IEEE
OCEANIC ENGINEERING SOCIETY
NEWS LETTER

VOLUME XXIV NUMBER 3

EDITOR: FREDERICK H. MALTZ FALL 1990 (USPS 420-910)

PRESIDENT'S MESSAGE

Greetings from the office of the new president of the IEEE Oceanic Engineering Society. My name is Glen Williams and I am a professor in the Computer Science department at Texas A&M University in College Station, Texas. I have been landlocked at TAMU for 20+ years, and I obviously enjoy the freedom/rigors and blessings/curses of the academic environment. My currently active research areas include computer graphics and scientific visualization, in addition to intelligent control systems for autonomous underwater vehicles.

First, I want to extend the sincere appreciation of the entire Oceanic Engineering Society to Dr. Dan Alspach, the past president of the OES. Dan did a super job of running the Society in a difficult time and was very active in initiating the expansion of the Society's role in support of the organizational foundations, the local chapters. I hope to continue that activity, and therefore would invite any interaction with local chapter personnel.

I would like to take this opportunity to bring you up to date on this years conference activities of the OES. On June 5-6, 1990, OES sponsored the Symposium on Autonomous Underwater Vehicle Technology at the Dulles Marriot in Washington, D.C. Charlie Stuart of DARPA was the General Chair of this meeting, and DARPA also sponsored a classified Unmanned Underwater Vehicle Symposium on June 7, 1990 in Washington. Both were a great success. Will give more details on the program in the Winter Newsletter

The Oceans '90 Conference is being held in Washington D.C. at the Convention Center on September 24-26, 1990. As Dr. Alspach stated in a previous Newsletter, the OES and the Marine Technology Society have jointly agreed to pursue their separate interests, and therefore Oceans '90 and MTS '90 will be separate conferences starting in 1990. However, both conferences were originally scheduled within one week of each other in the same city this year, and, to make a long story short, the OES has agreed to shift our conference to Monday-Wednesday of the week of September 24, 1990, while the MTS will have their conference on Wednesday-Friday of of the same week. The exhibits are running from Wednesday-Friday, thus giving participants in both conferences the opportunity to take part in the exhibit activities. The technical program for Oceans '90 has some 110+ papers with a special emphasis on underwater acoustics.

In late Newsletters, I'll try to give you a bit of an introduction to each of the upcoming OES conferences, workshops and symposia. See you at Oceans '90 or next year or both.

Glen N. Williams
President Oceanic Engineering Society

President Oceanic Engineering Society

IEEE OCEANIC ENGINEERING SOCIETY

(Continued on inside back cover)

CHAPTER CHAIRMEN

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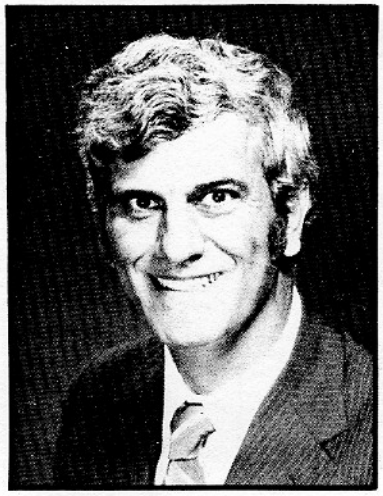
FROM THE PAST EDITOR



I am retiring as OES Newsletter editor, so it is my duty to reminisce. When I assumed this position in 1978, the Chicago Daily News had just ended publication, and this past year the Los Angeles Herald-Examiner went belly-up. Hence, of three great American newspapers, only the OES Newsletter has survived the last dozen years. (Yes, I know that the OES Newsletter is a transnational publication, but calling it an American newsletter fits the context better, don't you think?) Our survival is due to the great support given me by the OES AdCom and members, to whom, individually and collectively, I owe many thanks.

Let me start by thanking Don Bolle, who, as the first editor of the IEEE Journal of Oceanic Engineering, invited me to submit a manuscript for the first issue. I did, and he published it; if you don't believe me, you could look it up in IEEE J. Oceanic Engineering, Vol. OE-1, No. 1, pp. 32-42. Then Don urged me to join the Council on Oceanic Engineering, insisted that I replace him as editor of the Newsletter, and finally directed me to be COE's non - academic representative to ABET, the Accreditation Board for Engineering and Technology. And I did all of this stuff faithfully, and semi - cheerfully. (I met Don when I was an undergraduate at Purdue University in the late '50's, and he was an undergraduate TA for one of my classes; perhaps I never outgrew this student-teacher relationship with Don.) I don't know if my having known Don has made me a better man, butit has certainly made me a busier one.

Art Westneat is also a Purdue man, though of a earlier generation. In fact, he had my father, Elias Sabbagh, as a teacher some thiry years before. Art was more than just a kind friend; he was one of the early driving forces in COE, and our Society is the better for his service to it.

COE/OES has been blessed with the leadership of excellent chairmen. Those that I served under were: Ed Early, Lloyd Maudlin, Don Bolle, Stan Chamberlain, Tony Eller, and Dan Alspach. Each has left his mark on OES, and I thank them for their support.

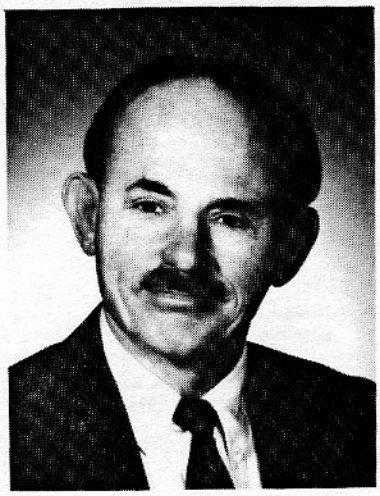
Prof. George Mueller, who was a colleague of dad's at Purdue, was my first 'TIZ A PUZZLEMENT editor. When George stepped aside, Dave Hollinberger stepped in, and continues to do an excellent job. Thanks, fellas; I appreciated your help. LeRoy Kingman, of McGregor & Werner, Inc., was diligent in overseeing the preparation of the Newsletter; Peggy Sholty, of Graphic Printing is handling those duties now. Finally, I want to thank Larry Booda, editor emeritus of Sea Technology, a Compass publication, for allowing me to reprint their material.

Fred Maltz has agreed to replace me. He will want your input and support to improve the Newsletter. Give him your thoughts, and roll up your sleeves to help him. Don't be passive; for, as my grandmother taught me,

> God gave us two ends
> one to sit on and the other to think with.
>
> A man's success depends on which end he uses most.
> It is a case of heads you win and tails you lose.

Harold A. Sabbagh
November 1989

INCOMING EDITORIAL



I am pleased to become editor of the Oceanic Engineering Society Newsletter. Hal Sabbagh has retired after serving twelve years as editor, for which he received the OES Distinguished Service Award. We want to thank him for his outstanding Contribution and for his many years of service.

I had worked with Hal on the newsletter for a year, and first became familiar with the society's activities while serving on the OES AdCom and through my participation in Oceans Conferences starting with Oceans '83 in San Francisco where I presented a paper entitled "Time Difference Raytrace Method for Ranging and Sound Channel Probing." I have found the OES to be a great society for professionals involved in ocean related activities. My involvement in ocean related systems at the Lockheed Missiles & Space Company ranges from radar oceanographic satellites to autonomous underwater vehicles.

Conferences and Symposia play a central role in the society with the Oceans '89 Conference last year in Seattle a huge success. There were over 400 technical papers with more than 100 papers on Ocean Pollution presented. The commitment to oceanic concerns was highlighted by a special forum on Navy technology needs led by RADM Richard Pittenger. There was also a NSIA report on Intelligent Systems Technology Applications by Michael McKisic, and a collection of papers describing the First Annual International Submarine Races. One of the papers associatred with the H.A. Perry Foundation Award Winning Submarines is reprinted in the issue of the newsletter.

The other OES sponsored meeting last year was the 6th International Symposium on Unmanned Unteth ered Submersible Vehicle Technology. There were 50 technical papers in two parallel sessions and a classifie session at John Hopkins University. This year's Autonomous Underwater Vehicle Technology Conferenc at the Dulles Marriott was well attended. Oceans '90 promises to be as equally exciting. Your participation in these activities is always welcome.

I am looking forward to working with our new president, Glen Williams, and supporting him as OES Newsletter editor. Let us all give Glen our full suppor in carrying forward the initiatives of our previous president, Dan L. Alspach, and in leading our society i the coming years. Your inputs to the newsletter will b appreciated as they have been in the past.

Frederick H. Maltz,
Newsletter Editor
Oceanic Engineering Society

DISTINGUISHED TECHNICAL ACHIEVEMENT SERVICE AWARD

Oceanic Engineering Society
Oceans '89

VICTOR C. ANDERSON

This award is given in recognition of his long and distinguished record in ingenious and innovative engineering in acoustics and the ocean environment including the RUM (Remote Underwater Manipulator) vehicle, the ADA (Advanced Detection Array) two dimensional broadband array, the ORB (Ocean Research Buoy) for handling RUM, and the Deltic and Dimus sonar system concepts which became operational equipment on board Navy ships.

Born in Shanghai, China, of missionary parents, Vic Anderson has been a leader in underwater acoustics and ocean engineering in a wide variety of projects. Two of them resulted in systems installed aboard Navy submarines, the DIMUS sonar and the DELTIC correlator. He received the Navy Distinguished Service Award in 1976 and the industrial (ADPA/NSIA) Admiral Charles Martell ASW award in 1986 for technical excellence for his DIMUS achievements. This was the first digital sonar system (albeit one bit) and the acronym meant DIgital MUltibeam Steering.

After more than four decades with the University of California, he elected to retire as of June 30, 1989. He is unique in so many ways that it may not be possible to recall all of them, nor would there be space for a complete listing.

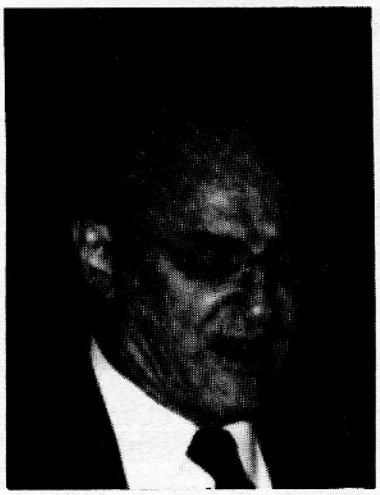
DISTINGUISHED SERVICE AWARD

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 A. Nierenberg
1986 - Robert J. Urick
1987 - James R. McFarlane
1988 - Chester M. McKinney

DISTINGUISHED SERVICE AWARD

Oceanic Engineering Society
Oceans '89

ERIC HERZ



This award is given in recognition of outstanding, creative leadership and initiative in inspiring and guiding the founding of the Council on Oceanic Engineering and the transition to the Oceanic Engineering Society, and for vigorous and long standing commitment to the technical strength of the Oceanic Engineering Society, as a member, as Division Director and Vice President for Technical Activities of the IEEE.

After Receiving the BEE degree in 1952 from the Polytechnic Institute of Brooklyn (now Polytechnic University), Eric Herz worked at the Sperry Gyroscope Company on the development of radio navigation system predecessors to Loran-C. He later joined General Dynamics Convair in San Diego, where he developed the industry's first capability to rapidly process large quantities of telemetered information, managed the development of a new military range measuring and communications system, and participated in early space shuttle studies.

Eric Herz joined IEEE as General Manager and Executive Director in January 1979. . Prior to joining the IEEE staff, he had been an active volunteer in IEEE for over 20 years - last, as Vice President for Technical Activities. He had numerous IEEE assignments and held a number of elected positions. He is a fellow of IEEE and AAAS.

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

SCENES FROM SEATTLE

Robert Spindel, Chairman of Oceans '89 receives commendations from Richard Shamp, President of MTS and Glen Williams, President OES.

Ed Early receives award for managing Oceans '89 from Richard Shamp, Robert Spindel and Glen Williams.

Eric Herz, Joseph Czika (OES Vice Pres.) and Wife. Mary Williams (OES Pres. wife) in background.

Professor Werner Kroebel (University of Kiel - Germany), Nick Carter, and Dr. Robert Spindel.

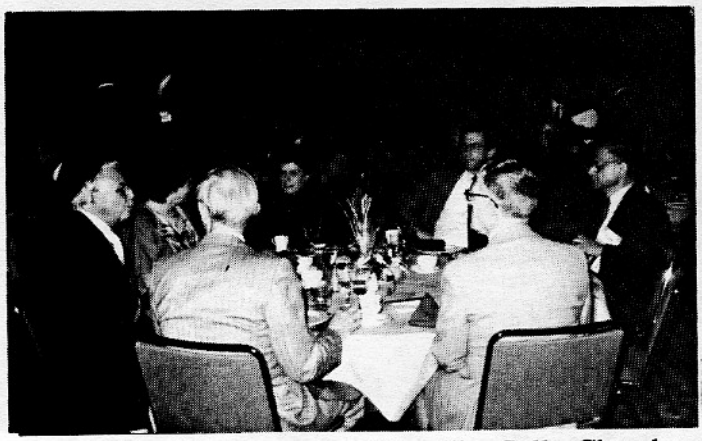
Fred Fisher accepts the OES Distinguished Technical Achievement Award on the behalf of Dr. Victor C. Anderson.

Eric Herz, General Manager of the IEEE receives an award from Dr. Glen Williams.

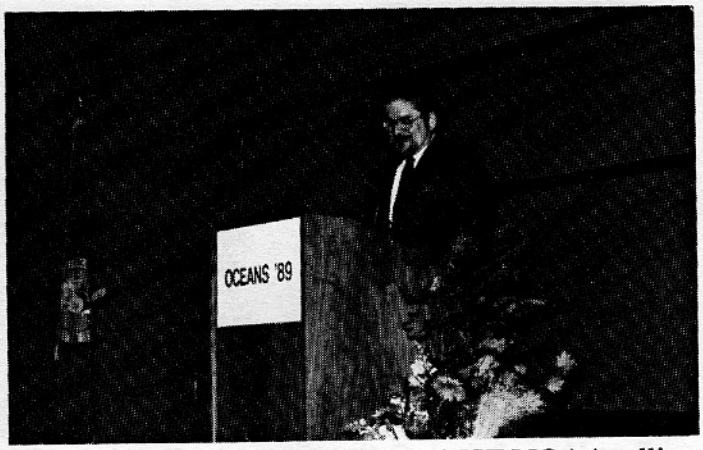
OCEANS CONFERENCE

Lloyd Maudlin (OES Vice Pres.) Mrs. Maudlin and Dr. Gordon Raisbeck (OES Secretary)

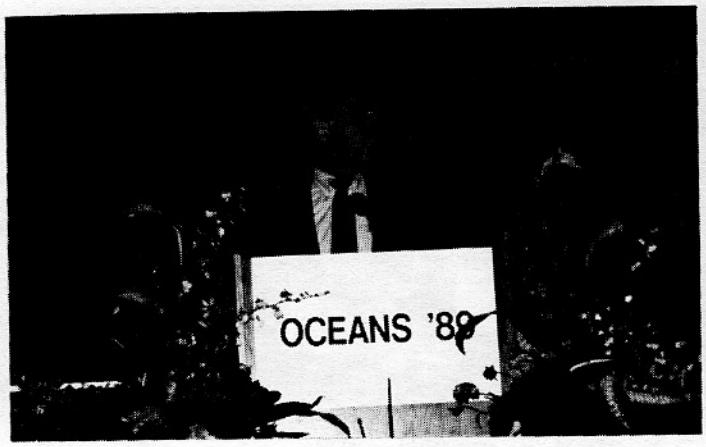
Eric Herz (IEEE General Mgr.) and Norm Miller (West Sound and OES Adcom).



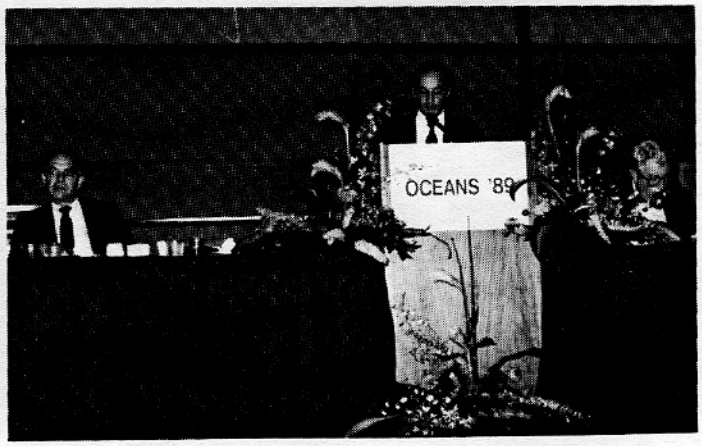
Lloyd Maudlin, Laura Lee Maudlin, Sally Chamberlain, Stan Chamberlain, Rui De Figueiredo, Norm Miller and ? (Starting from far left) at Banquet.



Dr. Joeseph Vadus OES AdCom/NSF/NOAA telling his sick joke at banquet.



Dr. Robert Correl, Asst. Director, NSF, addressing plenary session.



Dr. Correl, Dr. Spindel, Dr. Knauss - Plenary Session.

SEATTLE 1989

Franz Hover, MIT/WHOI was selected as the winner of the student poster session. Eric Herz presented the award.

L. to Rt. - Sally Chamberlain, Stan Chamberlain, Eric Herz, Norm Miller, Lloyd Maudlin, Rui De Figueiredo and Mrs. Early (with back showing.)

Eric Herz and Dr. Ferial El Hawary - Halifax - Canadian Atlantic OES chapter chair.

United States/Japan Natural Resources (UJNR) Marine Facilities Panel - Japanese contingent singing at banquet

Eric Herz, Norm Miller and Lloyd Maudlin.

Dr.John Knauss, RADM. Richard Pittenger, Dr. Dan Alspach, and Dr. Glen Williams at Plenary Session.

(Reprinted from Oceans '89 Proceedings)

PROJECT SQUID
A Lesson In Design Simplicity

M. L. NUCKOLS, P. K. POOLE, T. C. PRICE, R. M. MILLER, J. MANDICHAK

U. S. Naval Academy
Annapolis, MD 21402

ABSTRACT

The U. S. Naval Academy's entry in the 1st Annual International Submarine Races in Riviera Beach, Florida during 23-25 June 1989, **SQUID** (Submerged **QU**ick **I**ntervention **D**evice), was designed and fabricated with simplicity as the primary emphasis. While it was evident during the competition that vehicle speed was of major interest by most competitors, including USNA, vehicle reliability was considered as important a feature of the **SQUID** design. As first time competitors in an event of this type the design philosophy was to create a vehicle that would foremost **not embarrass the Naval Academy**. We considered it essential to have a vehicle with sufficient reliability that could be counted on to start the race and maneuver the course to the finish line. To be sure, winning was not completely absent from our wishes, but this was admittedly only a secondary objective for this project.

This emphasis on simplicity and reliability paid off beyond all our expectations. USNA ***SQUID*** won the Best Overall Performance prize worth $5,000 based on it achieving the highest total score in speed, cost effectiveness, and innovation of all eighteen entries. Not only did the ***SQUID*** design show proven reliability in the competition by not logging a single mechanical failure in the 3 day event, but minimal design failures were noted during all prior vehicle testing beginning in mid-March.

Although not a slow vehicle (***SQUID*** was clocked the second fastest vehicle behind Cal Poly's ***SUBVERSION*** over the 100 meter time trial course), the Naval Academy vehicle did not depend on speed alone in winning this event. This paper highlights some of the more significant features of the **SQUID** design in the areas of structural design, power conversion, man-machine interface, control, and innovation in complying with rules of the race. These features, along with others, are listed categorically in the accompanying charts.

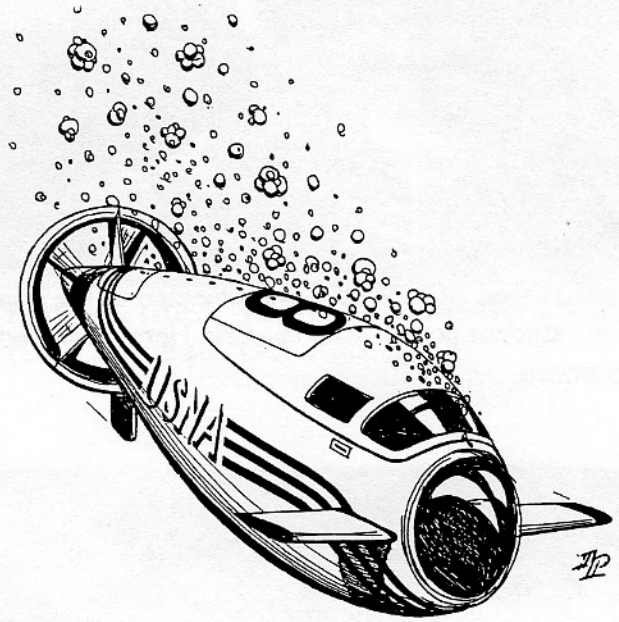


Figure 1: Artists sketch of the human-powered submersible **SQUID**

STRUCTURAL DESIGN & FABRICATION

STRUCTURAL DESIGN & FABRICATION
MAIN FEATURES

- COMPUTER GENERATED HULL SHAPE
- EXTENSIVE USE OF COMPOSITES
  -LOW WEIGHT/INHERENTLY BUOYANT
  -MINIMAL CORROSION
  -LOW COST
- MALE PLUG LAYUP OF HULL
- HOT WIRE CUTTING OF PROPELLERS AND CONTROL SURFACES
- VACUUM BAGGING OF LAMINATES
- PRESSURE BLOWN ACRYLIC WINDOWS
- ALUMINUM FRAME PROVIDES ALL STRUCTURAL SUPPORTS
- STRATEGICALLY LOCATED VENT/FLOOD HOLES

The **SQUID** hull is an elongated tear-drop shaped similar to the high performance Albacore submarine hull created in the 1950's. The shape of the vehicle hull (approximately 10 feet long by 3 feet maximum diameter) resulted from extensive modelling efforts to minimize wetted surface area while still providing enough internal volume for the two operators and their equipment. The resulting wetted surface area of 69.1 ft^2, excluding control planes, and a predicted drag coefficient of 0.01 (based on wetted surface area) was projected to give a top speed of 5.2 knots when powered at 0.20 HP (our predicted output of a healthy adult over a duration of 20-30 minutes).

The selection of the hull material was particularly beneficial in keeping the vehicle design simple. A sandwich construction of 3/8-inch thick closed-cell polyvinyl chloride (PVC) foam was laminated inside and outside with 3 layers of 8 ounce bi-directional glass with epoxy as the matrix. This low-density (5 lbs/ft^3) PVC foam laminate provided a sturdy hull construction with an inherent buoyancy when assembled with all support frames of approximately 80 pounds. Complex flotation system designs were thus eliminated through this judicious material selection.

SQUID'S most innovative features included a kort-nozzled, counter-rotating propeller, ie, back-to-back propellers spinning in opposite directions to provide extra thrust and stability. A similar sandwich construction using unidirectional glass was utilized during the fabrication of the propeller blades following shape contouring with a hot wire cutting technique. This low-cost technique allowed custom fabrication of blade designs to uniquely match **SQUID'S** requirements, and eliminated the need to select off-the-shelf, non-optimized propellers.

This innovative use of strong, low-cost composites was a major factor

in the **SQUID** design being additionally awarded the DuPont Company's $2,000 prize for the Best Use of Composite Materials at these submersible races.

POWER CONVERSION AND PROPULSION SYSTEM

Little, if any, data was available for the design of an effective propeller for a low speed submersible having power levels as low as those anticipated in these races. This, and the fact that little time was available for trial and error, a computer analytical simulation model of the propulsion system was generated from first principle analysis. Development of the model was done after the decision to use a bicycle type mechanism was made but before the design and construction of the propulsion transmission and propeller. The model provided the component designers not only with the expected vehicle velocity for the given input pedal horsepower, but also specific design parameters such as propeller blade angles, gear ratio, shaft torque, hull drag, propeller thrust, etc. It additionally had the capability of providing predictions for both a single propeller system, as well as, a counter-rotating design. Figure 2 shows a graphical representation of the various parameters that the model can provide.

POWER CONVERSION

- COMPUTER-AIDED PROPELLER BLADE DESIGN
- COUNTER-ROTATING PROPELLERS
  -MINIMAL SWIRL LOSSES
  -ELIMINATES VEHICLE ROLL
- KORT NOZZLE
  -MAXIMIZES PROPELLER EFFICIENCY
  -PREVENTS SURFACE BUOY LINE ENTANGLEMENT
  -AIDS CONTROL OF STEERING AND DEPTH
- DRIVE TRAIN
  -VARIABLE GEAR RATIO
  -GEAR BOX USING MITRE GEARS PROVIDES COUNTER-ROTATION
  -NON-METALLIC THRUST BEARINGS/ BUSHINGS MINIMIZES CORROSION

The model's value in the initial design process was overshadowed by its ability to accurately predict the effect of follow on design changes. Most significant of these was the "eleventh hour" addition of a Kort nozzle surrounding the propellers. This addition served several purposes, primary of which was allowing a reduction in the propeller flow annulus without a significant decrease in propeller effectiveness. The reduced flow annulus provided an increase in thrust resulting in a significant increase in vehicle speed. It had the additional benefit of reducing the required propeller RPM, and therefore propulsor RPM, for the same existing blade angles. This allowed for a simple cropping off of approximately 5 inches of the original 3 foot existing blade without a loss of effectiveness. The model predictions for this anticipated change for a constant pedal force and RPM are shown in Table 1. The addition of the Kort nozzle also provided the bonus feature of preventing propeller entanglement with the surface buoy line required by the competition rules.

Table 1: Pre/Post Kort Nozzle Model Predictions

	W/O Nozzle	W/Nozzle
Speed (Kts)	3.55	4.0
Propeller RPM	100	80
Propulsor RPM	58	59
Pedal Force (Lbf)	44	44
Gear Ratio	1.71	1.36
Mid-Chord Blade Angle	37°	36.6°

The Kort nozzle itself, Figure 3, was designed from a potential flow representation of the hull with an increase in annulus flow such that a 25% change in the hull freestream was achieved. The resulting slipstream provided the inside surface curvature while the outside surface was maintained at the hull freestream. The increased annulus flow was then used to determine the change in propeller diameter allowable while maintaining the propeller effectiveness.

MAN-MACHINE INTERFACE

When breathing from an open-circuit, self-contained underwater breathing apparatus (SCUBA), as dictated by the competition rules, body positioning is extremely important in maximizing the diver's power output. Unlike breathing surface air, where lung pressure is essentially equal to the pressure of the air being delivered, breathing on SCUBA underwater creates a substantial pressure differential between the air supply pressure and lung pressure in certain body orientations. This occurs since the supply pressure is controlled by the vertical position of the diver's second stage regulator, while the lungs must counteract the local pressure at their depth. In a sitting position the diver's regulator, located at mouth level, is located approximately 5-6 inches above his lung centroid (generally given as being adjacent to the suprasternal notch). This physical separation can account for up to 0.25 psi differential pressure between the air being supplied to the diver and the ambient pressure surrounding the diver's lungs. As small as this may seem, this differential accounts for a significant increase in the work which must be expended by the diver to breathe.

In a prone position, as that used by the propulsor in **SQUID**, the vertical separation between the regulator and lung centroid is small. With a well tuned regulator, negligible breathing energy will be attributable to this small separation.

To verify the significance of propulsor positioning, a series of test dives were performed at the Naval Academy on a test platform which attempted to simulate the **SQUID** propulsor activity in both sitting and prone positions. Table 2 compares the cycling output and air consumption data for 6 diver subjects in prone and sitting positions over a 10 minute period. Although only a slight improvement in diver output was seen in the prone position during these tests, on average 20% less air was consumed for the 6 subjects when prone as compared to the sitting position.

One complication in using the prone position is the diver can not use his back as a positive restraint during peddling. A simple harness (a single SCUBA tank harness), with a single-point release, was worn on the propulsor's back and was attached to the aluminum framing structure within the vehicle hull via 1-inch strapping to provide the resistive action in this prone position.

MAN-MACHINE INTERFACE
MAIN FEATURES

- DIVER POSITIONING/ERGONOMIC TESTING
  -20% LESS AIR CONSUMPTION
  -MORE WORK CAPABILITY
  -EFFECTIVE USE OF AVAILABLE CABIN VOLUME
- RESTRAINING HARNESS TO RESIST PROPULSOR ACTION
- ACRYLIC NOSE BUBBLE ALLOWS GOOD FORWARD/PERIPHERAL VISION
- CABIN/HATCH LAYOUT ALLOWS EASY CABIN ENTRY/EXIT
- MINIMUM REGULATOR BREATHING RESISTANCE

CONTROL

The one-kilometer course planned for this competition called for a vehicle having good maneuverability. With turn radii as low as 9 meters on the course good vehicle control was a must. Again, design simplicity played a major part in selecting the control surfaces for **SQUID** while

minimizing control surface area. Dive planes having split controls were located on the bow to allow the vehicle to roll about its body axis as it entered a turn, bank throughout the turn, and thus minimize turn radius. A single rudder located just forward of the counter-rotating propellers gave the required turn radii during practice trials when used with this banking technique.

On straight-aways, in excess of 90 pounds of lead ballast which was used to offset the positive buoyancy of the composite hull, kort nozzle, and propellers provided excellent vehicle stability when located semi-permanently on the sub floor. By carefully locating the diver air supply (two 100 cubic foot air flasks) in close proximity to the vehicle center-of-gravity, minimum trim variations were observed in training runs as the air supply was depleted. Surprisingly, the approximately 12 pounds of additional buoyancy which resulted as the air bottles were depleted appeared to have an insignificant impact on the vehicle control.

CONTROL

- DIVE PLANES
  -SPLIT CONTROL TO MAXIMIZE MANEUVERABILITY
  -LOCATION MAXIMIZES DIVING/ STEERING MOMENT
  -SIMPLICITY
- EASILY ADJUSTABLE LEAD BALLAST SYSTEM
- LOW CG TO MAXIMIZE STABILITY
- AIR SUPPLY AT CG TO MINIMIZE TRIM VARIATIONS
- STRATEGICALLY LOCATED COMPASS, DEPTH AND PRESSURE GAUGES
- CAPILLARY DEPTH GAUGE SENSITIVE TO MINOR DEPTH CHANGES
- FLEX CABLE FOR OPERATION OF RUDDER
- NOZZLE ACTS AS FIXED CONTROL SURFACE

INNOVATION IN COMPLYING WITH RULES OF THE RACE

The race rules required that all vehicles had to maintain at least 2 pounds of positive buoyancy at all times. As stated previously, this requirement was solved through material selection. The extensive use of composites eliminated any need for complex ballasting systems or controls. This simple solution was a strong factor in the **SQUID** design being awarded the DuPont prize for the Best Use of Composite Materials.

An air supply of 175 standard cubic feet was estimated to complete the 1-kilometer course and meet the 150% capacity requirement dictated by the race rules. This was broken down according to usage as 135 cubic feet required by the propulsor, and only 40 needed by the navigator/pilot. Initial attempts to provide separate air supplies for the two occupants, including double 80 cubic foot tanks for the propulsor and a single 53 cubic foot tank for the pilot, proved unsatifactory due to space restrictions inside the **SQUID** cabin. This problem was solved by cross-connecting double 100 cubic foot bottles with a high-pressure cascading hose, and allowing both divers to breathe from the same air source. This not only minimized the volume requirements for the air supply system but maintained vehicle symmetry with the dual tank solution.

Although not used in the competition, a seven second time delay was designed in the emergency recovery buoy activation switch to minimize the risk of accidental release of the emergency buoy. A momentary release of the required dead man switch by either the propulsor or the pilot during the competition would not falsely signal the race personnel with this delay in the circuit.

INNOVATION IN COMPLYING WITH RULES OF THE RACE

- COMPOSITE HULL GIVES NECESSARY BUOYANCY REQUIREMENT
- CROSS-CONNECTED DOUBLE 100's
  -MINIMIZES CABIN VOLUME USE
  -SYMMETRY
- PROPELLOR SHROUD MINIMIZES ENTANGLEMENT
- SIMPLE/EFFECTIVE HATCH RELEASE
- DELAY/LED WARNING FOR EMERGENCY RECOVERY BUOY ACTIVATION

SUMMARY

Only a few of the features of the **SQUID** design have been highlighted above. Some of these features, including the counter-rotating propellers and Kort nozzle, have impacted the performance of the vehicle design more significantly than others. However, they all share one main theme which contributed to the ultimate success of the **SQUID** design -- ***simplicity.*** This simplicity resulted in the hull durability and drive train reliability which characterized the vehicle design. The success of this design philosophy in the 1st Annual International Submarine Races has left a valuable lesson for future design competitions. Certainly not a new lesson, but one that should be reemphasized again and again.

And what will we do differently next time? With the success that was seen with **SQUID** we might be inclined to go with what proved successful in the past. However, we can be assured that the next submarine race will bring even more competitive entries, and to stand still will bring certain failure. First on our agenda for changes will be improved side visibility for the pilot. Second, to further minimize vehicle drag we will attempt to produce a smaller hull cross-section to reduce wetted surface area, and extend the hull shape at the stern to produce a smaller hub diameter. This will be accomplished by closer attention to the man-machine interfaces. Finally, for improved control/maneuverability and vehicle symmetry we intend to add an additional rudder directly above the existing one.

TABLE 2: PROPULSOR POSITION TESTING

SUBJECT #	CYCLIC OUTPUT RPM'S		AIR CONSUMPTION Lit/Min	
	Prone	Sitting	Prone	Sitting
1	63.7	69.0	34.0	54.3
2	74	68.3	45.3	52.8
3	76.8	71.0	79.2	86.8
4	67.3	73.7	34.0	45.3
5	75	74.5	71.7	75.5
6	79.5	73.6	75.5	94.3
AVG	72.7	71.7	56.6	68.2

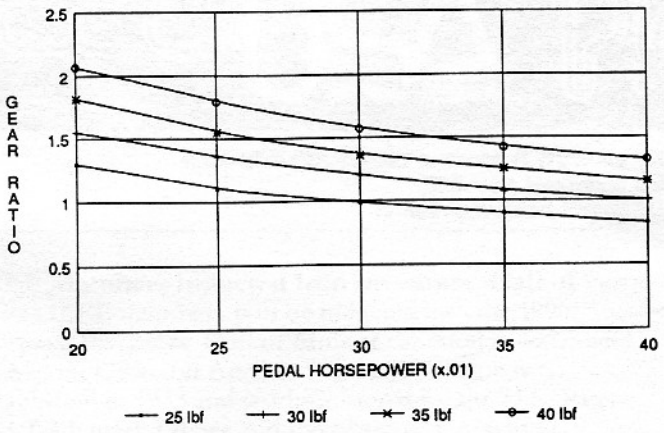


Figure 2a: Gear ratio versus pedal horsepower for varying pedal force; blade angle = 38 degrees; pedal arm = 8 inches

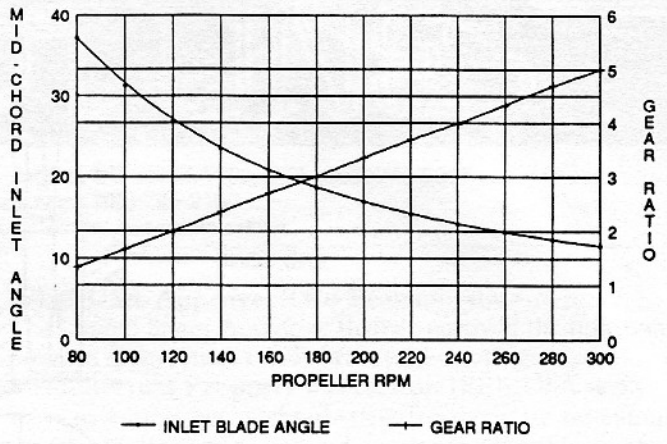


Figure 2b: Mid-chord inlet blade angle versus RPM; 0.25 HP; 30 lb crank force

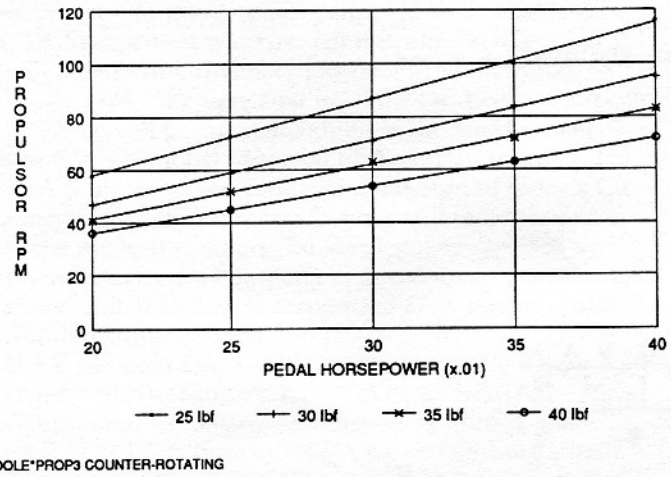


Figure 2c: Propulsor RPM versus pedal horsepower for varying pedal force; blade angle = 38 degrees; pedal arm = 8 inches

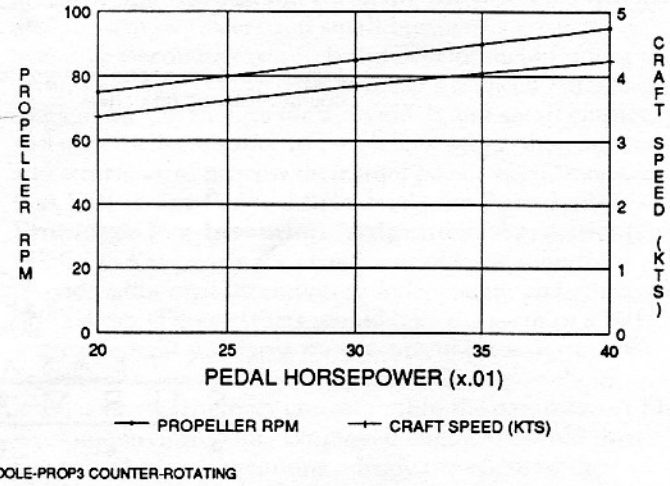


Figure 2d: Craft speed and propeller RPM versus propulsor HP; blade angle 38 degrees; pedal arm = 8 inches

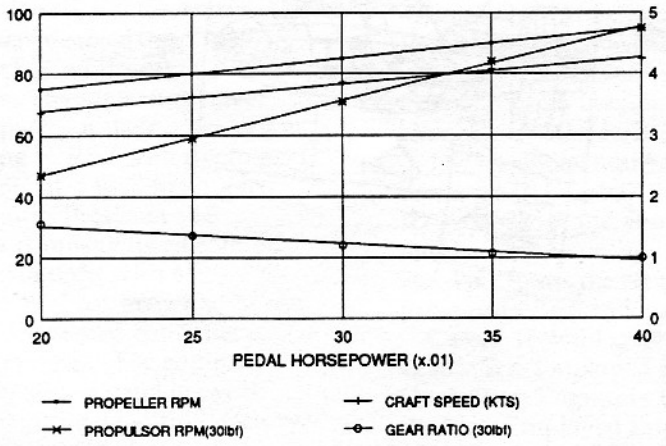


Figure 2e: Craft speed, propeller RPM, propulsor RPM, and gear ratio versus pedal horsepower; blade angle = 38 degrees; pedal arm = 8 inches

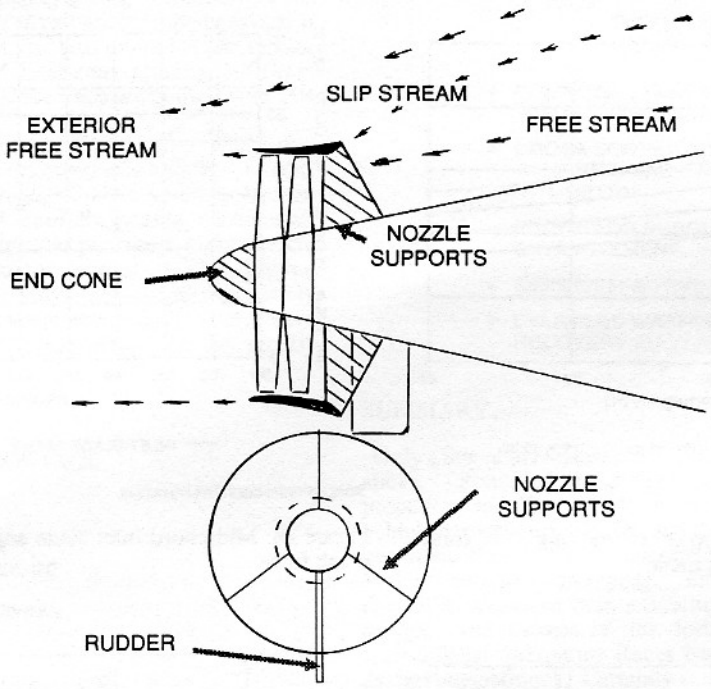


Figure 3: Kort nozzle design for USNA **SQUID** which housed counter-rotating propellers

1st
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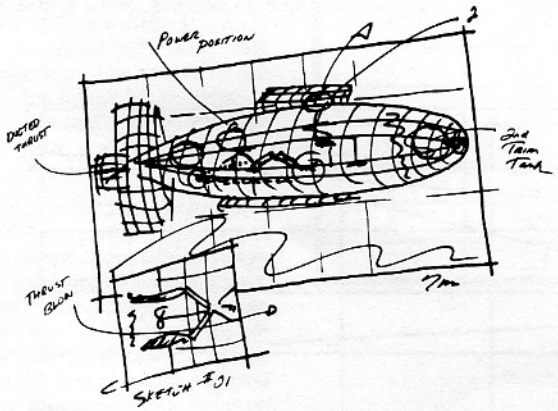
INTERNATIONAL
SUBMARINE
RACES



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IEEE Members Inducted Into Inventors' Hall of Fame

Three IEEE members will be inducted into the 1990 National Inventors' Hall of Fame at ceremonies to be held in Akron, Ohio, on April 8. The Hall of Fame was established in 1973 and is administered by the U.S. Patent and Trademark Office and the National Council of Intellectual Property and Law Associations. The ceremonies will mark the 200th anniversary of the U.S. patent system.

Among those honored is Robert S. Ledley, a member of IEEE-USA's Intellectual Property Committee. Dr. Ledley is being recognized for inventing the first whole-body CT (computerized tomography) scanner in 1973. Called the ACTA Scanner—it was first put into clinical operation at the Georgetown University Hospital in Washington, D.C., in 1974. The very first machine Dr. Ledley built can now be seen on permanent exhibit at the Smithsonian Institution's National Museum of American History. The ACTA Scanner set the fundamental design of today's CT scanners and included many features still incorporated in modern medical scanners. Dr. Ledley is recognized by his peers as a pioneer in computer applications in medicine and biology, and he is widely recognized as an initiator in the medical informatics field.

IEEE Member Charles P. Ginzburg is being honored for inventing the first commercial videotape recorder, which revolutionized the television industry. Ginsburg was elected an IEEE Fellow in 1965. One of Ginsburg's basic patents, patent No. 2,956,114, was selected by the Patent and Trademark Office as one of about one-hundred and fifty to be included under the title "Some Important Patents" in the booklet entitled "Revolutionary Ideas—Patents and Progress in America," which was published in the Bicentennial year of the U.S. Patent and Trademark Office.

IEEE Member Kenneth H. Olsen invented the minicomputer. Known as the "father" of the minicomputer and the minicomputer industry, he envisaged individual professionals working with computers at their desks or workstations interactively. Starting in 1957 with two other persons and $70,000 in venture capital, Olsen has guided Digital Equipment Corporation as its President and Chairman to being a $7+ billion company listed 55th on the FORTUNE 100. From its beginnings with Mr. Olsen's innovative technology, Digital has grown to be the world's leading manufacturer of networked computer systems, with 660 offices in 48 countries. The company supplies information management systems and network products for the office, government and education, factory and labor automation, engineering, personal computing, and small businesses. Ledley, Ginsburg and Olsen are three out of seven living inventors being inducted into the National Inventors' Hall of Fame.

IEEE-USA Approves Two Position Statements

The United States Activities Board approved the following position statements at its February 18 meeting:

- **Intellectual Property Protection** IEEE-USA seeks ways to protect new technologies effectively by amending patent and copyright laws and developing new forms of legal protection. Immediate goals include finding methods to provide increased protection for easily copied products, such as computer software semiconductor chips, and other intellectual property rights.

IEEE-USA also supports reducing the costs and red tape involved in obtaining and enforcing patents. This will give independent engineers and small businesses greater incentive to conduct research and development leading to inventions. IEEE-USA also advocates reduced Patent and Trademark Office fees for individuals and small entities; and increased assistance to enable inventors, their agents and attorneys to process their own patent applications.

- **A Bill to Set Federal Standards for Permissible Employee Pre-Invention Assignment Agreements** IEEE-USA supports the enactment of legislation to provide additional incentives to independent and employed originators. These efforts would take the form of a bill setting Federal standards for pre-invention assignment agreements, permitting employers title only to those inventions the engineer creates within the parameters of his working environment. Employed engineers could then feel free to make inventions outside the scope of their employment, further stimulating creative and inventive activity in the United States.

Employment Services Move to New Location

Career Technologies Corporation, the contractor that operates the Professional Engineering Employment Registry (PEER), has relocated to the following address:

PEER Service Center, Career Technologies Corporation, 6 Londonberry Commons, 44 Nashua Road, Londonberry, NH 03053; (603) 437-PEER.

The telephone number for the talking computer continues to be (508) 263-6823 (when requested enter User ID 200# 225# and your password PEER#). The telephone number for the on-line career network is still (508) 263-3857 (press the return key twice and enter the password PEER to log on.)

Career Technologies Corporation also operates IEEE-USA's Self-Employed Engineers Registry (SEER), the Graduating Engineers Employment Registry (GEER), and the Non-Employed Engineers Employment Registry (NEER). For additional information about these services, please contact the PEER Service Center.

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IEEE-USA's 1990 PACE Workshop Planning Is Under Way

The theme of this year's IEEE-USA PACE Workshop is "Engineers Meeting the Professional Challenges of the 1990s." The Labor Day Weekend workshop will be held at The Pointe at Squaw Peak in Phoenix, Arizona, August 31 through September 3.

"The 1990 PACE Workshop will focus on the many challenges facing IEEE's U.S. members in the last decade of the 20th century," according to PACE Council Chairman Robert P. Noberini. "These challenges include the shift from military to civilian technologies and resulting employment adjustments, U.S. competitiveness, environmental concerns, emerging technologies, securing pension programs responsive to the unique needs of engineers, improving precollege math, science and technology education, and improving the image of engineers," he said.

The Workshop will open with a reception and welcoming ceremony Friday evening. Sessions will get under way on Saturday morning with a special orientation meeting for PACE Chairmen. The opening plenary session will follow, with Michael J. Whitelaw, IEEE Vice President for Professional Activities and Chairman of the United States Activities Board, presenting a "State of the Board" address and responding to questions from the five USAB Council Chairmen. Saturday's agenda also includes a presentation on IEEE-USA's Legislative Initiative, focusing on USAB's efforts to enhance U.S. competitiveness at home and abroad and to secure legislation supporting pension portability.

Session Chairman Edward J. Doyle will lead a discussion of the "peace dividend" and its anticipated impact on employment and the development of new technologies. Session Chairman James Leonard's speakers will address six activities in which engineers interact with the public. James Strother's session will cover many of the technology policy issues facing the United States in the next decade and IEEE-USA's perspectives on them. The final session, led by William Whipkey, will present new information on career management and development. All the topics discussed at the Workshop will provide material and ideas for PACE activities at the local level.

Nominations Sought for AAAS/Westinghouse Award

The American Association for the Advancement of Science is requesting nominations for the 1990 AAAS/Westinghouse Award for Public Understanding of Science and Technology. This annual award is for working scientists and engineers who make outstanding contributions to the public's understanding of science and technology and who are not members of the media.

The Award will be presented during the AAAS Annual Meeting in Washington, D.C., February 14-19, 1991. The recipient will receive a $2,500 prize. For additional information contact Patricia S. Curlin, Award Administrator, AAAS Committee on Public Understanding of Science and Technology, 1333 H Street, NW, Washington, D.C. 20005. The telephone number is (202) 326-6600. The deadline for nominations is August 1, 1990.

Senior House Committee Member Addresses IEEE-USA's Aerospace R&D Committee

Representative George E. Brown, Jr. (D-California), a senior member of the House Committee on Science, Space and Technology, addressed IEEE-USA's Aerospace R&D Committee at the National Press Club in Washington, D.C., on March 21. *"Space: Key to America's Future"* was Brown's theme, and he emphasized that "an ambitious space program will help the United States regain its competitive position in key trade and technology areas."

The United States must commandeer three key roles today, which will make significant contributions to the world's condition in the future with respect to space policy. America must be a competitor, partner, and leader, according to Brown. In our role as competitor, we must ensure that our space program is the world's best. In our role as partner, we must engage in cooperative space enterprises with other nations. As a leader, the United States must establish policy directives ensuring that the international community receives maximum benefits and knowledge from space exploration, Brown said.

Brown also said that the United States must look for "maximum national return in high-leverage areas." He specified such projects as the national aerospace plane, advanced communications technology satellites, reducing space transportation costs and work directed toward exercising lunar resources.

IEEE-USA's R&D Policy Committee has been instrumental in supporting U.S. civilian space policy. As early as 1984, the committee lent its support to the advanced communications technology satellite program. In 1985, the group outlined a five-point program for development of a permanently-occupied U.S. space station. On behalf of IEEE-USA, the committee has been a long-term supporter of NASA R&D funding.

IEEE-USA has also undertaken a major legislative initiative to enhance U.S. competitiveness. The initiative calls for the re-establishment of tax-sheltered, long-term savings programs and investments in manufacturing firms whose R&D and product operations are located in the United States.

WATCH FOR IN-DEPTH COVERAGE OF EMPLOYMENT ASSISTANCE ACTIVITIES IN FUTURE ISSUES . . .

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IEEE-USA Publishes New Employment Guidelines

IEEE-USA's new printing of *Guidelines to Professional Employment for Engineers and Scientists* is now available. The third edition has been updated and approved by 33 engineering and scientific societies, including the Institute.

The guidelines were developed for use by employers in evaluating their own practices, by professional employees in evaluating their own responsibilities and those of their employers, and by new graduates and other employment seekers in evaluating their potential new employers.

A sample copy of the document and information about receiving bulk copies for distribution are available from the IEEE-USA Office in Washington, D.C.

If You Become Unemployed . . .

IEEE-USA makes several forms of employment assistance available to help you in finding a job.

- ***Free Employment Guide Includes Directory of Employers***

A free copy of the book, *Employment Guide for Engineers and Scientists,* published by IEEE-USA, is available to unemployed members simply by writing to the IEEE-USA Office in Washington, D.C. The 236-page revised, expanded second edition of this popular guide contains chapters on employment agencies, resume preparation, employment contracts, and interviewing. The guide includes a recently updated directory listing employers of IEEE members by state with addresses and contact names. When requesting the book, please mention that you are currently unemployed and include your IEEE membership number. You can also purchase the book through the IEEE Service Center by calling (800) 678-IEEE.

- ***Computerized Employment Registries Are A Member Benefit***

IEEE-USA also maintains a computerized resume database called PEER, the Professional Engineering Employment Registry, which is free for members. A segment of the registry is the Nonemployed Engineers Employment Registry, or NEER. The difference between the two registries is that PEER is confidential (members' names and current employers are shielded), while NEER is nonconfidential and free of charge for employers. Two other employment registries are also available: SEER, the Self-Employed Engineers Registry for consultants, contractors, and subcontractors; and GEER, the Graduating Engineers Employment Registry for graduating student members.

The PEER registries include an on-line job posting system accessible to members with a personal computer (or terminal) and a modem. You can call the on-line Career Network at (508) 263-3857. Simply press your RETURN key twice and enter the password "PEER" to log on. Additional information about the PEER services is available by talking computer. Call, using a touch tone phone only, (508) 263-6823. When requested, slowly enter User ID 200# 225# and the Password PEER#. For more information about the PEER services, call or write PEER Service Center, CTC, 6 Londonderry Commons, 44 Nashua Road, Londonderry, NH 03053; (603) 437-PEER.

- ***Employment Assistance Seminar Is Available to Your Section***

If your employer has initiated a large layoff, you might want to contact your IEEE Section Chairman or PACE Chairman. IEEE-USA presents a one-day seminar entitled *Career Planning & Employment Assistance,* which Sections can sponsor. IEEE-USA will provide planning materials and handouts and even partially subsidize a speaker for the seminar from its Employment Assistance Committee. For more information about this service, contact IEEE-USA Employment Assistance Committee Chairman John Miller at (703) 475-3420.

- ***Get In Touch With other IEEE Members***

Remember that local IEEE meetings are a great place for networking. You can find more jobs through personal contacts than by answering advertisements. Simply introduce yourself, and don't be embarrassed about being unemployed. It happens to most people at least once in their careers. If you are still unemployed at IEEE dues renewal time, there is a dues reduction available.

Good luck on your job search! For more information about any of these services, contact IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036; (202) 785-0017.

IEEE-USA Selects WISE Interns

IEEE-USA selected two college seniors to participate in the Washington Internships for Students of Engineering (WISE) program at a recent WISE Board meeting. Brian J. Conjelco is an electrical engineering major at the United States Military Academy in West Point, New York. Bruce Maxwell is a political science major at Swarthmore College in Swarthmore, Pennsylvania.

The WISE program's concept is to bring engineering students to Washington to learn about the relationship between engineering and public policy. Its long-term goal is to enhance the engineering profession's ability to contribute to public policy decision-making on technology issues.

According to his application, Bruce Maxwell is particularly interested in information management and storage—specifically in data from satellites that NASA currently stores. Brian Conjelko's interest lies in electronic communications. He would like to research government policy in satellite communications regulations.

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IEEE-USA Committees Testify on FY 1991 Federal Budget

Two IEEE-USA Committees recently gave testimony and submitted statements on the FY 1991 budget request for key U.S. government agencies.

- ***National Aeronautics and Space Administration (NASA)***

George F. Sponsler III, Chairman of IEEE-USA's Aerospace R&D Policy Committee, presented IEEE-USA's view on civil aerospace policy and the proposed FY 1991 NASA budget in a statement for the record of hearings held by the House Subcommittee on Space, Science and Applications and the Senate Subcommittee on Science, Technology and Space, and in testimony before the House and Senate Appropriations Subcommittee's on Veterans Administration, Housing and Urban Development and Independent Agencies.

IEEE-USA's statement welcomes President Bush's strong support of the U.S. civil space program in the FY 1991 budget request for NASA, especially his emphasis on advanced technology. IEEE-USA, however, expressed its concern with what it believes to be NASA's overemphasis on manned missions in general and the space station in particular. The committee's testimony notes that there is currently a lack of agreement in both the technical and the political communities on the particular applications that the space station could best serve, especially in light of overall budgetary restrictions. The testimony calls on NASA and the National Space Council to ensure that the respective missions of the space station and NASA's manned space flight program are carefully defined and generally accepted as nationally important and economical before significant expenditures are made.

IEEE-USA takes the position that better balance is needed between NASA's manned and unmanned space programs and calls for budget reprogramming to support the applied research and exploratory development needed to define and develop an integrated space program that advances U.S. industrial competitiveness. To achieve this balance, the Aerospace R&D Policy Committee recommends NASA consider reorienting its R&D into two balanced and complementary programs: Automated Satellites and Probes (ASAP) and Manned Aerospace Transport (MAST). MAST would incorporate all NASA projects on man in atmosphere and space, giving high priority to reducing costs for manned space flight. ASAP would encompass work on all earth orbit applications, satellites and scientific space probes.

The statement also calls on NASA to develop a National Aerospace Plane to replace the space shuttle and to plan for the successful test and demonstration of the Advanced Communications Technology Satellite (ACTS), which is on the verge of completion.

- ***National Institute of Standards and Technology (NIST)***

IEEE-USA's Engineering R&D Policy Committee submitted a statement on the FY 1991 budget for the National Institute of Standards and Technology (NIST) to the House Subcommittees on Science, Research and Technology and on Commerce, Justice, the Judiciary and Related Agencies. The Committee is alarmed that a major expansion in the Advanced Technology Program (ATP) mission has not been accompanied by a funding increase. While IEEE-USA supports ATP's goal to encourage industry, university and government cooperation in technology development, it is concerned ATP will drain essential resources from NIST's critical standards role.

The Committee continues to support NIST computer science and technology programs, such as the National Computer Systems Laboratory, the Computer Security Program, and Integrated Services Digital Network standards and urges increased funding. IEEE-USA also voiced its support for measurement science and precision measurement standards, U.S. participation in international standards bodies, and improved government organization for commercial technology development. The Committee also called for creation of a civilian equivalent to the Defense Advanced Research Projects Agency to support advanced technology research and development projects essential to U.S. competitiveness.

- ***National Science Foundation (NSF)***

In a joint statement to the House and Senate Appropriations Subcommittees on Veterans Administration, Housing and Urban Development and Independent Agencies, the Engineering R&D Policy Committee presented its views on the Bush Administration's FY 1991 budget request for the National Science Foundation (NSF).

IEEE-USA supports the Administration's goal of doubling the NSF budget by 1994 but is concerned that the annual appropriations process in Congress has fallen considerably short of this goal and that there is inadequate support for engineering technology research. The statement points out that requested funding for NSF's engineering research divisions, except for the engineering research center's program, remains at 1989 levels when adjusted for inflation, a situation which will adversely influence research, graduate student production and, ultimately, U.S. competitiveness.

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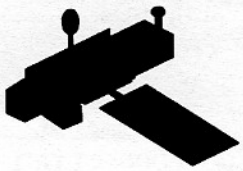

Engineering in the Ocean Environment

September 24–26, 1990
Convention Center
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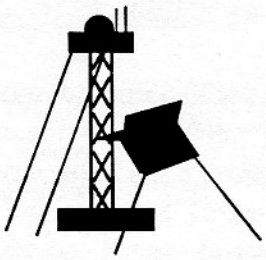

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