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OCEANIC ENGINEERING SOCIETY

Newsletter

OES

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IEEE OCEANIC ENGINEERING SOCIETY

(Continued on back cover)

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Halifax, Nova Scotia Canada

Monday October 6, 1997
to Thursday October 9, 1997

MTS/IEEE

500 Years of Ocean Exploration

In 1497, 500 years ago, John Cabot reached the shores of Atlantic Canada and began an unbroken period of European discovery and exploration of the oceans. Atlantic Canada is now the centre of ocean science and technology in Canada, where university, government and private companies combine to create the third largest concentration of ocean engineering professionals in North America.

Halifax is a vibrant, cosmopolitan capital, filled with history, exciting night life, pristine walkable streets and friendly Maritime smiles. Strong emphasis is placed on heritage and cultural diversity, historic restorations, growth in science, industry and education, and the preservation of a healthy and happy lifestyle.

Oceans '97 is an ocean engineering conference sponsored by MTS/IEEE...
*come and **explore it!***

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IEEE

OES

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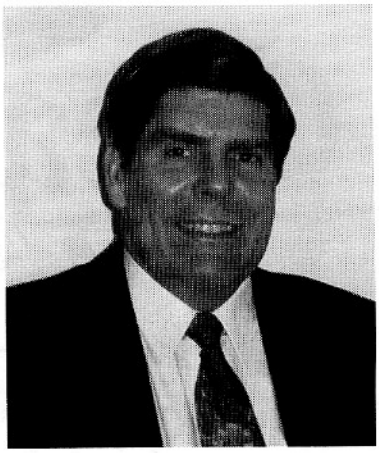
Editorial of Outgoing President



It has been an honor for me to serve as your President for the last three years. I can think of no higher professional service than to serve one's peers. The satisfaction I received from administering the Society is immeasurable. I thank you for the privilege.

I would like to thank those OES officers who have served with me: Jim Collins, V.P of Technical Activities; Norm Miller, V.P. Professional Activities; Ferial El Hawary and Pierre Sabathe, V.P.s of International Activities; Roger Dwyer, Treasurer; Claude Brancart, Secretary; and Glen Williams and Dan Alspach, Past Presidents. Their solid support was instrumental in conducting the Society's business.

We can all be proud of the accomplishments of the last three years. These include: Oceans'94 was our first conference outside of North America, two chapters were established outside North America - France and Japan, the student program supporting travel to Oceans was expanded, the Society's WWW home page was established, and Oceans'94, '95, '96 were each more successful than its precedents. Special thanks to the individuals that played key roles in these accomplishments.

Many challenges still face the Society. These include maintaining membership above a critical threshold, sustaining the high quality of the Journal of Oceanic Engineering, ensuring that the Oceans conference is the premier technical meeting forum for the oceanic community, satisfying member needs in specialty conferences, transforming into as truly global society, and finding new electronic ways of disseminating societal information.

The challenges, however, are difficult. They require the attention of all members of the society. The new leadership is highly capable, but they need your help. Please step forward to do your part. For those technically inclined, the technology committees need members, the Journal of Oceanic Engineering needs research papers and qualified guest editors, and conferences need presenters and session chairpersons. For those members having an interest in professional activities, there are education, standards, and employment forums.

Join me in pledging support of your new President Claude Brancart and the new Executive Committee.

Joseph Czika

Who's Who in OES

I have been appointed OES Publicity Chair by President Brancart and as part of that job have permission from him to publish a column in our newsletter about our members and their jobs. To go through some 2000 members would take considerable time and digging. So, if you want to get published, please let me know by mail – PO or email, or by telephone. Prepare a short resume, your job description and what product or service your organization provides. Short technical descriptions and some advertising should be acceptable but we do not yet have guidance from IEEE Headquarters and OES AdCom. Also, you may want to tell us when you get a promotion and we will try to print that. So, things may change – but let's get started.

Our object in this endeavor is be a service to our members. Please let us know how you feel about it. Any comments are welcome. This is for members only – any non-members who want the publicity are free to join the Society and of course, we would welcome you with open arms.

To get included contact me:

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Incoming President's Message

I appreciate the opportunity to be your President for the next two years. I joined the society in early 1990 when asked to be the Publicity chairman for AUV'90. Since that time, I have been involved with every AUV conference. Recently, I accepted the task to be Chairman for OCEANS 96 MTS/IEEE. My greatest exposure to our society has been through the position of Secretary. I supported Glen Williams through his second term, and Joe Czika. My interactions with the OES officers gave me exposure to every facet of our society. I am a Program Manager with Draper Laboratory in Cambridge, Massachusetts. I was stationed in Washington DC the last eight years supporting the Defense Advanced Research Projects Agency (DARPA) Unmanned Undersea Vehicle (UUV) Program. In June of last year, I moved to Cambridge, Massachusetts. My professional interests have always related to anything on or in the ocean. I started diving by building my own equipment. I then progressed to manned submersibles which included both design and operation. When the trend was to remove the human element from the water, I became involved the Remotely Operated Vehicles (ROVs). The next logical step was the untethered ROV, the Autonomous Underwater Vehicle, AUV. That is where my interest is now, and will remain till I retire, a long time from now.

Joe Czika is to be congratulated and thanked by our society for his leadership the last two years. During the tenure in office, we traversed the imaginary barrier around North American and expanded our horizon to Europe with OCEANS 94 OSATES in Brest, France. Joe also was instrumental in reorganizing the Executive Committee (ExCom) by assigning Vice President responsibilities by function (Technical, Professional, and International) in lieu of by area (East, West, and International). Our VPs are now more involved in all society matters.

My major objective is to expand our society in both areas of involvement and numbers. I will have very active Membership and Chapters Chairpersons. We will revitalized the Chapters and add new ones. The OCEANS conferences have always presented a high quality technical program. This will continue. The AUV conferences, every even years, has reached a milestone where we may want to consider consolidation with another similar interest conference, or within the OCEANS conference structure. I will set up a committee to evaluate the situation and present options to the Administrative Committee (AdCom). Our Journal will continue to be a respected information source by the professional community. The OES Newsletter has been an excellent vehicle to present information to the OES membership. I plan to have every person in the ExCom and AdCom electronically interconnected and accessible by the membership. We will be more aggressive in using the Net. There will be other objectives as expressed to me and officers by the membership and others. We will act upon them as effectively and prudently as possible.

I will be able to achieve my objectives with a strong and active ExCom, AdCom, Technology Committee, Journal, Newsletter, and specialty Chairs. We will all work together. Local chapters will be given more support and guidance. We will seek out new qualified members. The Journal will issue special editions on focused technologies. This should attract more interest towards the OES. The Newsletter will not only cover events and technology, but also members within the OES, starting with the ExCom and AdCom. Internationally, we will expand; electronic mail has made this possible. In '98, we will be in Nice, France with OCEANS, and in Japan with a special Underwater Technology conference. The Advance Conference Committee will continue to seek out new areas and opportunities.

The OES Society can maintain its quality position within the professional community through leadership and involvement by our membership. I expect all officers and chairs to be available to the membership via mail, telephone, or e-mail and to react promptly on issues or suggestions. I personally will be available to all (e-mail preferred). Help me make the next two years an exciting period of growth and challenge for OES and its members.

Claude Brancart

Editor's Note

Welcome to our new president Claude Brancart. Also Joe Vadus, our new Vice President for Technical Activities, new Treasurer, Thomas Wiener, and Eric Nelson our new secretary. It was a pleasure working with Joe Czika, and I look forward to the next two years working with Claude Brancart in support of his objectives.

I am in the process of updating the front and back pages of the newsletter and would appreciate inputs since some of the information may be out of date. E-mail would be best.

Fred Maltz

OCEANIC ENGINEERING SOCIETY

Distinguished Technical Achievement Award

1975	Robert Frosch
1976	Werner Kroebel
1977	Howard A. Wilcox
1978	Richard K. Moore
1979	David W. Hyde
1980	Neil Brown
1981	(No Award)
1982	Ira Dyer
1983	Alan Berman
1984	John B. Hersey
1985	William N. Nierenberg
1986	Robert J. Urick
1987	James R. McFarlane
1988	Chester M. McKinney
1989	Victor C. Anderson
1990	Robert C. Spindel
1991	Henry Cox
1992	Arthur B. Baggeroer
1993	WilliamJ. Plant
1994	Edmund J. Sullivan
1995	Mack O'Brien
1996	Frederick H. Fisher

DISTINGUISHED TECHNICAL ACHIEVEMENT AWARD

Oceanic Engineering Society OCEANS '96

Frederick H. Fisher

The IEEE Oceanic Engineering Society Distinguished Technical Achievement Award is presented to Dr. Fred Fisher for his outstanding contributions to the field of Ocean Acoustics.

He received B.S. and Ph.D. degrees in 1949 and 1957, respectively, from the University of Washington. He became head of a research group at the Marine Physical Laboratory (MPL) of the Scripps Institute of Oceanography, University of California in 1958, and became Associate Director of MPL in 1974, and was Deputy Directory of MPL from 1989-94. During 1963-64 he served as Director of Research for Havens Industries, San Diego, which was involved with desalination of sea water by reverse osmosis. During 1970-71 he was Professor and Chairman of the Physics Department at the University of Rhode Island. He was Scientific Officer and codesigner of the manned ocean buoy, FLIP, and was responsible for working out the "flipping" operation with 35-foot-long 1/10 scale models. He was Scientist In-Charge of the sound propagation research which led to the need for the development of FLIP and has participated in numerous sea-going expeditions in submarines since 1959 and aboard FLIP since 1962.

Since 1965 Dr. Fisher has been a Principal Investigator fo National Science Foundation grants devoted to high-pressure measurements related to the physical chemistry of sound absorption in sea water due to magnesium sulfate and other salts. His interest in the low-frequency anomalous sound absorption in the ocean below 1khz led to the discovery of boric acid as the cause of the low-frequency relaxation. He has also been a Principal Investigator on various Office of Naval Research contracts related to measurements of sound propagation in the ocean, especially in the use of vertical arrays to study acoustic multipath structure of signals at ranges up to 800 miles. He was also involved with studies of the anisotropy in vertical directionality of noise and in the development of a vertical trifar array with three axis hydrophone sensors.

DISTINGUISHED SERVICE AWARD

Oceanic Engineering Society OCEANS '96

Dr. Glen N. Williams

The IEEE Oceanic Engineering Society Distinguished Service Award is presented to Dr. Glen N. Williams for his dedicated service in support of the OES.

Glen holds B.S., M.E. and Ph.D. degrees in Civil Engineering and is a Professor of Computer Science at Texas A&M University in College Station, Texas. His primary research interests are in the areas of computational science and engineering and scientific visualization. He is currently the Director of the Autonomous Underwater Vehicles Intelligent Control Program, a multi-year hardware/software development effort funded by the US Navy. He has also directed several projects in scientific visualization which have resulted in high resolution video animations of physical systems such as molecular dynamics, submarine geotechnical structure simulation and sonar-based collision avoidance.

Glen has been active in the Oceanic Engineering Society for the past 20+ years, serving on the Administrative Committee since 1976, and as Vice President of the OES during 1985-1989. He also served as the OES President during 1990-1993. Glen also is an active participant in the Oceans conference series in a myriad of roles, but particularly as the Technical Program Committee Co-chairman for OCEANS'95 and the North American Liaison for OCEANS'94 (Brest, France) and OCEANS'98 (Nice, France). He was also instrumental in initiating the successful series of Autonomous Underwater Vehicle Symposia, serving as AUV '90's Technical Program Chairman. Glen also served as the OES representative to the Program Committee, the Executive Committee and the Board of Directors of the Offshore Technology Conference from 1976-1992.

Glen also received the IEEE Centennial Medal in 1984 and was elected to IEEE Fellow in 1995.

OCEANIC ENGINEERING SOCIETY

Distinguished Service Award

1975 Arthur S. Westneat

1976 Frank Snodgrass

1977 Calvin T. Swift

1978 Edward W. Early

1979 Richard M. Emberson

1980 Donald M. Bolle

1981 Lloyd Z. Maudlin

1982 Arthur S. Westneat

1983 Elmer P. Wheaton

1984 John C. Redmond

1985 Joseph R. Vadus

1986 Stanley G. Chamberlain

1987 Stanley L. Ehrlich

1988 Harold A. Sabbagh

1989 Eric Herz

1990 Anthony I. Eller

1991 Frederick H. Fisher

1992 Gordon Raisbeck

1993 Edward Early

1994 Daniel Alspach

1995 David Weissman

1996 Glen Williams

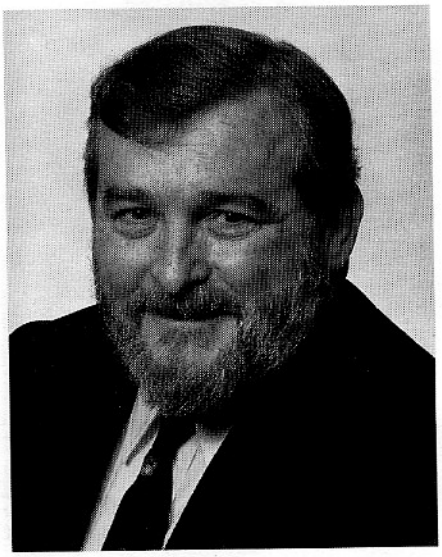
IEEE OES Fellows

Akihiro Ametani
Saul Aronow
M. P. Bachynski
Arthur B. Baggeroer
P. L. Bargellini
Laurence Batchelder
Georges Bienvenu
Leif Bjorno
W. M. Boerner
Johann F. Bohme
D. M. Bolle
J. V. Bouyoucos
Gary S. Brown
Homer E. Brown
William R. Brownlee
Janis A. Bubenko
Norman Caplan
William M. Carey
G. Clifford Carter
J. H. Chadwick
Paolo Corona
H. V. Cottony
Henry Cox
Rui J. de Figueiredo
W. N. Dean
William H. Doherty
W. L. Doxey
C. C. Duncan
Ira Dyer
William B. Elmer
Irving Engelson
Adrian K. Fung
Fred E. Gardiol
R. W. Gilbert
Gerald G. Gould
Eugene W. Greenfield
W. M. Hall
C. W. Harrison, Jr.
R. K. Hellmann
Peter R. Herczfeld
Eric Herz
R. C. Honey
R. A. Isberg
A. W. Jacobson
I. B. Johnson
Saleem A. Kassam
Demetrios Kazakos
Charles M. Knop
Harry R. Lubcke
R. W. Masters
R. B. McGhee
R. E. McIntosh
George F. McClure
David Middleton
Shota Miyairi
Hitoshi Mochizuk
R. K. Moore
Jose M. F. Moura
Yoshiei Nakano
Russell C. Newhouse
A. J. Pansini
W. W. Pendleton
H. A. Peterson
E. J. Powers, Jr.
John G. Proakis
G. Raisbeck
V. Ramachandran
R. K. Raney
H. F. Rempt
Paul Rosenberg
O. H. Schmitt
Morris Schulkm
Gustave Shapiro
S. M. Sherman
Robert C. Spindel
C. A. Strom, Jr.
Calvin T. Swift
Chen-To Tai
Ikuo Tanaka
K. Tomiyasu
Donald W. Tufts
A. Uhlir, Jr.
Harry L. Van Trees
W. A. Von Winkle
David E. Weissman
W. C. Whitman
Glen N. Williams
Jay W. Wright

IEEE FELLOW AWARD

Oceanic Engineering Society OCEANS '96

William M. Carey



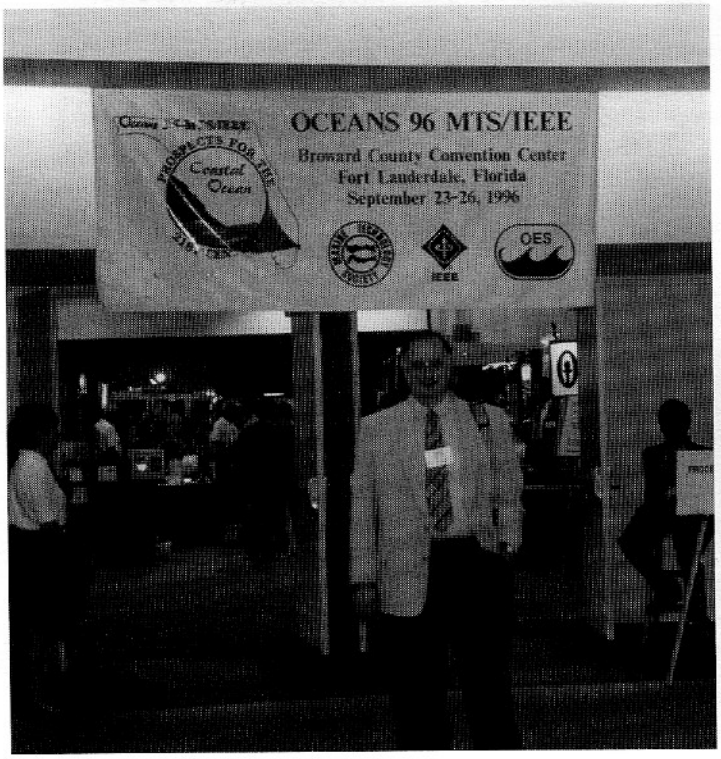
William M. Carey (M'85, SM'91, F'96) received the B.S. degree in mechanical engineering in 1965, the M.S. degree in physics in 1968, and the Ph.D. in nuclear science in 1974 from The Catholic University of America, Washington, D.C.

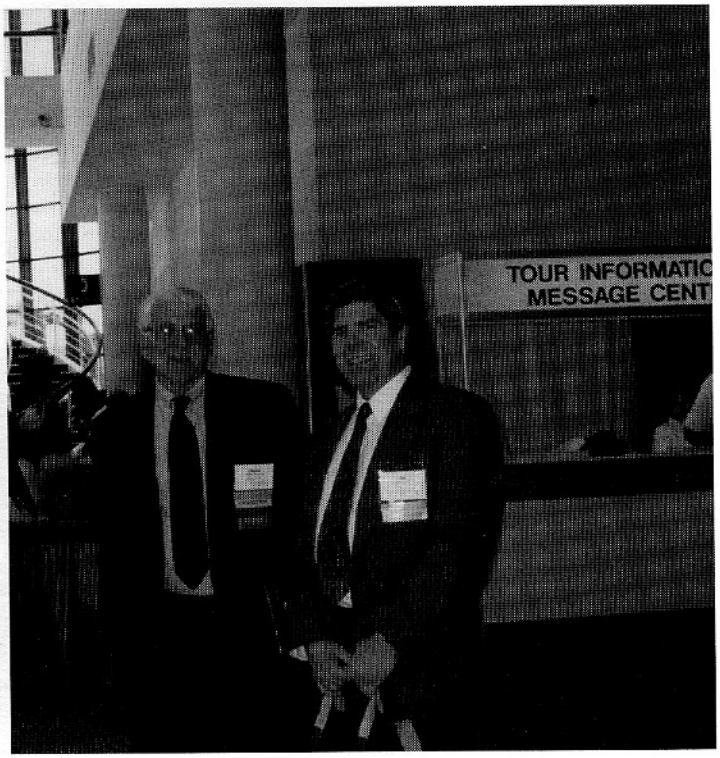
Presently, he is the Editor of the IEEE Journal of Oceanic Engineering and a Physicist with the Defense Advanced Research Projects Agency assigned under the I.P.A. to the M.I.T. Department of Ocean Engineering where he teaches Acoustics and conducts research. Prior to this he was a Research Physicist and Engineer at the Naval Underwater Systems Center, the Naval Oceanographic Research and Development Activity, and the Naval Research Laboratory. At The University of Chicago's Argonne National Laboratory he was an Associate Scientist and Section Manager of acoustic surveillance of reactors. He has been a consultant to both industry and government in the areas of nondestructive testing, nuclear science/environmental measurements, and applied ocean acoustics.

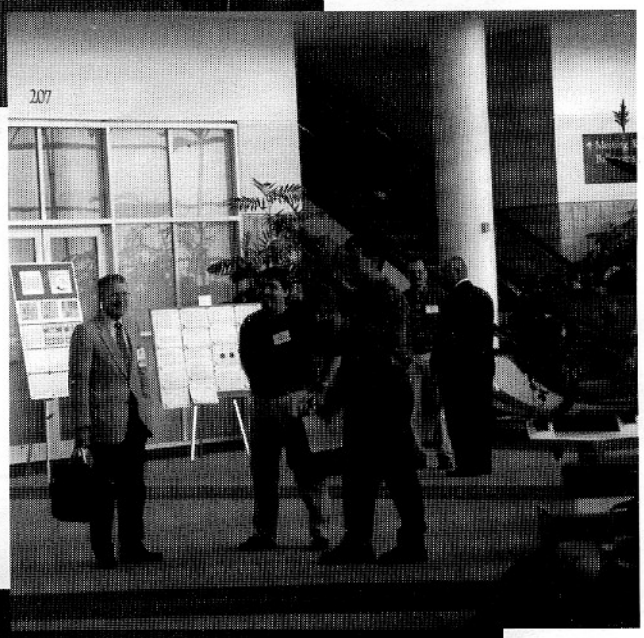
Dr. Carey has contributed to the following areas. He developed a measurement technique and method to measure low level nuclear isotopes in the environment. He developed methods, instruments and established acoustic surveillance techniques for use in the power generation industry. Early in his career he and his colleagues at the Chesapeake Instrument Corporation were instrumental in developing towed array sonar systems such as the ITASS/TASS. This particular area of work expanded in the use of ocean acoustic arrays as sonars and measurement systems. Dr. Carey and his colleagues performed experiments in many of the world's ocean basins using directional systems to characterize the noise field and sound propagation. He has also contributed to the field of ocean ambient noise by measuring directional properties and recognizing that breaking waves produce micro bubble distributions which can collectively radiate low frequency sound. During the last several years he has studied the properties of the shallow water wave guide. His experiments are well known as data and results have been made readily available to the research community. These activities have resulted in an improved understanding of scattering, reverberation, transmission and the coherency of the shallow water wave guide.

OCEANS '96

Fort Lauderdale, Florida

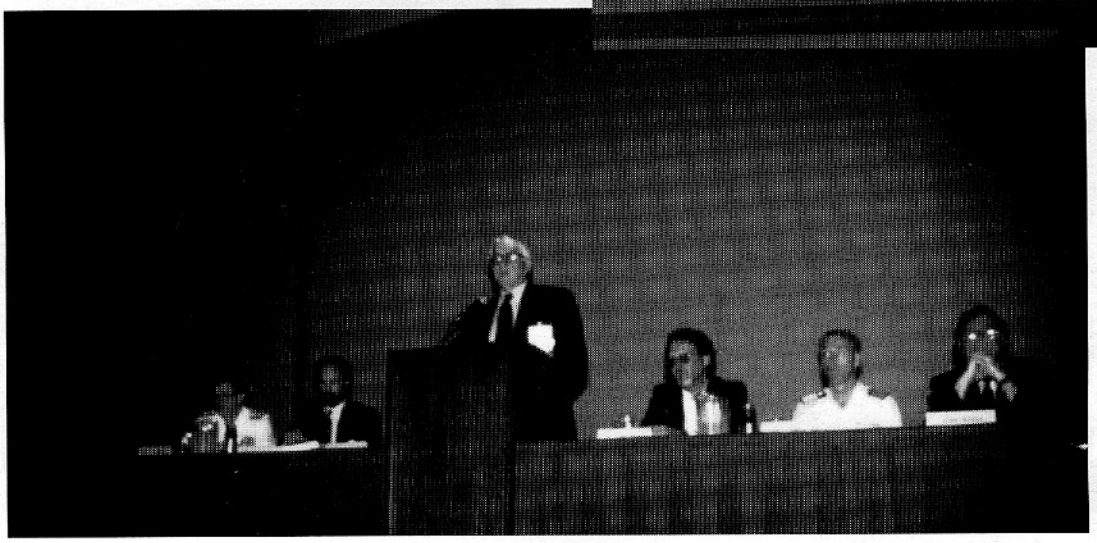






OCEANS '96

Fort Lauderdale, Florida



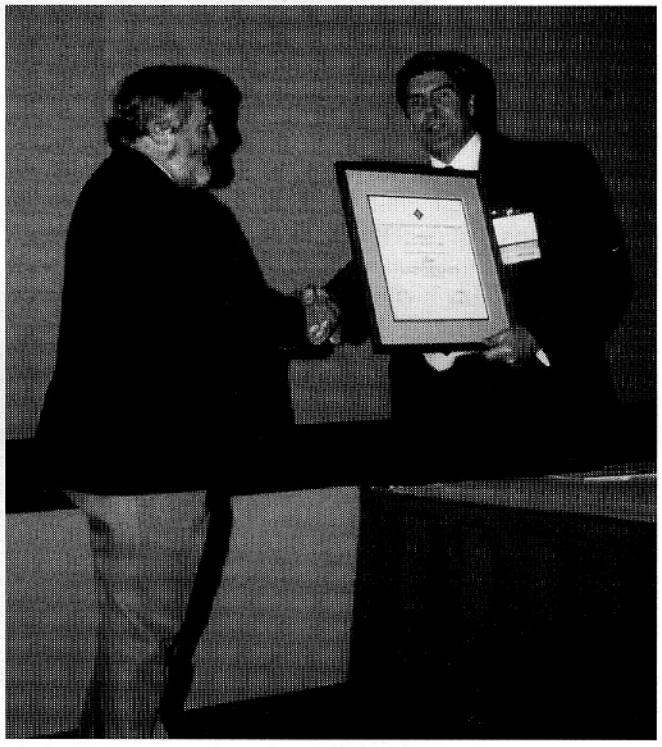
Plenary

Awards Luncheon

Glen Williams and Joe Czika

Claude Brancart and Joe Czika

Stan Chamberlain and Joe Czika



Bill Carey and Joe Czika

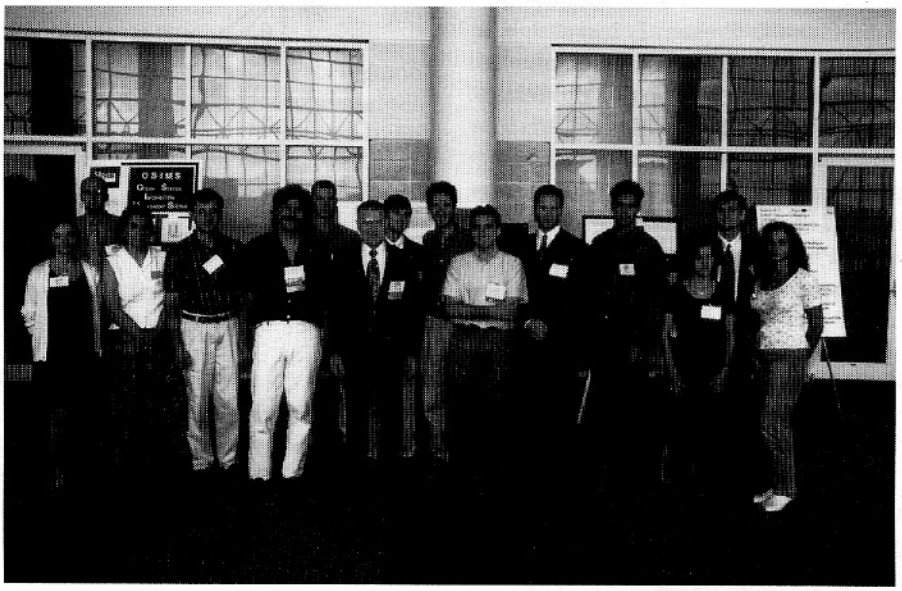
Reception

Congratulations to Ed Early

Ed Early, past Chairman of the Seattle Chapter of OES, received the Region 6 Individual Achievement Award. The award was presented to Ed by Dr. Wallace Read, President of IEEE, at a dinner held in Seattle on December 3, 1996. The inscription on the plaque reads "For dedicated service and untiring support of the IEEE and the Oceanic Engineering Society," signed by William E. Murray, Region 6 Director. Congratulations, Ed.

OCEANS'96 MTS/IEEE Student Poster Program

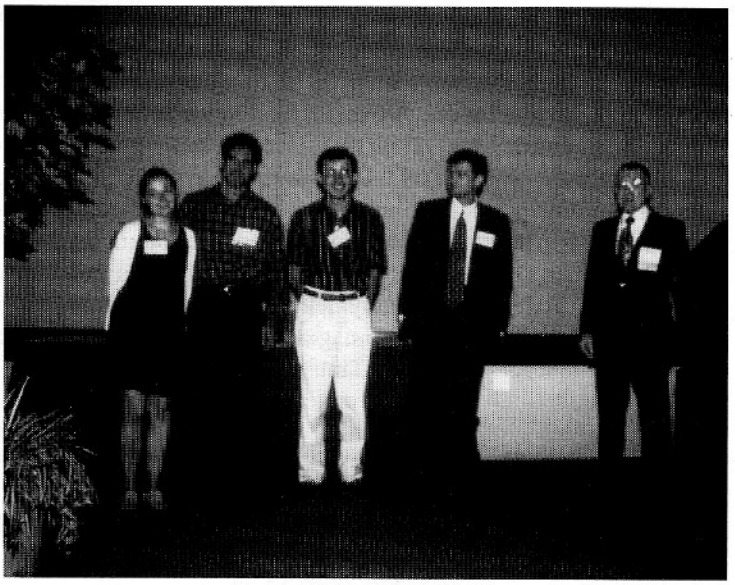
OCEANS'96 MTS/IEEE sponsored a Student Poster Program to encourage the participation of engineering and science students in professional conferences. Thirteen students were invited to present their posters which were displayed on the second floor foyer during the Conference. The posters were of high quality and represented a wide variety of work from the theoretical to the results of ocean operations. A judging of the posters was made to select the best posters. Poster awards were presented at the MTS Luncheon on Thursday, September 26, 1996. Miss Samantha Dugelay, IFREMER, Brest, France, was selected for the first place award. Mr. Rick Driscoll, University of Victoria, Victoria, BC, Canada, received the second place award and Mr. Rolando Blanco, University of Miami, Miami, Florida, received the third place award. In addition, an Honorable Mention award was given to Mr. Andrew Vasilev, Technical University of Varna, Varna, Bulgaria. On Wednesday, September 25, 1996, Edward Prieto and Virginia Moll, from the MAST Academy in Miami, Florida, presented their science fair posters. These students were the first place winners in the Florida State Science Fair competition.



OCEANS'96 Student Poster Program participants

The following students participated in the poster program:

Rolando Blanco, University of Miami, Miami, Florida
Claude Deyres-Pescay, Universite Paul Sabatier, Toulose, France
Frederick Driscoll, University of Victoria, Victoria, BC, Canada
Samantha Dugelay, Ifremer Centre de Brest, Plouzane, France
Stephane Grassin, Telecom Bretagne, Brest, France
Michael J. Ingram, University of Rhode Island, Narragansett, RI
Claire S. Maroni, ENSIETA, Brest, France
Thierry Rastello, CREATIS, Villeurbanne, France
Elbatoul Soussi, CETP/CNRS, Velizy, France
Andrea Trucco, University of Genoa, Genoa, Italy
Andrew V. Vasilev, Technical University of Varna, Varna, Bulgaria
Ascension Vizinho, Sheffield University, Sheffield, UK
Fabian Wolk, University of Victoria, Victoria, BC, Canada



OCEANS'96 Student Poster award winners: (l to r) Samantha Dugelay, 1st place; Rick Driscoll, 2nd place; Rolando Blanco, 3rd place; Andrew Vasilev, honorable mention; Norman D. Miller, student poster chairman.

(Reprinted from OCEANS '96 Proceedings)

Deep Seafloor Characterization with Multibeam Echosounders using Image Segmentation and Angular Acoustic variations

S. DUGELAY
Ifremer Centre de Brest, BP70, 29280 Plouzané, France
e-mail:sdugelay@ifremer.fr

Abstract- Because the use of multibeam echo-sounder imagery in sea-floor identification is constantly increasing, a semi-automatic mosaic interpreter is presented. It is based on the statistical and acoustical properties of the image pixels, and relies on the use of Markov Random Fields image models within a Bayesian framework for partitioning mosaics into homogeneous regions. Further, we introduce a Gibbs distribution model of the original image for computing its Maximum a Posteriori estimate. Effects of backscattering angular variations are compensated by injecting a first estimate of these into the calculation. Segmentation result of low-frequency multibeam mosaic is presented and compared to geological interpretation.

I. MULTIBEAM ECHOSOUNDER SIGNAL CHARACTERISTICS

The EM12 system is composed of two antennas installed on the hull of the ship which send a 10ms pulse length signal at a frequency of 13 kHz and provides accurate mapping up to a depth of 11,000 metres. The transmit beam is 150° wide across track and 1.8° wide in the along track direction. Reception is undertaken using 162 overlapping beams 3.5° wide across track and 20° wide along track. The echoes coming from the intersection area between transmission and reception beam patterns produce a signal from which two quantities are computed: depth (computed from the arrival time) and reflectivity (related to signal amplitude). A transmission/reception cycle is commonly named "ping". This configuration allows to record signals from a seafloor stripe up to seven times the water depth. As a primary function for the system, the bathymetry measurement is performed from a phase cancellation algorithm for the lateral beams, and from an energy criterion in the central beams. Together with bathymetry measurements, the system is able to record acoustical images from the sea-floor in the same way as a side-scan sonar. Time signals from the various beams are recorded and juxtaposed in order to rebuild the backscattered time signal from the whole swath [1].The sampling period is 3.2 ms, corresponding to a spatial sampling of 2.4 m along the wave propagation direction, which has then to be projected on the sea-floor to get the actual inter-sample spacing in the ship's acrosstrack direction (Figure 1). Typical values for a water depth of 2500m are presented in Table I, as a function of incident angle.

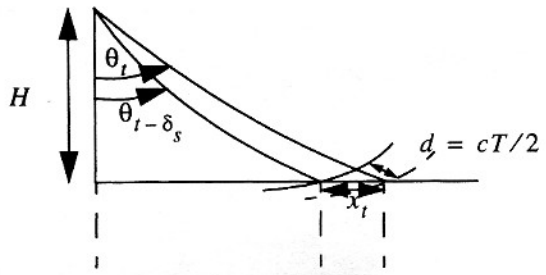


Fig. 1. Inter-sample spacing on the seabed

Various aspects of the backscattered signals are of interest. First, the average signal intensity is strongly dependent on the incident angle. This is partly due to the geometry of the physical phenomenon (since the instantaneous insonified area depends on the incident angle), but also to intrinsic properties of the sea-floor; it has been known for long [2] that the backscattering strength level and angular dependence are characteristic of the sea-floor type, and that this measurement using a multibeam echosounder is a valuable method for identification. Basically soft sea-floors (mud, clay) will provide a strong and narrow angular maximum around the vertical, with low values at lateral incidences, while hard and rough sea-floors correspond to a slow angular decrease.

This is classically obtained through theoretical develop-

Table I Sampling distance on the seafloor

time (ms)	3.2	6.4	9.6	12.8	16.0	...	1267.2	1268.8	...	3184.
angle (°)	2.5	3.5	4.34	5.01	5.6	...	55.38	55.40	...	69.90
x_t (m)	109.5	45.42	34.87	29.42	25.94	...	2.91	2.91	...	2.55

ments [3], and was checked experimentally [2][4]. The obvious limitation for exploiting this method is that it supposes a homogeneous sea-floor type all over the explored swath corresponding to the angular analysis. Beyond this first (and most useful) aspect of things, it is necessary to study the statistical characteristics of the measured backscattering strength, since these characteristics will be needed for an image segmentation processing based upon BS values. It is found experimentally, that for a given incident angle on a geologically homogeneous sea-floor area, the backscattered signal amplitudes follow a Rayleigh law:

$$f_X(x) = \frac{x}{\sigma_X^2} \exp(-x^2 / 2\sigma_X^2) \quad (1)$$

which is consistent with the fact that in our low-frequency and deep-water case, the beam footprint features the great number of elementary scatterers needed for Rayleigh's theory to be valid [5]. It is equivalent to say that the intensity I is a $\frac{1}{\phi^2}\chi^2$ variable with two degrees of freedom:

$$f_I(z) = \frac{1}{2\phi^2} \exp(-\frac{z}{2\phi^2}) \quad (2)$$

However, in the multibeam echosounder, decibel values are truncated and located in a byte array so that only truncated values are available for analysis. The χ^2 distribution has then to be replaced by a different law in:

$$P(W = w) = \exp(-w/2\phi^2) - \exp(-w10^{1/20}/2\phi^2) \quad (3)$$

II. MOSAIC CONSTITUTION

Practically, when exploiting sonar images ("mosaics") one has to deal with pixel values possibly corresponding either to averaged values over several time samples, or to duplicated values between distant samples [6]. A mosaic image is a grid of square pixels, each one representing an area of $m \times m$ square metres on the seabed [1]. All raw sonar samples located in a same mosaic pixel are averaged, and alternatively, sonar samples are duplicated at vertical to compensate for the poor spatial resolution of the echosounder. As an example, in Figure 2, we present the relocation of raw samples in a cartographic mosaic, where the sonar samples are interspaced as in the previous numerical example (Table(I)), and size of the mosaic pixel is 50 metres. The case where pixels are issued from an averaging of raw data is especially important, and requires the definition of probability densities for such averaged random variables; such densities are readily obtainable when the summed data are χ^2 distributed but become practically underivable with the modified law due to truncature.

Finally, it was empirically supposed and, checked with success on experimental data, that the averaging over n truncated values could reasonably fit a χ^2 distribution with $2n$ degrees of freedom. Typical results are presented in Figure 3 for various values of n.

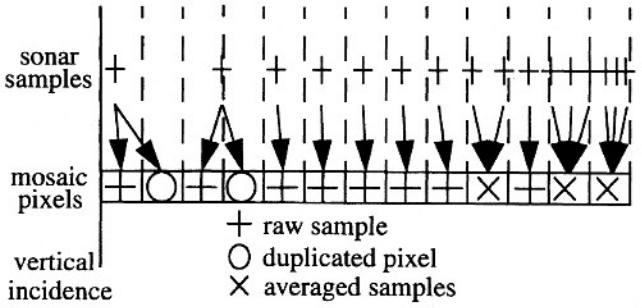
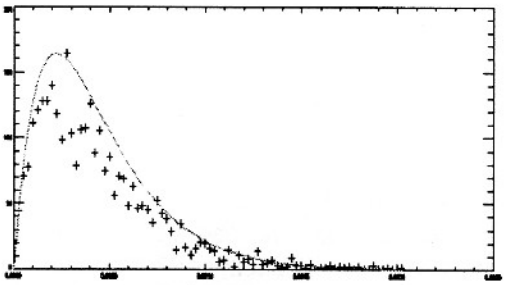
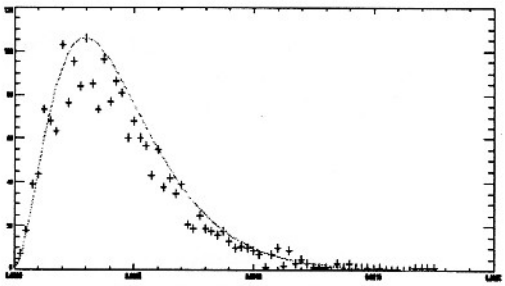


Fig. 2. Relocation of the samples in a cartographic mosaic

Hence, in order to apply a sound segmentation algorithm to the mosaic, every echo-sounder and image characteristic must be taken into account:

- a non-linear intersampling distance on the seabed
- angular variations of the signal
- statistical pixel distributions which depend on the position of the pixels in the image and the mosaic scale


over 2 observations


over 3 observations

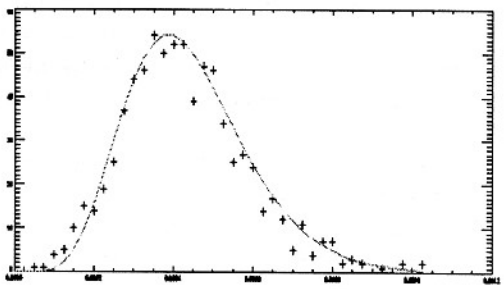

over 8 observations

Fig. Histograms for various averaging rates and corresponding χ^2 distributions

III. SEGMENTING WITH MARKOV RANDOM FIELDS

Segmenting means associating to a pixel a label from a set $\Lambda = \{\lambda_0, \lambda_1, ..., \lambda_{L-1}\}$ in order to partition the image into homogeneous regions. Segmentation is achieved by employing Markov Random Fields (MRF) in a Bayesian context [7] [8] [9]. The mosaic Y that is to be segmented is in reality a degradation of a real image X which is to be estimated.

By definition, X is said to be a Markov Random Field (MRF) according to a neighbourhood ϑ_s if:

(1) $P(X = \omega) > 0$,

$\forall \omega \in \Omega$ -set of all possible configurations

which means that no configuration is impossible,

(2) $P(X_s = x_s | X_r = x_r, r \neq s)$

$= P(X_s = x_s | X_r = x_r, r \in \vartheta_s)$

$\forall s \in S$ -grid of points-,

$\forall (x_{s_1}, x_{s_2}, ..., x_{s_n}) \in \Omega$ which means that there is no need to take into account the whole image when analysing a specific pixel, a set of local neighbouring pixels is sufficient.

In order to achieve a most probable segmentation, a Maximum a Posteriori estimator is employed in maximizing the a posteriori distribution $P(X = \omega | Y = y)$.

Using Baye's rule

$$P(X = \omega | Y = y) = \frac{P(Y = y | X = \omega) P(X = \omega)}{P(Y = y)} \quad (4)$$

From the Hammersley-Clifford Theorem, we know that X is a MRF according to a neighbourhood ϑ_s if and only if $P(X = \omega)$ is a Gibbs distribution,

$$\text{i.e. } P(\omega) = \frac{1}{Z} \times e^{-U(\omega)} \quad (5)$$

where $U(\omega)$ is the energy function defined over the neighbourhood ϑ and Z the partition function, a normalizing constant.

$X|_Y$, $Y|_X$ and X are all MRFs. Therefore:

$$P(X = \omega | Y = y) = \frac{1}{Z} P(Y = y | X = \omega) P(X = \omega) \quad (6)$$

$$= \frac{1}{Z} e^{-U_1(y|\omega)} e^{-U_2(\omega)}$$

$$= \frac{1}{Z} e^{-U_1(y|\omega) + U_2(\omega))} = \frac{1}{Z} e^{-U(\omega|y)}$$

where $U_1(y|\omega)$ is the energy function translating the deformation from X to Y, and $U_2(\omega)$ the component due to the spatial interaction of the labels.

So, the maximization problem has now become the minimization of the energy functions.

Our studies have primarily been concerned with three major points which will be discussed in this paper:

- Acquisition and modelling of labels
- Modelling the interaction energy $U_2(\omega)$
- Modelling the deformation energy $U_1(y|\omega)$

A. Acquisition and modelling of labels:

The grey level of any pixel depends on its position in the mosaic, that is, the angle of incidence with which the sea floor is "seen". Before segmenting, visual homogeneous regions are interactively delimited by geologists; hence for each delimited region, and for every incidence angle, a mean energy value is calculated using three mosaic canals: reflected energy y_s, incidence angle θ_s, and identification number n_s. The identification number defines the duplication-compression rate. If $n_s = 1$, then y_s is raw data, if $n_s = -k$, then y_s is a duplicated pixel because $n_s < 0$ and there exist k other identical neighbouring pixels, one raw data and $k - 1$ duplicated, and if $n_s = k$, then y_s is a pixel issued from the averaging of k observations.

Estimation of the label curve model then takes into account only raw data and averaged observations. We are therefore introducing angular backscattered energy levels into the segmentation algorithm [10], and taking into account one of the echo-sounder characteristics, that is, the angular variations of the signal.

B. Interaction energy $U_2(\omega)$:

We have decided to analyse strictly non-interpolated mosaics, and this mainly for a reason of size, but also, a desire to remain as near as possible to raw data.

In Figure 4, we present an extraction of a mosaic where conventional **interaction** neighbourhoods are superposed (neighbourhoods (1) and (2)). Clearly, conventional neighbourhoods such as sliding windows are no longer adapted to the dispersed pixels we have. Consequently, this has meant creating a new kind of mosaic (straight mosaics), where pings are piled up chronologically, and only a lateral geometrical correction is applied. In Figure 5, we present the corresponding straight mosaic with the corresponding neighbourhoods.

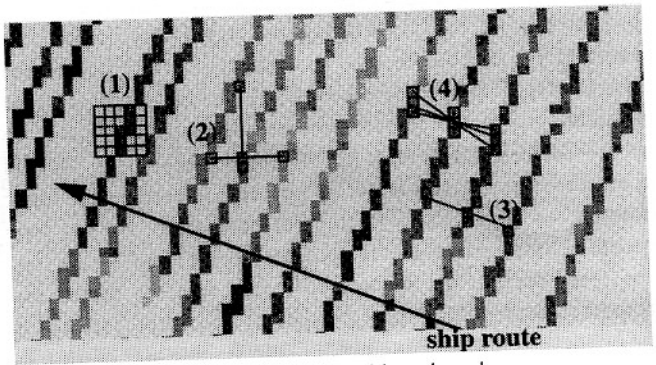


Fig. 4. Mosaic extraction and neighbourhoods

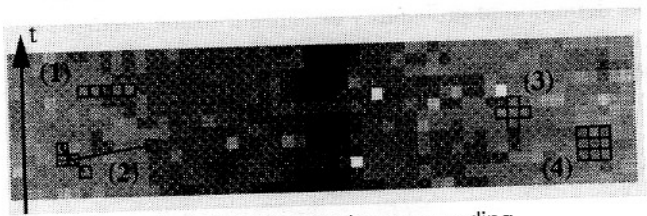


Fig. 5. Chronological mosaic and corresponding neighbourhoods

Conventional neighbourhoods (1) and (2) on the geographically relocated mosaic correspond either to a ping by ping segmentation in the first case, and to physical nonsense in the second. Whereas convention neighbourhoods on the chronological mosaic (3) and (4) are in reality route-wise oriented neighbourhoods. So, as long as angular deviation between successive pings is not important, in great many cases the error made by parallelling pings resides in the fact that the inter-ping distance is dropped. We then employ conventional rectangular neighbourhoods where certain corrections are undertaken in order to compensate for the geometrical artifice:

- A rectangular neighbourhood in the mosaic is taken so that in reality a square neighbourhood is considered on the seabed,
- The influence of a pixel is weighted by the inverse of its relative distance on the seabed.

Interaction energy is then described by the following equation:

$$U_2(x) = \alpha \sum_{(s,t)} c_{st}\delta(x_s, x_t) \tag{7}$$

where c_{st} is the weighting coefficient and
$\delta(a, b) = 1$, if $a = b$, and $\delta(a, b) = 0$, if $a \neq b$

The weighting coefficient and the considered pixels in the windows are in effect considering the non-linear inter-sampling distance on the seabed.

C. Deformation energy U_1 (y|ω):

The deformation from X to Y is modelled by a weighted χ^2 distribution which weighting coefficient and degrees of freedom depend on the scale of the mosaic and angle of incidence.

Raw data has a truncated probability distribution while averaged observations are modelled by a weighted χ^2 law. Therefore, energy for the deformation model is

$$\begin{aligned} U_1(y|\omega) = & \sum_{s \in S} -\ln(\exp(-y_s / x_s) \\ & -\exp(-10^{1/20}\, y_s / x_s))\delta_{(n_t=1)} \\ & +(-(n_s - 1)\ln y_s + n_s y_s / x_s \\ & -n_s \ln(n_s / x_s) + \ln\Gamma(n_s))\delta_{(n_s>1)} \end{aligned} \tag{8}$$

First segmentation results proved an accurate modelling for lateral incidence angles. But still, specular segmentation was disappointing, and this because of the high confusion when choosing the label for small incidence angles. Bearing this in mind a "collective" energy is conceived for a pixel, i.e. instead of attributing a label to a pixel solely because of its value, a label is chosen depending on its value and those of neighbouring pixels on the same ping. As a result, the deformation energy is modified accordingly with the deformation neighbourhood ϑ_s^D:

$$\begin{aligned} U_1(y|\omega) = & \sum_{s \in S} \sum_{t \in \vartheta_s^D} -\ln(\exp(-y_s / x_s) \\ & -\exp(-10^{1/20}\, y_s / x_s))\delta_{(n_t=1)} \\ & +(-(n_t - 1)\ln y_t + n_t y_t / x_s \quad \ddot{y} \quad \ddot{y} \quad \ddot{y} \\ & -n_t \ln(n_t / x_s) + \ln\Gamma(n_t))\delta_{(n_t>1)} \end{aligned} \tag{9}$$

with the hypothesis that variables Y_s are independent.

Consequently, this energy is taking into account the statistical distributions of the pixels, but also the angular variations of the signal, especially at vertical incidence where it considers consecutive pixels to affect a label.

IV. SEGMENTATION ALGORITHM

The employed algorithm for the segmentation is that of the Iterated Conditional Mode defined by Besag [9]. It's convergence is highly dependent on initialisation, but since segmentation is supervised, initialisation is very reasonable and in favour of the ICM, and also speed is a major benefit considering the great mosaic sizes obtained by multibeam echosounder data.

Summary:

(i) A number of visible homogeneous zones are interactively delimited on the mosaic by the geologist.

(ii) Label curve models are estimated within these zones.

(iii) Initialisation for the segmentation is obtained by minimizing $U_1(y_s/x_s)$ for each pixel

(iv) The iterative procedure of estimating $\hat{x}$ for a fixed number of cycles or until approximate convergence of $\hat{x}$ is carried out.

We have observed that 10 to 15 iterations are generally sufficient in attaining the criteria where less than 0.01% pixels change label in one iteration.

V. SEGMENTATION RESULTS

Although label curves and the segmentation algorithm are respectively estimated from and applied to straight mosaics, we will not present intermediate results but only geographically positioned mosaics and final relocated segmentations. In Figure 6, we present a mosaic of a survey near the Azores. This image covers approximately 1107 square kilometres (~256 square miles) and is composed of 745,696 pixels (~863 × 863). A mosaic pixel represents a 32m × 32m square footprint on the seabed. A geological analysis of this mosaic associated with coring and study of the bathymetry reveal five important features: volcanoes clearly distinguishable, a sedimentary shelf (mainly foraminiferal mud), a transitory zone of coarser sediments, an area composed of rocky seabeds and pools of sediments, and a steep chaotic zone where rocks and fine or coarse sediments alternate.

The resulting segmentation using angular backscattering variations and collective energies is presented in Figure 7 where the main features are correctly differentiated by the algorithm. The segmented zones appear to actually comply to

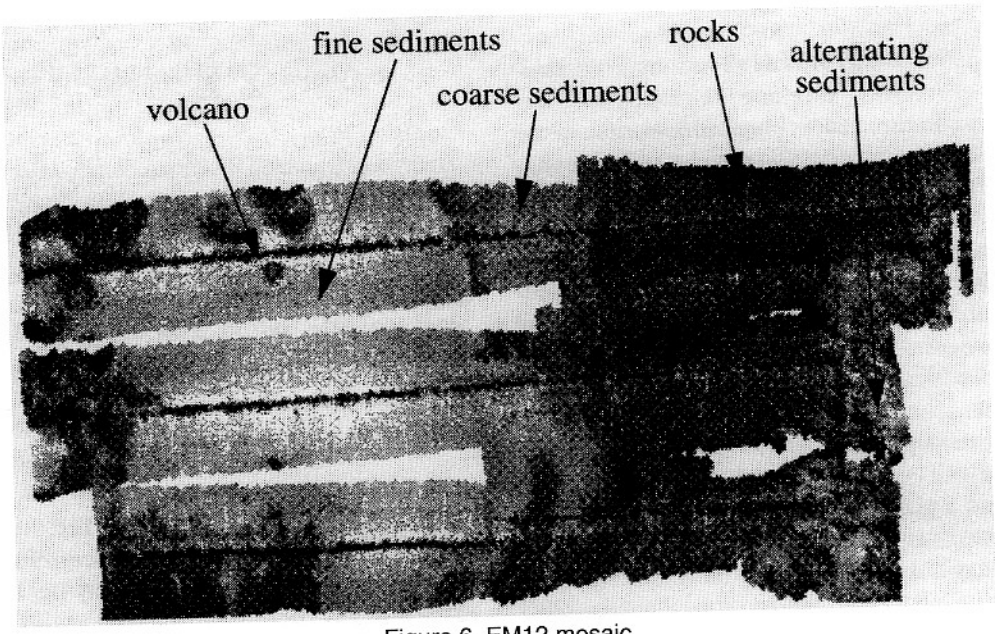


Figure 6. EM12 mosaic

geological delimitations, and the image artefact due to the specular reflection near vertical has been suppressed. This result was obtained after 14 iterations and, is encouraging in the way that first, the segmentation algorithm is fast and easy to use, and secondly, because angular variations are taken into account, the process is effectively segmenting seabed nature, and therefore substracting the bathymetry effect in echosounder imagery.

VI. CONCLUSION

We have developed a method for partitioning low-frequency echosounder mosaics into homogeneous regions taking into account the acoustical variations of the time signal and geometrical characteristics of the system. Energy functions are based on the spatial interactions between pixels which depend greatly on the acquisition system geometry, the scale of the mosaic, and also on the pixel distributions. Hence every sounder characteristic is exploited to establish an optimum model. Our ultimate aim is to constitute a data base of labels for a large variety of seabeds and propose unsupervised segmentations at high resolutions. In order to achieve this goal, parallel studies are undertaken in relating the angular backscattered variations to theoretical and empirical models. Multiscale methods are also being considered for high resolution mosaics (pixel size ~ 5m x 5m) in order to accelerate calculation time and improve homogeneity inside a region.

ACKNOWLEDGMENTS

I would like to acknowledge my three wonderful supervisors, Christine Graffigne for her advice in imagery, Xavier Lurton (the Extra Large Boss) who taught me everything I know in underwater acoustics, and Jean Marie Augustin (Chef), who put up with me very day. Nothing would have been possible without them.

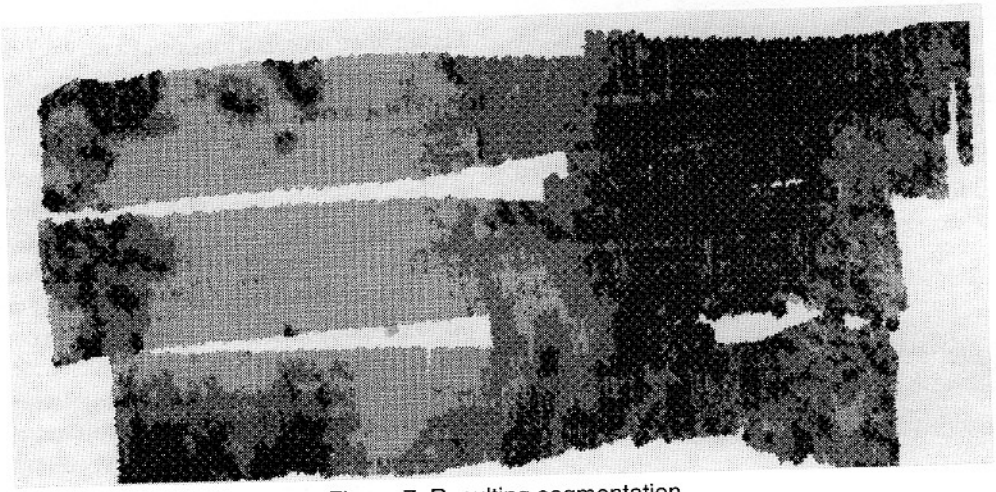


Figure 7. Resulting segmentation

I would also like to thank the SHOM (Service Hydrographique et Oceanographique de la Marine) for supplying data, and T. Garlan for his geological interpretation and discussions; also M. Voisset (IFREMER) for his support (especially at sea!). And finally thanks for all the encouragement at home. You were always right.

The work of S. Dugelay is supported by the SHOM.

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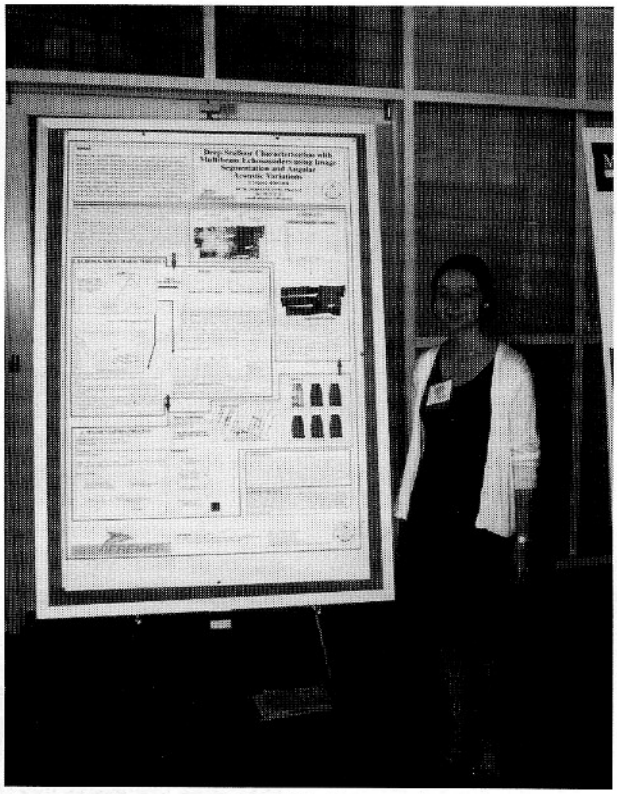
BIOGRAPHY

I obtained my Master's degree in applied mathematics at the Université de Bretagne Occidentale in Brest in 1992. I then passed my DEA Modélisation Stochastique et Statistiques at Université de Paris Sud in Orsay. I am currently finishing my phD sponsored by the SHOM (Service Hydrographique et Océanographique de la Marine Française) at Ifremer (Institut Française de recherche et d'Exploitation de la Mer) in Brest, and I will be defending my thesis in March 1997 at Orsay. I also was awarded the best student paper award at the 3rd European conference of underwater acoustics in Crete in June 1996 for my phD work.



Samantha Dugelay, IFREMER, France, first place award in the OCEANS'96 Student Poster competition.

1996 PACE Conference and Workshop

The 1996 PACE Conference and Workshop was held in Phoenix over the Labor Day weekend. It was the largest PACE Workshop to date with over 300 delegates at the conference. With the spouses and guests there were over 500 people in attendance. There was an emphasis on the Young Professional and it was notable that the age level of the conference was at least ten years younger than past conferences. PACE supported the attendance of the YP's and encouraged the Sections and Regions to assist in bringing them to the workshop. It was thrilling to hear babies during the luncheons and public sessions!

There were Plenary sessions each morning and afternoon in which all attendees participated. These were followed by concurrent workshops for the younger professionals and the OP's (Older Professionals). The YP sessions were bolstered by the new IEEE GOLD program, Graduates Of the Last Decade, and a number of the attendees were sponsored through this program. It was encouraging to see participation of the YP's and the enthusiasm with which they took the leadership training.

Some of the highlights of the plenary sessions and other sessions follows. The dinner speaker at the Friday nights opener was Dr. Richard Gowen, Past IEEE President and President of South Dakota School of Mines, who spoke on importance of continuing education in our changing world. The opening plenary session on Saturday was entitled Changing Environments: The Proactive Engineer. This was a panel which discussed the theme of the conference - The Pro Active Engineer, and talked about the engineer being more visible and active in his community life and society as well as in determining his career path. The afternoon plenary session was divided between the YP's and the OP's. The OP session discussed career management, Work Force/Immigration issues, Financial Self-defense during career transitions, and M-PACS (Member Professional Awareness Conferences). IEEE has a new soft ware tool, CAM, which is a career asset manager. The work force issue presented and up-date on current immigration legislation and IEEE's position. The Sunday morning Plenary was a Tech Policy Session. Mr. Jim Turner, who is on the Science Committee Staff of the US House of Representatives spoke on pending legislation and how IEEE and individual members can be influential in the legislative process. The disarming bit of information that Mr. Turner presented was how few technically trained staff people there are on the Science Committee Staff. Under the current political mix, only four members of the Republican staff have any science background and only one is an engineer. There are 34 members of the Democrat staff who have science backgrounds. This is scary and makes it important that the professional societies work to see that our interests are made known in the legislative process. Mr. Turner stated the IEEE and ASME are well respected by the Science Committee and they do listen to our presentations. Mr. Turner did and excellent job of explaining how each of us can influence legislation through our local congressman. He pointed out that there is one person on each congressional staff that is charged with technology legislation. We should get to know that person and through them make contacts with our congressmen. It is amazing how much can be accomplished through e-mail and eye-ball contact with your congressman.

The Sunday afternoon Plenary was a joint session with two parts. The first was a report from the Ethics Committee of IEEE. The Ethics Committee has moved from USAB to an Institute Wide group and this was their first report. It received a lot of interest. One of the things they have been doing is to go through the IEEE bylaws and removing conflict statements that can cause ethical problems. They have also established an information hot-line for "whistle blowers". The second part of the plenary was a Student Professional Paper Competition. This was the first sponsored by PACE and three students presented papers. These were the winners from competitions held earlier in the year. PACE supported their attendance at the conference. The presentations were very interesting and well done. Prizes were awarded to the participants during the Awards Ceremony Sunday evening. It should be noted that there were a number of students attending the conference partly as a result of S-PAC programs.

The annual "Issues Forum" turned out to be a rather dull affair. This is usually the time where any one with an axe to grind brings it forward to be presented as an issue to USAB. Most of he issues were voted down and only three relatively minor issues were sent forward. One hot issue regarded immigration and legislation to tax industries that export jobs or hire foreign engineers at lower wages. There were several impassioned opinions voiced on both sides of this matter. In the end, it was not prudent for IEEE to take a stand that involved penalization of employers. The forum endorsed IEEE's position that immigration reform should be directed towards levelling the playing field for all engineers. In the wrap up Plenary on Monday morning, Joel Snyder, IEEE Vice President, Professional Activities, presented the current IEEE BOD proposal for reorganization and the establishment of IEEE-USA. It was an interesting concept and as usual there was a lot of opposition voiced by people who saw themselves as losing turf. The best part of the plan was that all of the executive and assembly positions were filled by membership vote. For 1997 dues and assessments will be the same as 1996 and IEEE-USA will be supported as USAB has been in the past.

The 1996 PACE Conference and Workshop was very successful and succeeded in training a new generation of leadership for IEEE. It also demonstrated that today's engineers are becoming pro-active and taking charge of their careers. They are looking out for themselves from both professional and financial points of view and recognize that they must continually be prepared for job changes throughout their career. The older professionals have a role to play too and are encouraged to act as mentors to their younger associates.

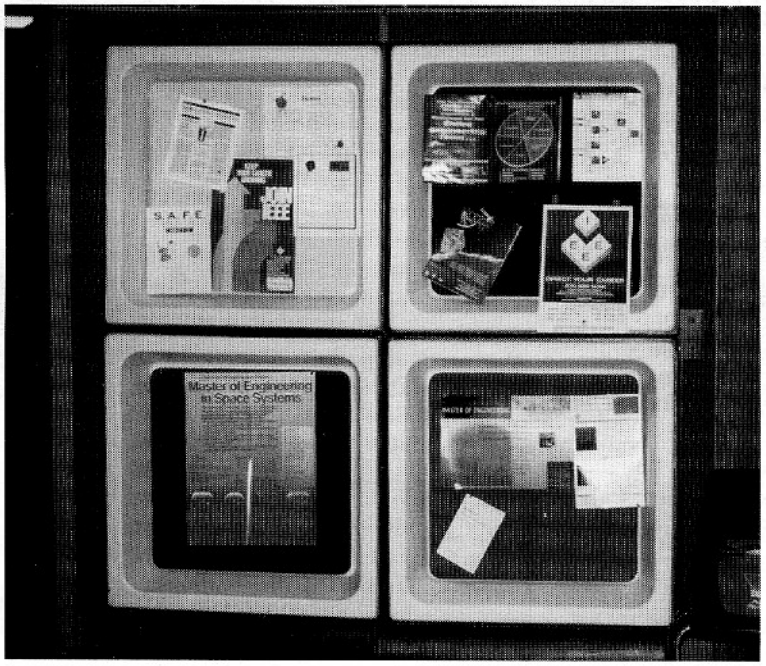
IEEE Student Branch at Seattle

Hello, we're the IEEE Student Branch at Seattle Pacific University. Our first engineering class started in the fall of 1984, and as juniors they founded our IEEE Student Branch in April 1986. Every year we focus on the new students and how to best represent the IEEE to them. To this effort we plan informal meetings, tours and alumni nights.

Last year we were fortunate to receive a display board from Ed Early, Seattle Section OES Chair. This display board had belonged to OES National and was stored in Ed's basement. When he mentioned that it was available for anyone who could use it, we decided that it would be a great place for us to advertise our meetings. The display board has allowed us to include other fields of study within our IEEE meetings, such as the Computer Science and Applied Science departments. This allows us ot highlight some of the options our students will have upon graduation.

We'd like to thank the members of the OES National for this display board. It has given us a central information location in our Science Building.

Sheri L. Rees
SPU IEEE Student Branch Chair '95-'97
MTS Councilor '96-'98
MTS Student Participation Committee Chair



Comment by Ed Early:

The display boards the Seattle Pacific University has received were used in the past at the OCEANS conferences but became both too expensive to ship around to the various conference sites and also inappropriate to the way booths are arranged. With the approval of President Czika I told the Seattle Section of IEEE that it was available for a worthwhile IEEE purpose, and it was grabbed up by S.P.U. which has a strong IEEE student branch. Actually the branch has become strong because of Sheri Rees who is also very active both in the Seattle Section and OES Chapter activities.

Chapter Activities

The French members of IEEE/OES (around 60 members) hat formed a chapter for 4 years now and thought that he could be a good idea to have a larger chapter in order to have a stronger representation and participation within the OES activities. Our first idea was to sent a "petition" to all European members in order to create a so-called "Eurochapter".

One of our goal was to try to strengthen the IEEE/OES community in Europe (at large), especially for countries where the critical number of members for starting a chapter was far from being reached. Another one was, of course, to encourage the countries having (or being able to reach) this possibility to do so. For instance Norway was being in the process of starting a chapter of his own and the Norwegian declined the offer to participate in the newly sought chapter.

The number of positive answers to the "petition" was sufficient for deciding IEEE headquarters to consider our proposition, which eventually came out as an "extension" of the French chapter, i.e. a body consisting all Region 8 members "attached" to the French chapter with a board being presided by a French and having a certain number of Region 8 members associated (not necessarily from all the countries). As a very large majority of members are from European countries there was no fundamental contradiction to proceed to the extension in the regional way sought be IEEE.

By the way, the new chapter is formed by more then 300 members. We then proceeded to formal elections, the outcome of which is as follows :

Rene Garello, Telecom Bretagne, President
Pierre Sabathe, (General Chairman of OCEANS'94), International relations
Jean-Yves Jourdain, Thomson Marconi Sonar
Vincent Rigaud, IFREMER
Rodney Coates, University. of Birmingham, England
Giuseppe Conte, University Ancona, Italy
Fernando Lobo Pereira. Porto University, Portugal

Among the possible action that the chapter is going to handle, I am pleased to announce the selection of Nice, France on the French Riviera for hosting the OCEANS conference in 1998. Nice is a renowned international place and has already hosted many large conferences. It is the main cities on the French airport allows an easy access from all major cities in the USA and Europe and its location makes it a definite best choice for many companies and Universities (national or international) working in the field of Oceanic Engineering. Several research groups in companies (Ifremer, Thomson-Marconi, ...) and Universities (Nice, Toulon, Marseilles) have expressed their interest and commitment for being part of that event. Furthermore, the organization and technical committees will benefit from the experience and advises of all the people that participated in OCEANS '94 held in Brest, France.

I would like to conclude to give a "personal" message to all Region 8 members : Please, do not hesitate to contact me by e-mail (or fax) if you feel that you can help either in the organization of OCEANS '9 8 or the "everyday life" of the chapter. Let me know particularly if you are organizing a workshop or a conference in order for the chapter to advertise and to act as a sponsor for your meeting. We are thinking to put an OES ("Region 8 Chapter") forum on the WEB.

Let me know your e-mail by contacting me at

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Upcoming Conferences

AES '97
First International Symposium and Exhibition, CIVIL OR MILIARY ALL ELECTRIC SHIP
Paris, France 13 & 14 March 1997
Contact: Frank Cipollone, SEE, 48 rue de la Procession-75724 PARIS Cedex 15 - FRANCE
Tel: +33 1 44 49 60 60/17 Fax: +33 1 44 49 60 44

4TH INTERNATIONAL CONFERENCE REMOTE SENSING FOR MARINE & COASTAL ENVIRONMENTS
Orlando, Florida 17-19 March 1997
Contact: ERIM/Marine Conference, P.O. Box 134001
Ann Arbor, MI 48113-4001
(313) 994-5123, ext 3234

OFFSHORE TECHNOLOGY CONFERENCE
Houston, Texas 5-8 May 1997
Contact: OTC (214) 952-9494 Fax: (214) 952-9435

SIGNAL & IMAGE PROCESSING (SIP'97)
New Orleans, LA 4-6 December 1997
Contact: Nader M. Namazi, Dept. of Electrical Engineering, The Catholic University of America, Washington, D.C. 20064

OCEANS '97 MTS/IEEE
Halifax, Nova Scotia 6-10 October 1997
Contact: Dr. Ferial El-Haway
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UNDERWATER TECHNOLOGY '98
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HOTLINES

IEEE-USA News Service November 1996

'CORPORATE RESPONSIBILITY' ISSUE HASN'T TRANSCENDED CAMPAIGN RHETORIC

After Republican presidential candidate Pat Buchanan injected the issue into the New Hampshire primary, "corporate citizenship" became a mantra in the 1996 political campaign, with politicians of both parties seeking to capitalize on pockets of economic insecurity and distrust of the changing corporate culture. Now that President Clinton has been re-elected, it is unclear whether the corporate-responsibility issue will resonate with the next administration or the 105th Congress.

Last year, several policy-makers urged the government to create incentives for responsible corporate citizenship. In February, Labor Secretary Robert Reich argued that companies need an economic reason to do things which are beneficial for society as a whole but which do not necessarily improve their balance sheets. President Clinton himself seized the "bully pulpit" by inviting 100 business leaders to a May 16 summit that exhorted U.S. businesses to emulate companies chosen as models of corporate citizenship.

In Congress, Sen. Edward Kennedy, D-Mass., introduced the American Workers Economic Security Act, calling for tax and other economic incentives to businesses that invest in education and training, child care, health insurance and retirement benefits, new technologies, and profit sharing.

The Kennedy bill echoed a Senate Democratic task force's conception of the model corporate citizen — the so-called "A-Corp," defined as a business allied with America's working families. Earlier, Sen. Jeff Bingaman, D-N.M., proposed that such corporations should "get the benefit of favorable tax, regulatory and government-contract treatment" if they met the following criteria:

- contribute at least 3 percent of payroll to a pension plan;
- spend at least 2 percent of payroll on employee training or education;
- offer their employees a health-care plan of which the employer pays at least half the cost;
- establish a profit-sharing plan for U.S. workers in which at least half of all employees participate;
- ensure that highly compensated employees receive no more than 50 times the compensation of the lowest-paid full-time employees;
- agree that 50 percent of new R&D investment, and 90 percent of plant investment, will occur in the United States; and
- maintain above average occupational safety and environmental compliance records.

IEEE-USA joined the debate in May by publishing full-page ads in THE WASHINGTON TIMES and ROLL CALL titled, "American Engineering and Corporate Citizenship." According to the IEEE-USA ads: "Government can encourage responsible corporate citizenship through tax and other incentives. Legislation to expand health-care and pension portability can be part of the solution. In the long run, however, it is up to individual companies to recognize the value of investing in their people and in their communities."

IEEE-USA is determined to work with the administration and Congress in 1997 to promote legislative improvements in pension portability, and to encourage employers to develop employer-employee relationships that help to attract, motivate and retain well-qualified workers.

IEEE-USA WEB UPDATE: ENERGY POLICY AND R&D POLICY COMMITTEES GO ON-LINE

Two key committees of IEEE-USA's Technology Policy Council have established new Web sites. IEEE-USA's Energy Policy Committee launched its web page on Nov. 12 to keep members up to date on IEEE-USA's efforts to promote sound energy-related policies, laws, and regulations at the national, state, and local level.

The IEEE-USA Research and Development Policy Committee's new Web presence aims to keep members informed of the committee's efforts to promote a strong national investment in research and development. The committee has also compiled on-line a comprehensive reference to R&D policy reports and resources, including science and technology documents from the United Kingdom, European Commission and Japan, as well as the U.S. government.

The Energy Policy Committee web page is located at URL <www.ieee.org/usab/DOCUMENTS/FORUM/COMMITTEE/epc.html>, while the R&D Policy Committee's site resides at <www.ieee.org/usab/DOCUMENTS/FORUM/COMMITTEE/rdc.htm>.

WANTED: IEEE CONSULTANTS

Anyone wishing to be included in the 1997 IEEE-USA DIRECTORY OF ELECTROTECHNOLOGY CONSULTANTS should contact IEEE-USA's Bill Anderson at 202-785-0017, ext. 330, or <w.anderson@ieee.org>, for more information on how to register for the directory and the Web database.

IEEE-USA SALARY SURVEY COMING SOON

IEEE-USA will mail the 1997 salary survey questionnaires to a sample of U.S. members in early January. If you receive one, please take the time to complete and return it. The survey report is an important source of information for members who are in salary negotiations and companies that are considering salary increases. Your contribution helps to ensure the statistical validity of the survey results.

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