Reliability Society Newsletter

Editor: Susan Eames
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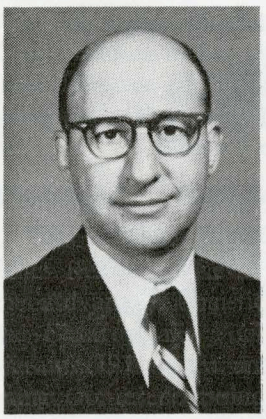
President's Report



Anthony Coppola, Fellow IEEE

THERE are insufficient words available to express my delight with the elevation of Tony Coppola to IEEE Fellow. This recognition results specifically from Tony's work in the Reliability field, and all who are familiar with his dedication and achievements will agree that this is a richly deserved honor. Tony has made countless contributions to the Reliability discipline. He can also be counted on to support the Reliability Society in any way asked. He currently is Vice President for Publications, Chairman of Advanced Devices and Techniques, and serves on the R & M Symposium Management Committee. My sincere congratulations to Tony.

Congratulations are also in order to three other members of the Reliability Society who were elevated to IEEE Fellow in recognition of achievements outside the Reliability field. Kudos from all of us to Al Gross, Hiroshi Hirayama, and H. Bertil Thoren.

Congratulations also go to Hank Malec for his election to Reliability Society Vice President. Hank is a dedicated worker for the Society and has a long record of accomplishment as Chairman of Chapters. Hank will assume the duties of Vice President for membership. I shall enjoy working with Hank this year along with the re-elected Vice Presidents Naomi McAfee, Tony Coppola, and Dave Troxel.

The Editor's Corner

GREETINGS from your new editor! I would like to take this opportunity to express a few of my opinions on the Newsletter to let you know where I stand. This Newsletter, fellow members, is YOUR Newsletter. It is a vehicle through which you can express your ideas and gain knowledge about items of interest happening in the world of reliability and associated disciplines. On a regular basis I receive inputs from various sources that allow me to keep you informed about symposiums, seminars, call for papers, AdCom reports, conferences, news releases, new members of our society, and special features. This keeps you informed on what is happening.

But what about you? What are you doing that would be of interest to your fellow engineers? Why not share some new techniques you have found that work in running Reliability tests? What about the new algorithm you developed to calculate failure rates or MTBFs meantime between failures) on state-of-the-art devices? We, your fellow Reliability Society members, would like to hear about these. Is there something you would like to get off your chest? Write to the editor. We can start an editorial column for this purpose.

I am here, as your editor, to help you. I look forward to hearing from you. Bye for now!

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Chapter Reports

Central New England

Activities for the fiscal year began with a September technical meeting at Hanscom Air Force Base, Bedford, MA. The speaker was Al Spann of the GTE Sylvania Systems Engineering Staff, and the discussion dealt primarily with the application of the assurance sciences in the early conceptual design process.

The Fall Lecture Series began in October, at RCA, Burlington, MA, with Hank Wristen of Assurance Technology Corporation, and John Chipchak of System Effectiveness Associates, as instructors. The topic was Maintainability with particular emphasis on commercial programs. Also in October, Wil Aubert, Chapter Chairman, participated in the National Meeting of Chapter Chairmen in Washington, DC.

In December another technical meeting was held, at the Speare House in Lowell, MA. The speaker was Ezra Sheffres, Director of Product Assurance for Raytheon Company, who discussed Military versus Commercial Reliability.

Cleveland

The Cleveland Chapter has had three good meetings so far this year:

9/08/81 Medical Diagnosis Using Computers by *P. Hunter*
10/15/81 Reliability Testing and Demonstration by *V. Lalli.*
11/19/81 Reliability Training by *F. Barini*

At press time, the chapter was planning on three more meetings this year:

3/18/82 Reliability Simulation by *H. Cheng*
4/15/82 Research on Controls by *R. Collins*
5/20/82 Sneak Circuits in Electronics by *J. Burkhart*

The Cleveland Chapter is happy to announce that Ms. N. J. McAfee will be the featured speaker for March. The Cleveland Chapter chairperson is Ms. C. W. Jurkashek.

The Cleveland Chapter is working with the Electro Expo AdCom for their conference in Cleveland this year, April 27 to 29). The conference will be held at the Cleveland Convention Center with about 150 exhibits. The Reliability chapter will staff an IEEE booth and help to organize papers, workshops, and social events.

Denver

The Denver Chapter held a special two-day Hardware/Software Reliability Course on January 29 and 30. In addition, the Chapter held a joint meeting with ASQC Tuesday, February 16, which had a Reliability Roundtable discussion in the afternoon, followed by cocktails and dinner. In the evening a Reliability panel met with special guests Dr. Thad Regulinski, past President of the IEEE Reliability Society, and Robert W. Smiley, Chairman of the Reliability Division of the ASQC.

The Denver Chapter plans to hold the special two-day Hardware/Software Reliability Course again on April 16 and 17. Their final spring meeting is scheduled for Thursday, May 13.

Washington

Washington Chapter activities during the first half of the 1981/1982 meeting year have included talks by Dr. Arthur Siegel (reported in the January Newsletter); Col. Thomas A. Musson, USAF; Col. Ben H. Swett, USAF; Mr. H. S. Itkin; Dr. H. B. Chenoweth, and Mr. Jack Lavery.

Colonel Musson, the assistant for Reliability and Maintainability in the Office of the Under Secretary of Defense for Research and Engineering, was the October speaker and discussed current initiatives in the Department of Defense to improve Reliability. He outlined actions being taken to improve the acquisition process and to update and improve military standards and handbooks pertaining to Reliability.

The November talk on DoD Directive 5000140 was given by Colonel Swett, currently Director of Engineering and Standardization at the Defense Industrial Supply Center in Philadelphia, and Col. Musson, his predecessor in DoD during much of the development of 5000140. Col. Swett reviewed the background that established the need for a DoD-wide policy on R & M; outlined the major thrusts of the directive; discussed the policy issues relating to the military departments, and described the current implementation status of policy requirements.

The December meeting featured two speakers, Mr. Henry S. Itkin, an electronic engineer with the Reliability and Quality Engineering Office, Surface Warfare Systems Group of the Naval Sea Systems Command, and Dr. H. B. Chenoweth, a Reliability Engineer in the Westinghouse Defense and Electronics System Center.

Mr. Itkin spoke on design approaches to alleviate supportability constraints. He pointed out that supportability factors are currently significant drivers of operational availability, and are influenced more by the maintenance concept, provisioning criteria and characteristics of the supply system, than by the design characteristics of reliability and maintainability. Various programs to improve supportability of Navy ship systems were presented by Mr. Itkin, along with design analogies.

Dr. Chenoweth discussed the subject of vibration-thermal screening Reliability prediction, presenting a model for the prediction of low level fatigue failure in electronic assemblies. The model relates the benefits of screening to material parameters, thermal characteristics and dynamic variables.

January's speaker was Mr. Jack Lavery, Assistant for Product Assurance, Air Force Systems Command. He described the current direction and emphasis of the Air Force's product assurance efforts.

If there are any questions on planned meetings for the remainder of the year contact either: Bil Hamby (703) 979-2766 or Henry Hartt (301) 871-4328.

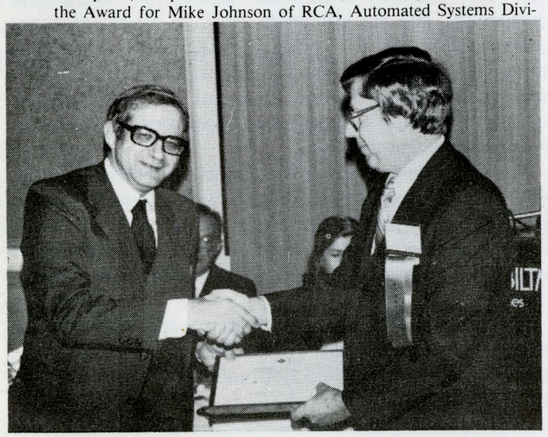
The IEEE Reliability Society Award Citation (left)

The IEEE Reliability Society Award Citation was presented to Dr. Nancy R. Mann at the IEEE Reliability Society, Fourth Annual Awards Program held on Tuesday, January 26, 1982 at the RAMS Symposium in Los Angeles, California. Dr. Mann was presented this award for the research and development of methodology used in life test data analysis and in modeling confidence bounds on system reliability. Presenting the award to Dr. Mann is Carl Bird, IEEE Reliability Society President. The picture was provided by Tony Coppola.

Chapter Awards (below)

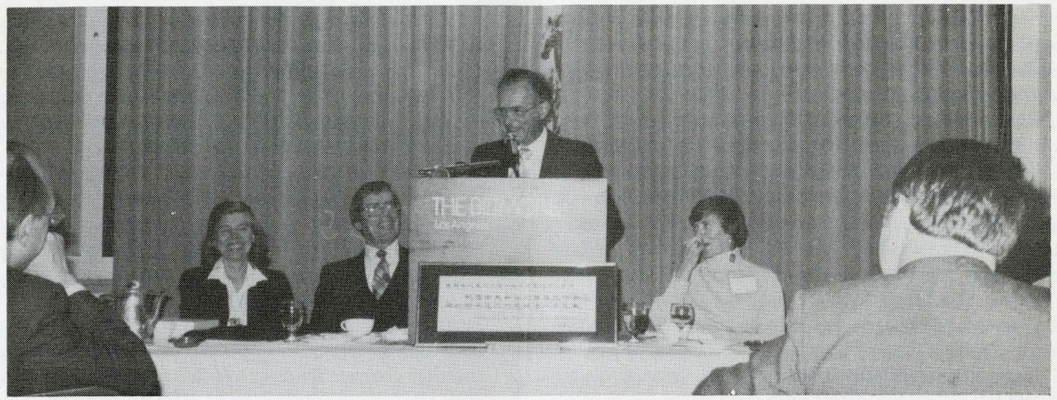
At the IEEE Reliability Society Annual Awards Program, held on Tuesday, January 26, 1982, Chapter Awards were given to the top three chapters which elected to participate in the awards program. First place went to the Central New England Council Chapter, Chairman: Mike Johnson. Second place went to the Washington, D.C. Chapter, Chairman: Paul Coscos. Third place went to the Los Angeles Chapter, Chairman: Irv Doshay.

First place, Chapter of the Year: Central New England. Accepting the Award for Mike Johnson of RCA, Automated Systems Division, Burlington, MA is Susan Eames. Picture provided by Bud Stiehl. Presenting the award is Carl Bird, Society President.



Second place: Washington, D.C. Accepting the award for Paul Coscos is Irv Fiegelbaum. Presenting the award to Irv is Carl Bird, Society President. Picture provided by Tony Coppola.

Third place: Los Angeles Chapter. Accepting the award is Irv Doshay. Carl Bird, Society President is presenting the award. Picture is provided by Tony Coppola.

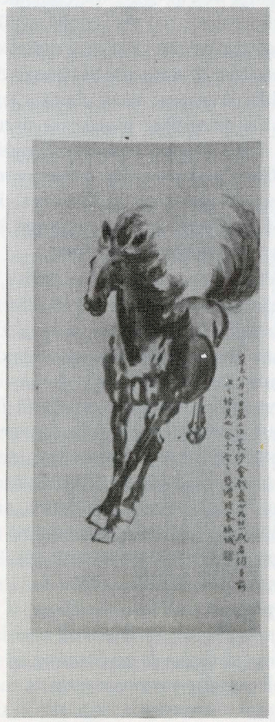


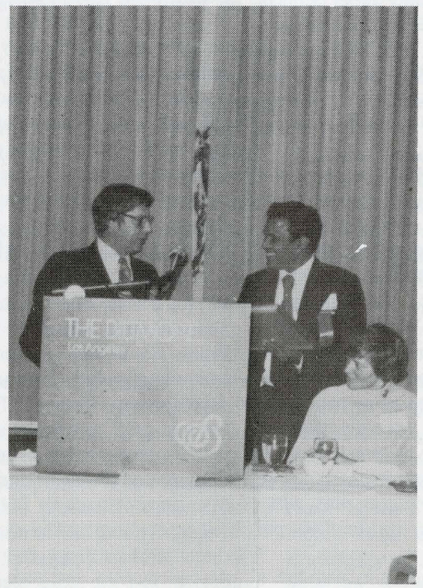
Dr. Thaddeus Regulinski made a presentation to the IEEE Reliability Society at the Annual Awards Luncheon. This presentation was from the Chinese Institute of Electronics, Reliability & Quality Control Society. The presentation was twofold. An award and a picture of a steed were presented.

Dr. Thad Regulinski is presenting a plaque that reads as follows:

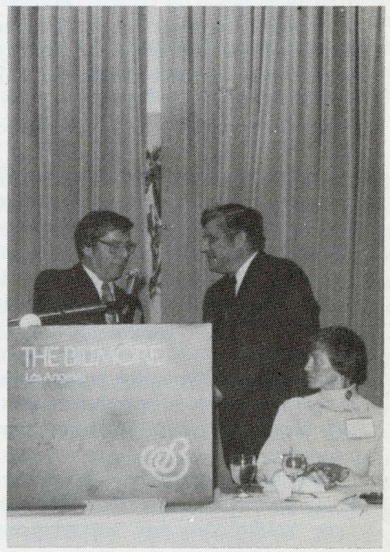
"To the IEEE Reliability Society: May the friendship and cooperation between the Reliability Society Scientists of the United States of America and the People's Republic of China, flourish vigorously." Presented to Dr. T. L. Regulinski by Mr. Lu on behalf of CIE/R&QC Society, September 22, 1981, PRC.

Below left is the picture of a steed that was presented to the IEEE by the Chinese CIE/R&QC Society. The steed symbolizes overcoming difficulties, making progress, and reaching out to something tenable. The inscription is the same as on the award. Both pictures were provided by Bud Stiehl.





Dr. K. K. Aggarwal was presented a Special Guest Editor Award at the Fourth Annual Reliability Society Awards Luncheon by Carl Bird, President of the Society. Dr. Aggarwal was the editor for the special section on the state of reliability effort in the India Subcontinent, in the April 1981 issue of The Reliability Transactions. The picture was provided by Bud Stiehl.



Dr. Richard Kowalski was presented a Special Guest Editor Award for his work on the August issue of *The Reliability Transactions.* This was a special issue dedicated to the discipline of Maintainability. Carl Bird, President of the Society, presented the award at the Fourth Annual Reliability Society Awards Luncheon held in Los Angeles, California, during the 1982 RAMS Symposium. The picture was provided by Bud Stiehl.

The Status of the Reliability Technology 1981

By Anthony Coppola, Chairman,
Advanced Reliability Technology Committee

This report attempts to summarize the status of the Reliability and Maintainability Engineering technology as it stands at the end of 1981. Comments are organized in sections, one each pertinent to devices, equipment, and systems human reliability, software, and R&M references.

Devices

The Very High Speed Integrated Circuit (VHSIC) program sponsored by the Department of Defense continues its drive to bring a new technology into practical use. This attempt to increase circuit density is aggravating a number of reliability and maintainability problems.

The age old problem of heat dissipation is only one of these problems. VHSIC circuits will dissipate much lower power per active element than previous technologies, but the sheer number of elements will result in a higher dissipation per chip. Another familiar problem, preserving hermeticity, becomes more difficult as polyimide connections between chip and package can absorb moisture and release it to the chip. Some device memories become more susceptible to soft errors (bit changes) caused by alpha particles emitted from impurities in the ceramic packages and solder connections. VHSIC is also encouraging the use of chip carriers, already a trend throughout the industry. The chip carriers do eliminate connection problems in VHSIC and less exotic devices and have cost benefits, but are subject to thermal fatigue failure of the solder joints caused by thermal expansion.

Another problem aggravated by VHSIC is increased susceptibility to damage from electrostatic discharge. Until these problems are solved, the reliability of VHSIC devices will be severely limited, according to Eugene Blackburn of the Rome Air Development Center (RADC) Reliability Branch. Mr. Blackburn also noted that the high speed capability built into the chip can be easily lost in the packaging and integration into a board. This, and the necessity to guard against differing thermal expansion coefficients, require an integrated approach between the chip, packaging and board designers. Another design consideration he recommended is the reduction of external connections by further integration on the chip, since existing testers can handle devices of no more than 120 input/output pins, while some VHSIC designers are suggesting up to 240 pin packages.

These problems resulted in a DoD program to establish a VHSIC Technology Standardization Working Group. All three services were invited in September 1981 to join the group to be headed by the Defense Material Specifications and Standards Office, (DMSSO), until a plan of action was developed. The objective of the group will be to standardize the following: hardwae descriptive languages; chip interfaces and specifications; hardware/software architecture; computer aided design and manfacturing; packaging, and electrical parameters. Such standardization could greatly reduce the problems addressed above.

Another problem aggravated by VHSIC is the susceptibility to radiation damage. Clyde Lane, also of the RADC Reliability Branch, noted that the smaller geometry of VHSIC is more susceptible to various effects of radiation. Even single occurrences of neutrons or heavy ions can transmute boron doping with a resulting shower of alpha particles. Where error correcting codes such as the hamming code can correct bit changes caused by one alpha particle, multiple changes result in lost information. Heavy particles may also permanently damage VHSIC circuitry. Transient voltage caused by ionizing radiation is also more damaging to VHSIC because of the lesser tolerance for voltage fluctuations.

Mr. Lane noted that concern for radiation damage should not be limited to military applications. Commercial nuclear power plants and satellite applications must also consider potential failures caused by radiation effects. He stated a need for more guidance in predicting reliability in radiation environments. As an example, he stated that a test using Cobalt 60 as a radiation source will provide the equivalent of years of radiation in a short time, but the results will ignore the natural recovery of the device. Ionizing radiation results in the build-up of positive charges which change the circuits' operating thresholds. However, these charges leak off with time. Because of this annealing process, a circuit may work reliabily under a much greater total dose of radiation than indicated by the Cobalt 60 tests. Mr. Lane recommended futher development of guidance in the area, including the provision in MIL-HDBK-217 of radiation effects in failure rate models for satellite applications.

A final concern of the VHSIC program is the ability to test the device. This resulted in nine VHSIC research efforts, now ongoing, related to testability. These are part of the Phase III VHSIC program, the development of support technology, which is running concurrently with the device development, Phase I. The efforts encompass: CAD for testable LSI; automatic test generation by function level search; development of testability design technology; identification of problems and solutions in testing VHSIC; fault tolerant architecture; failure management techniques, and self-test concepts. The study managers are spread among all three services, and the contractors include universities, device vendors, and system houses. Results will be fed into the VHSIC Phase I developments, and into the Phase II to come. This will hopefully mitigate the problem of assuring that an enormously complicated device is performing all of its myraid functions. Details on the various contracts may be found in a paper by Major Clovis Hale, RADC, in the *Proceedings of The NSIA Testability Workshop,* Arlington VA, November 18-20, 1981.

Following are various other developments in the reliability of devices, contributed by E. P. O'Connell of RADC:

a. The Microcircuit/Semiconductor Reliability Assessment Program (MRAP/SRAP) is a computer program which was developed and maintained inhouse at RADC to track MIL-M-38510 and MIL-S-19500 detail specification (slash sheet) activity from the time that a device is selected as a potential standard part candidate through its inclusion on the Qualified Products List (QPL). The data base for MRAP/SRAP includes information on every microcircuit and discrete semiconductor which is currently covered, or is projected to be covered, under a MIL-M-38510 and MIL-S-19500 specification. This information includes the detail specification status, the most recent revision or amendment and the QPL status, as well as usage recommendations. In addition, the reliability gate count, technology, generic part number, and function are included for each entry.

The data in MRAP/SRAP are updated continuously and can be used as a preferred parts list for new system designs, or can be used to evaluate system parts lists when making recommendations for substitution of nonstandard parts. The Military Parts Control Advisory Group (MPCAG) has used MRAP as a basis for developing the microcircuit section of the Defense Electronics Supply Center Baseline Program parts selection list. In an effort to provide wider distribution of this document to military equipment builders, RADC has made arrangements with the Reliability Analysis Center (RAC) to distribute this document on a paid basis.

As a part of this program, RAC provides a telephone response service for use by purchasers of the MRAP/SRAP publication to enable them to obtain up-to-the-minute qualifications status. For information on obtaining a subscription, contact the Reliability Analysis Center, RADC/RBRAC, Griffiss AFB, NY 13441, (315) 330-4151.

b. The advent of the analog signal processor adds a new dimension to the electronic world. The analog signal processor provides military designers with the opportunity to utilize a single chip, real time processor to implement analog filters. This field of analog signal processors is still in its infancy, but even at this stage of its development it presents a challenge in testing. Since the device contains both analog and digital circuitry on one die, new approaches to testing the devices must be developed. RADC is leading the attack with both in-house and contractual efforts. In-house, the acquisition of an analog signal processor development system allows RADC engineers to develop an in-house design and test capability for analog signal processors. This effort, coupled with the characterization of the analog signal processor efforts at GE Ordnance Systems, Pittsfield, MA, will assure that present-day and future application of the analog signal processor in military systems occurs with minimum reliability risk, and sets the stage for optimum testing techniques for future analog signal processor device types.

c. Due to the increased need to interface digital and analog signals in Dod systems, the government has become heavily involved in the use of A/D and D/A converters. Because of this trend, RADC has set out to develop test methodologies to examine the linearity characteristics of D/A and A/D converters. This parameter is the most important and most difficult to test. Obtaining linearity data for D/A converters is accomplished by using an 18 bit D/A reference module. The high accuracy of the reference enables the user to subtract the analog signal for the Device Under Test (DUT) from the reference analog signal to obtain the linearity information. By using a binary counter, complete linearity data can be acquired on a strip chart recorder in minutes, with high accuracy. Linearity data for A/D converters are achieved using the Dynamic Crossplot Technique. This method uses an 18 bit reference D/A and a "dither" signal, which is summed and entered into the A/D under test. The DUT's two least significant bits are put through a D/A converter and monitored using an oscilloscope. A step function is observed and the deviation in width of the step is the linearity error. This method is extremely accurate but time consuming, hence the next step, which is currently underway, is to automate the test approach to work on the Tektronix S-3270 microcircuit tester.

Another new device development of interest to Reliability Engineers is the Obituary Circuit, (OBIT) under development by Boeing. The OBIT circuit would record memories of the environments exerienced by an equipment to provide the means for better failure prediction models, ease failure analysis, and provide clues for isolating and repairing intermittent failures. The device could be used as a part of a VLSI chip or as an independent chip to monitor the condition affecting a board. In 1981 Boeing refined its concept and applied for a patent on the device. Boeing hopes to actually produce samples in the future, but have no scheduled time of availability. Further details may be obtained from Mr. F. M. Gardiner, Boeing Aerospace Company, P.O. Box 3999, Seattle, WA 98124.

Equipment and Systems

Reports on Equipment and System Reliability show both persistent problems and some evidence of improvements. The former is exemplified by a Comptroller General report to the Congress on Jan. 29, 1981 entitled "Effectiveness of US Forces Can be Increased Through Improved System Design." Numbered PSAD-81-17, the report is available from the U.S. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20760. It states, "Systems being deployed are not as reliable as they are intended to be. Part of the problem is that the reliability inherent in the system designs is being lost in the transition from design to production and deployment." Specific problems identified were unreliable Built-in-Test (BIT) and intermediate shop equipment for the F-15, low MTBF and poor BIT for the TOW missile used on the AH-1 Cobra Helicopter and low availability of the Navy MK-86 Fire Control System due to large numbers of random failures and resupply difficulties. Its recommendation to the Congress was that it direct more attention to logistic support, human factors and quality assurance considerations in the design and development of weapons systems.

In contrast, a comparision between the F-15 and F-4E

shows the following improvements in R&M figures of merit:

Figure	F-4E	F-15
Percentage of time full mission capable	49.5	53.1
15 year cost of operations (minus fuel) as percentage of flyaway cost	255	140
Flight hours between unscheduled maintenance	0.38	0.47
Unscheduled maintenance manhours/ flight hour	26.0	21.3
Number of avionics maintenance personnel per wing	307	218

These figures were extracted from the course notes of a DoD Executive Seminar for Product Assurance held by the Defense Systems Management College in December 1981. The notes also document that the F-16 made reliability history by delivering an aircraft in March 1980 which after a thorough series of tests and inspections, was found perfectly free of even minor defects. This was unprecedented for a military aircraft of such complexity. Compounding the achievement, in May 1981 a second F-16 also passed the acceptance tests without a single discrepancy. This was accomplished by an airplane assembled by General Dynamics in Fort Worth, using parts and assemblies from several coproducers, some overseas.

The Executive Seminar cited above not only provides some evidence of the potential of reliability engineering, but also of a high level interest which may be countering the common complaint that reliability does not receive sufficient attention from management. Some other evidences of increasing reliability awarenesses were a special report on the drive for Quality and Reliability in the May 1981 issue of *Electronics,* and an *IEEE Spectrum* special issue on Reliability in October 1981. At an AFSC Reliability and Maintainability workshop, held in November 1981 at Eglin AFB, FL, General Marsh, AFSC Commander, stated that Reliability will be given equal weight with schedule, cost and performance in all Air Force acquisitions. This policy will be enforced by the AFSC Assistant for Product Assurance, Mr. Jack Lavery, who reports directly to General Marsh. Similar functions are being established throughout the Air Force Systems Command, thus further indicating an increase in reliability emphasis.

The DoD initiatives to improve the acquisition process (popularly known as the "Carlucci initiatives") also address the need for R&M emphasis in DoD programs. Initiative #31, for example, is on improving Reliability and support for shortened acquisition cycles.

Nevertheless, problems persist. Dr. John de S. Coutinho, AAMSA, noted that a deteriorating industrial base in some critical areas (eq. the closing of foundries capable of providing castings for tanks) limits the capability to obtain needed resources. He also stated that R&M technology is still not being applied as it should be, and noted that social factors rather than technical ability have spurred Japanese advances in quality and R&M.

Some specific concerns were provided by the Air Force Test and Evaluation Center (AFTEC). This agency is responsible for the operational test and evaluation of Air Force systems, and has provided several technical papers to the Air Force on R&M problems found in its activities. Some excerpts:

a. Often development concentrates on the really sophisticated, hard to design items, and assumes that "simple" things such as connectors, wiring, software operation, and equipment interaction will present few problems in the actual operational environment. However, the results of operational testing often show that it is the overlooked "simple" things that create severe reliability and maintainability problems. We must keep the tenets of Murphy's Laws in mind, especially in not overlooking simple things, because when they fail they do the most damage.

b. Combined Environment Reliability Testing (CERT) is one technique which has shown considerable promise in achieving more reliable systems. The results from testing conducted at the USAF Flight Dynamics Laboratory at Wright-Patterson AFB and the USN Pacific Missile Test Center at Pt. Mugu are most encouraging. The emphasis in the DoD R&M directive (DoDD 5000.40) supports use of this testing technique: "Test conditions shall be operationally realistic, and they shall be defined early enough to influence item design. Performance, Reliability, and environmental stress testing shall be combined, and types of environmental stress will be combined insofar as practical." This technique has been applied primarily in two areas. CERT has been used as a developmental Reliability test to identify potentially unreliable components. Clear correlation has been shown between failures experienced in laboratory CERT tests and failures experienced in the field. CERT has also been used as a production screening tool as a workmanship quality control technique. However, considerable controversy has arisen concerning the cost effectiveness of full mission profile CERT versus tailored CERT versus lower cost, "quick and dirty" test techniques. This controversy has hampered the application of CERT on USAF projects.

Application of CERT in providing valid OT&E results requires that we obtain answers to several important questions. If it is possible to project mature system operational reliability through laboratory test techniques such as CERT, how much can we save by choosing such techniques? How do we determine the cost/benefit ratio for test savings (cost, time, test articles)? How, where, and when during the acquisition cycle should CERT be employed for optimum benefit? Should CERT testing be accomplished continuously throughout development or only during specific acquisition phases? Will CERT remain supplement to full field testing or can it be used as a substitute? Can CERT meet OT&E requirements?

c. A trend in recent acquisition programs (especially munitions) is the operational concept of storing an item for extended periods until it must be used. Reliability during dormancy impacts operational availability and mission success. A methodology is needed to design, predict, and test Reliability for such a system.

Air Force Systems for Which Dormant Reliability Is an Issue

System	*Dormancy Period*
Air Launched Cruise Missile	12 months for Air Vehicle 30 months for engine
Ground Launched Cruise Missile	30 months
Medium Range Air to Surface Missile	36 months
MX	?
Advanced Medium Range Air to Air Missile	10 years
WASP	10 years
Low Level Laser Guided Bomb	10 years
Extended Range Anti-Armor Munition	10 years
IR Maverick	3 years
Sparrow (AIM-7M)	30 months
IR GBU-15	3 years
Miniature Anti-Satellite System	180 days

d. Heavy investment in sophisticated automatic diagnostic systems has typified the acquisition of major weapons systems during the past decade. The focus of diagnostic development changed in the 1970's as military planners saw in the burgeoning of microprocesser technology a possible solution to the problems of personnel instability and increasing life cycle costs.

How well have automated diagnostic systems done as solutions to these problems? Based upon the Air Force's experience with weapon system diagnostics, they could do better. Recently evaluated diagnostics systems have performed far below expectations, with these impacts: where maintenance and training concepts were based on automated diagnostics, such concepts were invalidated or required extensive modification; unprogrammed support equipment had to be procured; existing technical data often required revision, and new technical orders had to be written, and in some cases, contractor support for the system had to be extended indefinitely. Such impacts resulted in increased personnel instability and costs, instead of the expected decreases.

e. Reliability growth is an area of increasing concern at AFTEC. We frequently use growth projections to project system Reliability and maintainability test results to maturity. There is a need for standardization of growth projection techniques and also to extend the techniques to other systems such as missiles and munitions.

The unresolved problems in R&M engineering and the need to keep pace with technology forces the continuation of research and development of R&M techniques.

Mr. Harold Ascher, Naval Research Laboratory, provided the following discussion on a new statistical technique for repairable systems:

D. R. Cox (1972), "Regression Models and Life Tables (with Discussion)," *Jour. Roy. Stat. Soc.,* Ser. B, Vol. 34 (Cox 1972) introduced a powerful technique for survival analysis by which, in principle, explanatory factors could be studied for their effects on the Reliability of nonrepairable items. His model has been applied very extensively in the biometry field to such problems as determining the effect on mortality of smoking × packs of cigarettes per day. It is equally appropriate for assessing the effect of, say, varying levels of vibration on the Reliability of nonrepairable items such as transistors or capacitors. In spite of its great potential for studying Reliability problems, Cox's model has never been used in such application.

Cox's model has very recently been extended, by R. L. Prentice, B. J. Williams and A. V. Peterson (1981), "On the Regression Analysis of Multivariate Failure Time Data", *Biometrika,* Vol. 68, (PWP 1981), to the analysis of multiple events on the same subject. The application, in PWP 1981, is to times between successive infections suffered by a subject, but this technique is equally applicable to repairable system Reliability. The PWP 1981 model is being modified at the Naval Research Laboratory (NRL) for optimum application to Reliability problems but, as a first approximation, only the word "infection" needs replacing with words like "repairable failure".

The PWP model has been used by NRL to assess the importance of mounting position on the Reliability of a type of marine gas turbine. More generally, this model can be used to determine the importance of any known differences in construction or operating procedures among a group of copies of a system type. For example, it is commonly believed that being assembled on a Monday affects a car's Reliability. If we have data on a group of cars, some of which are known to have been assembled on a Monday, we can use PWP 1981 to:

1. determine whether Monday assembly affects Reliability, and
2. if Monday assembly is important, the degree to which such assembly influences the car's Reliability.

Widespread use of PWP 1981 for the analysis of repairable systems is certainly warranted; it should also promote the use of Cox 1972 for nonrepairable items.

Environmental stress screening (burn-in) continues to receive attention, with three major contributions appearing in 1981. These were the environmental stress screening guidelines prepared by the Institute of Environmental Sciences, September 1981; a Textbook, *Burn-in. An Engineering Approach to the Design and Analysis of Burn-in Procedures,* written by F. Jensen and N. E. Peterson, Copenhagen, which is appearing as a publication by John Wiley & Sons Ltd., in 1982, and a report on "Stress Screening of Electronic Equipment," prepared by Hughes, Sarri, Schafer and VanDenBerg, for RADC, which is expected to be published as an RADC Technical Report by April 1982. RADC is responsible for preparing a military standard on burn-in in FY-1983.

Other new Reliability standards in process are derating guidelines and Bayesian Reliability Demonstration Testing, both by RADC scheduled for FY-83. The latter will be based on RADC-TR-81-106 "Bayesian-Reliability Tests Made Practical", July 1981, and work now in progress by the United States Air Force Academy which is developing Bayesian tests for nonrepairable systems.

In the Maintainability/Testability area, the Modular Automatic Test Equipment (MATE) Office of the Air Force Aeronautical Systems Division has selected Sperry as its contractor for continued development of the MATE concept. MATE is designed to be a disciplined acquisition process using standard architecture to produce cost effective test equipment. There are five guides available from the MATE Program Office, each containing several volumes. These are: an *Electronic Test Equipment Acquisition Guide;* a *Development Guide;* a *Testability Guide;* a *Production Operational Guide;* and a *Test Program Set Acquisition Guide.* The guides are available from Sperry at $200 a volume or $1600 for a complete set of all 5 guides. MATE will be applied in 1982 to the A-10 Inertial Navigation Systems Test Set and to the development of a Depot Automatic Test Station for Avionics (DATSA). Sperry will be excluded from the DATSA bidding to verify that the concepts can be used by any contractor.

Testability was the subject of a great deal of activity in 1981. A design for testability course is available with instructors from the Naval Surface Weapons Center, Giordano Associates and ManTech International, which have been in close contact with the MATE Office and the NSIA Automatic Test Equipment Committee (which is continuing the activity of a JLC-Industry ATE Panel). Contact for the course is Mr. William Keiner, Naval Surface Weapons Center, Dahlgren VA.

Testability workshops were held under sponsorship of the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics), which held a built-in-test workshop at the Institute for Defense Analysis, Arlington, VA, Feb 11 to 13, 1981, and NSIA, which held a testability workshop in November 1981. A workshop on diagnostic errors was scheduled at Wright-Patterson AFB in March 1982 under joint sponsorship of the Air Force Human Resources Laboratory and RADC. Also scheduled for Dayton, Ohio, in October 1982 is AutoTestCon '82 sponsored by the IEEE and AIAA featuring papers on testability.

A new development in testability begun in 1981 is the use of artificial intelligence (AI) techniques. The MATE Office sponsored a study by Hughes to use AI for self improving diagnostics. Both the Air Force and Navy held workshops to develop programs for applying AI to testability. RADC is currently studying potential applications and expects to formulate an R&D program by the end of 1982. One idea expressed by RADC is to use AI to help separate intermittent failures from true false alarms in BIT, perhaps coupling AI techniques with the Boeing OBIT circuit, discussed earlier, to help isolate intermittent faults. For the Navy, the Naval Air Engineering Center will start a program in FY-82 to investigate applications of AI to support Navy ATE. In addition, the basic research program of the Naval Research Laboratory, under Dr. Carroll K. Johnson, is currently developing an expert advisory system. NRL will investigate its utility for maintenance and calibration of test equipment.

While AI applications are still to come, 1981 saw the wide use of a printed circuit board testability rating index developed by Grumman for RADC. Documented in RADC-TR-79-327, "An Objective Printed Circuit Board Testability Design and Rating System," the technique has been found useful in producing more testable boards by such companies as Lockheed and Raytheon. RADC plans to use the technique as a building block in developing equipment testability measures, through a current contract with the Boeing Company.

RADC testability studies completed in 1981 are a study of the causes of false alarms, a study of the causes of unnecessary removals and the compilation of a testability notebook. Reports of these efforts should be available early in 1982. In FY-82 RADC will begin studies of computer aided design for testability.

Nuclear power plant Reliability continued to be of significant interest in 1981. The IEEE and the Nuclear Regulatory Commission held a review conference on the probabilistics risk assessment procedures guide for nuclear power plants, October 26 to 28, 1981, Washington DC. The current status of the IEEE activity was provided by David P. Wagner, Secretary of the IEEE Reliability Society Nuclear System Reliability and Safety Committee, and a summary follows:

The Nuclear Systems Reliability and Safety Committee is currently involved in three areas of activity:

1. Several members of the committee are participating in the IEEE/NRC effort to establish procedures for probabilistic risk analysis of nuclear power plants. We feel that this is a very important program that will have a significant impact on the future of risk analysis in the nuclear power industry.

2. The Working Group on Risk Evaluations of Radioactive Waste Management is involved in critiquing several sets of proposed criteria and standards for radioactive waste management. The working group's role is to serve as a third-party reviewer of criteria and standards related to risk evaluations of radioactive waste management and to make recommendations on acceptable approaches, procedures and data bases for these risk evaluations to regulatory bodies and other groups.

3. The committee's "Guide for Qualitative Common Cause Failure Analysis of Engineered Systems" (Project 831) is being temporarily held until the next committee meeting (Jan. '82). We have received comments from several individuals representing organizations both inside and outside of the IEEE. These comments may result in revision of the document after the committee meeting.

Comments on the status of mechanical reliability were provided by Mr. R. W. Mair of RADC. These follow:

A significant breakthrough in mechanical and structural engineering analyses has occurred that will eventually impact electronic and microelectronic products. The use of computer aided design techniques for mechanical systems has grown tremendously over the past five years. The finite element method is the fundamental technique used in practically all computer aided mechanical design efforts. A current contractual effort for RADC/RBES will provide documentation and guidelines for the application of finite element methods for mechanical and thermal analyses of microelectronic packages. Package failure mechanisms that can be analyzed with finite element computer codes will be evaluated for suitability to microelectronic application. The guidelines will show how to apply finite element methods to such "nontypical" structures as microelectronic packages and printed circuit boards.

RADC/RBES is also applying other computer aided methods, in-house, to electronic devices. RADC will be developing a front end preprocessor to SINDA (a finite difference computer code for thermal analyses) directed toward electronic application. Because existing heat transfer characteristics for electronic devices have been found to be significantly inaccurate, RADC will work to develop accurate thermal models for electronic application. In addition, laboratory thermal measures of electronic piece parts, in various environments, will be obtained for establishing proper derating factors for system reliability parameters.

Along with purely electronic device reliability programs, RBES has several efforts pertaining to "electromechanical" devices. After acquiring baseline data for field performance of electromechanical devices used in C^3I systems, new efforts have been initiated to investigate field reliability performance of ancillary electromechanical equipments utilized in C^3I systems; a wide range of electronic connectors covered by MIL-STD-1353, and fiber optic cables and connectors. Also, an investigation of condition monitoring techniques for electromechanical equipment used in C^3I equipment is underway. Monitoring the condition of electromechanical devices using nondestructive sensing systems should prove to be as cost effective and successful as has been experienced for purely mechanical equipments, such as jet engines and rolling element bearings. Also, recognizing the need for electromechanical prediction data, RADC is planning a major revision to its "Nonelectronic Reliability Notebook." The notebook will contain up-to-date failure rate data for a wide variety of electromechanical devices used in several environmental categories. Furthermore, knowledge of actual field performance of electromechanical equipments is necessary for accurate reliability predictions. This knowledge is difficult to obtain with existing field failure reporting systems. Therefore, RADC is performing an in-house development effort to establish an effective field reporting system, beginning with electronic equipment shelters used in ground communications and surveillance systems.

Human Reliability

Dr. Arthur I. Siegel, Chairman of the IEEE Reliability Society Human Performance Reliability Committee provided the following report on new developments, current problems and trends in human performance Reliability:

Interest in the role of human unreliability continued to increase in what seems to be an exponential manner. Probably as the result of the Three Mile Island nuclear incident, in which human error played a significant role, the human element in a system is becoming an almost ubiquitous component for study and analysis. In the nuclear field, organizations seem to be stampeding to develop human performance analytic capability. The military's continued interest seems unwavering, and in the consumer field there is an increased emphasis on operator and maintainer error minimization. Thus, persons concerned with office equipment, such as copying machines, are now placing considerable emphasis on analysis and test for minimizing human error. The widening interest is also evidenced by the sponsorship of a tutorial in March 1982 on human performance Reliability by the Washington Chapter of the Reliability Society.

Computer simulation models, probability compounding techniques, and regression models, continue to represent the principal analytic and predictive techniques. The lack of emphasis on new analytic methods may represent a gap in the evolving technology. The technology has also suffered because of the lack of a firm data base on which to base its analyses. There has been some, but minimal, effort to correct this situation. In the nuclear energy field, the systematic collection of operator error data is now taking place. Others are attempting to come to grips with the data base problem by building "data free" models. These models are not truly data free, but depend on minimum data, and generate input distributions on the basis of available hard data. The techniques, which depend on advanced scaling methods, address both the time to perform and the error probability questions at the task element level. Data, so generated, are used as input to computer simulation models. However, the robustness of these approaches and the validity of projections based on such data, remain to be demonstrated.

There has also been an extension of interest in variables affecting human performance. Variables and tradeoffs which remained unconsidered or only minimally considered previously are now assuming import during the design phase. Examples are: operator stress level, motivation, decision complexity, and temperature effects.

A related recent interest is the development of operator decision aiding systems. These suggest but do not make decisions for the operator. The utility, applicability, and benefits of various classes of decision aids for some Navy decisions, have been demonstrated by the Office of Naval Research.

Finally, from the maintainer unburdening point of view, there is continued emphasis on automatic test equipment. Such equipment, again, relieves the maintainer of much of the decision-making involved in trouble shooting. Here, the trend is toward universal, automatic test equipment, as opposed to embedding the test equipment in each complex electronic system.

Software Reliability

A study by E. A. Davis and P. K. Giloth in the *Bell System Technical Journal,* Vol. 60 No. 6, July to August 1981, noted that 25 percent of failures of an electronic switching system were caused by software. One comment from this report is:

"It is not technically or economically feasible to detect and fix all software problems in a system as large as No. 4 ESS. Consequently, a strong emphasis has been placed on making it sufficiently tolerant of software errors to provide successful operation and fault recovery in an environment containing software problems."

This illustrates the continuing concern for software Reliability. Unfortunately, there is little organized guidance. A software Reliability handbook planned for release by RADC in 1981 is still under development, and may appear in 1982. In 1982, however, RADC did complete a study on combining hardware and software considerations into a model for total system Reliability, using a Markov chain approach. The final report will be available in 1982. A similar modelling technique was presented in a paper on "Models for Hardware-Software Systems Operational-Performance Evaluation", by A. L. Goel and J. Soenjoto, in the August 1981 issue of the *IEEE Transactions on Reliability,* which also included an article on "Software Maintainability—What it Means and How to Achieve It," by A. E. Resene, J. E. Connolly and K. M. Bracy.

R&M References

Besides documents already mentioned, the following new, revised or proposed R&M references are of interest:

a. A comprehensive handbook on electronic Reliability design has been developed under the auspices of RADC. This handbook represents a distillation of various publications, exhibits, pamphlets, regulations, instructions, and directives on Reliability (R) and Maintainability (M) used within the DoD. The approach taken has been to emphasize the practical aspects of R and M design and management techniques and to concentrate on real-world examples which would give the reader insight into how the techniques might be applied. The intent was to provide sufficient theoretical and practical information to solve commonly-encountered R and M problems. In addition, a comprehensive list of reference materials has been compiled to allow the reader to explore, for himself, aspects of the techniques required by those special problems which inevitably appear. Publication is scheduled for 1982.

b. Failure analysis is an important Reliability field, providing significant impact in improving, through corrective action, the Reliability of semiconductor technology devices used in commercial and military applications. Devices-oriented technology advancements have forced the continuous development of many innovative failure analysis techniques and analytical instruments. For some time, the microelectronics sector has recognized the need for a compendium of techniques to provide the analyst with the latest analytical methods for part reliability problem solving. The *RADC Microelectronics Failure Analysis Techniques Procedural Guide* is an effort to satisfy this demand by providing the failure analyst, R&QA activities, semiconductor user and Reliability program manager with a failure analysis techniques reference document.

The *Guide* information base was derived from an extensive literature search; on-site failure analysis laboratory surveys; a document review board composed of acknowledged experts from government and industry, and technical inputs from Reliability specialists. The document was compiled and edited by the General Electric Co., Electronics Laboratory, Syracuse, NY. RADC provided the technical direction and administrative guidance for document preparation, incorporated several major sections into the *Guide,* notably: "Package Ambient Gas Analysis Techniques"; "Liquid Crystal Analysis Techniques," and "Environmental/Mechanical Accelerated Stress Testing Facilities and Test Methods." RADC provided other technique inputs to various sections. Another major section covering "Electrical Overstress/Electrostatic Discharge Effects and Failure Analysis Techniques" was prepared by the Reliability Analysis Center (RAC-IITRI) and was incorporated into the final document. The procedural guide includes practical technique applications and typical results obtained for facilitating personnel training, increasing analyst proficiency, projecting facilities upgrading and improving the Reliability engineer's knowledge of available diagnostics, useful in planning, specifying and assessing failure analysis tasks or services.

The *Guide* has been published using quality materials for extended usage and distributed in a hard-cover, loose-leaf binder format to facilitate future update and addition of supplemental material by the individual user. The document, Ordering No. MFAT-1 at $125 per copy, is available through the Reliability Analysis Center (RAC), a DoD Information Analysis Center, Rome Air Development Center (RBRAC), Griffiss Air Force Base NY 13441. Limited no-cost text copies are available to authorized DoD and government agency personnel requesters by contacting Mr. E. A. Doyle, Jr., RADC/RBRP, Griffiss AFB, NY 13441 (AV: 587-2735).

c. MIL-HDBK-217D, *Reliability Prediction of Electronic Equipment,* has been coordinated and will be available early in 1982. This version includes a model for Bubble Memory Devices and revised models for Opto-Electronic and Traveling Wave Tube Devices.

The monolithic microcircuit models will remain the same except for the addition of nine new military environmental factors and a new quality level factor. In addition, the complexity factors for random access memories will use the same value regardless of whether they are static or dynamic. Section 5.2 of MIL-HDBK-217D, *Parts Count Reliability Prediction* has been revised to reflect these changes.

d. The results of a new study, *Correlation of Field Data with Reliability Prediction Models,* will be published as an RADC technical report later this year. This study evaluates the monolithic microcircuit prediction models using a data base acquired since the completion of the model development program in March 1979. Efforts are now underway to extend the capability of the monolithic models to include VLSI and VHSIC devices and also to update the existing hybrid microcircuit model.

e. Revisions to MIL-STD-781 *Definition of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety,* and MIL-STD-756 *Reliability Prediction,* were published in 1981. A change to MIL-HDBK-472, *Maintainability Prediction,* is in final stages of coordination and is scheduled to be published in early 1982, as is a revision of MIL-STD 470 *Maintainability Programs for Systems and Equipment.* A revision to MIL-STD-471, *Maintainability Demonstration,* is expected later in the year. Military standards and handbooks are available from the Naval Forms and Publications Center, 5801 Tabor Ave., Philadelphia PA 19120.

f. John Wiley & Sons published two new Reliability textbooks in 1981: *Extending the Limits of Reliability Theory* by Harold Goldberg, and *Engineering Reliability* by B. S. Dhillon and Cranan Singh. Also published in 1981 was *Practical Reliability Engineering* by P. D. T. O'Connor, a Heydon & Son Inc. publication.

AdCom Reports

Technical Operations Vice President's Report

Naomi J. McAfee

All committees are actively working toward their stated objectives. A summary of activities follows:

Solar Energy Device Reliability

Federal support of solar energy has been drastically reduced in FY-82 and may very well suffer further cuts in FY-83. In this environment, it has been very difficult to generate any coherent committee activity.

The major meeting concerned with solar cells in the IEEE Photovoltaic Specialists Conference, which will take place in San Diego at the end of September. The general chairman, Dr. H. Brandhorst, was approached in April 1981 and asked to set up a joint session with the Reliability Society. Recent discussions with the technical chairman, Dr. A. M. Barnett, indicate that a plenary session on Reliability will take place if submitted papers justify this. The Photovoltaic Specialists Conference does not appear to have ever conducted formal joint sessions with other parts of IEEE.

John Meakin

Maintainability

Three objectives were identified for 1981. Progress toward meeting each objective is summarized below:

a. Provide an interface between the IEEE Reliability Society and other technical organizations on matters to the MC.

Three diverse technical organizations with maintainability interests were contacted during the year: the air transport industry's "Avionics Maintenance Conference (AMC)" and the Solar Reliability & Materials Program (SRMP) at Argonne National Laboratory. Points of contact were identified and the background material was received from each organization. Copies of the *Transactions on Reliability—Special Issue on Maintainability,* August 1981, were sent to the points of contact.

b. Contribute articles and other information related to Maintainability to the *Newsletter.*

A "Maintainability Matters" column was prepared for the July and September 1981 issues of the *Newsletter.* The following topics were addressed:

July 1981—*IEEE Transactions on Reliability—Special Issue on Maintainability* and the Air Force's "Product Performance Agreement Guide."

Sept. 1981—Avionics Maintenance Conference; Software Impact on Part Numbering Systems, and DoD Moves to Improve the Acquisition Process.

c. Develop a core group to conduct activities.

The points of contact identified in item *a.* represent a diverse set of backgrounds for discussing MC issues. Further effort is required in 1982 to develop a larger core group for the MC.

Richard Kowalski

Human Performance Reliability

The major activity of the Human Performance Reliability Subcommittee over the past period was planning a "Human Performance Reliability" tutorial to be conducted in conjunction with the Washington Group. Full plans were derived; hotel and meeting room arrangements were largely completed; "faculty" members were organized; a mail-out brochure was written; financial support for printing the brochure was obtained from VITRO; mailing lists were obtained, and the full content and sequencing of the tutorial were derived. This subcommittee chairperson and the Washington group had been given to believe that the national group would lend to the Washington group the money needed for mailing the brochure. This was the perception of at least three separate persons. However, the national group decided that such a loan was not possible on the basis—as reported to this chairperson—that such support is not the purpose of the national group. Accordingly, the whole project and 12 months worth of work were doomed.

A review of the "current state of the art" in human performance Reliability was written and submitted for inclusion in the annual reliability state-of-the-art report.

Arthur I. Siegel

Mechanical Failures Prevention Group 35th Symposium,

"Time Dependent Failure Mechanisms and Assessment Methodologies"
Gaithersburg, MD
April 20-22, 1982

The Mechanical Failures Prevention Group (MFPG), under the sponsorship of the National Bureau of Standards, will hold its 35th Symposium at the National Bureau of Standards, Gaithersburg, MD, April 20 to 22, 1982.

The meeting will focus on the prevention of failure resulting from time-dependent mechanisms. Emphasis will be on the critical evaluation of input data through the use of in-service inspection and condition monitoring, and the comparison of existing assessment methodologies or failure prediction approaches. The objectives are to:

1. evaluate and present data in such a way that it can be efficiently used to assess the time-dependent failure problem, and
2. identify the necessary changes in design, fabrication processes, or service conditions needed to reduce the chance of failure.

The proceedings of this symposium will be published by the National Bureau of Standards and distributed to all conference attendees. It will be available publicly through the Government Printing Office. For more information, Contact: Dr. J. Early (301) 921-2976.

1982 Microwave Power Tube Conference

April 26-28, 1982

The objective of the 1982 Microwave Power Tube Conference is to maintain lines of open discussion between tube manufacturers, systems manufacturers who use tubes, and the Department of Defense.

Due to facility limitations, attendance will be by invitation only. Requests for invitations should be addressed to: Mr. John Skowron, Invitations Chairman, Raytheon Co., Microwave Power and Tube Div., 190 Willow Street. Waltham, MA 02254, telephone number: (617) 899-8400 X 4311.

Reliability Chapter IEEE Boston Section

April 29, 1982

The twentieth Annual Reliability Seminar is scheduled for Thursday, April 29, 1982. The seminar will be hosted by the IEEE Boston Section Reliability Chapter. The theme will be "Assurance Technology Application in the 80's".

For more information, contact: Sid Gorman, Seminar Chairman, at (617) 358-2721, ext. 2200 or 2864.

1982 IEEE Power Electronics Specialists Conference

Cambridge, MA
June 14-17, 1982

The 1982 IEEE Power Electronics Specialists Conference will be held at the Massachusetts Institute of Technology in Cambridge, MA. For detailed information, contact Prof. John G. Kassakian, Electric Power Systems Engineering Lab, MIT Room 10 098, Cambridge, MA 02139, or call him at (617) 253-3448.

The conference will be open to all persons, subject to a registration fee of $125.00 (U.S.), with a marked reduction for students and retirees. Individuals who are not on the conference mailing list may obtain general information by contacting the Conference Chairman: P. E. Wigen, Physics Department, Ohio State University, Columbus, OH 43210 USA.

EUROCON '82

Copenhagen, Denmark
June 14-18, 1982

Product quality and reliability is steadily increasing in importance and determines more and more the acceptance of existing and new products.

Recent results and general trends on theoretical aspects and practical applications of reliability in components, products and systems will be presented and discussed. The conference program is structured in such a way that it is useful to: electrical engineers and electronic engineers; marketing experts; and other persons who are concerned with research and development, manufacturing, and applications of electrical and electronic systems.

Approximately 160 papers will be presented in the technical sessions. About 1000 delegates are expected at this international conference which will be held at the Technical University of Denmark.

For more information, contact the conference office DIEU, Danish Engineers' Post Graduate Institute, The Technical University of Denmark, Bldg. 208, DK-2800 Lyngby, Denmark. Or call the secretary, Mrs. Aase Sonne at 45-(0) 2 88 23 00, ext. 37 (Telex: 37529 DTHDIA DK).

Third Joint Intermag—Magnetism and Magnetic Materials

Montreal, PQ, Canada
July 20-23, 1982

The Third Joint Intermag MMM Conference will be held at the Hotel Sheraton, Mount Royal, Montrel, Quebec, Canada. The Conference is jointly sponsored by the American Institute of Physics and the Magnetics Society of the IEEE, in cooperation with the American Physical Society, the Office of Naval Research, The Metallurgical Society of the AIME, and the American Society for Testing and Materials.

Seminar: The Eighth Annual Reliability Testing Institute

University of Arizona
Tucson AZ
April 19-23, 1982

The Eighth Annual Reliability Testing Institute of the University of Arizona will be held at the Ramada Inn, 404 North Freeway, in Tucson, AZ. The course is presented by the University of Arizona College of Engineering, and Hughes Aircraft Company, Tucson, AZ Operations.

The objective of this course is to provide Reliability engineers and managers, product assurance and quality control engineers and managers and other interested parties, a working knowledge of: analyzing component, equipment and system performance and failure data to determine the distributions of their times to failure, their failure rates, their reliabilities and their confidence limits; planning small sample size, short duration, low cost tests and analyzing their results, and conducting accelerated testing, Batesian testing, suspended items testing, sequential testing, and others.

The fee is $675.00. There are 2.8 continuing education units assigned to completing this course.

For more information, contact Dr. Dimitri Kececioglu, Institute Director, Aerospace and Mechanical Engineering Dept., the University of Arizona, Building #16, Tucson, AZ 85721, or call (602) 626-2495.

Seminar: Electronic Systems Effectiveness and Life Cycle Costing

University of East Anglia
Norwich, Norfolk, England
July 19-31, 1982

Conducted by the NATO Advanced Study Institute at the University of East Anglia, Norwich, Norfolk, England, "Electronic Systems Effectiveness and Life Cycle Costing" is addressing problems in the design of large systems in the current economic climate. Because of the exploding nature of electronic technology, the study of these aspects is essential, but difficult. Therefore great stress is placed on the fact that the lectures are of a tutorial character. An attempt is made to present new mathematical disciplines which are of great importance in predicting and hence ensuring high effectiveness and low life cycle costing. The program has several panel discussions and presentations by representatives of large organizations in the satellite, communications and military fields. An additional feature is a session on software reliability and its quantitative measurement, as well as the methodology of successful programming.

For participation in this program, please apply to the director of the course: Mr. J. K. Skwirzynski, Manager, Theoretical Support Services, Marconi Research Laboratories, Gec-Marconi Electronics Ltd., West Hanningfield Road, Great Baddow, Chelmsford, Essex CM2 8HN, United Kingdom.

Seminar: Life Data Analysis

Pennsylvania State University
University Park PA
June 15-18, 1982

A 3½ day seminar on "Life Data Analysis" will be conducted by John McCool and Wayne Nelson from June 15 to 18 at the Pennsylvania State University Radnor Center for Graduate Studies and Continuing Education.

This course is aimed at Reliability engineers, statisticians and others who must extract accurate information to make well informed decisions. The short course will cover such topics as basic concepts and life distributions, probability plotting, testing goodness of fit, hazard plotting, and competing failure models. Also the course will cover standard analyses of complete and singly censored data, maximum likelihood analysis of multiple censored and inspection data. The fee will be about $585.00 including textbook, materials and daily lunches.

For further information on the course, contact: Barbara A. C. Wood, D Ed. at (215) 293-9860.

Publishing News

Book on Digital Integrated Circuits Published by IEEE Press

The publication of *Digital MOS Integrated Circuits,* a book of selected reprints, has been announced by the *IEEE Press.* This volume, sponsored by the IEEE Solid State Circuits Council, was edited by Mohamed I. Elmasry of the University of Waterloo in Canada.

The last two decades have seen a spectacular development of digital systems for both data and signal processing—a development made possible by advances in IC technology. This has created a need for a new generation of VLSI circuit designers, and this book is intended to assist the efforts to meet this need.

The book opens with an extensive tutorial article, specially written by the editor, on digital MOS integrated circuits. This is followed by 72 carefully selected reprints arranged by subject into the following four parts, which are further divided into sections: MOS Digital Circuit Design, Digital VLSI, MOS Memory Cells and Circuits, MOS Digital Circuit Applications. The book concludes with a bibliography of over 500 citations.

This volume complements the 1980 IEEE Press book of selected reprints, *Analog MOS Integrated Circuits,* edited by Paul R. Gray, David A. Hodges, and Robert W. Brodersen.

Call for Papers

1983 Annual Reliability and Maintainability Symposium.
Sheraton Twin Towers Hotel, Orlando, FL USA.
January 25, 26, 27, 1983
Theme: Increasing Productivity—The Continuing Challenge
Submission Deadline: May 1, 1982.
Paper Submission Requirements: If you wish to present a paper at the RAMS 1983 Symposium, now is the time to submit the necessary paperwork. It is needed as soon as possible but May 1, 1982 is the deadline.

For each author and co-author: name, work address and phone number, home address and phone number, and a brief biographical sketch. The paper title is not to exceed 50 letters and spaces. The paper summary should not be more than 1000 words and should be structured in the following three sections: 1. Problems or questions addressed, 2. Work performed, and 3. Results and/or conclusions reached.

All papers must be new and must not have been presented at a national meeting prior to the Symposium.

Ten Copies of each author and co-author's name, work address and phone number, home address and phone number, brief biography, paper title and paper summary must be sent to:

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Authors will be notified of Program Committee decisions during June 1982. Full text draft required by August 16, 1982.

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The names and addresses of new members who joined from October 1 through December 31, 1981, are listed below. For U.S.A. members, they are listed by alphabetical order of their state. For members outside the U.S.A., they are listed by alphabetical order of their country's English name.

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IEEE Follows Named: Reliability Society

Special recognition was given to the four members of the IEEE Reliability Society who were elected to the status of Fellow starting in January of 1982. These four members were H. Bertil Thoren, ASEA AB, (Sweden), for advancing the understanding of the design and operation of equipment for ultrahigh voltage power transmission systems; Hiroshi Hirayama, Waseda University, for contributions to active network theory and leadership in graduate education; Al Gross, Parsons Peebles Electric Products, Inc., for pioneering work in VHF and UHF mobile radios, and Anthony Coppola, U.S. Air Force Rome Air Development Center, for contributions to improving the Reliability and Maintainability of electronic systems and components. Congratulations from the Reliability Society to each of you on your great achievement!

Anthony Coppola Named Fellow of IEEE

Anthony Coppola, Publications Vice President of the Reliability Society, was elected a Fellow, IEEE, effective January 1, 1982, for contributions to improving the reliability and maintainability of Electronic Systems and Equipment. He was nominated by the Mohawk Valley Section of IEEE and endorsed by the Reliability Society.

Mr. Coppola was born in Brooklyn, NY on July 14, 1935. He holds a Bachelor's Degree in Physics and a Master's Degree in Engineering Administration, both from Syracuse University. He has been employed by the Rome Air Development Center since 1956 when he joined the newly organized RADC Reliability Group. He is currently Chief of the RADC Reliability and Maintainability Engineering Techniques Section which is responsible for developing methods for predicting, measuring and improving Reliability and Maintainability in Air Force Electronic Systems. This Section is the DoD preparing activity for MIL-HDBK-217, on Reliability Prediction; MIL-STD-470, on Maintainability Program Requirements; and MIL-STD-471, on Maintainability Demonstration. Mr. Coppola's most recent personal contributions are an improved All-Equipment Reliability Test Plan, a Design Guide for Built-in-Test, an R&M Management Manual, and a Practical Guide to Bayesian Reliability Demonstration. He has published over 30 papers on R&M engineering and management. He has served as a reliability consultant on the Advisory Group to the Japanese Government on a Japan Air Defense System in 1963; the Weapons Systems Industry Advisory Committee (WSEIAC) in 1964; the F-111 Mark II Avionics Review Team in 1969; the F-111 Integrated Display System Action Team in 1971; the F-5E Radar Reliability Audit Team in 1972; the Project ACE (Acquisition Cost Effectiveness) Workshop in 1973; the F-16 Avionics Reliability Review Team in 1974 (as Chairman); the Advanced Logistics System Review Team in 1975; the Electronically Agile Radar and AN/ARC-164 Radio Programs (1974-1978), and the Annual USAF Avionics Planning Conferences since 1978.

In addition, he has been a guest lecturer for the George Washington University short course on System Effectiveness in 1969 and 1970; the Air Force Institute of Technology (AFIT) Laboratory Management of R&D course in 1964 and 1965; the AFIT short course on Reliability in 1973, 1974, 1977, and 1978, and the Air Force Academy short course on Inertial Navigation System Testing in 1973.

Mr. Coppola has been a member of the IEEE since 1958, a member of the Reliability Society since 1960 and of the Engineering Management Society since 1968. He was the organizer and first Chairman of the Mohawk Valley Chapter of the Reliability Society (1969) and a Chairman of the Mohawk Valley Section, IEEE (1974). He was again Chairman of the Mohawk Valley Chapter of the Reliability Society in 1978 when it won the "Outstanding Chapter Award." He was publicity Chairman for the Reliability Physics Symposium in 1968 and 1969. He was editor of the IEEE Reliability Society Newsletter for 1981. He was elected a member of the Reliability Society AdCom in 1978 and reelected in 1981. He is currently the AdCom Publications Vice President. He is also a member of the AIAA Systems Effectiveness and Safety Committee and a Program Vice Chairman for the 1982 Annual Reliability and Maintainability Symposium.