Reliability Society

NEWSLETTER

April 1995

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President's Report

The theme of this message is "History Repeats Itself". As you might Know, I was recently elected President of the Reliability Society after being on the ADCOM for 4 years. This is my first column since taking on the duties of president. However, I am fortunate in that there have been 20 outstanding presidents and they have established a good precedence. We are one of the original societies out of the 36 societies of IEEE. This is indicated by our Society number, R07, which indicates that we were the seventh society formed.

We in the Reliability Society particularly appreciate that "History Repeats Itself". We use this principle on a daily basis in measuring historical events such as failure rates. We use this historical data to predict future (new) failure rates. All we need is correlation between past events and future events. As you know, not all things are well correlated and history does not exactly repeat itself. Changes in history, using a more recent terminology, are called "Paradigm Shifts". These shifts are what we try to look for and adapt to. In this way we can provide a better prediction based on the most recent data.

As for the Reliability society, we want to continue to improve our operation and services to our members. Therefore, we want to repeat the "good" from the past and improve on any problem areas. Fortunately for us the problem areas are very few. Now, you might say that I am making that judgment based on a "self audit". This is not true. We were audited recently by TAB (Technical Activities Board) and they gave us extremely high marks. However, there are some specific areas as noted in the report were deficiencies exist. These were presented in the last edition of the Newsletter and an approach to resolving these findings is as follows:

How are we going to improve the society and what steps have we taken to show a positive improvement? These are basically two fold: The first is; we have asked Henry Hartt to perform an independent review. He will address the problems identified in the audit and suggest possible approaches to resolve these shortcomings. He will address both short term and long range solutions. Also, we have established a long range planning committee composed of the past 20 Reliability Society presidents. This committee will be chaired by our Junior Past President, Dr. Tom Weir. The activities of both groups will be presented in future articles in the Newsletter. A third area of improvement is: We are in the process of appointing a new society historian. We wish to review and correlate our past activities. This will give us insight as to where we might improve. The purpose is to benefit the society members and improve the operation of the ADCOM organization. This should result in a well run organization and provide growth in our society. However membership alone is not our only measure of success. The quality of our publications is extremely important. We take pride in and will continue to improve the Transactions which is an exceptional product of the Reliability Society. The Newsletter is also outstanding but possibly there are areas for improvement. Please see the article "Expanding Our Newsletter" in this edition.

The key point about the Newsletter is the need for additional support in producing and improving it. Presently one person has

been performing all of the work. This is the work of our outstanding editor, Bruce Bream. Needless to say this requires a 110% effort. We need to give more consideration to support of this potential growth area. If you would like to participate in the production of the Newsletter, please contact Bruce by e-mail, phone call or in writing.

Volunteers are the success of our Reliability Society. This volunteer effort takes place at all levels. Members of the individual chapters provide good topics, programs, and facilities. This results in membership interaction and generates interest in the Society. They also provide good articles for their chapter and section news letters.

After the Chapter Chairperson has completed his/her term we look forward to their advancement to an ADCOM position. Please ask to be placed on a committee or volunteer for a function of ADCOM. These different activities are described in the Newsletter frequently. There are many positions to be filled. These activities are associated with the conference activities, including both the IRPS and RAMS conferences, the Professional activities PACE, the Newsletter, the Transactions, and all of the technical activities under our Tech. Ops Committees.

One of the most recent advancements in communications has been the use of e-mail and it has become very effective in our Reliability Society. Through e-mail we can coordinate meeting agendas, new topics, etc. We can have more members participate in the various activities. They can serve as participating members or solely as corresponding members of the different committees. Each one of you is valuable to the Reliability Society. I urge you to contact one or more of the Vice Presidents of the committees or an activities chairperson and indicate that you are interested and would like to work with them. Contact the individuals through e-mail (or other methods) and let them know that you are interested in their activities. Explain your talents and the activities that you would like to support.

To create more interest in the membership we will continue to report the major activities and discussions taking place at the ADCOM meetings. Some of these subjects presently being discussed include: 1.) Standards, which we are taking a major interest in since the military is withdrawing support of this activity. The standards activity must continue, maybe at a lower lever, by the various engineering organizations. 2.) We are trying to develop a set of engineering guidelines for electronic design. This will provide high reliability by providing low stresses in parts and having the parts operate at lower temperatures. Preliminary work has been performed and is ongoing by a committee presently associated with RAMS. It was originally a major focus of the Leesburg Workshops. 3.) We try to give support to major reliability conferences including RAMS, IRPS, and several other conferences. There are conferences needing our society support. These include software reliability, component reliability and various other reliability activities. 4.) We want to elevate membership status by advancing members to senior members. Please address Dr. Marvin Roush with a request for a senior members packet, fill it out and submit it to headquarters. Also, we are trying to advance highly qualified individuals to Fellow Grade. Please contact Dr. Thad Regulinski for a fellows packet and guidance in this area. As mentioned earlier, we invite all of you to participate in the various Reliability Society activities. Primarily in our publications, either in chapter publications, Newsletter publications or in the Transactions.

The last subject that I would like to cover is my participation in TAB (Technical Actives Board) as your representative. I meet with the Presidents Forum and the 36 Society Presidents three times per year. I also meet with TAB executive officers and Headquarters staff. In addition to these meetings, I have been appointed to two subcommittees and will report on all of these

activities in upcoming Newsletter editions. As of this writing, I am just attending my first TAB meeting as President of the Reliability Society.

Lastly, a little information and background on myself: I have been an IEEE member for almost 20 years now. I have been active in Section and Regional activities in Region 6, where I was Region Director and a member of the IEEE Board of Directors in 1987 and 1988. My professional background is primarily in reliability analysis. I have been a private consultant for the past 15 years, primarily in the San Diego area. I teach a 2 day seminar in Mechanical Reliability and I teach a 3 day seminar in "Thermal Analysis of Electronics". These seminars a presented to graduate engineers at US Navy facilities. The topics are directed at solutions to their electrical problems. Further, I have a Masters degree in Electrical Engineering from the University of California, Irvine and a BS in Mechanical Engineering for Oregon State University. I am a registered professional engineer in both Civil Engineering and Electrical Engineering in the State of California.

I look forward to supporting the membership of the Reliability Society and providing as much assistance to each of you as I possibly can. THANK YOU!

Richard L. Doyle
President, Reliability Society

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Editor's Column

The Reliability Society (RS) and Newsletter (RSNL) now have World-Wide Web (WWW) home pages on the Internet. We are linked to the IEEE WWW Home Page (http://www.ieee.org/). On the RS home page there are links to listings of the RS officers, chapter chairpersons and technical committees. The RS bylaws, and constitution are also available. You can find it at:

- http://www.glue.umd.edu/enre/rs_home.htm

You can also read the RS newsletters, starting with the January 1995 issue, on the RSNL home page. Youl'll also find a link to the latest conference calendar. The RSNL page is at:

- http://www.glue.umd.edu/enre/rsnl_hom.htm

I'd like to thank Marvin Roush and the University of Marlyand for their assistance in setting up a site for us and getting our documents on-line. We're just starting to explore usage of the WWW for distributing information to our members. If you have any comments, suggestions or contributions, please contact either of us.

- Marvin Roush (roush@eng.umd.edu)
- Bruce Bream (bruce.bream@lerc.nasa.gov)

You can access the WWW page with a web browser like Mosaic or Netscape. Some of the major on-line service providers offer this capability (e.g. Prodigy). If have internet access, contact your network provider to find out how to obtain the necessary software. Don't be discouraged if you don't have a graphical interface (e.g. Windows). There are text-based browsers, such as Lynx from Univ. of Kansas, that allow you to view the text of WWW pages.

Bruce Bream
Newsletter Editor

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Chapter Activities

Cleveland Chapter

Our November meeting was a tour of the Plain Dealer's Tiedeman Production and Distribution Center. This is Ohio's largest newspaper that brings us news from around the world and around the corner. This was a very popular tour; more expressed interest than we could include. All were satisfied but breakfast at 7:30 am was a little early for some.

The annual mid-year social was held at NASA LeRC, Guerin House. Old friends and new members got together for an evening of relaxation, general information, and a cold buffet. No speaker was used. Pool, ping pong and dancing were enjoyed by many.

Our January meeting was on a Study of Total Quality. Ademola Solaru, Quality Council Expert, took time out from his busy schedule to bring us up-to-date on applying total quality to R&D organizations. The Red and Blue Teams are working to respond to the NASA HQ White Paper; 40% changes are being implemented in many organizations. Many projects will be paralyzed. Should we use Institutes to reduce our costs? Progress is being made on our Journey to Excellence. A timely, well received topic with another full house.

We will be helping RAMS '96 on an Ad Hoc basis. We are working with Kelly Clunn from the Cleveland Convention Center to try and bring the RAMs to Cleveland in 2000. Cleveland has made a lot of improvements and should be ready for the Symposium by then.

We will be helping the Joint Engineering Technical Council to organize a Symposium on "Interdisciplinary Integration of Aerospace and Manufacturing in Northern Ohio". The symposium will be an all day event, scheduled for September 14, 1995, at Cleveland State University.

All-in-all here in Cleveland we are having fun staying active and trying to serve our members.

Sincerely,
Vince Lalli, Chairperson
Cleveland Chapter

Los Angeles Chapter

In February we heard Myron Lipow present the latest methodologies for producing reliable software. Verification and Validation paradigms were explored along with examples of the effectiveness of each method.

In March, we plan to hear Tyronne Jackson discuss "New Reliability Guidelines for Air Force Contractors".

Planned for April is a talk by John Kenyon of Hughes Network Systems on DirectPCTM, "A New Hi-Tech Software Delivery System". The system is based on small dish satellite transmission technology.

Our bulletin board is still very active and can be reached at (818)-768-7644 (300-9600 baud). Most presentations are recorded on video, copies are available to members and affiliates through our Video Exchange Program. A full listing of available titles may be downloaded from the bulletin board. For information on obtaining copies contact the Los Angeles chapter chairperson.

David Franklin
Chairperson

Philadelphia Chapter

September 94 - Do You have the Skills to Survive in the 20th Century? - Dr. Charles K. Alexander and High Frequency Magnetic Excitations: Resonance, Spin-Wave Instability and

Solitons - Dr. Carl Patton

October 94 - Effective Communication - A Key to Your Professional Success - Ms. Marilyn S. Nyman and The Liberty Net: A Way to Access What's Going on in Philadelphia - Mr. Max H. Kraus

November 94 - Big Bang or Big Atoms, A Presentation on the Microatomic Theory of the Universe - Mr. H. M. Richardson and Advent of Biometric Identifiers in Our Society - Mr. C. B. Kuhla

Fulvio E. Oliveto
Chairperson, Philadelphia Section

Swiss Chapter

As announced in the January issue, here is the program of our activities for 1995 (from April on):

Conferences

Aug. 30 - Seminar on Focused Ion Beam Technology, ETH Room ETZ E6, 9:30 am - 5:00 pm.

Oct. 11-12 - Conference on In-Process Quality and Reliability Optimization for Electronic Microsystems and Assemblies, ETH Room ETF F1, 9:30 am - 5:15 pm.

Courses

Sep. 13 - 14 - Chip and Package Related Failure Mechanisms in Microelectronics, ETH Room ETZ E6, 9:30 am - 5:00 pm (M. Ciappa).

Meetings

Apr. 24 - Approximate Solutions to Complex Reliability Structures (Dr. D. Kumar, IIT, Bombay).

May 15 - Experimental Mechanics, a Tool for Quality and Reliability Improvement of Mechanical Systems (Prof. A. Freddi, Univ. of Bologna).

June 20 - Reliability Models for Repairable Equipment with Preventive Maintenance (Dr. J. Endrenyi, Ontario Hydro Tech., Toronto).

June 26 - Good Data In - Garbage Out (Dr. H. Ascher, Potomac MD).

July 3 - Statistical Tests for Concurrent Failure Causes (Dr. B. Gerlach, Humboldt University, Berlin).

Nov. 13 - Development of Cable and Wireless Telephony in Germany with Special Attention to Reliability (P. Jacob, ETH Zurich).

The meetings take place at 5:15 pm at the ETH Zurich, room ETF C1. For further information please call Ms. Sybill Steffen at +41 1 632-2743, fax: +41 1 632-1258, e-mail: birolini@zuv.ee.ethz.ch.

One course and two meetings have already taken place. Professor A. Birolini gave his course on Quality and Reliability of Equipment and Systems (March 8-10). On Jan. 23 Professor W. Schneeweiss (Fern-Universitat Hagen, Germany) spoke on the Reliability Analysis of Complex Systems Using the Fault-Tree Method, and on Feb. 20, Dr. B. Stamenkovic (Ascom Ericsson Transmission, Berne) discussed the Reliability and Availability of Telecommunications Equipment and Systems.

Professor Alessandro Birolini
Chairman

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ADCOM Nominations

It is time to consider nominations for the Reliability Society Administrative Committee Members who will serve the Society from 1996 through 1998. There are two ways for a candidate to be placed on the ballot:

1. A nominating petition signed by ten or more Reliability Society Members in good standing (excluding student members).
2. Selection by the Reliability Society's Nominating Committee

Last year nine candidates were placed on the ballot, which does not distinguish between type 1 and 2 candidates. Three were nominated by petition and six were placed on the ballot by the nominating committee. All three of those nominated by petition were elected. The entire Reliability Society Membership elects six people to serve a three year term.

The sponsor of a nominee should secure the candidate's willingness to serve (The AdCom meets four times per year. Expenses for attending the meetings ar not borne by the society). A Nominating petition signed by at least ten members and a biographical sketch, to be included with the ballot.

For uniformity, the biographical sketch should be typed (Courier 12), limited to one side of one 8.5" by 11" sheet of paper. and include:

- Education
- Work Experience
- EEE Experience
- Other

The nominating material:

1. Signed agreement to serve if elected
2. Biographical Sketch
3. Nominating Petition

should be sent to:

Dr. W. Thomas Weir
Public Service Electric & Gas Company
Nuclear Business Unit - MC N20
P.O. Box 236
Hancocks Bridge, NJ 08038

on or before June 1, 1995.

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IEEE Reliability Society Fellows

The following four Reliability Society Members have been honored by IEEE by being elected to the Fellow Grade. These four individuals were so recognized by their extraordinary achievements in their technical field. Each was recognized as follows:

Dr. Samuel J. Keene (Boulder, CO)
: For the advancement of reliability technology in components and systems. He was presented with his Fellow Grade certificate at the Reliability Societies awards banquet in conjunction with the RAMS Conference (Reliability and Maintainability Symposium) on the 23rd of January 1995. Present at the Banquet were most of the Reliability Society ADCOM and officers along with the

Executive officers of the RAMS Conference. As you all know, Sam is Senior Past President of the Reliability Society and is still extremely active with this group.

Dr. W. Kent Fuchs (Urbana, IL)
For contributions to reliable computing. He received his Fellow Grade certificate from the Computer Society.

Dr. Butrus T. Khuri-Yakub (Stanford, CA)
For development of innovative nondestructive evaluation techniques, and for contributions to zinc oxide technology. He received his Fellow Grade certificate from the Ultrasonics, Ferroelectrics, and Frequency Control Society.

Dr. Kenichi Okuyama (Hitachi, Japan)
For contributions to the development and analysis of power transformer coil design. He received his Fellow Grade certificate from the Power Engineering Society.

All of these people deserve the very best congratulations that we can offer. They have distinguished themselves among us and are a major benefit to the Reliability Society, IEEE, their companies or universities and to all of the World. I am sure that their past and present work will reflect this contribution for years to come.

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Award to Professor Igor Bazovsky

The Slovak Academy of Sciences (SAS) conferred its prestigious Aurel Stodola Golden Plaque upon Professor Igor Bazovsky on January 20, 1995 at a special ceremony at the Ripley Center of the Smithsonian Institution in Washington, D.C. The presentation was made by the Slovak Republic Ambassador to the U.S., Dr. Branislav Lichardus. The SAS plaque was awarded to Dr. Bazovsky for his pioneering role in the research and development of 'reliability' engineering methods and techniques, in electronic, mechanical, and nuclear systems, particularly in the designs of aircraft, missile, satellite, ship, automotive, nuclear reactors, and electrical power generating systems. Among his numerous technical papers and books is the standard text, Reliability Theory and Practice published in 1961 when we was the Chief Reliability Analyst at the Raytheon Co.

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Reliability Society Awards

1995 Reliability Society Engineer of the Year

The Reliability Society honors one engineer for their contributions to Reliability each year. There is an awards committee that nominates candidates and reviews those that are nominated. This year Ms Naomi J. McAfee was recognized for "Distinguished Contributions to the Practice and Management of Reliability Engineering and for Active Involvement in the Professional Organizations Supporting that Discipline". The Awards Committee considered several candidates for Reliability Engineer of the Year. When Naomi's name came forward, she was unanimously supported by the committee members. The 1996 Awards chairman is Dr. Tom Weir, Jr. Past President of the Reliability Society who can be contacted to make nominations for next year.

Other Reliability Awards

Several other people were recognized for their contribution to the field of Reliability. These people received a plaque at the awards banquet:

Henry Malec
Vincent Lalli

Dr. Dick Kowalski
Prof. K. B. Misra

Photos from RAMS Conference

Past President Dr. Sam Keene presents the Outstanding Engineer of the Year award to Naomi McAfee. This is the highest award given by the Reliability Society. It is a pleasures to see this award given to someone so well deserving for all of her contributions to both our society and to the RAMS conferences.
- View Photo

Sam Keene (awards chairman) presents Hank Malec with a special award for his contributions to the Reliability Society.
- View Photo

Dr. Sam Keene and his wife Karen after he had just received the notification certificate for advancement to IEEE Fellow Member. As you know, this is very prestigious and a mark of exceptional achievement.
- View Photo

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ADCOM Election Results

Newly Elected Officers

President	Richard Doyle
VP Technical Operations	Loretta Arellano
VP Meetings	Dennis Hoffman
VP Publications	Joe Gruessing
VP Membership	Marvin Roush

1995 Election of AdCom Members

TERM EXPIRES 1995 (DEC 31)

J. Adams	H. L. Barton
V. R. Lalli	H. A. Malec
M. G. Pecht	A. O. Plait

TERM EXPIRES 1996 (DEC 31)

L. J. Phaller	R. L. Doyle
J. A. Gruessing	D. Hoffman
T. L. Regulinski	M. L. Roush

TERM EXPIRES 1997 (DEC 31)

L. Arellano	D. A. Baglee
D. L. Erhart	R. A. Kowalski
D. G. Raheja	O. D. Trapp

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Reliability ADCOM meeting schedule

The next five ADCOM meetings have been scheduled. Some interesting topics will be discussed at each of these meetings. Any Reliability Society member wishing to attend is cordially invited as a guest. However, please notify either Dick Doyle, Tel: (619)459-6504, or Dennis Hoffman, Tel: (214)480-1000, if you plan to attend.

The next meeting will be at the Riviera Hotel in Las Vegas on Monday, 3 April 1995, from 1:00 PM until 5:00 PM. This will be in conjunction with the 1995 International Reliability Physics Symposium. The major subjects of interest will be: 1) Preliminary

study results of providing a Reliability Society Video Tutorial on Software Reliability, 2) Improving our Fee structure per Headquarters request, 3) Methods of providing better support to Bruce Bream and our Newsletter, 4) Preliminary report on our rewrite of the MIL-STD-785 replacement, and 5) All Committee Reports. Much more information will also be presented at this action packed meeting. If you are not able to attend the meeting, then possibly a future meeting will be more convenient.

DATE	MAJOR LOCATION	EVENT	HOURS
3 Apr 95	Riviera Hotel Las Vegas, NV	IRPS	1:00 - 5:00 PM
14 Jul 95	The Broker Inn		6:00 - 9:00 PM
15 Jul 95	Boulder, CO		8:30 - 3:00 PM
6 Oct 95	IEEE Headquarters		3:00 - 9:00 PM
7 Oct 95	Piscataway, NJ		8:30 - 4:00 PM
22 Jan 96	The Sahara Hotel Las Vegas, NV	RAMS	10:00 - 9:00 PM
25 Mar 96	Loews Anatole Hotel Dallas, TX	IRPS	1:00 - 5:00 PM

As you know, IRPS is the International Reliability Physics Symposium and RAMS is the Reliability and Maintainability Symposium. These are always the first two ADCOM meetings held each year. Also, you might want to have a tour through our IEEE Headquarters at Piscataway, NJ.

Unfortunately the Reliability Society is unable to provide any monetary support to our meetings, but you can count on us buying you a "Free Lunch or Dinner". You might even want to volunteer for some future activity or join a committee.

Sincerely Yours,
Richard L. Doyle

IEEE Reliability Society Newsletter
Editor: Bruce Bream
Associate Editor: Dave Franklin
Last Update: 15-April-1996

Reliability Society

NEWSLETTER

April 1995

Status of the Reliability Technology

Jan 1, 1995

Author: Anthony Coppola

Abstract:

The American aerospace industry is still trying to ascertain all the ramifications of the U.S. Secretary of Defense's edict to move away from MIL Standards in DoD procurements. In contrast, the ISO 9000 family of quality program standards is (relatively) quietly becoming a universal norm. Chronic problems persist with the accuracy of reliability predictions, the applications for plastic integrated circuits, computer aided engineering for reliability, and software reliability. Cooperative research efforts and networking are increasing, and reliability nodes are being established on the internet. As always, there are many useful tools available, but no "silver bullets" offering easy solutions.

Introduction:

This report is a compilation of information from the technical literature, contributions by IEEE Reliability Society technical committee chairs, and inputs from other leaders in the reliability engineering community. It fulfills the requirement in the charter of the IEEE Reliability Society Advanced Technology Committee for an annual report on the status of the reliability technology.

The market:

"Reliability," reports one of the contributors to this report, "is no longer just for the Military and the Space Markets." He notes that suppliers of medical devices face demands from regulatory agencies and customers alike for reliability. Hospitals are willing to buy re-usable medical devices in lieu of disposable devices, if the costs are reasonable and the devices are reliable. A survey by the Government Computer News showed that federal consumers considered reliability as the most important feature of their computer products, but rated only nine products of 136 listed in the survey as high in reliability. Continued advances in semiconductors come with new failure mechanisms to be identified and new problems in testing to be solved. A comment at a concurrent engineering conference that the Quality war is over (meaning that American Industry is again producing products with competitive quality) was greeted with dismay by another contributor, who emphasized the point that maintaining quality and reliability requires continual attention (the war is never over).

The big news:

In June 1994, William J. Perry, U.S. Secretary of Defense, issued a memo to all services that the use of military specifications and standards would be the last resort in U.S. Defense acquisitions when performance specifications and commercial standards would not meet program needs, and would require a waiver approved by the designated Milestone Decision Authority for the program. This edict has sent shock waves throughout the aerospace industry. The reliability community has some unique concerns with this, because many of the commercial and international standards used in reliability are derivations from military standards, and the most recent military device standards

are intended to be "dual-use" documents serving both military and commercial agencies.

Perry's policy was based on the recommendations of a Process Action Team, (PAT) but does not go as far as the PAT suggested. Mil standards would still be used where the DoD leads industry, where needed to assure a "level playing field," and where other means will not insure operability. In contrast, the PAT recommended that the following be prohibited from reference in acquisition documents:

- MIL-STD-470, Maintainability Program for Systems and Equipment
- MIL-STD-781, Reliability testing for Engineering Development, Qualification and Production
- MIL-STD-785, Reliability Program for Systems and Equipment Development and Production
- MIL-STD-882, System Safety Requirements
- MIL-STD-965, Parts Control Program
- MIL-STD-1388, Logistic Support Analysis
- MIL-STD-1543, Reliability program for Space and Launch Vehicles
- MIL-STD-1546, Parts, Material and Process Control for Space and Launch Vehicles
- MIL-STD-1556, Government-Industry Data Exchange Program (GIDEP) Contractor Partner Requirements
- MIL-STD-1574, System Safety Program for Space and Missile Systems
- MIL-STD-1586, Quality Program Requirements for Space and Launch Vehicles
- MIL-STD-1625, Safety Certification Program for Drydocking Facilities and Shipbuilding Ways for U. S. Navy Ships
- MIL-STD-1686, ESD Control Program for Production of Electrical and Electronic Parts
- MIL-STD-1843, Reliability Centered Maintenance (RCM) for Aircraft, Engines and Equipment
- MIL-STD-2164, Environmental Stress Screening (ESS) Process for Electronic Equipment
- MIL-STD-2165, Testability Program for Electronic Systems and Equipment
- MIL-STD-40000, Parts Control for Non-developmental Items (NDIs)
- MIL-Q-9858, Quality Systems
- ASQC/ANSI Q90 series, (the U. S. Equivalent of ISO 9000)
- ISO 9000 series, the International Quality System standards

While official comments on the policy since its release indicate the DoD recognizes and intends to avoid the fallacy of dogmatism, the policy is being seriously enforced. Unofficial reports cite 1100 requests for waivers being processed by one military agency and the firing of a government executive who was too slow to implement the policy.

Though industry representatives have long criticized government regulation, the new policy has created a state of consternation (one respondent called it "chaos") in the industry. In the device area, vendors sought reassurance that they can cite military standards, such as MIL-STD-883, Test Methods and Procedures for Microcircuits, in the specifications they generate. (Answer: yes, contractors are free to cite military standards in their own product specifications, and to proposed them in response to government solicitations). The continued maintenance of much-used military references such as 883 and the future of dual-use specifications such as MIL-I-38535, General Specification for Integrated Circuits (Microcircuits) Manufacturing, are of significant concern to the industry, and are questions as yet unanswered.

Other device concerns are the lack of "hooks" for Built in Test of commercial microcircuits and the lower temperature range of

many commercial devices compared to military. One "horror story" of an apparent over-reaction to the DoD policy was the complaint of a program manager that he was directed to use commercial parts with a 70 degree maximum rating in an application where higher temperatures are sure to be encountered.

Other concerns expressed about the policy are the loss of the history embodied in the military standards and the loss of accountability as the infrastructure built around compliance to the standards dissolves. There is also a fear of increased costs to purchase commercial standards replacing the free military documentation.

It has been found that a tactical fighter and a wide body airliner both need about 2000 different specifications and standards to produce. Of these, for the fighter, 55% are DoD documents, and, for the airliner, 20%. In both cases, there is cause for concern that the DoD documents may become obsolete under the new policy without adequate replacement. Industry comments accuse the DoD of "unilateral withdrawal from a 50 year old partnership," and express the fear that abandoning existing, widely-used MIL documents threatens safety and reliability and adds unexpected cost.

This issue will probably dominate the concerns of the U. S. aerospace industry in 1995, and perhaps longer.

ISO-9000

Compliance to one of the family of ISO-9000 quality system standards (see box) is a requirement for suppliers of certain products to the European Union (EU). These products are covered by EU Directives which call for a "third party" to audit the supplier and certify that his quality system meets the designated ISO-9000 document. It has been estimated that 50% of U. S. Exports to the EU are covered by these directives. It is expected that the EU will continually place more products under directives, and compliance to ISO 9000 is starting to be used as a requirement in other parts of the world. For example, office supplies for the Canadian Government will be purchased from suppliers compliant to ISO-9000, and Long Island Rail Road car suppliers will be compliant to ASQC/ANSI Q90 which is the U. S. Version of ISO-9000. (Practically all non-military quality standards in the world are now harmonized with ISO-9000.) There is therefor an increasing competitive pressure for companies to be registered as ISO-9000 compliant. The Canadian Manufacturer's Association has set a goal for registering 7500 Canadian sites to ISO-9000 by 1998 (from about 750 in 1994).

Companies (actually, specific sites) are registered as compliant to ISO-9000 by audits conducted by "third parties" who are accredited by an agency designated by National Authority. These "third parties" are called "notified bodies" in the EU, and, technically, there are no official notified bodies outside the EU. However, auditors have been accredited by agencies outside the EU. For example, the U. S. Registrar Accreditation Board (RAB) was set up by the American Society for Quality Control (ASQC) and the American National Standards Institute (ANSI). A treaty between the U. S., Australia and Great Britain has established official mutual acceptance of accreditation by each country's designated agency. Mexico has established the Mexican Standards Directorate (DGN) for accrediting auditors and is working with Canada for mutual recognition of accreditations. Other agreements are in negotiation. Despite some fear that the lack of protocols for mutual recognition of accreditation agencies might make ISO-9000 a barrier to trade instead of an enhancer, there seems to be an international good will making the system work while the legal infrastructure is in construction.

ISO-9000 is not, however, universally acclaimed. Detractors claim it adds a bureaucratic burden which does nothing to affect quality in a product. (The standards describe a quality system only. The

EU directives mentioned above also include other requirements, such as type testing, to assure the system is effective.) The reader may have noted that the ISO-9000 standards were also condemned by the team who advocated the new DoD policy on standards (discussed above).

ISO-9000 Documents

- ISO-9000, "Quality Management Standards" presents guidelines for the selection and use of ISO-9001, 9002, and 9003.
- ISO-9000-3, "Software Quality Assurance," guides the application of ISO-9001 to Software products.
- ISO-9001, "Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing," is the most comprehensive of the three quality systems standards.
- ISO-9002, "Quality Systems - Model for Quality Assurance in Production and Installation," contains only the portions of ISO 9001 concerned with production and installation.
- ISO-9003, "Quality Systems - Model for Quality Assurance in Final Inspection and Test," contains only those portions of ISO-9001 and 9002 pertaining to final inspection and test.
- ISO-9004 , "Quality Systems - Guide to Quality Management and Quality System Elements," discusses quality system elements as a guide to managers and auditors.
- ISO-9004-2, "Guidelines for Services," provides guidelines on the application of quality management standards to services.

Total Quality Management (TQM)

There is no doubt that TQM has arrived. A flood of TQM books is on the market, and a myriad of consultants are flying the TQM banner. However, some (consultants and customers alike) have adapted the name without acquiring the "profound knowledge" W. Edwards Deming cited as necessary to be effective. Hence, a Caveat Emptor situation exists, with the unfortunate effect of tarnishing the reputation of TQM. However, there is plenty of evidence of the application of TQM principles. The health industry has been aggressive in adapting TQM to control their costs. Chances are good that the reader's local hospital has initiated a TQM initiative, and has several Process Action Teams (PATS) at work. Process improvement and the formation of Process Action Teams (PATs) is becoming a routine way of doing business, though some agencies do not use the TQM acronym. Whether called TQM or not, it is having an impact. (However, as some other sections of this status report will show, there is still plenty of room for improvement.)

Software

In the September 1994 issue of Scientific American, there is an article by W. Wayt Gibbs entitled "Software's Chronic Crisis." It is an excellent summary of the current situation, which, in reliability engineering terms, is that software reliability is inadequate because it is produced by a process not in control. The article includes a graph showing the probability of program cancellation increases as complexity (measured in function points) grows. A program of 10 thousand function points has only an even chance of survival. The reason, according to Gibbs, is that software engineering is still a "cottage industry," and "years -perhaps decades- short of mature engineering design." The Software Engineering Institute (SEI) has a rating scale for software producers ranging from one (no formal process or metrics) to five (well controlled software production process). Gibbs notes that of 261 companies rated by SEI, 75% received ones and 99% were three or less. Only two companies earned a five. Gibbs also reinforces the contention in last year's status report that "islands

of automation" exist which need bridging. He cites the examples of unsuccessful attempts to combine the California Department of Motor Vehicles license system with its registration system, and to combine the American Airlines SABRE reservation system with hotel and rental auto systems.

The utter dependence of modern systems on software is probably indisputable, and for many programs the cost of the software dwarfs the cost of the hardware. Considering these facts, the word "Crisis" in Gibbs' title is quite appropriate. He also notes that distributed processing will compound the problem and reports that the FAA estimate for code produced for a proposed distributed system was $500 a line, five times the standard for well managed code. On the other side of the coin, Gibbs reports that the Raytheon company saved $17.2 million dollars through software process control. Large cost savings and increased reliability were also reported in last year's status report for Japanese companies using software process control tools (specifically, the Rome Laboratory Software Quality Framework). Clearly, there is money to be made by improving software engineering. For this reason, Gibbs might be too pessimistic about the time it will take to mature the discipline.

Computer Aided Engineering (CAE)

While CAE continues to increase in importance, reliability engineering packages continue to be "islands of automation" crying for integration into the process. One correspondent stated that while many have been talking about the integration of reliability analysis with CAD, he had yet to see a "really good and complete integrated system." However, progress is being made. In June, 1994, the Department of Defense Joint Logistics Commanders chartered a joint technical coordinating group (JTCG) for Integrated Product Data Environment, combining the JTCG for Computer aided Logistics Support with the JTCG for Flexible Computer aided Manufacturing. The new group will promote an integrated data environment designed to support its motto: "readiness through cooperation."

Cooperation is also the backbone of Project ARIES. The ten professional groups which sponsor the Annual Reliability and Maintainability Symposium have created a Council on Reliability, Quality and Competitiveness who have further combined with a Tri-service Process Action Team on Concurrent Engineering - Computer Aided Design in an effort to identify, summarize and provide generic design rules and best design practices in a fashion so that the data is usable in CAE/CAD tools. (Participation by other interested parties is invited. Contact is Dennis Hoffman of Texas Instruments. (214) 480-1000)

The University of Maryland Computer Aided Life Cycle Engineering (CALCE) center has initiated a project to examine integration strategies between CALCE software and commercially available CAD/CAM tools.

The U.S. Air Force Armstrong Laboratory program includes the development of an integrated suite of tools for process analysis and system development under a project called Information Integration for Concurrent Engineering (IICE) and a software system called Requirements Analysis process in Design (RAPID) which will be a system development decision tool integrating such concerns as reliability, maintainability and supportability with cost, performance and schedule.

The U. S, Air Force Rome Laboratory is extending the VHSIC High Order Description Language (VHDL) to cover analog and hybrid circuits as well as digital. The use of VHDL for the exchange of data among microelectronics producers and users is a significant factor in making this community arguably the most effective user of CAE. The laboratory also performed a joint research effort with the University of Massachusetts to produce a software tool using machine reasoning to generate mesh models

of multichip modules for use in finite element analysis, greatly reducing the overall time needed for the reliability analysis of proposed designs, and thus encouraging incorporation into the design process.

There are undoubtedly many more programs of interest in this area. It should be noted that the IEEE sponsors a workshop on CAE, Concurrent Engineering and Integrated Product Development, which is now incorporated into the program of the Annual Reliability and Maintainability Symposium.

Networking

Several factors are fostering cooperative efforts in the industry. The Perry initiative (see "The Big News" above) inspired a meeting of professional Societies concerned with R&M Standards in May 1994, which resulted in actions to develop a memorandum of Understanding for mutual review of standards developed by individual societies, Identify national and international standards organizations and their roles in creating dual-use R&M standards, and identify all current efforts to develop R&M standards.

The U.S. National Policy on encouraging dual-use of emerging technology has led to innumerable partnerships of government, industrial and academic institutions.

Reductions in defense funds have also encouraged attempts to leverage investments by creating partnerships. One example is the initiative to transfer responsibility for dual-use specifications from government agencies to professional societies. Unfortunately, the same fund shortage is discouraging companies from underwriting the participation of their employees in professional activities. Reports from two professional societies indicate their membership is declining even as they are being asked to assume a greater role in creating and maintaining standards.

Another facet of networking is the increasing use of the internet. The IEEE Reliability Society Newsletter has listed a electronic bulletin boards, one maintained by the Los Angeles Chapter of the society, another a statistics bulletin board, a Computer Aided Logistics System (CALS) bulletin board, on-line standards information from the Defense Electronics Supply Center (DESC), A JPL/NASA Radiation Effects Data Bank, and a bulletin board on the DoD Field Failure Return Program (the latter no longer on-line). The World Wide Web (a linkage of dispersed computers through the use of the concept of Hypertext permitting automated transfer from one to the other) is being used by the National Technical Information Center (NTIC) to establish connections to each of the information analysis centers (IACs) under its management. For example, a user can access the NTIC "home page" (using a software "browser" such as MOSIAC) and select a menu item which will automatically transfer him to the home page of the Reliability Analysis Center (RAC) on another computer in a different location. The RAC home page can also be reached directly at its own Uniform Resource Locator (URL) address (RACs URL is: http://iitri.com/RAC/). The home page will provide links to other RAC files, including: current information, a list of RAC services, a catalog of RAC products, a compilation of frequently asked questions and answers, and electronic copies of the RAC Journal.

Other IACs are also going on-line through the World Wide Web and more conventional bulletin board systems. For example, the Supportability Investment Decision Analysis Center (SIDAC) bulletin board can be reached at (800) 537-4322 (53-SIDAC). Other agencies in the reliability community are also joining the network; the Rome Laboratory Reliability Sciences Status Report is available on the world wide web (at http://erd.rl.af.mil/ER-News/Newsletter.html). The Reliability Society's Newsletter listings of computer addresses showed great foresight: there will soon be a great need for topical directories of internet addresses.

Data needed

A persistent theme is the lack of data bases for reliability engineering. Continual cries for general and specific reliability data fill the literature.

- Building upon a database of the NASA Software Engineering laboratory, A U.S. National Software Data & Information Repository is being created. Started with Air Force Sponsorship, the repository is intended to grow to cover other, DoD government, industry and academic organizations. Contact is Mr. Charles Shank, ESC/ENS, 5 Eglin St, Bldg 1704, Hanscom AFB MA 01731-2116. (617) 377-9365. e-mail: shankc@gwl.hanscom.af.mil.
- The International Electronics Reliability Institute (IERI) is reorganizing to become a member-supported agency, and offers discounts in exchange for field data contributions. Contact: Mrs. S. Dart, IERI, Dept. of Electronic and Electrical Engineering, Loughborough University of Technology, Loughborough, Leicestershire, LE11 3TU, U.K. Tel: 44(0) 1509-222849. Fax: 44(0) 1509-222854.
- The Reliability Analysis Center has advertised for ESD susceptibility data and failure modes information to update its data compendiums. Contact: William Crowell, RAC, 201 Mill Street, Rome NY 13440-6916. Tel: (315) 339-7054. Fax: (315) 337-9932. e-mail: wcrowell@mail.iitri.com.
- The University of Maryland Center for Reliability engineering is seeking corporate and federal affiliates to help create a research, engineering and testing group dedicated to Radiation Effects on Electronics and Electronic packaging. Contact: Dr. Walter Chappas, Center for Reliability Engineering, University of Maryland, College Park MD 20742-2115. Tel: (301) 405-7748.
- A specific interest of many organizations is data on the reliability of commercial devices in military environments, especially plastic encapsulated integrated circuits (plastic ICs).
- The Reliability Analysis Center (RAC) is compiling a report "Plastic Microcircuit Packaging- A Technology Review II," under the sponsorship of the Defense Technical Information Center. The results will be made available to the industry as a RAC report.
- The U. S. Air Force Rome Laboratory and the French Ministry of Defense has signed a data exchange agreement. One transaction under the agreement is the sharing of French data on the reliability of commercial semiconductors in a French army radio.
- The U. S. Navy Surface Weapons Center is subjecting plastic circuits to highly accelerated stress testing (HAST) and performing failure analysis on the parts that do not survive, in order to evaluate their reliability in military use conditions. Plastic IC data may also be available from an effort by the U. S. Navy Standard Hardware Acquisition and Reliability Program (SHARP) who have begun collecting data on Commercial Off-the -shelf (COTS) products used in Navy System. Data is also being sought to evaluate the accuracy of reliability predictions and to develop new prediction models.
- There are currently at least eight different compilations of failure rate models based on an assumed constant failure rate (see below). Five of these were compared to each other and to field data for six different printed circuit boards in the International Electronics Reliability Institute (IERI) database. The results showed wide and inconsistent variations between the models and between the models and the field data.

Failure rate compendiums Assuming Constant Failure Rates

- MIL-HDBK-217 (Parts Count Method)

- MIL-HDBK-217 (Stress Analysis Method)
- Bellcore Reliability prediction Procedure
- British Telecom Handbook of Reliability Data (HRD4)
- Nippon T&T Standard Table for Semiconductor Devices
- French National Center for Telecommunications (CNET) Stress Model
- French National Center for Telecommunications (CNET) Simplified Model
- Siemens Procedure

(Note: IERI study compared one version of MIL-HDBK-217, One version of CNET, Bellcore, HRD4 and Siemans models).

Within the U. S. Army, there is a program to replace statistical models of failure rates with new models based on the Physic of Failure. As of yet, there is no compendium of failure rates based on physics of failure comparable to the many based on constant failure rates. There is also the objection that field failures include more than failure mechanisms inherent in the part (e.g. maintenance induced failures, etc.) and hence require a statistical model for provisioning and other logistical operations. Nevertheless, physics of failure studies are universally recognized as a key to device improvement. Both Rome Laboratory and The University of Maryland Electronic Packaging Research Center (EPRC) continue to aggressively pursue physics of failure studies. A recent achievement of the Rome Laboratory program was the savings of $16 million to the Air Force by using the knowledge of failure mechanisms in TWT's to refurbish tubes condemned for scrap.

Fresh looks at prediction methods are being taken by the Society of Automotive Engineers (SAE) who are doing a comprehensive review of electronic reliability prediction methods including MIL-HDBK-217, Physics of failure and automotive approaches, and by Rome Laboratory who have initiated a project to review all current practices and develop new and innovative methods.

The lack of trusted data in general, and prediction models in particular, will likely continue as chronic, perhaps insoluable, problems to the reliability community.

Tools

Besides those mentioned previously, current developments in reliability tools are:

- Highly Accelerated Life Testing (HALT) and Highly Accelerated Stress Screening (HASS) are reported to be becoming commonplace. The step stress testing techniques developed in the aerospace industry are now being used by commercial concerns. The University of Maryland is investigating the cost-effectiveness of simultaneous vs. sequential stresses for accelerated tests, and is developing accelerated tests for plastic microcircuits.
- Reports received show increasing emphasis on reliability before hardware is prototyped. Cited are reliability analysis being integrated with CAD/CAM (and a need for improvement in this), increased use of modeling and simulation and the exploitation of rapid prototyping and stereolithography to enable fast and accurate evaluations to reduce testing and shorten the design cycle. A correspondent in the automotive industry also reports an interest in robust design, but a lack of agreement on what the concept entails.
- Human performance reliability (HPR) tools are not broadly used except in the nuclear power industry where they are needed for Probabilistic risk analyses (PRAs) of nuclear plants. Recent developments are a cognitive reliability and error analysis method by Human Reliability Associates in the U. K., and NUREG/CR-5534, Task Linked Evaluation Technique, an approach to addressing HPR in PRAs by the

U.S. Nuclear Regulatory Commission. More broadly applicable is an interactive system design tool, the Reliable Human-Machine System Developer (REHMS-D) created by the University of Maryland Center for Reliability Engineering, and the Operator Model Architecture (OMAR), being developed by the U. S. Air Force Armstrong Laboratory to provide computer-based human performance models for use in system simulations.

- Maintainability tools continue to progress. The use of neural networks for diagnosis is being explored by various agencies. The Armstrong Laboratory Integrated Maintenance Information System (IMIS) program continues to develop a portable automated troubleshooting device, explore its applications to related fields, such as aircraft battle damage assessment and repair, and develop enhancements such as monocular displays for easier viewing. IMIS field tests are being performed in a variety of fighter aircraft. Rome Laboratory continues its integration of their time stress measurement device with built in test, currently adding the capability to measure the electromagnetic environment as well as the physical environment. Rome Laboratory devices have been installed in two dozen B-1 bombers for test. A joint Rome Laboratory - San Antonio Air Logistic Center effort developed and demonstrated software to automate the generation of digital board test programs for Automatic Test Systems.

Needs

Besides those mentioned previously, needs identified by respondents include:

- Cutural Changes - Although one noted that industry is accepting product development as a process that can be defined and improved, our inputs included many calls for a cultural change starting with top management to make constant improvement a way of life. Also, in discussing the Perry initiative (see "The big news", above) one contributor stated that the U.S. congress must change laws that govern government procurement, and another cited the required accounting procedures and other mandates of the Federal acquisition Regulations as more costly than the MIL Standards. More than one input noted that there were no "silver bullets" offering easy solutions to all problems, though management sometimes expected too much from a promising tool. Robust design and CASE (Computer Aided Software Engineering) were two tools cited in different inputs as examples of this.
- Failure mechanisms for emerging technologies such as GaAs and multi-chip modules need to be identified to provide design guidance.
- Self-diagnostics must be built-in to highly integrated circuitry and meshed with higher level diagnostics to provide a cost-effective means for trouble-shooting failures.

Conclusion

This report summarizes the status of a dynamic reliability engineering discipline. There are undoubtedly many more items of interest which could be added. The undersigned takes the responsibility for any errors and omissions. Thanks to Carl A. Rust, Bertram W. Cream, and John Bart for describing their corporate activities and to J.R. Adams, Richard J. Rudy, Dennis R. Hoffman, Ken Lasala, Andrew Chruscicki, Eugene Blackburn, Dan Fayette, Jim Collins and Frank Born for their views as specialists.

Anthony Coppola
Chairman, Advanced Technology Committee

Editors Note: Reference links to internet resources added by the WWW page curator.

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