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EDITOR: FREDERICK H. MALTZ SPRING 1992 (USPS 420-910)

AUV '92
WASHINGTON, DC

Symposium on Autonomous Underwater Vehicle Technology

Program

June 2 and 3, 1992

Washington Dulles Airport Marriott
Washington, DC

(Continued on inside back cover)

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New OES Journal Editor

Effective January 1, 1992, Dr. William Carey of the Defense Advanced Research Projects Agency (DARPA) was named as the Editor of the Journal of the Oceanic Engineering Society of the IEEE. Bill succeeds Dr. Fred Fisher of the Marine Physical Laboratory at Scripps Institution of Oceanography. Fred has carried the Journal through some quite interesting times over the last four years, and has been most instrumental in enhancing Journal offerings with Special Issues covering a wide array of topics. Fred, please accept the appreciation of the entire society for a job well done.

Many of you know Dr. Carey of NUSC (now NUWC) fame. Our DARPA Dr. Carey is one in the same, as Bill moved to DARPA as of the first of the year. Bill is a Senior Member of the IEEE, and is a Fellow of the Acoustical Society of America. He's also a Member of Sigma Xi and has a history of service on technical committees of several organizations. Bill has worked as a Research Physicist in NUWC, NORDA, and NRL, and continues in that capacity at DARPA. His responsibilities include program management and the conduction of basic and exploratory research in applied ocean acoustics, with specific research areas involving ocean ambient noise, low frequency sound scattering, properties of acoustic arrays, and active signal processing. He has been a Principal Investigator on several projects funded by the Office of Naval Research and the Office of Naval Technology, the Long Range Acoustic Propagation Project, and the Signal Propagation and Noise Studies Projects in the Mediterranean, Pacific and Atlantic Oceans, as well as the Gulf of Mexico.

Bill brings an impressive list of credentials to this position, as he has extensive conference participation and numerous publications in the Journals of the Oceanic Engineering Society and the Acoustical Society of America, among others. He also brings his own personal enthusiasm to work with the Associate Editors to take the OES Journal to the next level among the recognized archival publications.

The Oceanic Engineering Society is extremely pleased that Dr. Carey has accepted this Editorship position. Please take an opportunity to welcome Bill aboard and work with him in his new endeavors.

Glen N. Williams, Ph.D., P.E.
President – Oceanic Engineering Society

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

Presently, he is a Research Physicist in the Surface Ship ASW Directorate at the Naval Underwater Systems Center, New London, CT. Prior to this assignment, he was with the Naval Ocean Research and Development Activity and the Naval Research Laboratory. He was also a manager and scientist at the Argonne National Laboratory.

Dr. Carey is a Fellow of the Acoustical Society of America and a Member of Sigma Xi.

WASHINGTON, DC

AUV '92

to be held in the Washington, D. C. metropolitan area at the Dulles Airport Marriott Hotel

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS OCEANIC ENGINEERING SOCIETY

AUV 92

SYMPOSIUM ON AUTONOMOUS UNDERWATER VEHICLE TECHNOLOGY
June 2 and 3, 1992

PROGRAM

PLENARY SESSION

Tuesday, June 2, 1992
8:30 am - 9:00 am

Introductory remarks: CAPT Alan Beam, *DARPA*

Invited Speaker

AUV92 VEHICLE DESIGN I
Tuesday, June 2, 1992
9:00 am - 12:00 noon

Chairperson: Dr. Dana Yoerger,
Woods Hole Oceanographic Institution

Integrated Simulation for Rapid Development of Autonomous Underwater Vehicles
Donald P. Brutzman, Yutaka Kanayama and Michael J. Zyda, *Computer Science Dept., Naval Postgraduate School, Monterey, CA*

Development of Multipurpose Graphic Simulator for Autonomous Underwater Vehicles
J. Yuh and V. Adivi, *Autonomous Systems Laboratory Dept. of Mechanical Engineering, University of Hawaii, Honolulu, HI*

Local-Remote Telerobotics for Autonomous Underwater Vehicles
Paul G. Backes, *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA*

Naval Architectural and Powerplant Selection for Underwater Vessels
I. J. Potter and G. T. Reader, *Dept. of Mechanical Engineering, University of Canary, Calgary, Alberta Canada*

Semi-Autonomous Underwater Vehicles for Shallow Water Mineclearing
R. Peter Bonasso, Jr. and Dana R. Yoerger, *Autonomous Systems Laboratory, The MITRE Corporation, McLean, VA*

Self-Powered Underwater Vehicle for MCM Operations
S. Ghignone, A. Ortel'i and C. Podesta, *Riva Calzoni S.p.A., Calzoni Division, Bologna, Italy*

AUV92 MISSION MANAGEMENT/CONTROL I
Tuesday, June 2, 1992
9:00 am - 12:00 noon

Chairperson: Dr. Anthony Healey,
Naval Postgraduate School

Autonomous Vehicle Software Taxenomy
William Hall, *The Charles Stark Draper Laboratory, Cambridge, MA*

Design and Experimental Verification of Mission Planning by Autonomous Mission Execution and Data Visualization Using the NPS AUV II
A. J. Healey and D. B. Marco, *Naval Postgraduate School Monterey, CA*

Multi-Sensor Based AUV with Distributed Vehicle Management Architecture
Teruo Fujiii, Tamki Ura, Yoji Kuroda and Yoshiaki Nose, *Institute of Industrial Science, University of Tokyo, Tokyo, Japan*

AUV Path Planning: An A* Approach to Path Planning with Consideration of Variable Vehicle Speeds and Multiple, Overlapping Time-Invariant Exclusion Zones
Kevin P. Carroll, Stephen R. McClaran, Eric L. Nelson, Dave M. Barnett, Donald K. Friesen and Glen N. Williams, *Dept. of Computer Science, AUV Laboratory, Texas A&M University, College Station, TX*

Integrated Mission Planning Autorouting System With UUV Sensor Platforms
Mike Puleiot, General Dynamics, Convair Division, San Diego, CA Jeffrey T. Smith, *General Dynamics, Applied Remote Technology, San Diego, CA*

Three Dimensional Path Planning for AUV
Liu Shuzhong and Song Guaning, *Artificial Intelligence Laboratory, Shengyang Institute of Automation, Shengyang, P. R. China*

A Simple Approach to Planning and Executing Complex AUV Missions
Mimi Kao, Geoff Weitzel and Xichi Zheng, *ISE Research Ltd., Port Coquitlam, British Columbia, Canada*
Mervin Black, *Defense Research Establishment Pacific, Esquimalt British Columbia, Canada*

AUV92 VEHICLE DESIGN II
Tuesday, June 2, 1992
1:00 pm - 4:30 pm

Chairperson: Claude Brancart,
Charles Stark Draper Laboratories

Dynamic Simulation Tools for the Analysis and Design of AUV's
Riccardo Bono, Giorigio Cannata, Giuseppe Casalino and Gianmarco Veruggio, *Naval Automation Institute, National Research Council, Genova, Italy*

Dynamic Cable-Body Computations for an AUV with a Towed Secondary Body
John R. Guala, *Westinghouse Electric Corp., Oceanic Division, Annapolis, MD*

Hydrodynamics of Simple Robot Arm/Body Configuration
Carlos Rivera and Michael Hinchley, *Ocean Engineering Research Centre, Memorial University of Newfoundland, St. Johns, Newfoundland, Canada*

Cooling of Electronics in Underwater Vehicles Using Heat Pipes
G. W. Somers and J. M. Mang, *Westinghouse Electric Corporation, Annapolis, MD*

A Gas Actuated Hydraulic Actuator for Underwater Robots
Karen Muggeridge and Michael Hinchey, *Ocean Engineering Research Centre, Memorial University of Newfoundland, St. John's, Newfoundland, Canada*

AUV Trends Over the World in the Future Decade
Liu Yongkuan, *Underwater Laboratory, Shenyang R&D Centre of Robotics, The Chinese Academy of Sciences, Shenyang, P.R.C.*

AUV92 MISSION MANAGEMENT/CONTROL II
Tuesday, June 2, 1992
1:00 pm - 5:00 pm

Chairperson: Dr. Alan Schultz,
Naval Research Laboratory

Integrating Learned Behaviors In Autonomous Underwater Vehicles
Alan C. Schultz and John J. Grefenstette, *Navy Center for Applied Research in Artificial Intelligence, Naval Research Laboratory, Washington, DC*

Neural Network Based Approach to Failure Diagnostics for Underwater Vehicles
A. J. Healey, *Naval Postgraduate School, Monterey, CA*

An Experimental Comparison of Hierarchical and Subsumption Software Architectures for Control of an Autonomous Underwater Vehicle
R. B. Byrnes, S. H. Kwak, M. L. Nelson and R. B. McGhee, *Department of Computer Science, Naval Postgraduate School, Monterey, CA*

Layered Control of a Practical AUV
Xichi Zheng, *ISE Research Ltd., Port Coquitlam British Columbia, Canada*

A Fully Distributed AUV Control Architecture
Dave M. Barnett, Donald K. Friesen and Glen N. Williams, *Dept. of Computer Science, AUV Laboratory, Texas A&M University, College Station, TX*

FTMP: A Protocol for Distributed Fault Tolerant Operating System Services for an AUV Control System
Dave K. Hess, Udo W. Pooch and Glen N. Williams, *Dept. of Computer Science, AUV Laboratory, Texas A&M University, College Station, TX*

User Interface Design Strategies for AUVC Software Development
Eric L. Nelson, John F. DeSol, John W. Mollenharner and Stephen R. McClaran, *Dept. of Computer Science, AUV Laboratory, Texas A&M University, College Station, TX*

Adaptive Testing of Controllers for Autonomous Vehicles
Alan C. Schultz, John J. Grefenstette and Kenneth A. De Jorg, *Navy Center for Applied Research in Artificial Intelligence, Naval Research Laboratory Washington, DC*

AUV92 COMMUNICATIONS
Tuesday, June 2, 1992
1:00 pm - 4:30 pm

Chairperson: Dr. Donald Miller,
Naval Undersea Warfare Center

An Improved Acoustic Communication System for Autonomous Underwater Vehicles
William R. Garner, *Applied Remote Technology Inc., San Diego, CA*

Robust Multiuser Communication for Underwater Acoustic Channels
David Brady, *Electrical and Computer Engineering Dept., Northeastern University*
Josko A. Catipovic, *Woods Hole Oceanographic Institute Smith Laboratory, Wood's Hole, MA*

Phase Coherent Acoustic Communication for Shallow Water Dynamic Multipath Channels
Geir Helge Sandsmark, *DELAB/Univ. of Trondheim Norway*
Josko A. Catipovic, *Woods Hole Oceanographic Institute Smith Laboratory, Wood's Hole, MA*
Cory Myers, *Lockheed/Sanders Inc.*

High Data Rate Telemetry Using Code-Division Multiple-Access (CDMA) Modulation
John W. Irza, *C. S. Draper Laboratory Inc., Cambridge, MA*

High Data Rate Undersea Laser Communication System
James H. Morris, *Jamar Technology Co., San Diego, CA*

Coupled Command Generator for Tethered UUV System
Douglas W. Fries, *Lockheed Missiles and Space Co., Inc., Sunnyvale, CA*

AUV92 SENSORS I
Wednesday, June 3, 1992
8:30 am - 12 noon

Chairperson: Norman Estabrook, *Naval Command, Control and Ocean Surveillance Center*

Automatic Camera Control for AUV's: A Comparison of Image Assessment Methods
J. Chu, L. Lieberman and P. Downes, *Westinghouse Electric Corporation, Annapolis, MD*

Use of Laser Scanning Systems on Mobile Underwater Platforms
Bryan W. Coles, Alan Gordon and William Herr, *Spectrum Engineering, Inc., San Diego, CA*

Dynamic Turbidity and Range Measurement to Enhance Light Employment for Underwater Visual Image Collection
Gary M. Trimble, J. A. Vilaro, D. T. Okamura and R. Lee, *Marine Systems, Lockheed Missiles and Space Co., Inc., Sunnyvale, CA*

A New Dynamic Performance Improvement Method for Multi-Sensor Systems
Jun-Qin Huang and Xiaomao Xiao, *Dept. of Automatic Control, Beijing University of Aeronautics & Astronautics, Beijing, P. R. China*

AUV92 ENERGY/PROPULSION
Wednesday, June 3, 1992
8:00 am - 12 noon

Chairperson: Dick Bloomquist, *David Taylor Research Center*

A Knowledge Based Aid for the Selection of Autonomous Underwater Vehicle Energy Systems
Lt. Commander J.G. Hawley, *Royal Naval Engineering College, Manadon, Plymouth, UK*
Professor G.T. Reader, *University of Canary, Canary, Canada*

A Performance Envelope Comparison of H_2-O_2 Fuel Coils and Advanced Battery Power System for Autonomous Underwater Vehicles
Gary Schubak and Dr. David Sanborn Scott, *Institute for Integrated Energy Systems and Mechanical Engineering, University of Victoria, Victoria, British Columbia, Canada*

Aluminum Silver Oxide Reserve Primary Battery for Small Submersibles
Kenneth J. Gregg and Marylin J. Niksa, *ELTECH Research Corporation, Fairport Harbor, OH*

A Wick Combustor Based Liquid Metal Energy Source for UUV Applications
T. G. Hughes, *Applied Research Laboratory, The Pennsylvania State University, State College, PA*

Technology Challenges and Optimization of Superconducting Electromagnetic Thrusters (SCEMT) for Small Undersea Vehicle Applications
Peter J. Hendricks and J. Dana Hrubes, *Naval Underwater Systems Center, Newport, RI*

Quiet Underwater Propulsion Motors and Controllers
Roy Alien Kampmeyer, *Westinghouse Electric Corporation, Oceanic Division, Annapolis, MD*

AUV92 SENSORS II
Wednesday, June 3, 1992
1:00 pm - 5:00 pm

Chairperson: Dr. Edward Belcher, *Applied Physics Laboratory University of Washington*

High-Resolution Monopulse Piezopolymer Sonar Sensor
Shawn E. Burke and Paul A. Rosenstrach, *The Charles Stalk Draper Laboratory, Cambridge, MA*

A Low Frequency High Resolution Sonar for AUV's
John W. Irza and John A. Halsema, *C. S. Draper Laboratory, Inc., Cambridge, MA*

A Shaped PVDF Hydrophone för Producing Low Sidelobe Beampatterns
W. Jack Hughes and Charles W. Allen, *The Pennsylvania State University, Applied Research Laboratory, State College, PA*

An Acoustic Lens Sonar Using Micromechanical Hydrophones for Unmanned Undersea Vehicles
Jonathan Bernstein and Paul Rosenstrach, *The Charles Stalk Draper Laboratory, Cambridge, MA*

3-D Reconstruction of Small Underwater Objects Using High-Resolution Sonar Data
Lawrence J. Rosenblum and Behzad Kamgar-Parsi, *Naval Research Laboratory, Washington, DC*

Synthetic Aperture Beamforming with Automatic Phase Compensation for High Frequency Sonars
Robert W. Sheriff, *Westinghouse Electric Corporation, Oceanic Division, Annapolis, MD*

Weight, Volume, and Power Consumption Reduction In Side Look Sonar Systems for Autonomous Underwater Vehicles
Paul E. Jaenke, *Westinghouse Electric Corporation, Oceanic Division, Annapolis, MD*

A New Adaptive Signal Detector in the Noises
Haung Junquin and Meng Xiafeng, *Dept. of Automatic Control, Beijing University of Aeronautics and Astronautics; Beijing, China*

AUV92 L&R AND NAVIGATION
Wednesday, June 3, 1992
1:00 pm - 5:00 pm

Chairperson: Dr. James Bellingham, *MIT Sea Grant Program*

A Distributed Launch and Recovery System for an AUV and a Manned Submersible
Robert C. Gwin III, *General Dynamics, Electric Boat Div., Groton, CT*
Jeffrey T. Smith, *General Dynamics, Applied Remote Technology, San Diego, CA*

Launch and Recovery System for Autonomous Underwater Vehicle EXPLORER-01
Wang Ditang, Guan Yulin and Kang Shouquan, *Underwater Laboratory, Shengyang Research & Development Center of Robotics, The Chinese Academy of Sciences, Shenyang, P. R. C.*

Robot Crane for Underwater Vehicle's Automatic Launching and Retrieval
S. Ghignone, A. Ortelli and C. Podesta, *Riva Calzoni S.p.A., Calzoni Division, Bologna, Italy*

Incorporation of Global Positioning System Into Autonomous Underwater Vehicle Navigation
James B. McKeon, Se-Hung H. Kwak and Robert B. McGhee, *Naval Postgraduate School, Monterey, CA*

The Application of the Correlation Sonar to Autonomous Underwater Vehicle Navigation
Brian L. Grose, *EDO Corporation, Electro-Acoustic Division, Salt Lake City, UT*

Hyperbolic Acoustic Navigation Designed for Multiple Untethered Vehicles
James G. Bellingham, Thomas Consi and Usha Tedrow, *Massachusetts Institute of Technology, Sea Grant College Program, Cambridge, MA*

New Report Analyzes R&D Initiatives in National Defense Authorization Act

WASHINGTON, March 13 — A new report highlighting key provisions of the National Defense Authorization Act is available from the United States Activities' arm of The Institute of Electrical and Electronics Engineers, Inc., (IEEE-USA).

The report describes authorized research, development, test and evaluation (RDT&E) funding levels at the Pentagon. It also examines restructuring of the Strategic Defense Initiative, liberalization of independent research and development/bid and proposal rules, and defense industrial and technology base initiatives.

The defense technology base is increasingly indistinguishable from the national technology base, according to the reports author, Chris J. Brantley, administrator of professional programs for IEEE-USA.

Defense spending represents approximately 60 percent of Me Federal investment in research and development and over 25 percent of the total national investment. As such, the annual legislation that authorizes appropriations for defense RDT&E has become an important vehicle for Congressional initiatives that promote U.S. technological competitiveness. *Public Law 102-190*, the *Defense Authorization Act* for fiscal years 1992 and 1993, was signed by the President last December 5.

The IEEE is the world's largest technical professional society, with more than 320,000 members in over 145 countries. The Institute is a leading authority on areas ranging horn aerospace, computers and communications to biomedical technology, electric power and consumer electronics. IEEE-USA promotes the career and technology policy interests of nearly 250,000 U. S. members of the IEEE.

Copies of the *Defense Authorization Act* report may be obtained without charge by writing Sharon Richardson, IEEE-USA, 1828 L Street, NW, Suite 1202, Washington, DC 20036-5104.

IEEE NEWS BRIEF

To minimize travel and meeting expenses for staff and volunteer committee meetings, the use of teleconferencing is encouraged. The IEEE facilities in NY, NJ and DC provide teleconference capabilities for conducting meetings with people at off site locations.

Each facility has the ability to set up a conference room with teleconferencing equipment suitable for a small group. Small committees may find it convenient to conduct short meetings by gathering at one or more of the IEEE facilities and tie in with other committee members by phone to minimize travel.

To arrange for conference rooms and teleconferencing use the list of contacts shown below:

NY - Valorie White	212-705-7900
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DC - Arnette Riddick	202-785-0017

Easels, flip charts, overhead projectors & other meeting support equipment is available for use at these meetings & may be reserved at the time meetings are set-up. Food service is available at cost to the requestor.

(Reprinted from Oceans '91 Conference)

THE MBARI PROGRAM FOR OBTAINING REAL-TIME MEASUREMENTS IN MONTEREY BAY

F.P. Chavez, H.W. Jannasch, K.S. Johnson, C.M. Sakamoto, G.E. Friederich, G.D. Thurmond, R.A. Herlien and L.A. Codispoti

Monterey Bay Aquarium Research Institute
160 Central Avenue
Pacific Grove, CA 93950

ABSTRACT

The Monterey Bay Aquarium Research Institute (MBARI) has among its major goals the development of new technology for studying the sea and providing a better understanding of Monterey Bay and the Monterey Canyon. To pursue these goals, moored instruments that can telemeter meteorological data, thermistor chain temperatures, and the chlorophyll content of the waters in the bay have been deployed. New instruments for obtaining real-time chemical data are also being developed. These include a pumping system that provides vertical nutrient profiles immediately after a cast, an *in-situ* nitrate analyzer, and an "idiot-proof" mapping system. Results from the instruments that are already in place demonstrate the relationships between meteorological forcing, upwelling events and primary production rates in Monterey Bay. Preliminary modeling of these data suggest that much of the primary production signal can be predicted from local winds and annual irradiance cycles. The continuous nature of the time-series shows complexity in the transition between the three oceanographic seasons in Monterey Bay (Upwelling, Davidson Current, Oceanic) not previously reported.

INTRODUCTION

Discrete measurements of properties made throughout the global ocean, beginning with the British Challenger expedition, through the days of Gran[1], Sverdrup[2], Riley[3], Menzel[4] and programs such as GEOSECS and more recently JGOFS and WOCE, have provided the basis for the development of conceptual models which relate biological and chemical processes to the dynamics of the ocean circulation. As a result, the large scale patterns of nutrient distribution and ocean productivity are relatively well described in the literature[5,6,7,8,9] and while the subject is still under debate, maps of ocean production from the first intuitive effort by Sverdrup[10] to the more recent objective analysis by Berger[9] are surprisingly similar.

It is clear, however, that current global estimates of biogeochemical ocean rate processes are only accurate to an order of magnitude, partly as a result of the temporal and spatial aliasing of the discrete measurements (see Levitus[11] for further discussion of the spatial aliasing problem and any time series text book for temporal aliasing). The need for accurate estimates of biological and chemical properties has become even more important as the result of increasing anthropogenic inputs into the oceans and atmosphere. In addition to accurate estimates, the regulation of biological and chemical variability needs to be understood to provide a mechanistic explanation of the climate/productivity feedback loop. Continuous observations of physical and meteorological properties that resolve the important scales of variability are currently being taken throughout the globe, but there are few parallel concurrent observations of biological and/or chemical properties. To develop a predictive and quantitative understanding of the now well-described relationships and to test the validity of analytical models, measurements of biological and chemical properties on the appropriate time and space scale are required. The needed coverage will ultimately come from a combination of observations made from space and from moorings and drifters with arrays of *in situ* sensors. These, of course, will still need to be supplemented by shipboard observations.

This contribution describes a program for studying the spectrum of biological and chemical variability in Monterey Bay. There are multiple, somewhat independent, aspects to the program but the unifying theme is the desire to obtain continuous spatial and temporal series of biological and chemical properties on scales that are equivalent to physical measurements such as ocean currents, local winds, temperature, salinity, sea level etc. Three aspects are emphasized: 1) continuous vertical and horizontal measurements of chemical properties; 2) chemical sensors for long-term untended ocean observations; and 3) a mooring with biological, chemical and physical sensors capable of real-time data telemetry.

THE SETTING

The Monterey Bay Aquarium Research Institute (MBARI) was founded in 1987 by David Packard to "develop better equipment, instrumentation and procedures for scientific research". The objective is to use Monterey Bay as a test-bed for technology development; the result being that a thorough understanding of the biogeochemical dynamics of the system would be achieved. This task is made easier as a result of the presence of several other local institutions with active ocean research programs: 1) the Naval Postgraduate School, 2) the Hopkins Marine Station of Stanford University, 3) Moss Landing Marine Laboratories of the California State University system, 4) UC Santa Cruz, 5) several NOAA laboratories including the newly formed Center for Ocean Analysis and Prediction (COAP).

Monterey Bay is located at the eastern edge of the California Current, on the eastern boundary of the North Pacific gyre. While northwesterly (upwelling-favorable) winds prevail over most of the year, their intensity is strongest during the late spring[12,13]. Cold water is often found in the central and outer portions of the Bay during the upwelling season, while warm water is found inside the Bay in a narrow band nearshore[14,15,16]. The fall and the spring are transition periods between the "upwelling" regime and the winter period when horizontal and vertical thermal gradients are reduced and the Davidson Current flows over the shelf and slope in a predominantly northward direction all along the central California coast[15,17,18]. During the fall transition period, the warmer oceanic waters come closer to shore prior to the appearance of the so-called Davidson Current. Three oceanographic seasons have been defined for Monterey Bay: 1) upwelling, 2) oceanic and 3) Davidson[15,17] and these are evident in a time series of temperature structure from a MBARI mooring (Fig. 1).

A deep submarine canyon, Monterey Canyon, penetrates the Bay (Fig. 2) so that pristine deep waters, with strong eastern boundary character, are relatively close to shore. For example, moorings deployed by the MBARI are in 1000 m of water but at less than an hour's boat ride from shore allowing for testing of new deep-ocean technology with relative ease.

The field program at MBARI can be divided into three major areas: 1) observations from an ROV; 2) repeated observations from MBARI's research vessel the POINT LOBOS; and 3) observations from moorings. An example from the first area is described in a companion paper by Pilskaln et al.. Examples from the other two areas are described below.

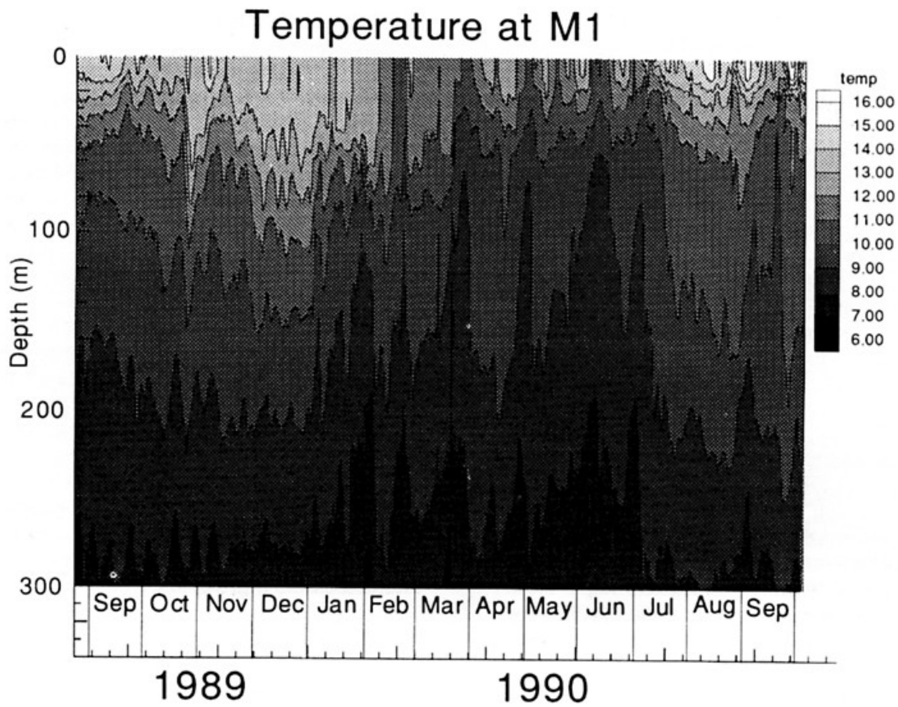

Figure 1. Time series of temperature structure from the M1 (see Fig. 2) ATLAS mooring. Electronic failure resulted in a data gap from January through March 1989 and the gap was filled in with data from the M2 mooring. Evident are the three oceanographic seasons: 1) the upwelling period with raised isotherms from February-June; 2) the oceanic season with warmer surface temperatures, increased surface stratification and deeper isotherms from July-September and 3) the winter Davidson period with deeper mixed layers from October-January.

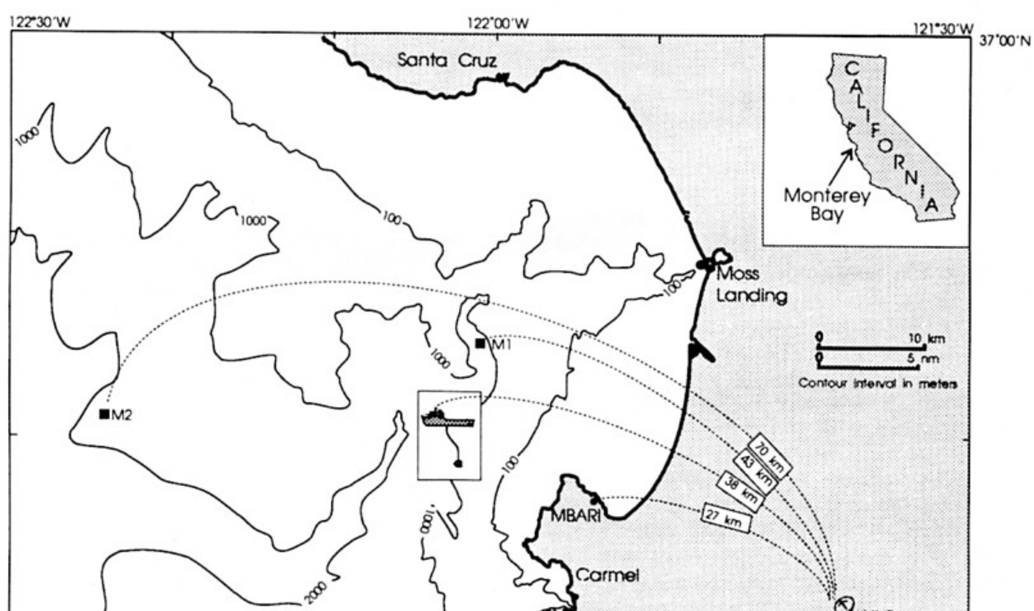

Figure 2. Map showing the location of two ATLAS moorings (M1 and M2) deployed in the waters adjacent to Monterey Bay. Also shown are the location of a receiving station on Mt. Toro, MBARI's facilities in Pacific Grove and a site on the walls of Monterey Canyon frequently visited by the R/V POINT LOBOS and its ROV VENTANA. Live video and data will be transmited from the ship and the two moorings to Mt. Toro and subsequently to the lab in Pacific Grove.

CONTINUOUS VERTICAL AND HORIZONTAL MEASUREMENTS OF NITRATE

An automated surface nitrate mapping system

This project involves the development of a user-friendly automated shipboard mapping system for measuring surface seawater nitrate concentrations. The goal has been to develop a system to measure seawater nitrate concentrations that any individual with minimal instruction can operate and that it requires only once a week servicing. The ultimate goal is to produce a system that can operate from ships of opportunity for periods of several months with no attention beyond turning a switch off and on when prompted by the computer. The existing system is already highly suitable for situations where it can be serviced weekly (e.g. research vessels, ferries).

A version of this system is now in place on the POINT LOBOS and is undergoing shipboard testing. Surface seawater is pumped from the intake below the hull of the ship past temperature, conductivity, and fluorescence sensors. A portion of this stream flows to the nitrate analytical system housed in a van on the ship. The present analytical system is based on an Alpkem Rapid Flow Analyzer (RFA). Surface seawater is drawn from this flowing stream across a 10 micron Nuclepore filter. The appropriate reagents are added and the color development is measured. An MS-DOS computer is used as a controller and data logger, recording data once every 10 seconds. Standards are run automatically at startup, at shutdown, and once an hour during the course of the day. The output is plotted on the screen, providing real-time estimates of the surface nitrate concentrations. Earth-location and merging with ancillary data (temperature, salinity, fluorescence, etc) presently occurs post-cruise (Fig. 3) but the long-term goal is to place the data on a local area network (LAN) to enable real-time earth-location and telemetry of the data to shore.

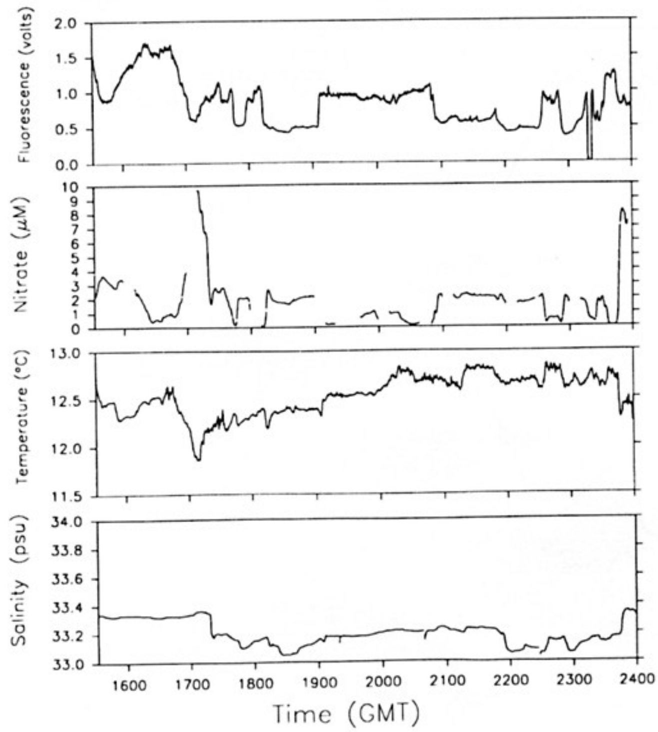

Figure 3. Near-surface properties collected continuously in Monterey Bay on February 21, 1991. Temperature, salinity and fluorescence were logged with a Seabird SBE. Nitrate was analyzed and collected with an Alpkem RFA system coupled to an HP Vectra personal computer.

A pumping system for continuous vertical profiles of chemical constituents

The present version of the profiling pump system is based on a prototype described by Friederich and Codispoti[19]. A hydraulic winch is used to deploy 400 m of cable to which the pump, a Sea Tech light transmissometer, and a Seabird SBE-9/11 CTD are attached. The winch is designed to give smooth lowering speeds from near 0 to 20 m per minute. Tests during very calm conditions suggest that lowering speeds of 6 m per minute are optimal.

The center of the pump cable consists of a continuous nylon hose with an internal diameter of 6 mm. The hose is surrounded by a Kevlar strength member; electrical conductors for data and power transmission form the next layer. A Dacron braid forms the outer jacket. The pump is a stainless steel and graphite positive displacement vane pump, coupled to a submersible deep well pump motor. The flow rate of about 4 liters per minute results in a travel time through the pump tubing of about 3 minutes. Delay times for the entire system including the time for each chemical analysis are derived for each cast by stopping the pump/CTD system for a short time during a profile and then matching the plateau generated in the chemical profile with that of the CTD pressure readings.

An Alpkem Rapid Flow Analyzer (RFA) system is used to perform the nutrient analyses. Data are acquired and processed by an HP Vectra ES/12, MS-DOS based computer. Preliminary color profiles of CTD, light transmission profiles can be displayed within minutes of collection, the time lags being determined principally by passage times through the pump tubing and analytical systems.

This system can form the basis of a data assimilating CTD/chemical probe because chemical data can be collected from the sample stream which is pumped directly into the laboratory, eliminating the need for collecting samples from bottles. Aside from measuring standard oceanographic variables such as temperature, salinity, oxygen, nitrate, nitrite, ammonium, phosphate, and dissolved silicon (Fig. 4), this system was used for obtaining samples for microbial experiments, trace metal oxidation experiments, sulfide oxidation experiments, sulfide analysis, trace metal analysis and specialized fluorescence data. The system is especially adapted to any chemical method that can currently be carried out in a

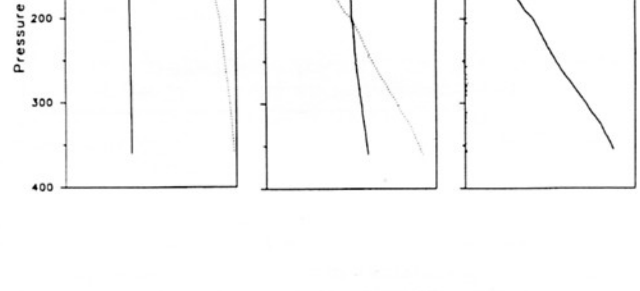

Figure 4. Continuous vertical profiles of nutrients, temperature and salinity collected with the pump profiling system in the Black Sea[20].

continuous mode in the laboratory. Batch subsampling during a profile is also feasible. The system can profile at rates of about 20 meters per minute and maintain and provide water with a vertical resolution of about one meter. In practice, profiling has been done at a slower rate (10 m/min) due to the response rate of the chemical analysis systems used and due to the uncertainty of the exact response functions. Besides providing high resolution chemical profiles, this system can produce these data in real time. During the 1988 Black Sea Expedition, much of the sampling strategy near the oxic/anoxic interface was guided by the availability of the chemical data during the pump casts (Fig. 4).

Marrying the pump technology with the automated mapping system, should make it possible for two to three scientists to take a complete suite of physical and chemical data during a typical hydrographic cruise. The goal is to develop a simplified pump system with predictable flow characteristics and greater depth capability. Such a system will remain useful even as *in-situ* methods are developed for some of the more routine parameters since it is easy to adapt most laboratory methods for use with this system.

The existing pumping system has performed well to depths of about 400 m and a scaled down hand deployed system has been used to depths of about 150 m[20,21,22].

A LONG TERM IN-SITU NITRATE ANALYZER

The long-range objectives of this program are the development of automated chemical sensors for dissolved chemicals in seawater and the application of this technology to further our understanding of chemical cycles in the ocean. The goal for 1991 is to construct an *in-situ* analyzer for measuring dissolved nitrate in seawater. The analyzer will be capable of operating unattended for periods on the order of 1 year and of detecting at least 0.1 µmol/liter nitrate. Laboratory tests of a nitrite analyzer have been completed and testing of a prototype nitrate analyzer is now under way (Fig. 5).

The analyzer used for this work is based on the continuous flow analysis principle[23,24,25,26,27,28]. Chemical reagents are continuously reacted with specific chemical compounds dissolved in the ocean by pumping the reagents into a stream of seawater that is flowing through a capillary tube. The colored products of the reactions are detected photometrically. Concentrations as low as 20 to 30 nM can be detected by this technique.

The use of this technology for long-term unattended deployments has now been made possible with the aid of osmotic pumps. These pumps utilize the osmotic pressure difference between a saline solution such as seawater and a saturated salt solution within the pump. Osmotic pumps deliver chemical reagents continuously at the required µl/hour flow rates. They require no external power, have only one moving part (a collapsible reagent bag), and pump at reproducible flow rates. Osmotic pumps have been used extensively for biomedical applications where they are implanted in laboratory animals. These pumps have been successfully incorporated into the prototype system (Fig. 5).

New nutrient sensors in the following years will include silica, phosphate and possibly ammonia. The development of trace metal sensors, most likely using chemiluminescent chemistries will be significantly more difficult because of the much lower concentrations at which these metals are found. Chemiluminescent chemistries for Co, Cu, Mn, and Fe are already worked out[29,30,31], but need to be adapted to a submersible low-power detection system. Charge-coupled device (CCD) and diode-array light detectors are being studied as substitutes for high-power photo-multiplier tubes that are currently used to detect the chemiluminescence.

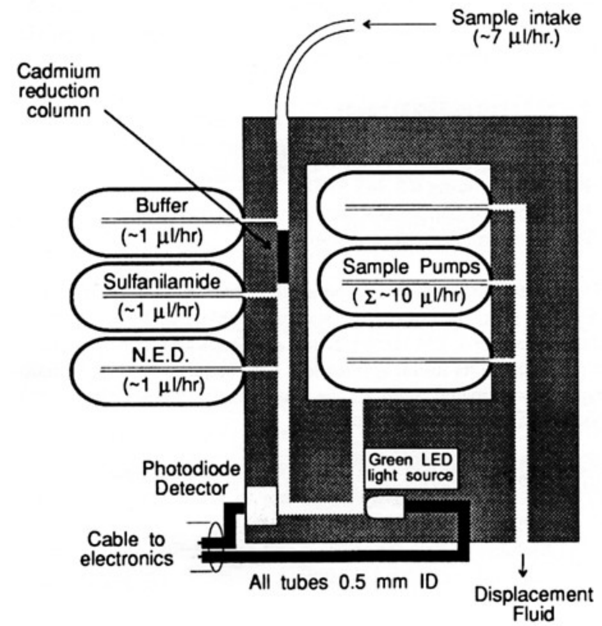

Figure 5. The long-term *in-situ* analyzer. This system utilizes the standard photometric azo-dye chemistry as a miniature flow analysis system to analyze for nitrate. Osmotic pumps are used to create a sample flow (the three pumps shown to the right) and add reagents (the three pumps at the left). Water diffuses into the pumps through their rigid exterior, and forces the reagent in an enclosed impermeable collapsible bag out through the tube. Nitrate concentrations are measured by a simple LED/photodiode photometer. Prototype analyzers utilizing commercially available 2 ml pumps have an approximate 3-4 week duration, and measure about 5x5x10 cm. Larger pumps with year-long lifetimes (100 ml) have run successfully now for over six months.

THE OASIS MOORING

MBARI currently maintains two ATLAS (Automated Temperature Line Acquisition System) moorings in the waters of Monterey Bay and is in the process of developing a new set of control electronics capable of assimilating data from multiple instruments and telemetering it real time via packet-radio and/or ARGOS. The ATLAS is a relatively inexpensive (~40K) but reliable and extensively used mooring system developed at PMEL[32]. It has meteorological instruments and a thermistor chain, key measurements that we believe tell us a great deal about the character and productivity of ecosystems[33]. The net of ATLAS moorings is most extensive in the tropics[34] but these platforms can be found at high latitudes as well (Milburn, personal communication). Because there is a large fleet of these systems (the ATLAS is probably the most abundant mooring in the ocean today), development and/or testing carried out in Monterey Bay is immediately transportable to several locations throughout the globe

The engineering objective of the mooring project has been to develop a new set of control electronics and software that will allow for the collection, storage, and telemetry of data from any of a wide range of scientific instrumentation. Expectations are that this work will be a beneficial contribution to the scientific community that employs moored instrumentation.

Specifically, the long range objective is to design a general-purpose controller that can interface to scientific instrumentation via any anticipated interface method, including:

- RS 232 (110 to 38400 baud)
- Analog voltage
- Digital logic (5 volt TTL or CMOS)
- RS-485, including RS-485 SAIL
- Frequency measurements, including pulse modulation
- Power control (turn device on/off)

The controller, centered around the Intel 87C196 chip, will acquire data from the configured sensors (Table 1 and Fig. 6), store the data as required, and telemeter the data back to shore via packet radio (Fig. 2). In its initial application, data acquisition at 10 minute intervals is anticipated, with all the acquired data being telemetered to shore no later than 4 hours later.

The advantages of real-time telemetry of data are several-fold:

1) Check on data integrity so as not to waste long, expensive mooring deployments.
2) Availability of data for analysis and assimilation into models.
3) An aid for shipboard sampling decisions i.e. event scale sampling.

The controller has been designed so that it is easily extensible and programmable. By extensible, it is meant that new devices can be easily added. It is programmable, allowing the user to change parameters such as sample rate, interface parameters, and telemetry parameters. The controller may also prove useful for other applications and for acquisition of data from other platforms such as shipboard data acquisition and drifters. The target longevity of the controller with an appropriate set of scientific instrumentation is one year before requiring servicing. The controller has been named OASIS: Ocean Acquisition System for Interdisciplinary Science.

DISCUSSION

Several efforts geared at collecting concurrent continuous series of biological, chemical and physical properties have been described. Preliminary analysis of the spatial and temporal series have defined the scales of variability in Monterey Bay and show significant energy at the 5-10 day and 5-10 km scale. Larger scale variability is also notable and of greater amplitude than the higher frequency variations, however, the transition between seasons can occur very rapidly (Fig. 1). The high frequency variability and the nature of seasonal transitions are examples of the type of information that is difficult to capture with discrete shipboard observations.

Table 1. Sensors and their specifications scheduled for deployments on OASIS

Sensor	Output Type	Sensor Range	Output Range	Control
ATLAS Ctrlr*	RS232	n/a	n/a	RS232
PAR (two)	Analog cur	0-3000 uE	0-20 ua	none
Seabird CTD	RS232	-5-35°C and 0-7 S/m	n/a	RS232
Fluorometer	Analog	0-30 mg/m^3	0-5 VDC	pwr
Transmissometer	Analog	0-100%	0-5 VDC	pwr
Pkt Radio TNC	RS232	n/a	n/a	(2)
User I/F	RS232	n/a	n/a	n/a
Spectroradiometer	RS232	n/a	n/a	RS232
ADCP	RS232	n/a	n/a	RS232
GPS	RS232	n/a	n/a	RS232
Nitrometer	RS232	0.1-30 µm	n/a	RS232
Acoustic modem	RS232	n/a	n/a	RS232
*ATLAS sensors				
Temp Array	frequency	8-32°C	1-5 KHz	pwr
Pressure Array	frequency	0-750 psi	1-5 KHz	pwr
Sea Surf Temp	frequency	8-32°C	1-5 KHz	pwr
Air Temp	Analog	-50-150°C	-.5-1.5 VDC	pwr
Humidity	Analog	0-100%	0-1 VDC	pwr
Wind Speed	frequency	.7-50 m/s	7-500 Hz	none
Wind Dir.	Analog	0-355 deg	0-10 Kohm	pwr
Compass	AC phase	0-360 deg		

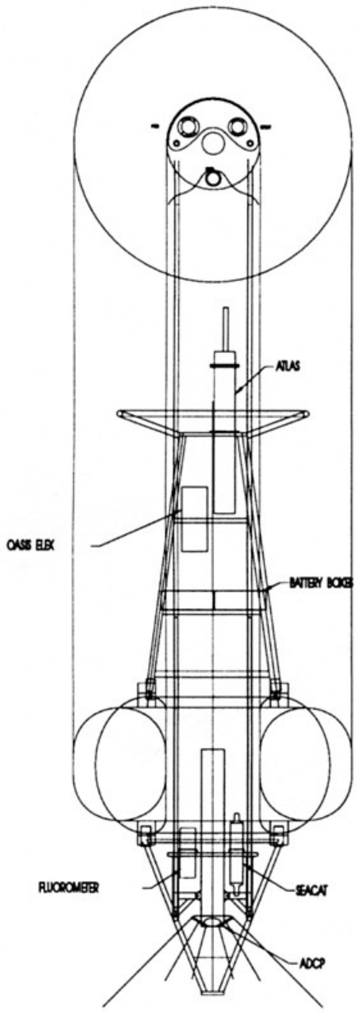

Figure 6. Layout of components on the new OASIS mooring.

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High-Tech Matchmaker Set To Link Engineering Job-Seekers, Companies

WASHINGTON, Feb. 18 — The electronic engineering profession. especially hard hit by cutbacks in defense-related technology companies, is introducing a sophisticated new system to help job-seekers find new employment.

Advanced technology devices will enter into a database hundreds of classified newspaper advertisements, employment listings at job fairs and other potential sources of employment for engineers. A proprietary artificial intelligence program will then match the information with data from the job-seeker's resume.

The service is offered for its members by the United States Activities arm of The Institute of Electrical and Electronics Engineers, the world's largest professional organization.

Known as Peer II (Professional Engineering Employment Registry), the electronic database is a more extensive service than an earlier version that relied solely on employer participation for financial support. Under current market conditions, employers are no longer using recruiting services on the scale of the 1980s. The new system is supports by IEEE members.

In addition to having their resumes placed on a computerized resume registry for use by prospective employers, IEEE members can request database searches for job openings up to three times a year for a fee of $15. Results are sent to them by hard copy or on a computer disk.

The electronic database, developed under contract by Success Systems of Torrance, Calif., correlates appropriate data such as job title, job description, benefits and salary ranges. The system permits users, if they choose, to specify preferences for any of 10 regional geographic areas. Counseling is also available through the contractor, along with the engineering society's newly revised job-hunting manual and other materials.

Peer II is also available to working engineers who are uncertain about the stability of their companies or who are seeking new employment for other reasons. These members may request use of "blind resumes" to protect their confidentiality', with their names and addresses released only under specified circumstances.

IEEE has more than 320,000 members in over 145 countries. The Institute is a leading authority in areas ranging from aerospace, computers and communications to biomedical technology, electric power and consumer electronics. IEEE-USA promotes the career and technology policy interests of nearly 250,000 U. S. members of IEEE.

Further information about the new job-search may be obtained from Marnie Clark-Ivey, IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036; telephone (202) 785-0017.

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Are You Happy?

Are you happy with the U.S. economy? Can you look forward to a comfortable retirement, built around a secure pension, in addition to your savings and investment income? Can your engineering colleagues do the same? Chances are, you're like most engineers; you've moved around a lot in your career, or you will be moving. That's why IEEE-USA has been working for many years toward portable pensions.

We made major legislative breakthroughs in the 1970s and 1980s, and now, in the 1990s, we have used $4 ($2 per year) of your dues to create the opportunity to achieve true portability. But we cannot do it without your support and a modest additional cost to you of three first class postage stamps—87¢.

That's the cost of writing three letters—one to each of your Senators and one to your Congressman. Timing is crucial—this is an election year, and Members of Congress will not only listen, but will also respond to their constituents. So, if you're not happy, tell them about it! Ask them to co-sponsor, support and vote for H.R. 2390, the ***Pension Coverage and Portability Improvement Act of 1991***, a bill endorsed by IEEE-USA. We've worked hard to get this bill together and to get it introduced. (Not a bad return for your $4.) We need members' support to get it passed.

Handwritten letters are fine—they represent sincere concern. BUT WRITE THEM NOW! Remember, you are the IEEE-USA. Even if you have a portable pension plan, send the letters anyway, so that other engineers and other U.S. workers can be helped. A lot is at stake. With letters from our 250,000 U.S. members and their families, friends and allies, we can have a tremendous impact on Congress.

Tell your Senators and Representative that you are not being merely self-serving. Implementing H.R. 2390 will significantly enhance national savings and will help improve U.S. competitiveness in global markets. Pension funds provide much of the investment capital in this country, and industrial expansion requires capital. Passage of this legislation could be the best $4.87 investment you've ever made in your own and your nation's future.

If you need assistance in identifying your Members of Congress, consult the reference pages of your telephone book or your local public library. If you want some tips on communicating with Congress or need more information on pension issues and legislation, contact the IEEE-USA Office at 1828 L St., N.W., Washington, D.C. 20036-5104; (202) 785-0017 (office); (202) 785-0835 (fax).

Address your letters to Congress to the U.S. Senate, Washington, D.C. 20510, or to the U.S. House of Representatives, Washington, D.C. 20515.

—*Edward C. Bertnolli*, Chair
National Government Activities Committee

IEEE-USA NEEDS YOUR HELP TO IMPROVE PENSION PORTABILITY

LEGISLATIVE ALERT IEEE—USA

Portable Pensions: Their Time Is Now

The boom/bust cycle that has characterized the U.S. aerospace/defense industry for more than 40 years is on the downhill slide again, after a steep defense buildup and a prolonged commercial expansion. Cutbacks and layoffs during the past year have disrupted thousands of careers and prompted numerous industry professionals to ponder whether this is the right business to be in.

As in the early 1970s, the latest aerospace drought is forcing the industry to confront a persistent problem: It does not offer its people a decent retirement system. Most aerospace companies have competitive retirement plans; they must if they are to attract needed talent. But few ever pay out full pensions, because relatively few employees can stay with one company long enough to qualify.

It is increasingly rare to find managers, engineers, technicians, production line workers or mechanics who have worked full careers with a single aerospace company. Most have experienced multiple layoffs or have changed jobs voluntarily, following major programs from company to company. These "aero-braceros" eventually end their working careers with no retirement fund other than what they have put aside privately.

"Portable Pensions" are needed to provide retirement security for these highly mobile employees. The concept is not new. It is being discussed in Washington now as a cushion for the 50% of Americans who reach retirement age with little or no financial security. Corporate managers typically take a mobile workforce for granted. In fact, they depend on it. If U.S. technology-intensive industries are to mature, while remaining competitive on a world scale, their leaders must recognize that skilled manpower is technology's lifeblood, not to be squandered.

AVIATION WEEK & SPACE TECHNOLOGY
MAY 6, 1991

Your help is needed to secure passage of legislation that will improve pensions for engineers, scientists, and other mobile professionals.

H.R. 2390, The Pension Coverage and Portability Improvement Act, sponsored by Congressman Sam Gibbons (D-FL), is based on retirement policy recommendations developed by IEEE-USA. ***H.R. 2390*** will expand pension coverage, reduce vesting requirements, improve the portability of benefits when workers change jobs (including defined benefit plans), promote individual savings, and help to ensure the retirement income security of our increasingly mobile work force.

As a concerned engineer or scientist you should communicate your support for this important legislation to your Congressman and both Senators in Washington at once!

Urge them to support the pension portability provisions of ***H.R. 2390*** when the House Ways and Means and Senate Finance Committees take up pension reform and simplification proposals.

Highlights of H.R. 2390

Coverage Expansion--Employers lacking current retirement plans would be required to offer voluntary salary reduction savings arrangements for their employees. Employees who wish to do so could contribute, on a salary-reduction (pre-tax) basis, up to 25 percent of compensation (or $30,000) per year.

Vesting Standards--One hundred percent vesting, required after one year of service, will earn for all full-time employees a non-forfeitable right to a pension benefit.

Portability in Defined Benefit Plans--Terminating employees would have the option of leaving earned benefits in a former employer's plan or transferring those benefits to another qualified plan or to an Individual Retirement Arrangement. The rollover or transfer value of earned benefits would be determined using an assumed (deflated long term) interest rate of 3 percent, rather than prevailing market rates, to help preserve the purchasing power of such benefits when workers change jobs.

Preservation of Benefits--The bill provides for the imposition of a 25 percent penalty tax on pre-retirement distributions that are not transferred to another qualified plan or to an individual retirement account.

Minimum Benefit Pension System--If pension coverage and portability do not improve substantially after 5 years, ***H.R. 2390*** establishes, for those not already receiving equivalent or better retirement provisions, a privately administered minimum benefit pension system to which employers must contribute a minimum of 6 percent of compensation. Employees will be permitted to make matching contributions on a salary reduction basis.

Suggested Letter of Support

"Dear Representative (or Senator):

"I am writing to you as a constituent and engineer to urge you to support ***H.R. 2390, The Pension Coverage and Portability Improvement Act of 1991***.

"***H.R. 2390***, as introduced by Congressman Sam Gibbons (D-FL), will expand pension coverage, reduce vesting requirements, improve portability, and help preserve pension benefits when workers change jobs. The resulting increase in savings by companies and individuals will also enlarge the pool of capital available for productive investment in the nation's economy.

"Prompt enactment of ***H.R. 2390*** is needed to strengthen the nation's voluntary private pension system and improve the retirement income security of America's increasingly mobile work force.

"Thank you for your support."

Sign your letter, and mail to U. S. House of Representatives, Washington, D.C. 20515, and to U. S. Senate, Washington, D.C. 20510. Send copies to Vin O'Neill, IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036.

102D CONGRESS
1ST SESSION

H. R. 2390

To amend the Employee Retirement Income Security Act of 1974 and the Internal Revenue Code of 1986 to expand pension coverage, improve pension portability, increase retirement savings, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MAY 20, 1991

Mr. GIBBONS introduced the following bill; which was referred jointly to the Committees on Education and Labor and Ways and Means

A BILL

To amend the Employee Retirement Income Security Act of 1974 and the Internal Revenue Code of 1986 to expand pension coverage, improve pension portability, increase retirement savings, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Pension Coverage and Portability Improvement Act of 1991".