement 15.3 governing the preparation of entity position statements for recommendation of approval by the IEEE Board of Directors. This addition will require clear identification of the issuing entity throughout the position statement.

Proposed Revisions to IEEE Policy Statement 15.8 — Testimony Before Government Bodies. To provide a similar review process for written testimony, which can eventually become a Technology Policy Statement, as that which exists for entity position statements, TABAC endorsed the concept of modifying IEEE Policy Statement 15.8 governing testimony before government bodies. The TAB representatives on the joint TAB/USAB Ad Hoc Committee addressing this issue were asked to bring to the next TAB meeting a new proposal that preserves the approval process outlined in current IEEE Policy Statement 15.8.B, while adding the restrictions requested by the TAB representatives.

Document Delivery Initiative. TABAC endorsed a document delivery initiative "Ask IEEE," as presented by the Vice President-Publication Activities, that will enable researchers and IEEE members from around the world to obtain scientific and technical articles rapidly via telephone, fax, e-mail and on-line request.

Important Dates

Next Technical Activities Board Meeting. The Technical Activities Board will hold its next meeting in Phoenix, Arizona on December 4, 1992.

TAB Administration Council Retreat. A TAB Administration Council retreat will be held in the Piscataway, New Jersey area January 16-17, 1993.

"Celebrate National Engineers Week, February 14-20, 1993"

February 14-20 is set aside to honor American engineers and encourage young men and women to join us in the exciting tasks of finding solutions to today's technical challenges.

Please join us in this important effort by volunteering to give a Discover "E" presentation on engineering to a science or math class at a local school. Contact your engineering society chapter or headquarters to find out how you can help encourage the engineers of tomorrow.

Kenneth T. Derr
Chairman and CEO,
Chevron Corporation
Honorary Chairman,
National Engineers Week

Martha Sloan
1993 President,
The Institute of Electrical and
Electronics Engineers, Inc.
Chair,
National Engineers Week



ENGINEERS
Turning Ideas
into Reality.

IEEE USA HOT LINES

IEEE-USA Office, 1828 L Street, N.W., Suite 1202, Washington, DC 20036-5104, USA (202) 785-0017

IEEE-USA telephone hotline recording: (202) 785-2180

James A. Watson, Editor—Georgia C. Stelluto, Associate Editor

USAB Approves Position Statements

IEEE's United States Activities Board has approved these position statements during meetings this year. Copies are available from the IEEE-USA Office in Washington, D.C.

● **A Focus for Biomedical Engineering at the National Institutes of Health**—IEEE-USA and its Health Care Engineering Policy Committee recommend the establishment of a permanent organization at the National Institutes of Health (NIH) to act as a focus for biomedical engineering. The purpose of such an action is to assist NIH in planning initiatives and coordinating extramural and intramural activities related to basic and applied biomedical engineering research. Such research is intended to yield better understanding of biological systems, foster medical device improvement and innovation, promote technology transfer, advance the efficient application of technology to health care, and contribute to the process of health care cost containment.

● **Human Exposure to Radio-Frequency Fields From Police Radars**—Recognizing public concern about the safety of exposure to electromagnetic fields, IEEE-USA, in conjunction with the American National Standards Institute, has published guidelines for the safe limits of exposure to microwaves to protect human beings from harmful exposure to radio-frequency and electromagnetic fields. IEEE-USA's Committee on Man and Radiation (COMAR) has stated that prolonged exposure at or below the levels recommended is not hazardous to human health, based on present knowledge. COMAR has concluded that microwave exposure near police radar is safe by existing standards and that there is no scientific basis for the alleged link of police radar with cancer.

● **Health Aspects of Exposure to Electric and Magnetic Fields from RF Sealers and Dielectric Heaters**—Radio-frequency (RF) dielectric heaters are used in industry for a variety of heating applications. For many of those in operation, leakage of electric and magnetic fields in excess of all existing RF safety guidelines have been measured, causing concern about the safety of such devices. IEEE-USA and COMAR recommend that RF sealer manufacturers install adequate shielding on their equipment; that the nature of RFEM fields and induced body currents be documented; that RF owners perform periodic monitoring to determine whether an exposure problem exists, and that appropriate health and safety agencies call attention to this occupational exposure and require adequate monitoring of RFEM devices.

● **Human Exposure to RF Emissions from Cellular Radio Base Station Antennas**—IEEE-USA recognizes the public's safety concern for microwave exposure from cellular communications base stations. Prolonged exposure at or below the published recommended levels is considered safe for human health and the general

population, based on present knowledge. However, COMAR recommends that in circumstances where workers could be exposed to fields greater than the standards specify, access can and should be restricted.

● **The Safety of Electromagnetic Pulse Simulators**—Members of IEEE-USA's COMAR and experts in engineering and biological issues associated with EMP fields have evaluated the engineering, physics, and biomedical literature on EM fields. Based on an analysis of all available information, COMAR found it highly unlikely that any detrimental effects on human health or the environment will result from chronic exposures to EMP simulator fields. IEEE-USA believes that conforming with established exposure limits will adequately protect workers at EMP simulator sites, the surrounding communities, and the environment.

Office of Government Ethics Removes Section Affecting Professional Associations in Final Rule

As a result of IEEE-USA's and other professional associations' efforts, the Office of Government Ethics (OGE) has decided not to publish a section on "Participation in Professional Associations" in its final ethics rule. The section would have a devastating effect on Federal employees' participation in professional associations, effectively stifling participation of U.S. members in IEEE's technical, regional, and professional activities, if those members happened to be employed by the Federal Government.

After asking OGE to clarify the section's ambiguous language, IEEE-USA participated in meetings of the American Society of Association Executives' (ASAE) Special Task Force on Government Ethics Rules and co-signed a response to OGE drafted by ASAE representing the professional association community. Each Federal agency will be allowed to continue to make its own decision on authorizing its employees' participation in professional association activities.

IEEE Workshop Examines Global Integration Challenges

What is the impact on U.S. economic competitiveness of such changes in global markets as the pending economic integration of the European Community, the proposed North American Free Trade Zone, the collapse of communism in Eastern Europe, and the continued growth of the Pacific Rim economies? The engineering community examined this question at a Global Integration Workshop hosted by IEEE's Technology Policy Conference Committee in conjunction with the Annual Government Affairs Conference of the American Association of Engineering Societies.

A Workshop Report will be available soon.

IEEE USA HOT LINES

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IEEE-USA telephone hotline recording: (202) 785-2180

James A. Watson, Editor—Georgia C. Stelluto, Associate Editor

Committee Member Challenges Alleged Radar-Cancer Link During TV Interview

Police radar does not pose a cancer threat, according to Eleanor R. Adair, Vice Chair of IEEE-USA's Committee on Man and Radiation (COMAR). In an interview broadcast on *60 Minutes*, Adair told correspondent Morley Safer that there is no scientific evidence that exposure to police radar causes cancer.

Police officers have alleged that exposure to radio frequency fields from radar guns they used in the line of duty caused them cataracts and cancers. COMAR members, however, have pointed out that radar guns release less electromagnetic radiation than alarm clocks. "The units are safe, even when operated at the maximum exposure levels," Adair said.

In addition, at an August 10 Senate hearing on the subject, IEEE Standards Board member L. John Rankine called for "continuing research on biomedical effects across the entire frequency spectrum." Further information is available from the IEEE-USA Office in Washington, D.C.

IEEE-USA Pensions Committee Focuses on Future Initiatives

In addition to its efforts on pension portability, IEEE-USA's Pensions Committee is also backing several other legislative proposals on issues that directly affect the retirement income security of many IEEE members and other mobile professionals. The Committee is supporting H.R. 431, H.R. 1531, and S. 194, the *Pension Tax Equity Act of 1991*. This legislation would prohibit states from taxing the pension earnings of former residents.

Further, the Committee is monitoring H.R. 917 and S. 567, the *Social Security Notch Adjustment Act of 1991*, which would correct inequities in Social Security benefits earned by "Notch Babies" born between 1916 and 1921. The *Older Americans' Freedom to Work Act of 1991*, H.R. 967 and S. 194, bills proposing to amend or repeal current earnings tests that limit how much money retirees can earn without having their Social Security benefits reduced, are also being studied.

Intellectual Property Committee Chairman Testifies on Copyright Protection for Software

IEEE-USA Intellectual Property Committee Chairman David M. Ostfeld testified on behalf of IEEE-USA and the American Association of Engineering Societies on software copyright protection before the House Subcommittee on Intellectual Property and the House Judicial Administration Committee. IEEE-USA supported the *Technology Transfer Improvements Act*, H.R. 191,

which would allow Federal agencies to secure copyrights for computer software prepared in whole or in part by U.S. Government employees, while working under a cooperative research and development agreement (CRADA).

IEEE-USA believes that without intellectual property protection for computer software, the private sector has less incentive to enter into a CRADA, and the United States risks losing valuable software technology to foreign nations. H.R. 191 will enhance U.S. competitiveness and reward both Federal Government inventors and computer software authors.

IEEE-USA Honored for International PR Excellence

IEEE United States Activities public relations and advertising campaign, in support of maintaining competitive commercial technologies, recently received high honors from the International Public Relations Association (IPRA). IEEE-USA won a Golden World trophy in the competition's institutional programs category for its entry "Swords into Plowshares: Technology's Unfinished Agenda."

IEEE Public Relations Manager Pender M. McCarter accepted the recognition on behalf of IEEE-USA at the IPRA Professional Development Conference held in Hong Kong. More than 100 companies, PR firms, and associations in 17 countries entered the competition.

Ethics Committee Releases New Guide

IEEE-USA's Ethics Committee has released a comprehensive speakers' guide to engineering ethics presentation, entitled *How To Be A Good Engineer*. The guide can be adapted easily to fit the needs of different audiences, including student lectures.

An outline of the lecture, which is keyed to projector visuals and includes slides of IEEE's Code of Ethics, comes with this speaker's guide. Comments and suggestions, scenarios suitable for discussion, role-playing exercises, a brief annotated bibliography, and a listing of resources are also included.

If you would like to use this slide-illustrated lecture or would like more information, contact Scott Grayson at the IEEE-USA Office in Washington, D.C.

Further information about IEEE-USA, engineering career and technology policy issues, and copies of testimony, IEEE-USA Position Statements, and complimentary publications are available from the IEEE-USA Office. Write or phone IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036-5104; (202) 785-0017.

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James A. Watson, Editor—Georgia C. Stelluto, Associate Editor

Presidential Candidates Respond to IEEE-USA's 10 Technology and Competitiveness Questions

Democratic Presidential nominee Governor Bill Clinton provided IEEE with a two-page statement outlining his position on national technology policy and competitiveness. Responding to IEEE-USA's challenge to the candidates to address U.S. members' concerns on these and other issues, Clinton pledged support for a Federal agency to fund research in promising new domestic technologies; comprehensive Government planning to direct defense contractors in peace-time pursuits; a high-speed rail network connecting U.S. cities; a door-to-door fiber optics system linking all U.S. homes, labs, classrooms, and businesses by the year 2015; and improved educational training supporting a skilled work force, including a national testing system in elementary and secondary schools and a nationwide apprenticeship program.

President Bush responded shortly before the Republican National Convention. In a detailed response, he renewed his opposition to industrial policy and called for incentives to reward risk-takers. He advocates an economic growth package to promote global competitiveness for U.S. products. The President told IEEE-USA he will continue his efforts to promote competitiveness with sound trade and tax policies; to eliminate rules and regulations that he said unnecessarily burden American businesses; and to revitalize the nation's manufacturing base and create jobs.

IEEE-USA To Continue Pension Reform Efforts

IEEE's United States Activities Board will renew its efforts to improve the nation's private pension system when the new 103rd Congress convenes in January. Whether these efforts will be limited to support for legislation to improve the portability of benefits when workers change jobs or address more comprehensive reforms directed at coverage, vesting, portability, and the preservation, adequacy, and security of earned benefits has not yet been determined. IEEE-USA's legislative strategy will depend, in part, upon the outcome of the Presidential elections, the composition of the new Congress, and the willingness of engineering and other national organizations to support IEEE-USA's pension policy initiatives actively.

During the 102nd Congress, IEEE-USA was successful in promoting the introduction and active consideration of comprehensive pension reform proposals in the House of Representatives and the Senate. H.R. 2390, the *Pension Coverage and Portability Improvement Act*, introduced in 1991 by Congressman Sam Gibbons (D-Florida), and S. 3184, the *Private Pension Reform Act*, sponsored by Senators Brock Adams (D-Washington) and Howard Metzenbaum (D-Ohio) in 1992, called for substantial improvements in portability from traditional

defined-benefit plans. Both bills also provided for a 5-year transition to a comprehensive minimum benefit pension system. These proposals are designed to increase individual retirement security and expand the pool of private savings available for investment in the nation's economy.

For more information on how you can help to promote the enactment of needed pension reforms when the new Congress convenes in January, call or write the IEEE-USA Office in Washington, D.C.

Staff Director of Professional Activities to Retire

Leo C. Fanning, Staff Director of professional activities at the IEEE-USA Office in Washington, D.C., for more than 13 years, has announced his retirement on December 31. With the office for 17 years, Fanning has played a critical role in the organization and growth of IEEE's United States Activities Board, which was started only three years before he joined IEEE.

In his early career, Fanning helped organize the U.S. Peace Corps program in Latin America. From 1957 to 1967, his work for the Peace Corps and the U.S. Agency for International Development spanned every country in Latin America, except Chile and Paraguay. Fanning has also taught at Arizona State University and in the Arizona public school system. He helped establish the Health Services Division of Westinghouse Learning Corporation in Washington, D.C.

USAB Chairman Arvid G. Larson said that Fanning has been a guiding light and inspiration to all volunteers involved in IEEE's professional activities. "He has been able to bridge the difficulties faced by a professional organization like IEEE in dealing with the real world of Washington, D.C.," he said.

Technology Policy Council Examines Impacts of Defense Budget Cuts

IEEE-USA's Technology Policy Council (TPC) hosted its 1992 symposium, *Coping With Defense Budget Restructuring*, on September 15-16 in Washington, D.C. TPC Council and Committee members, USAB leaders, and government policymakers examined key technology policy, related implications of upcoming defense budget cuts, and outlined possible IEEE-USA roles and responses.

The program's two keynote speakers, Mark A. Forman, Defense Economist for the Republican staff of the Joint Economic Committee of the United States Congress, and Victor H. Reis, Director, Defense and Engineering, and three panel sessions addressed "The Problem—A Look at What is Happening to the Defense Budget and a Prediction of the Consequences for R&D, Industry, and Engineering"; "Reactions and Responses—Creating new Opportunities for Engineering in the United States"; and "An IEEE-USA Agenda—Prospective Roles of IEEE-USA in Promoting Engineering Opportunity in the New Budget Environment."



**The Institute of Electrical and Electronics
Engineers, Inc.
United States Activities**

*Announces the 21st Annual Competition for
1993-1994*

IEEE-USA Congressional Fellowships

PROGRAM: Electrical and Electronics Engineers and Allied Scientists are competitively selected to serve a one-year term on the personal staff of individual Senators or Representatives or on the professional staff of Congressional Committees. The program includes an orientation session with other Science-Engineering Fellows, sponsored by the American Association for the Advancement of Science (AAAS).

PURPOSE: To make practical contributions to more effective use of scientific and technical knowledge in government, to educate the scientific communities regarding the public policy process, and to broaden the perspective of both the scientific and governmental communities regarding the value of such science-government interaction.

CRITERIA: Fellows shall be selected based on technical competence, on ability to serve in a public environment, and on evidence of service to the Institute and the profession. Specifically *excluded* as selection criteria are age, sex, creed, race, ethnic background, and partisan political affiliations. However, the Fellow must be a U.S. citizen at the time of selection and must have been in the IEEE at Member grade or higher for at least four years. Additional criteria may be established by the selection committee.

AWARDS: IEEE-USA plans to award at least two Congressional Fellowships for the 1993-1994 term. Additional funding sources may permit expansion of awards.

APPLICATION: Further information and application forms can be obtained by calling W. Thomas Suttle (202) 785-0017 at the IEEE-USA Office in Washington, D.C. or by writing:

**Secretary, Congressional Fellows Program
The Institute of Electrical and Electronics Engineers, Inc.
1828 L Street, N.W.
Washington, D.C. 20036**

Applications must be postmarked no later than March 31, 1993 to be eligible for consideration.

"Underwater '92" Seminar Held in Singapore

An overview of ocean-related activities in Singapore was provided at "Underwater '92: Technology and Opportunities," which was held 26 and 27 June, 1992 at the Ngee Ann Polytechnic in Singapore. The seminar was organized by the Department of Shipbuilding and Offshore Engineering at Ngee Ann, in collaboration with the Oceanic Engineering Society Special Interest Group of the Institute of Electrical and Electronic Engineers (IEEE) Singapore, and the Professional Association of Diving Instructors (PADI). The purpose of the meeting was to highlight the business, educational, and recreational opportunities related to the oceans around Singapore.

"Underwater '92," which had an attendance of around 200 ocean professionals and interested students, featured eleven speakers who covered topics ranging from satellite monitoring of coral reefs to underwater inspection of offshore pipelines; from atmospheric diving suits to the Global Positioning System.

Poolside demonstrations included a remotely operated vehicle, a transponder, and the latest in recreational diving gear. Audience participation took the form of the PAD "Discover SCUBA Experience." A small exhibit area hosted seven organizations.

Exhibitors and speakers represented the offshore oil industry, the Republic of Singapore Navy, environmental consulting firms, the National University of Singapore, the commercial and recreational diving fields, and shipbuilders, as well as manufacturers and sales representatives of ocean-related equipment.

Feedback from participants indicates enough interest to consider an "Underwater '93" seminar.

For further information contact:

Mr. M.K. Das Gupta, Head
Dept. of Shipbuilding and Offshore
Eng.
Ngee Ann Polytechnic
535 Clementi Road
Singapore 2159
Telephone: (65) 460-6528
FAX: (65) 462-0910

Nancy Penrose
Penrose Associates
7 Pandan Valley, #15-504
Singapore 2159
Tel & FAX: (65) 467-6552

**"STIRRED MY IMAGINATION...
ENHANCED PRODUCTIVITY"**

**"...THE PAPERS AND THE EXHIBITION KEEP ME
CURRENT ON INDUSTRY TECHNOLOGY."**

**"MEETING WITH ENGINEERS FROM
ALL OVER THE WORLD HAS EXPANDED
MY KNOWLEDGE AND AWARENESS..."**

These are typical of the comments made by those attending the Offshore Technology Conference in past years.

The 1993 OTC, May 3-6 in Houston, again will be the unequalled resource of information and contacts for offshore and related industry professionals.

Celebrating its 25th year, OTC will attract some 35,000 engineers, managers, scientists, technicians and other offshore industry professionals from around the world who will:

- See offshore products and service developments offered by more than 1,250 exhibiting companies.
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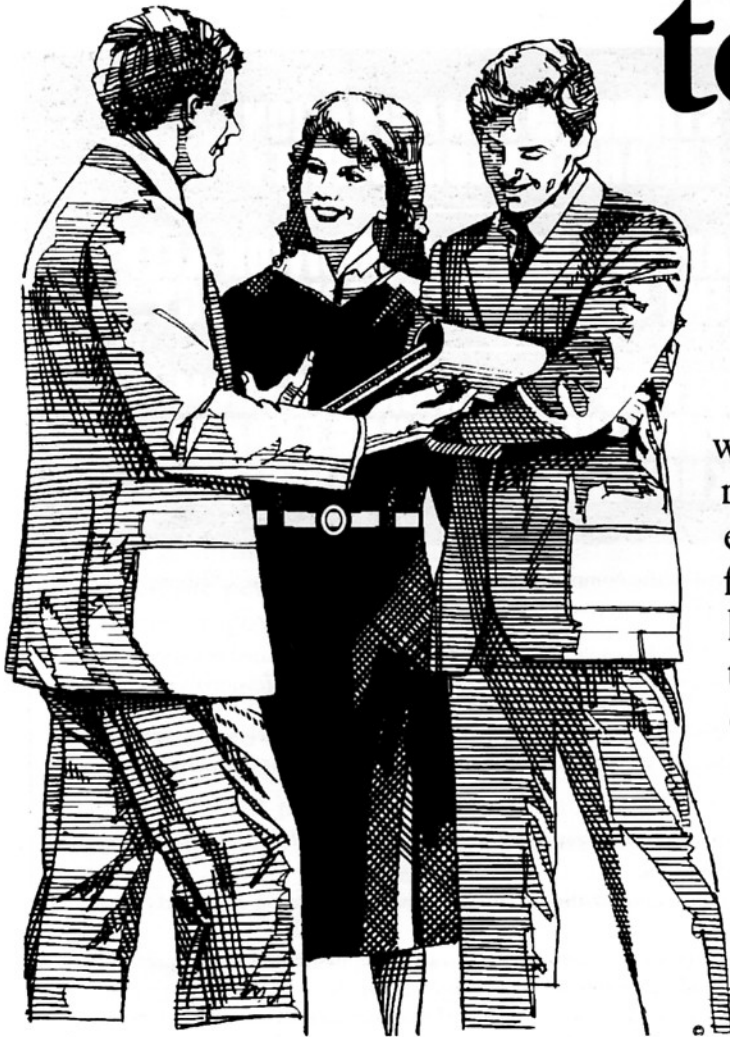


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