Reliability Society Newsletter

Editors: Gary Kushner and Mark Snyder
Vol. 31, No. 3, July 1985 (USPS 460-200)

Editor's Message

How many times during your professional Reliability career have you attended the RAM symposium? Five? Eight? Ten? Now ask yourself how many times have you attended a local Reliability symposium put on by your own chapter? Zero? One? Two? It is amazing to see the number of Reliability Engineers who attend the RAM symposium (which is great), but who do not support their local symposiums. Of course, this also presupposes that there is a local symposium put on by one's own chapter. If your chapter does not hold an annual or a two-year local symposium, then we would like to recommend that one be held. We are recommending this for a number of reasons. It would provide an opportunity for local members to present papers in front of a group of their peers, it provides the chance for engineers to attend a function without traveling a great distance. A third reason of which many members are unaware, is that the administrative committee of the reliability society presents points for the running of a local seminar.

A number of you are probably asking yourself, "Hmmm, why are our editors even mentioning this?" A very good question and a good reason why. Both of us just attended a very well run local seminar which just happened to be their 23rd annual seminar. It is only a one day affair with a wide range of topics, but no tutorials. This one day affair provides an outlet for the local reliability members to present their work to their fellow members and to receive the accolades that are due them. We both walked away with the feeling that the papers werre just as good as those found at the RAM symposium, the accommodations were in keeping with the professionalism of the event, and the calories gained were well received.

Not all local seminars need to be lavish affairs; they can be as simple as a group of tutorials up to a multiple day affair. There are many ways to accomplish this professional event, but the first step is to start planning now. This is not the kind of event that is put together in a month or two. It requires dedication and some effort from the members involved, but the final line is that it will be well received by the membership.

At this point we would like to reiterate that we are not suggesting that you stop attending the RAM Symposium, but attend your local events as well as the RAM symposium (this coming year to be held in Las Vegas).

Your Editors,
Mark and Gary

RS Newsletter Inputs

All RS Newsletter inputs should be sent to one of the associate editors, Gary Kushner, 499 Brigham St., Marlboro, MA 01752, or Mark Snyder, Digital Equipment Corp., 14 Walkup Drive (YWO/D12), Westboro, MA 01581, per the following schedule:

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Musings

The work of the Reliability/Maintainability Engineer is not quite over. New ideas are still forthcoming and will probably continue in the foreseeable future. Nevertheless, my personal belief is that completely new areas (some are old areas) must now be studied (restudied). My own work interests are a case in point: automatic testing, as characterized by Design for Testability (DFT) and field service.

It may be time to readjust our definitions of maintainability. Now that MIL-STD-2165 has been issued, Testability has become a new engineering watchword. No longer can we improve the ''testability'' of a circuit by adding more test points. It is necessary that additional thought be given to ''breaking'' logic chains to provide better observability and controllability of circuits. The complexity of the systems we are designing almost precludes manual testing altogether. The sun has really risen on automatic testing. But, can we now define Testability as the process (probability?) of detecting and isolating failures in a system of equipment; and Maintainability as ease with which a failed item can be accessed? Some accommodation seems to be required between these two fields of interest.

I have been in touch with the Association of Field Service Managers (AFSM) which deals with field failures in a most direct sense. They have to fix 'em. The shortcomings of design reliability and the failure of manufacturing people and processes are reflected in their work. Much of my exposure lately has been a concern with quality, or the lack thereof, manifested in field service requirements.

Putting all this in a bucket and shaking it may spell out that your AdCom needs to once again relate to the Quality Assurance issues. I don't mean that we should try to define the areas of quality, since ASQC already does a good job of that. Rather, it may be time to assess quality impact on field reliability in a real sence many of the problems experienced in the field may not stem from design inadequacies. I have, therefore, asked one of our Senior Members to prepare a prospectus concerning that aspect of quality in manufacturing that impacts field reliability. Upon consideration and acceptance by the AdCom, this might possibly add a new function to our Technical Operations, along with Testability.

I welcome your comments. It was not all that long ago that we had the word ''Quality'' in the title of the AdCom. I don't propose that we do that again but suggest that some concentrated effort be applied to our sister field as it affects us.

Alan O. Plait
President

Chapter News

Central New England Council

The Central New England Council held their 23rd Annual Spring Reliability Seminar on Arpil 25, 1985, entitled "Customer Satisfaction Through Product Assurance Technology." The seminar was highly successful with a great deal of thanks due to Miss Jane Ferguson and Arsene Bajakian. The keynote address was presented by Mr. David Chapman, Vice-President of Manufacturing from Data General Corporation. He was followed by a wide variety of papers from both the area commercial and defense businesses. The papers were: "SWATT: Success with Application of Test Techniques" by J. Thomas Glass, DEC: "Software Supportability—From Design to Customer" by John Chapin and George Faidel, Data General Corp.; "Three Decision Inspection Plan Attributes Providing Protection Against Reworking Lot" by Marva H. Moore, GTE Laboratories Incorporated; "The Use of Regression Analysis in Setting Reliability Goals" by Cheryl Sharie, Data General Corp.; "System Reliability when Hot-Standby Units are Sometimes Non-Callable"by G. Cawood and J. Sullivan, Raytheon Corp.; "CURFIT (Log-Normal, Normal, and Exponential Curve-Fitting Program)" by Gilbert E. Parker, Sanders Associates, Inc.; "Automated Fault Prediction in a Continuous Sectionalized Structure" by Andrew Tabak, RCA/Government Systems Division; and "Sequential Probability Life Tests and Time Truncated Plans" by Vin Kane, Prime Computer.

I would also like to congratulate our new slate of officers for the 1985-1986 season. They are Sid Gorman, Chairman; Gene Bridgers, Vice-Chairman; Jane Ferguson, Treasurer; and Arsene Bajakian, Secretary.

Gary Kushner, Chairman (1984-1985)

Denver Chapter

The Denver Chapter held an all day meeting on May 10, 1985 at Ford Aerospace in Colorado Springs. The meeting, hosted by Ford, was a free workshop dealing with software reliability.

The topics covered were:

1. Software technology update
2. Incorporation of built-in-test
3. Reliability of LSI devices
4. Ford Aerospace system engineering procedure

Mohawk Valley Chapter

The Mohawk Valley chapter has elected Mr. John Bart as Chairman for 1985. Mr. Bart is the Technical Director of the Reliability and Compatibility Division of the Rome Air Development Center (RADC).

The first meeting of the chapter was held on May 6-7 in conjunction with a course on Weibull Analysis held at RADC. The local chapter of ASQC also met in conjunction with the course.

IEEE News Release

Local Engineer Honored by Worldwide Engineering Society

Recognized as Centennial Young Engineer by IEEE during Its Centennial

SAN Jose, CA, January 22: Julia V. Bukowski, a local electrical engineer with the Department of Systems Engineering at the University of Pennsylvania, was honored here recently as a Centennial Young Engineer by The Institute of Electrical and Electronics Engineers, Inc. (IEEE). Dr. Bukowski was recognized at a special banquet concluding IEEE's Centennial Year, attended by some 700 engineers and scientists as well as leaders from government, industry, and academe. The Institute is the world's largest technical professional organization with more than 260,000 members in over 120 countries.

Cited by the IEEE Reliability Society, Bukowski received a "Centennial Key to the Future" from IEEE President Richard J. Gowen. The "Keys to the Future" were presented to 34 individuals representing the Institute's 33 technical societies. Each recipient was identified as an individual in the early stages of his/her career "who best demonstrates sound understanding of the evolving technologies" in the individual's chosen field and whose "progress shows the greatest promise for applying these technologies to the development of new industrial products and systems for the improvement of society."

The Keys were laser cut from a three-inch silicon disc composed of 256k metal oxide semiconductor (MOS) material. The Reliability Society is part of IEEE Division VI encompassing engineering and the human environment.

Bukowski received the B.S.E.E. and Ph.D. degrees from the University of Pennsylvania in 1974 and 1979, respectively, as well as the Diploma of Membership of the Imperial College of Science and Technology, University of London, in 1976. She is currently an Assistant Professor of Systems Engineering at the University of Pennsylvania/Philadelphia. In addition, she has been involved in research on network and software reliability.

In remarks addressed to the Centennial Young Engineers, an actor portraying Benjamin Franklin who was perhaps the first great electrical engineer, issued a challenge encouraging the Key recipients to follow in the tradition of excellence and innovation of their forebears, serving others with technical skills.

The IEEE is a leading authority in areas ranging from aerospace, computers, and communications to biomedical technology, electric power, and consumer electronics. It sponsors numerous conferences and meetings, publishes a wide range of professional papers, and provides many educational programs. The IEEE was formed with the merger of the American Institute of Electrical Engineers and the Institute of Radio Engineers in 1963.

International Reliability Physics Symposium

The 23rd Annual 1985 International Reliability Physics Symposium was held during the week of March 25-29 in Orlando, Florida. The Symposium was sponsored by the IEEE Reliability Society and IEEE Electron Devices Society. Judging from the conversations that we heard in passing, from the long lines of people waiting to register, and from the presentations themselves, the symposium was a major success. We were not able to attend the tutorials, but considering the number of attendees carrying the tutorial books and again from hearing conversations, we also had to deem them a success.

We would like to extend a well deserved *Thanks* and *Congratulations* to the authors, session chairpersons, symposium board of directors, symposium committee chairmen, and symposium officers for a job well done. All of us who attended the symposium were subjected to a well planned and well run function.

Your Roving Newsletter Editors,

Mark and Gary

Reliability Prediction Software Available

The PC-PREDICTOR software packages automate several aspects of reliability engineering methodologies. PC-PREDICTOR automates with full menu and catalog capabilities, the MIL-HDBK-217D and E stress analysis methods. Automatic recognition of all M38510, 1N, 2N, and standard resistors and capacitors is provided.

Panel entry methods are used to access in-house part number equivalents of the automatically recognized parts. Non-recognized parts are easily described via selections on panels.

The programs are available for any IBM PC-compatible based on MDOS operations. The programs are fully backed by the large user base of PREDICTOR users. All PC-PREDICTOR capabilities are fully upward-compatible with the mainframe versions of MSI PREDICTOR reliability, failure modes and effects analysis, and maintainability predictions.

For further information contact:

MANAGEMENT SCIENCES, Inc.
6022 Constitution N.E.
Albuquerque, NM 87110
(505) 255-8611

Reliability Society Committee Positions

The Reliability Society needs members to serve in the following committee functions. Interested people should contact Al Plait, President, for any additional information.

Energy Council
Robotics and Automation Council
R&D Committee
P.A.C.E.

In Memorium

Dr. Arthur I. Siegel, 63, Director of Applied Psychological Services, Inc., died on February 7, 1985. He had been serving the IEEE Reliability Society as chairman of the Technical Committee on Human Performance Reliability, a function he performed for several years. His most recent contribution was a chapter on human performance reliability entitled, "Design for People," which he co-authored with K. LaSala. It deals with human performance reliability concepts and design considerations as they relate to planning and implementing a product's design and introduction. This chapter will appear in the McGraw-Hill *Reliability Handbook*.

Dr. Siegel received his B.A., M.A. and Ph.D. degrees in psychology from New York University. He founded the consulting firm of Applied Psychological Services, Inc. and served as its director for the past 30 years.

Committee Report

The Status of Reliability Technology 1984

Philip Eisenberg, Chairman
Advanced Techniques Committee

Introduction

Successful electronic companies apply major efforts towards improving product reliability and performance. High product reliability and performance are achieved by understanding the manufacturing materials, processes and tests to ensure that the product will meet the requirements of the application. This is especially true of the semiconductor industry where a great deal of emphasis is being put on upgrading the quality and integrity of the silicon material. More detailed and stringent silicon specifications are required to improve component reliability, and cooperation is urged between silicon suppliers and users.

Semiconductor processes must be completely revamped to accommodate the need of submicron features, and novel processes, such as dry etching, will need to be implemented, to etch anisotropic submicron features onto complex structures such as refractory metals, silicides and multilevel aluminum alloys. An automatic VLSI testing technique was recently announced whereby VLSI monolithic silicon circuits are repaired by laser action thereby eliminating the need to have chip redundant functions.

In integrated circuit technology, CMOS will become the dominant process supplanting NMOS and displacing bipolar technology. Previously, bipolar technology reliability could not, in any way, be challenged. This slant towards MOS has been realized because of the elimination and control of sodium contamination in the Si-Si02 system.

The simiconductor industry has now firmly adopted "automation" not only to improve reliability and integrity but to reduce human judgment and fatigue. One outstanding development in automation is the surface mounting of "leadless" components on "holeless" printed circuit boards (PCB). This process is possible because of a novel IC package, a leadless chip carrier (LCC). The LCC can be soldered on the surface of the PCB and eliminates the need of drilling holes through the PCB.

Electrostatic discharge (ESD) was once a problem only for insulated-gate field effect transistors but now all semiconductor devices are vulnerable. The military, reaching out for improved reliability, has ushered in MIL-STD-883C as well as the urging of expanded usage of JANS product assurance levels.

Silicon Wafers for VLSI and Beyond

As silicon monolithic integrated circuits become more dense and silicon wafers become larger in diameter, the requirements for silicon must improve mechanically, chemically, and crystallographically. The tolerances for flatness and parallelism must be minimal. Cleanliness is essential, including the absence of partcles on the backside of the wafer which can affect front side flatness when a wafer is on a lithographic exposure system.

Silicon wafer vendors are now being urged to preoxidize wafers since wafers are the cleanest after polishing and final cleaning. The oxidation of the silicon keeps the slices clean because of the hydrophilic oxide surfaces which do not attract foreign particles electrostatically.

Perhaps the greatest attention should be placed at the microscopic level where a recent newsletter by Schwuttke of A.S.U. has reported that United States-produced silicon wafers degrade faster than non-United States silicon wafers. The conclusions are based on minority carrier lifetime evaluations of 100 mm diameter Czochralski wafers commonly available for industrial production.

Minority carrier lifetime values are related to silicon defects. This study involved sampling of silicon wafers throughout the world and compared it with silicon wafers available in this country. Simple MOS-capacitance and minority carrier lifetime mapping measurements were used for the evaluation.

Computer simulation has shown that modeling with existing silicon material and wafer processing techniques does not yield the degree of confidence necessary for submicron technology. This limitation is due to defects in silicon and unproved silicon wafers are needed to sustain submicron technology. Previously, process techniques such as annealing, diffusion and back surface processes somhow always reduced and controlled defects to a tolerable level.

Automation

Automatic wafer processing, inspection, and final test continue to be the password and key to the semiconductor future. There is little doubt that automation of wafer fabrication will improve the reliability of the devices but the automatic processing and testing will have to be economical for its total implementation. In wafer process automation, critical processing steps such as wafer handling, lithography and dry etching are all being done by machines. Test and inspection will cover not only highly automated systems but also their use in repairing processed wafers by adjusting with lasers and automatic radiation testing of IC's at the wafer stage.

Automatic surface mounting of components directly on printed circuit boards is now gathering momentum. This new packaging revolution evolved from thin and thick film hybrid circuits.

Look for automatic surface mounting integrated circuits and other components on printed circuits boards to greatly improve reliability, cut costs, and increase packaging density.

CMOS and Bipolar Technologies

In 1984, there was an explsion of CMOS activity. The thermal advantages of MOS over bipolar devices has been well documented and CMOS has been clearly emerging as being the optimum of many circuit designs. Even further proliferation is reported by the utilization of silicon-on-insulator both by conventional techniques and oxygen ion implantation.

There is no doubt that CMOS is the technology of the 1980's. Few engineers realize that properly optimized n-well CMOS can now replace virtually all circuits fabricated in either n-channel MOS or bipolar technologies—at any speed and density level. With this speed and density, reliability and power dissipation CMOS is expected to win a greater market share from N-MOS and bipolar for the rest of the decade.

Further, CMOS will be the dominant IC technology by 1993. The upsurge in demand for CMOS products has resulted in rapid expansion for CMOS gate arrays and CMOS logic, and technical improvements in the CMOS process and in more new applications where CMOS is ideally suited. CMOS has the lowest speed/power product of all silicon based processes.

CMOS has had a number of drawbacks including sodium ion contamination at the Si-Si02 interface and latchup. Sodium contamination is now under control and latchup can be virtually eliminated through careful topological layouts at the IC design level. CMOS will clearly be the technology chosen for future circuits that are pushing both functional complexity and speed response. Market research forecasts the worldwide sales of CMOS IC's to grow from the current $1 billion to $58 billion per year by 1994.

For bipolar technology in 1984, there has been a great deal of pressure on bipolar devices to keep up with the demand for high frequency advanced digital systems. Schottky TTL logic circuits have been revamped through "on chip" circuit innovations to further optimize power performance tradeoffs.

This new TTL revolution has two logic families called ALS (Advanced Low-Power Schottky) and AS (Advanced Schottky) both superior versions to the popular LS (Low-Power Schottky) and S(Schottky) forerunners. The ALS/AS devices fit a much broader and more advanced range of system applications than their predecessors.

Dry Etching to Replace Liquid Chemical Etching

MOS devices in this decade will have more than 10 million components on one single chip. Design rules will require submicron features, and new and improved technologies will be required for generating and delineating the required patterns. Traditional lithographic processes will be pushed to their limits. Wet chemical etching will have to be complemented or replaced by dry etching.

All three types of plasma-based dry etching met the requirements of submicron features. The choice depends on the applications of the process and the interactions with the materials being processed. Plasma etching (PE) occurs predominantly by a chemical reaction between a reactive gas in the plasma and the substrate with little directionality. Reactive ion etching (RIE) adds a sputtering action to the chemical reaction with higher directionality. Reactive ion beam milling (RIBM) also combines physical and chemical action with even higher directionality.

RIE and RIBM will become the major dry processing techniques for the rest of the decade because of their characteristics and suitable etching compatability with tantalum over polysilicon for feature sizes in the one micron range. The best technique for high quality etching seems to be reactive-ion etching (RIE). The process consists of a chemical reaction enhanced by ions, bombarding the silicon wafer. The ions remove unvolatile etching inhibitors from its surface and in that way permit etching to continue anisotropically.

Surface Mounting Technology (SMT)

Solid state equipment manufacturers continually seek increased packaging density by packing more functions into a given size encloser and still maintain the same functional capability. Advances in integrated circuit designs and fabrication will result in little practical benefit unless accompanied by equally significant improvements in the assembly-packaging density. For the past 20 years integrated circuit (IC) densities have been improving by several orders of magnitude while printed circuit board (PCB) densities have only improved by one order of magnitude. That is to say that IC chip package miniaturization and PCB technology has not kept pace with silicon wafer fabrication technology.

Surface mounting components on PCB is expected to have the greatest impact ever on electronic packaging. Surface mounting technology (SMT) emerged and evolved from thin and thick film hybrid circuits. SMT is a new electronic assembly technology whereby dual-in-line (DIP) packages are replaced with surface mounted packages or a leadless chip carriers (LCC). The main advantage of LCC over DIP is that no PCB holes are required for the assembly but rather the LCC are soldered directly to the PCB solder pads. SMT eliminates the need to drill holes in the PCB and saves valuable surface area as LCC's are much smaller than DIP's.

This solid state assembly approach reduces manufacturing cost by approximately 50%, reduces the printed circuit board area by as much as 58% for the same density, and improves reliability. It is estimated that the component density will approach that of thin and thick film hybrids.

SMT is catching on. Their popularity can be attributed to short leads or pads which enhance electrical performance and are conducive to production assembly. Almost every type of new IC component can be obtained from the semiconductor manufacturer in this LCC.

There are many advantages of SMT and some of them are not obvious: (1) LCC have a reduction in area, volume and weight—all desirable in aircraft and satellite applications.

(a) An LCC has a reduction in area of 3 to 1 over a DIP
(b) An LCC has a reduction in volume of 8 to 1 over a DIP
(c) An LCC has a reduction in weight of 20 to 1 over a DIP.

LCC's lower mass makes them more durable and able to withstand shock and vibration and are superior to DIPs and flatpacks in this regard. (2) The short leads or pads have lower resistance, inductance and capacitance resulting in improved circuit performance, higher frequency response and less noise. (3) The LCC's or packaged IC chip, can be electrically prescreened, ac tested, temperature tested and burned-in before assembly. Because of their durability, the LCC can be reworked or replaced. (4) The vapor phase reflow solder used in this technology offers greater control of the high temperatures required to melt the solder and does not allow the assembled printed circuit board to pass over heated coils or through a molten solder wave as is required for DIP assembly. (5) LCC automatic assembly is greatly facilitated by automatic placement equipment which accurately places the LCC components on the mounting pads. All this contributes to cost reduction, consistent product quality and high reliability.

The only serious problem with LCC is the well publicized solder-joint cracking problem caused by the thermal expansion problem difference between the PCB and the LCC. This problem can be solved by the proper selection of the PCB material.

Gallium Arsenide Complements Silicon Technology

Gallium Arsenide technologists have made steady progress in the development of GaAs materials, processes and packaging technologies. Their commitment to move GaAs from the laboratory to the production line has made GaAs a powerful and proven technology in microelectronics.

The new GaAs technology has recently excelled and made advances in the integrated circuits. GaAs ultra high speed IC's provide the ultimate in speed for super computers and for other high speed signal processing applications which require clock rates in the gigahertz region and above. Clock rates of 2 to 5 times those available with the fastest silicon technology provide advantages for faster processing speeds, increase in throughput capability and reduced system complexity.

As an added benefit, the extended useful operating temperature range and radiation hardness of GaAs IC's open applications are not possible with silicon technology.

This year, GaAs 16K static random access memories (SRAM) are being produced while, just four years ago, single-cell memories were being discussed. This high speed GaAs 16 SRAM has an access time of 2 nanoseconds and integrates more than 10^5 FETs on a 7.2 mm x 6.2 mm chip.

Impact of Revision "C" of MIL-STD-883B

Quality-control specification MIL-STD-883C Paragraph 1.2 details extensive design, manufacturing, processing, operator-training and record-keeping procedures that manufacturers will have to meet in order to label their parts as MIL-STD-883C. The revised document also contains what is called a "truth in advertising clause" whereby manufacturers who refer to their products as being associated with MIL-STD-883C in advertising, brochures and marketing statements would have to conform with every single requirement of the specifications.

Needless to say that full compliance with MIL-STD-883C would result in significant cost increases to manufacturers. This in turn would increase unit cost and increase minimum order quantities. Further, many lower volume standard MIL-STD-883B components and older product lines would have to be discontinued. This increased obsolescence of components would add to the already very severe void of components.

It has been hinted by senior government officials that Revision C to quality-control specification MIL-STD-883 would allow some off-the-shelf components to be substituted for the more costly source-control-drawing (SCD) components in military hardware. To get more hardware and less paper for the same price would certainly be welcome. If SCD's could be eliminated entirely, then MIL-STD-883C would be certainly very welcome.

Forecasting Semiconductor Device Usage Requirements For "S" Level Applications

USAF/NASA under Contract Number NAS-8-35823 surveyed the needs for "S" level applications. The study summarizes the results of a survey conducted from March 1984 to July 1984, to provide data for forecasting microcircuit and other semiconductor usage requirements for "S" level applications. The data were collected through responses to a survey questionnaire which was sent to eighty-seven (87) major suppliers of aerospace systems and to four (4) major suppliers of "S" level microcircuits and other semiconductors. The results of the survey were entered into a computer database file and then merged with an existing (database) parts list for previous USAF-funded programs to add historical usage information. The overall response to the survey was good and it appears that the use of "S" level parts will be expanded.

Future Trends

For many years to come, silicon wafers will enjoy being the prime candidate for many electronic devices. However, for certain applications such as ultra high-speed computer elements and communications, other basic materials are being considered. In 1984, for the first time, commercial Gallium Arsenide (GaAs) integrated circuits were introduced. This was reported in a recent announcement where a GaAs universal shift register and a binary counter will operate five (5) times faster than the silicon integrated circuits available today. These GaAs devices will be the first of a comprehensive family of GaAs devices offered. The market for GaAs digital integrated circuits is now poised for a phenomenal explosive growth. It is anticipated that the standard-product gallium arsenide market will reach $5 billion by 1992. Advances in material technology and fabrication techniques such as ion implantation and ion milling direct-step-on-wafer phololithography and dry plasma etching has made the commercialization of gallium arsenide possible.

Surface-mount packages will dominate IC packaging. Their popularity is attributed to ease of assembly and short leads or pads which enhance both speed and performance. This package miniaturization is long overdue.

Conference and Course Calender

DATE	CONFERENCE	PLACE	CONTACT
1985			
Aug. 26-30	Relectronic '85	Budapest, Hungary	Scientific Society Telecommu- nication Organizing Com- mittee Relectronic '85 H-1372 Budapest PO Box 451 Hungary 531-027
Oct. 8-10	Melecon '85	Madrid, Spain	Prof. A. Luque Instituto de Energia Solar E.T.S.I. Telecomun. UP Ciudid-Univer Madrid-3, Spain
Oct. 21-24	Autotescon '85	Uniondale, N.Y.	Louis A. Luceri 660 Grand Avenue Lindenhurst, NY 11757 (516) 391-5592
1986			
Jan. 28-30	Annual Reliability and Maintainability Symposium	Las Vegas, NV	Norman Kutner Westinghouse Electric 401 East Hendy Ave. P.O. Box 499 (MS 21-9) Sunnyvale, CA 94088 (408) 735-2261
April 1-3	1986 Reliability Physics Symposium	Anaheim, CA	H. C. Jones Westinghouse Corp. P.O. Box 1521 MS 3664 Baltimore, MD 21203 (301) 765-7387

Publications of Interest

InterRam Proceedings

Once again, the Reliability Society offers its members a chance to receive a gratis copy of the Inter-RAM conference proceedings. The 12th Inter-RAM was held in Baltimore, MD in April and the Proceedings are now available to our members. The Conference services the power industry, both fossil and nuclear fueled.

Members interested in obtaining a copy should send their requests no later than November 30 to:

Alan O. Plait, President
5402 Yorkshire Street
Kings Park
Springfield, VA 22151

Maintainability Matters

The following article on the new Testability Standard (MIL-STD-2165) appeared in the March 1985 issue of the "ATE Newsletter."

Testability Military Standard Issued

MIL-STD-2165, "Testability Program for Electronic Systems and Equipments," was issued on January 26, 1985. This new standard may be applied to all electronics developments within the Department of Defense.

Testability addresses the extent to which a weapon system or subsystem supports fault detection and isolation in a confident, timely and cost-effective manner. The incorporation of adequate testability, including built-in test, requires early and systematic management attention to testability requirements, design and measurements.

Several studies have identified testability as a major contributor to improved system readiness and reduced development and support costs. Design for Testability is being adopted by more and more companies in the commercial sector as a cost-effective way of doing business. Yet the military, prior to MIL-STD-2165, has lacked a systematic, uniform method of invoking Design for Testability requirements in their contracts.

The development of MIL-STD-2165 was sponsored by the Naval Electronic Systems Command Test and Monitoring Systems (TAMS) Program Office (ELEX 08T) and coordinated through the Joint Logistics Commanders (JLC) Panel on Automatic Testing (AT). The standard went through two drafts. The first, issued in January 1983, presented a comprehensive testability program, applicable to a weapon system throughout its lifetime. The second draft, issued in February 1984, reduced the scope of the standard and relied more upon other disciplines (logistics, support analysis (LSA), maintainability, etc.) to support activities such as testability demonstration and field data collection. The final issue of the standard contains a more detailed definition of interfaces between testability and other disciplines.

MIL-STD-2165 contains seven tasks:

Task 101 Testability Program Planning
Task 102 Testability Reviews
Task 103 Teatability Data Collection and Analysis
Task 201 Testability Requirements
Task 202 Testability Preliminary Design and Analysis
Task 203 Testability Detail Design and Analysis
Task 301 Testability Inputs to Maintainability Demo

Although the tasks are succinct (twelve pages total), several pages of the MIL-STD are devoted to the non-contractual Appendix A which provides guidance for the selection and tailoring of tasks. Four of the tasks are discussed below.

Task 101—Testability Program Planning. Testability design involves close cooperation between a large number of organizational elements within a company—design engineering, maintainability engineering and logistic support are just three. The contractor's Testability Program Plan identifies a single organizational element to have overall responsibility for testability and for those inter-disciplinary efforts required to develop a testable system.

Task 201—Testabilitly Requirements. Determining a set of testability requirements which are sufficient, achievable and affordable requires a careful comparison of alternative diagnostic concepts. For example, in deciding whether or not to specify a two-level maintenance concept, one technical question might be: Can built-in-test (BIT) be made good enough to accomplish two-level maintenance? Also, will BIT cost more than is saved by eliminating I-level testers? Task 201 supports the Logistic Support Analysis (LSA) process with technical data.

Task 202—Preliminary Testability Design and Analysis. Testability design tasks require the contractor to integrate the testability discipline into mainstream design, perform early design trade-offs, apply early (inherent) testability measures, and provide visibility at design reviews. If testability is to be specified in a contract there must be a means for measuring testability in a design. The traditional test effectiveness measures (fault detection, fault isolation, fault isolation time, etc.) are the most important measures. Unfortunately, they may be applied only to systems which are well along in their development. In the new standard, "inherent testability" is introduced in the form of a testability design checklist. The checklist addresses compatibility, controllability, observability, partitioning and other testability concepts which are inherent in the design. These attributes are "measured" early enough in the design phase to permit lowcost redesign if testability problem areas are found.

Task 203—Detail Testability Design and Analysis. Once the inherent hardware structure supports testing, emphasis switches to the development of actual performance monitoring techniques and stimulus/response techniques for BIT. The task requires a quantitative prediction of fault detection and isolation levels for BIT using tools and procedures similar to those now used for Test Program Set (TPS) development. MIL-STD-2165 requires the submission of a Testability Analysis Report, DI-T-7199, to document the results of requirements tradeoffs, design tradeoffs, and test effectiveness predictions.

It is recognized that no matter how well planned a testability program is, some testing problems will not surface until very late in the development phase or even in the production or deployment phases. The MIL-STD-2165 testability program is constrained to those design tasks which occur prior to Critical Design Review (CDR) and "hands off" post-CDR issues to appropriate tasks in MIL-STD-1388, MIL-STD-470 and MIL-STD-2077.

Material from the proposed MIL-STD has already been incorporated in several contracts with generally good results. MIL-STD-2165 should be invoked on various kinds of system acquisitions and its cost/benefit assessed. As a result of this assessment the standard will change over time and may, in fact, be eventually integrated into a larger-scope document such as a Diagnostics Standard.

Additional information on MIL-STD-2165 may be obtained from William Keiner, Test Technology Office, Naval Surface Weapons Center, Dahlgren, VA 22448, telephone AV 249-8586 or Commercial (703) 663-8586. Also, the Joint Services Electronic Design for Testability Course has been updated to include training on the application of MIL-STD-2165 to system developments.

Power System Reliability Program Description

Charles R. Heising, **Chairman**
Power Systems Reliability Subcommittee

Reprinted from *IEEE Industry Applications Society Newsletter.*

History and Background

The IEEE and its predecessor society the AIEE has had a reliability activity on industrial and commercial power systems since 1960. Prior to that time a qualitative approach had been taken when designing industrial and commercial power systems. The need for a quantative approach was first recognized in the early 1960s when a small group of pioneers led by W. H. Dickinson organized an extensive AIEE survey of the reliability of electric equipment in industrial plants. A more extensive IEEE reliability survey was undertaken and published in 1973/74.

These IEEE industry surveys provided a source of credible pooled industry reliability data and cost of power outage data for use in the design of industrial and commercial power systems. This filled a major need that had existed before reliabiulity versus cost could be considered when designing industrial and commercial power systems. However, after this need was fulfilled, new needs were identified: (1) Teach plant electrical engineers and consultanta how to use the reliability data and the cost of power outage data when designing industrial and commercial power systems; and (2) Assemble all of the pertinent reliability material into a reliability handbook. The Power Systems Reliability Subcommittee of the IEEE Industry Applications Society (IEEE-IAS) undertook a program to meet these new needs.

Different Viewpoints on Reliability

There are many different viewpoints on the subject of reliability of industrial and commercial power systems. These include: (1) maintenance, (2) design—industrial, (3) electric utility, (4) equipment manufacturer, and (5) insurance company. All of these viewpoints are represented on the Power Systems Reliability Subcommittee.

Reliability Tutorial Sessions

Three-hour tutorial reliability sessions on the design of industrial and commercial power systems were conducted at the 1971 and 1976 IEEE Industrial and Commercial Power Systems Technical Conferences and at the 1980 IAS Annual Meeting. The tutorial sessions are slanted at getting decision makers interested in having reliability studies made when designing or modifying their power systems.

Reliability Handbook

The pertinent tutorial material, equipment reliability data and cost-of-power-outage data have been assembled into a single 224 page reliability handbook. This has been issued as ANSI/IEEE Standards N0. 493-1980—"IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems." Included are summaries of the data from the extensive IEEE-IAS equipment reliability surveys and cost of power outage surveys published as committee reports during 1973-1979. Also included are the following:

1. Basic concepts of reliability analysis by probability methods.
2. Fundamentals of power system reliability evaluation.
3. Economic evaluation of reliability.
4. Reliability analysis examples.
5. Evaluating and improving the reliability of existing plant power systems.
6. Emergency and standby power.
7. Electrical preventive maintenance.

Future Projects, Goals, and Needs

The reliability handbook is scheduled to be updated in 1986. Equipment reliability surveys will be continued as an ongoing program in order to update the data and to get better information in areas that have been identified as needing improvement; this includes trying to settle controversies generated by data from previous surveys, obtaining data on new technologies, and also for obtaining data on new equipment categories. Reliability tutorials will be given at periodic intervals in the future.

An area that has been identified as needing improvement in future equipment reliability surveys is the relationship between preventive maintenance and failure rate.

New equipment areas that have been identified for further reliability studies and possible future equipment reliability surveys include:

1. Emergency backup power supply systems; such as, uninterruptible power supplies, motor/generator sets, diesel generators, gas turbines, etc.
2. Solid state ac variable speed drives
3. Solid state ac starters.
4. Solid state dc drives.
5. Gas turbine generating unit used for toping.

Equipment Reliability Surveys

ANSI/IEEE Standard No. 493-1980 contains the data from all of the equipment reliability surveys published by IEEE-IAS during 1973-1979. These include power transformers, circuit breakers, fuses, motor starters, motors, generators, disconnect switches, switchgear bus, bus duct, open wire, cable, cable terminations, cable joints, protective relays, inverters, rectifiers, and electric utility power supplies. The pertinent data include: the failure rate, outage duration time, failure initiating cause, failure contributing cause, suspected failure responsibility, failure mode, type of failure, failure repair urgency, repair or replace, and data on maintenance.

Reliability surveys conducted since ANSI/IEEE Standard No. 493-1980 was published include power transformers [2], local generation equipment [3], emergency and standby power equipment [3], and motors [4], [5]. A circuit breaker reliability survey has been started and is scheduled to be published in 1986.

A program of continuing ewuipment reliability surveys is being carried on. An important part of this activitiy is the compilation of a report on the reasons for conducting the new survey; this is done at the beginning of each new equipment survey and is ;used as the basis for revising the questionnaire that had been used previsously. At the end of an equipment reliability surveyr a copy of the final report is sent to every participant; this feedback of information is an important part of keeping people interested in collecting and submitting reliability data.

Effect of Preventive Maintenance on Failure Rate

The subject of maintenance costs and the effect of maintenance on the failure rate of electrical equipment has come up many times during the past 24 years; some work has been done on this subject, but mush more still needs to be done before this factor is adequately considered in the design of industrial and commercial power systems. This problem was first addressed in the surveys published in 1973/74 and will be considered in all future equipment reliability survery. All of the IEEE-IAS equipment reliability surveys have found that inadequate maintenance is a major cause of failures of electrical equipment in industrial plants.

One of the important total operating cost decisions made by the plant manager of an industrial plant is how much money to spend for scheduled preventive maintenance of the electrical equipment. The amount of maintenance performed on a component can affect its failure rate. Very little quantitative data have been collected and published on this submect. Yet this is an important factor when attempitng to study the total owning costs of a complete power system. If maintenance effort is reduced the maintenance costs go down. This may increase the failure rate of the components in the power system and raise the costs associated with failures. There is an optimum amount of maintenance for minimum total owning cost of a complete power system.

A paper containing quantitative data and analysis of optimum maintenance intervals was published by D. J. Sheliga [6]. This paper was based upon 10,000 failures collected at the author's company over a period of seven years for 23 categories of electrical equipment. Included was a definition of what failures could be prevented by maintenance. Actual data were eused to determine how this failure rate varied with maintenance interval. The optimum maintenance interval was then determined based upon the maintenance cost and the cost of failures/power coutages. Failures that could be prevented by diagnostic testingg were then studied in a similar manner to those that could be prevented by maintenance. The optimum diagnostic interval was then calculated for 15 equipment categories based upon the cost of diagnostic testing and the cost of failures/power outages. Mr. Sheliga reported that 25 percent of the failures could have been prevented by maintenance, and additional failures could have been prevented by diagnostic testing.

The results from the IAS reliability surveys on the effect of maintenance on equipment failure rate have been summarized [7] along with the results from Mr. Sheliga's studies. It is hoped that the methods used by Mr. Sheliga can be incorporated into future IAS equipment reliability surveys. This approach fills an important link that needs to be considered when making studies on the economics of imporved reliability of industrial and commercial power systems.

Inputs to Other IEEE Standards

An effort has been made to get decision makeers to use the methods and data contained in ANSI/IEEE Standard No. 493 when designing industrial and commercial power systems. Part of this effort has included writing a reliability section into the following widely used IEEE Standards:

No. 141 "Recommended Practice for Electric Power Distribution for Industrial Plants."

No. 241 "Recommended Practice for Electric Power Systems in Commercial Buildings."

No. 399 "Recommended Practice for Industrial and Commercial Power Systems Analysis."

No. 446 "Recommended Practice for Emergency & Standby Power Systems Analysis."

References

[1] ANSI/IEEE Standard No. 493-1980—"IEEE Recommended practice for design of reliable indu;strial and commercial power systems." Approved as ANSI Standard, May 1982. 7000 copies sold. Price to IEEE members is $17.95 plus a $2.00 handling charge, from the IEEE Standards Office, 345 East 47th St., NY, NY 10017-2394.

[2] IEEE Subcommittee Report, J. W. Aquilino, coordinating author. "Report of transformer reliability survey—industrial plants and commercial buildings," *IEEE Trans. Indus. Appl.,* Sept./Oct. 1983, pp. 858-866.

[3] IEEE Subcommittee Report, P. O'Donnell, coordinating author. "Report of generator reliability survey—industrial plants and commercial buildings," IEEE Indust. Commercial Power Syst. Tech. Conf., May 12-15, 1980, Houston, TX.

[4] IEEE Working Group Report, P. O'Donnell, coordinating author, "Report of large motor reliability survey of industrial and commercial installations, Part 1," IEEE Indus. Commercial Power Syst. Tech. Conf., May 9-12, 1983, Milwaukee, WI.

[5] IEEE Working Group Report, P. O'Donnell, coordinating author, "Report of large motor reliaiblity survey of industrial and commercial insstallations. Part 2," IEEE Indust. Commercial Power Syst. Tech. Conf., May 7-10, 1984, Atlanta, GA.

[6] D. J. Sheliga, "Calculation of optimum preventive maintenance intervals for electrical equipment," *IEEE Trans. Indus. Appl.,* Sept./Oct. 1981, pp. 490-495.

[7] C. R. Heising, "Quantitative relationship between scheduled electrical preventive maintenance and failure rate of electrical equipment," *IEEE Trans. Indust. Appl.,* May/June 1982, pp. 268-274.

ASME Related Items

Reliability—Related Items From The American Society Of Mechanical Engineers (ASME)— 1985 Publications Catalog

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AMD-Volume 9
Reliability Design for Vibroacoustic Environments
Eds. D. D. Kana, T. G. Butler
1974 Bk. No. 100047 187 pp.
$18.00 Members $9.00

Advanced in Reliability and Stress Analysis
Ed. J. J. Burns
1979 Bk. No. H00119 248 pp.
$30.00 Members $15.00

Failure Prevention and Reliability
Eds. S. B. Bennett, A. L. Ross, P. Z. Zemanick
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$30.00 Members $15.00

Failure Prevention and Reliability 8 1981
Ed. F. T. C. Loo
1981 Bk. No. 100142 244 pp.
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Failure Prevention and Reliability - 1983
Ed. G. M. Kurajian
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Reliability, Stress Analysis and Failure Prevention Methods in Mechanical Design
Ed. W. D. Milestone
1980 Bk. No. H00165 328 pp.
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Advances in Life Prediction Methods
Eds. D. A. Woodford, J. R. Whitehead
1983 Bk. No. H00255 375 pp.
$60.00 Members $30.00

PVP-PB-023
Failure Data and Failure Analysis: in Power and Processing Industries
Eds. A. C. Gangadharan, S. J. Brown, Jr.
1977 Bk. No. G00123 109 pp.
$16.00 Members $8.00

PVP-Volume 72
Random Fatigue Life Prediction
Eds. Y. S. Shin, M. K. Au-Yang
1983 Bk. No. H00258 148 pp.
$30.00 Members $15.00

PVP-Volume 62
Reliability and Safety of Pressure Components
Ed. C. Sundararajan
1982 Bk. No. H00219 254 pp.
$50.00 Members $25.00

Call for Papers

Quality and Reliability Assurance in Communications

This Issue of the *IEEE Journal on Selected Areas in Communication* is sponsored by the Quality Assurance Management Committee. The objective of this issue is to provide a literary forum for planners, designers, manufacturers, service organizations and users to better understand the status of quality, reliability and maintainability standards and practices specific to the Communications areas.

Papers should be previously unpublished and address the areas of Quality and Reliability Assurance for Communication areas such as:

- Quality Management
- Fiber Optic
- Switching Systems
- Network Performance
- Hardware/Software
- Terminals/Transmission
- Analytical Methods

- Quality Technology
- Process and Product Design
- Standards and Measurements
- Field Performance
- Cost of Poor Quality

Practical papers or theoretical papers with applications are preferred.

Prospective au;thors should prepare a 600-word summary of their proposed paper by August 1, 1985 and forward it to one of the following:

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The following dates should be respected:

- Summary due: August 1, 1985
- Committement notification: September 2, 1985
- First draft due: November 18, 1985
- Acceptance notification: February 3, 1986
- Final paper due: April 11, 1986
- Publication: 4th Quarter 1986

Announcement

Workshop on Reliability Assurance of Computer Controlled Communication Systems

October 1 through Noon October 3, 1985

Hotel La Sapiniere, Val David, Canada
(near Montreal, Canada)
Sponsored by: IEEE Communication Society
Quality Assurance Management Committee

Objective

With the increased use of large sophisticated computer controlled systems in the world, the need for better methods to specify and evaluate the reliability of these systems has become apparent, if not critical. There is a specific need in the communications industry for more interaction between suppliers or stored program controlled systems and service providers to better understand the status of quality, reliability, and maintainability standards and methods specific to the communication industry. This workshop is directed toward identifying practical techniques for reliability assurance of communication systems. Specifically, the following topics will be discussed:

- Reliability Modeling Techniques
- Reliability Measurements and Case Histories
- Reliability Specifications and Standards
- Quality Assurance Management

Organizing Committee

Paul K. Giloth, Chm (AT&T-BL, Naperville, IL)
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Bob A. Kessler (Bell Canada, Montreal)
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Important Dates

June 15, 1985	Deadline for participation proposals
August 1, 1985	Notification of acceptance
September 1, 1985	Deadline for registration and payment of workshop fees

Information for Participants

The four topics listed above will be covered in short presentations by workshop participants. These presentations should emphasize current practices, problems, future directions, and initiatives. The attendance will be limited in order to facilitate open discussion and enhance interactions. Each presentation will be limited to 10 minutes followed by 20-minute discussions. *Speakers will be encouraged to present results of practical significance and actual case histories.* Each participant should submit a summary (not to exceed 500 words) or a proposed presentation and/or experience on a particular topic to the organizers as soon as possible with a cutoff date of June 15, 1985.The objective of the workshop is to stimulate open and frank technical dialogue between telecommunication suppliers of equipment, providers of service, and users of service. Participants' summaries and talks will not be published but a summary of the workshop discussions prepared by the organizers will be presented at ICC '86.

The workshop will be held October 1, 2, and 3, 1985, at Hotel LaSapiniere, a complete facility for conferences and leisure. The fee for the workshop is $280 US per participant or $420 US per participant and spouse. This covers conference expense, lodging for Monday through Wednesday nights, all meals through Thursday noon, and all taxes and gratuities.

Address all correspondence

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Statements by Candidates for 1986 President-Elect

The following independently written statements by the two candidates for President-Elect, Mr. Henry L. Bachman and Dr. Jose B. Cruz Jr., have been especially prepared for readers of IEEE newsletters. It is hoped that these statements will supplement the biographical sketches and other statements made by the candidates which appear elsewhere in the IEEE literature and that they will assist IEEE member voters in the election process.

Statement by Henry L. Bachman

My objective, as President of the Institute will be to assure that the Institute will provide the basis for the health and growth of the profession and its members, for their own benefit, for the benefit of the electrotechnology industry and supporting institutions and, as a result, for the benefit of the members of society at large.

Essential to accomplishing this objective is the need to maintain the vigor of the technical societies and to see that these activities are not compromised. The professional activities of the Institute must support these technical activities by encouraging and assisting able engineers to join and to prosper in a lifelong career within the profession. These activities together, must take action to strengthen the profession's image and its contribution to public policy and, by so doing, create the environment that is necessary to enhance the strength and stature of the profession and its members.

More specifically, there is a need to derive more benefit and broaden the impact of technical activities by better application of the resources and capabilities provided by the Regional and Educational activities, particularly as to the need to increase the utilization and make more productive the engineers that are already working, to prevent the loss of older engineers from the profession, and to be more responsive to the careers in industry with requirements for competitiveness in product cost and quality. This requires improving the ability of the Institute to deliver relevant technical information to the members, economically and effectively, both to individuals or local groups, and with emphasis on life-long learning through continuous education.

There is a need to assure the freest dissemination of technical information, as embodied in presentations or products, consistent with proprietary needs and national security, in order not to discourage the economic and intellectual pursuit of technological innovation. There is a further need to encourage the contributors of such innovation by proper recognition of their rights to intellectual property.

There is a need for the Institute to direct more attention to external affairs. With employers of engineers, for example, to further the understanding of the contribution of the Institute to all enterprises. With institutions at the local level, especially when certain member problems and concerns have more relevance and urgency regionally, than nationally, and with the media, and the public they serve, to combat the limited awareness and often, therefore, the low regard for technology, by speaking out knowledgeably about technology to the government and the public at large. The recently established Industrial Relations Committee, increased USAB interactions, through PACE, with local governments, an IEEE Annual Conference, and more media attention to Institute awards are examples of such public information programs which require more emphasis.

Statement by Jose B. Cruz, Jr.

Extend technical and educational services to a broader member base

IEEE is the largest technical professional society in the world. It disseminates numerous major advances in the field through its technical publications and technical conferences throughout the world. Our publications and conferences are preeminent but we need to extend our publications and conference activities to serve a broader member base. We should have more offerings of tutorial and practice-oriented material to assist our members in their career-long professional development. We need to develop effective delivery mechanisms using our own computer/communications technology.

Continuing education is for everyone—Advances in computers, communications, microelectronics, electronic materials, optoelectronics, electromagnetics, systems, power and energy, and other areas have been dramatic in recent years. IEEE members must continuously learn a significant amount of new material to maintain technical viability. The nature of our profession demands that life-long learning, in its broadest sense, occupy a central place in our individual activities.

Enhance opportunities for professional development—The most critical factor affecting the professional development of engineers is the presence of challenges for creativity and opportunities for growth in the work environment. IEEE should work with industry leaders to address the productivity problem through greater incentives for professional growth. We need to match our educational offerings with industrial challenges at the workplace.

Improve communications—We need to express our concerns and opinions to IEEE officers. Our representatives want to hear from us so that they can represent us more effectively. More communications with our local Section/Chapter officers, Society officers, and Institute officers should lead to a more effective organization.

Forecast engineering manpower demand—When demand exceeds supply, more high school graduates are induced to seek a career in engineering. Unfortunately, there is usually a lag of four to five years before an increase in supply is felt. This could then lead to an excess supply of engineers. We need longer term forecasts to improve stability. We must be very careful not to overestimate demand.

Fight Age Discrimination—IEEE should assist industry to achieve a more effective engineering manpower utilization. IEEE must assist its membership against age discrimination practices which may occur in advertising, early retirement, employment, promotion, transfer, or other forms. IEEE should support those industry leaders who create the necessary environment for employed engineers to have full and productive careers.

We Need Your Feedback

Based on my conversations with numerous IEEE members throughout the world I know that we need more services for technical and professional development in our stride for greater productivity, and we deserve improvement in our social and economic status. I believe that I have broad support for my goals to improve member services and to enhance the status of the engineering profession. I urge you to express your feedback by exercising your right to vote.

Statements by Candidates for 1986 Executive Vice President

The following independently written statements by the two candidates for Executive Vice President, Mr. Merrill W. Buckley, Jr. and Dr. Emerson W. Pugh, have been especially prepared for readers of IEEE newsletters. It is hoped that these statements will supplement the biographical sketches and other statements made by the candidates which appear elsewhere in the IEEE literature and that they will assist IEEE member voters in the election process.

Statement by Merrill W. Buckley, Jr.

The duties of the Executive V.P. are probably the least explicit of any of the IEEE corporate officers. This has been particularly evident since the adoption of the President-Elect concept in 1982. The value of the position therefore depends in large measure on how the person who is elected approaches their term of office.

If elected, I would enthusiastically undertake the usual functions of the office which are to assist the President, to chair the Conference Committee, and to coordinate and report on the activities of the committees assigned to the Executive V.P. But I would also spend a good deal of time on other important Institute issues. The recently completed Centennial Year survey of what our membership thinks should be done to improve the IEEE would be my agenda.

Since our bylaws state that "the Executive V.P. will be responsible for broad corporate matters and may appoint such ad hoc committees as may be required to discharge his/her duties" there is a ready made mechanism available to work on key issues.

I believe we need, and would initiate, ad hoc committees of our best people to address the membership's concerns and to develop specific recommendations for Board of Directors action on such issues as:

- Enhancing our professional image
- Low cost continuing education
- Application oriented publications
- Improving the IEEE/industry relationship
- Worldwide distinguished lecture program
- An affordable dues structure
- Priority review for professional activities
- Continuing support of AAES

Statement by Emerson W. Pugh

It is an honor to be considered for the office of Executive Vice President. If elected, I will devote myself to that position with four primary goals:

- Improve the volunteer structure of IEEE to attract our best members, to use their services wisely, and to assure that their efforts are applied to the good of all members.
- Help our members increase their technical competence through improved IEEE publications, conferences, and educational programs.
- Increase the monetary rewards and other recognition accorded to engineers through improved public awareness of their contributions and by developing broader opportunities for engineers.
- Make the international engineering community, and IEEE in particular, a force for promoting world peace and a better life for all.

In working to achieve these goals, I will seek the advice and help of as many members as possible; I will draw on my work experience in industry, government, academia, and international technology development and on my fifteen years of experience as an IEEE volunteer—including conference chairman, transactions editor, society president, Publications Board vice chairman, and member of the Board of Directors.

A specific function of the Executive Vice President is to chair the Conference Board, created last year to address a number of specific problems. As a member of that board this year, I am obtaining insights that will help me be more effective during the one-year term of the Executive Vice President.

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