Sponsoring Societies

AIAA
ASQ/RD
ASQ/ECD
IEEE/RS
IEST
IIE
SAE
SOLE
SRE
SSS

Participating Organizations

ALSTOM Transportation, Inc.
Applied Materials
California State Polytechnic Univ.
Crow Reliability Resources
Defense Acquisition University
Design for Competiveness, Inc.
DoD, US Army TACOM LCMC
Federal Communications Commission
Florida Institute of Technology
Ford Motor Co.
Halliburton Co.
IBM Global Services
Ingersoll Rand
IPS Group, Inc.
James Madison Univ.
Kansas State Univ.
Lockheed Martin Aeronautics Co.
ManTech International
Medtronic, Inc.
Millennium Engr. & Integration Co.
NASA/Caltech Jet Propulsion Lab.
NASA Glenn Research Ctr.
Northrop Grumman Corp.
OPS A La Carte, LLC
Pratt & Whitney Rocketdyne, Inc.
Raytheon Company
Relex Software Corp.
RMA Consulting Group, LLC
Scien-Tech Associates Inc.
Solomon Associates
Stellar Services, Inc.
Structural Integrity Assoc., Inc.
US Army Developmental Test CMD
US Army Evaluation Center
US Army PM-Soldier Warrior
Univ. of Arkansas
Univ. of South Carolina
Univ. of South Florida
VALADOR, Inc.
Virginia Tech
Warranty Warriors

An Invitation To:

RAMS®

The Annual Reliability and Maintainability Symposium

www.rams.org

OUR 56th YEAR

January 25 - 28, 2010
Doubletree Hotel San Jose
2050 Gateway Place
San Jose, CA 95110 USA
1-800-222-8733
1-408-453-4000
Fax 1-408-437-2898

General Chair's Message

Transcending Traditional Reliability Approaches — from Theory to Practice

Dr. John Healy

The theme of the 56th Annual Reliability & Maintainability Symposium (RAMS®) to be held in San Jose, California in 2010 is Transcending Traditional Reliability Approaches — from Theory to Practice. Reliability, maintainability, and safety have never been more crucial in the design, the development and the operation of components systems, and networks. Customers expect that products and services be nearly 100% reliable. Products and services that do not reach beyond existing reliability standards will lose market share. In order to attain this level of reliability, approaches that transcend existing approaches are needed. In communications, energy, space, defense, transportation, and medicine, reliability is becoming the paramount property.

In communications, networks must be designed to minimize outages even during natural disasters like Hurricane Ike or Hurricane Gustav. In defense, reliability failures can lead to complete mission failures and the loss of lives. In energy, designing reliable renewable energy sources is the newest challenges. In the manufacturing environment, "reliability is king." Collecting and using data on the reliability, performance and security of products and services is the scientific way to make improved reliability operational. Many of the new approaches will utilize different types of data and many more sources of data simultaneously. And finally, there are important new theoretical insights in all of these areas that can help others achieve advancements in the science and engineering of reliability, maintainability, and safety.

RAMS 2010 features a diverse technical program of over 90 papers in 23 sessions. There are sessions on reliability modeling, risk assessment, safety models, accelerated life testing, etc. Each of these sessions contain new and useful methods for transcending the results of traditional approaches. There is even a panel discussion on the revision to MIL-HDK-217.

For the Tutorial Program, RAMS 2010 attendees can choose from an offering of twenty tutorials. The topics of these tutorials range from the basic concepts of R&M engineering to advanced topics in cutting-edge areas of R&M research and applications. We are continuing the very successful RAMS Certificate Program that was started last year. Attendees can complete the first level of the certificate program requires attendees by attending the five core concept tutorials:

Introduction to R&M Management
Introduction to Life Data Analysis
Introduction to Fault Tree Analysis
Fundamentals of Failure Modes & Effects Analysis
Introduction to Probabilistic Methods in Reliability Modeling

Completing the second level of the certificate program requires attendance of an additional ten tutorials across at least two Symposia. Attendees are free to choose these ten tutorials based on their own professional needs and interests. Upon completion of the program, attendees receive a RAMS certificate and a letter of completion including a list of tutorials attended.

The Keynote Speaker for RAMS is Edmond Thomas who will be discussing technology trends in communications. Ed has held senior positions in business management, R&D, satellite and cellular/land based radio system design, and telecommunication/data network design and implementation. Ed is currently a partner at the law firm of Harris, Wiltshire & Grannis. He formerly was the Chief Engineer of the Federal Communications Commission. In 2003, he was named by Wired Magazine as one of the four most influential technical people in Washington.

There is one major change to RAMS this year that we believe will enhance the exposure of each of our speakers at the paper sessions. All but two of the technical paper sessions will be webcast in their entirety. This means attendees from around the world can view each paper presented.

RAMS is unique in the field of international conferences around the world in that it is produced and supported by ten professional societies that share the common objectives of improving reliability, availability, and safety. There is no doubt that these three tenets are of growing importance in the world community over an increasing range of products and processes.

RAMS marks its 56th year in San Jose, California. Regardless of the products, systems, and processes that create your reliability universe, there is a great deal more to learn than can be obtained in any classroom, library or literature search. Thank you for joining us in San Jose for a rich, human-based experience, in a unique, historical environment, where we can learn from each other.

Dr. John Healy, General Chair, 2010 RAMS
Federal Communications Commission
(chair@rams.org)

The Management Committee and Board of Directors gratefully acknowledge our 2010 RAMS Corporate Patrons.

Gold Level
Relex Software Company
Diamond Level
Millennium Engineering and Integration Company

Relex®
A PTC InSight Product

NOTICE — Sunday, January 24, 2010 Symposium Registration
Doubletree Hotel San Jose • RAMS Registration Desk • 3:30 PM to 6:00 PM
Avoid the Monday Morning Rush!

Registration Information

All Symposium registration MUST be done through the RAMS website at www.rams.org
Hotel reservations MUST be made with the hotel.

Symposium Registration- All Symposium registration must be completed no later than 24 hours before arrival at the Symposium. Payment by credit card may be made on the web site any time prior to arrival at the Symposium or upon arrival. Payments by cash, check, or travelers check must be made upon arrival. All payments are nonrefundable after January 9, 2010. Please contact RAMS as shown below to arrange other payment options.

Registration Fee – The Symposium registration fee is $1025 and includes (except as noted below) admission to all sessions, tutorials, exhibits and the banquet; as well as a copy of the *Proceedings* and the *Tutorial Notes* (each on one CD). Discounts are available as follows:

Participant Discount – Presenting authors, panelists, moderators, special guests, members of the RAMS management team, and exhibitors will receive specific information on discount eligibility and specific instructions on how to register. Failure to follow these directions will void this discount.

Student Discount – Full time students paying by credit card on or before January 9, 2010 are eligible for a discount of $845. Those paying by other means or after January 9, 2010 are eligible for a discount of $822. Those taking advantage of this discount will not receive a banquet ticket.

Member Discount – Members of one or more of our sponsoring societies, not eligible for Participant or Student discounts, are eligible for a discount of $100.

Advance Credit Card Discount – Registrants paying by credit card on or before January 9, 2010, not eligible for Participant or Student discounts, are eligible for a discount of $50.

One Day Discount – Individuals wishing to attend for one day only are eligible for a discount of $450. Those taking advantage of this discount will not receive a banquet ticket.

Group Discount – Groups of six or more using a single credit card and registering on or before January 9, 2010 are eligible for a discounted registration fee of $600 for members of the group who are not eligible for Student or Participant Discount. Registrants taking advantage of Participant or Student Discounts may be included in the group to meet the requirement of 6 members but will receive no additional discount. Please contact r.w.sears@ieee.org for more details.

Corporate Registration – Organizations wishing to send different individuals to different sessions may purchase a Corporate Registration for $1100. This registration provides access to papers, tutorials and exhibits for one individual at a time but does not include the banquet. Please contact r.w.sears@ieee.org for more details.

Doubletree Hotel Reservations

Hotel reservations must be made directly with the Doubletree San Jose before January 4, 2010 to qualify for the RAMS discount rate. The RAMS Registration web page *www.rams.org/registration* contains the following link to the Doubletree's RAMS reservation site:
http://doubletree.hilton.com/en/dt/groups/personalized/JOSE-DT-RMS-20100121/index.jhtml.
The "Special Accounts" Promotion/Offer Code is "RMS". If you need further information for symposium registration please contact:

Hotel Information:

Doubletree Hotel San Jose
2050 Gateway Place
San Jose, CA 95110 USA

Phone: 1-800-222-8733
1-408-453-4000
Fax: 1-408-437-2898

Earliest check-in: January 21, 2010, latest check-out: January 31, 2010
Rate $139/night plus taxes
Hotel provides a free shuttle from the San Jose International (SJC) Airport.
Call guest services at 1-408-437-2155 to arrange free shuttle service.

RAMS Exhibition

Every exhibitor has been carefully selected with improved reliability, maintainability, quality, and productivity in mind. All exhibits will be adjacent to the Tutorials and Sessions of the Doubletree Hotel. Coffee breaks will be held in the exhibit area. The Exhibition is a valuable component of the *R&M Symposium* as it provides information on products and services which can help you do your job more efficiently. Even if you plan to attend every technical session, there will still be plenty of time to visit the exhibits between sessions and during lunch breaks. The Exhibition is scheduled to be open at the following times:

Monday, January 25, 5:00 PM — 7:00 PM **Opening Reception!**
Tuesday, January 26, 9:00 AM — 5:00 PM
Wednesday, January 27, 9:00 AM — 4:00 PM

2010 RAMS Exhibitors

ALD Group/SoHaR Inc.
ARINC
EPRI (Electrical Power Research Institute)
exida
Fulton Findings™
Isograph, Inc.
Item Software (USA), Inc.
MEI Company
Minitab, Inc.
Ops A La Carte, LLC
PHM Technology
Relex Software Corporation
Reliability Information Analysis Center (RIAC)
ReliaSoft Corporation
RELIASS
The Omnicon Group, Inc.
University of Maryland
Valador, Inc.

2010 Exhibition Space Still Available!

At press time, there were still a few booths available in the exhibit area for this years RAMS. Contact: RAMS EXHIBITION MANAGER; David F. Barber, Jr.; Scien-Tech Associates, Inc., P.O. Box 2097, Banner Elk, NC 28604-2097 USA at 1-828-898-6375, email: dbarbsta@aol.com or by FAX at 1-828-898-6379. David can also provide information on the Year 2010 RAMS Exhibition.

IEEE Continuing Education Units (CEUs)

You can earn CEUs by attending our Tutorials and Workshops (0.1 CEU per hour). Simply use a CEU completion form included with your registration packet. Complete the form according to the instructions, and return it to the registration desk at the conclusion of the Symposium. Your CEU certificate will be e-mailed to you. The IEEE is an Authorized CEU Provider of the International Association for Continuing Education and Training. IACET Provider # 1255

Job Posting Board

This year the *Symposium* is sponsoring a job posting board on which openings in the assurance disciplines can be posted. Any business interested in describing its employment opportunities to the world's premier gathering of assurance professionals is asked to contact Raymond Sears at 1-603-863-2832 or by email: r.w.sears@ieee.org. The bulletin board will be made available to all *Symposium* attendees. This is an extraordinary opportunity to get your employment message out!

ASQ Certified Reliability Engineer, Six Sigma Black Belt and Six Sigma Green Belt Examinations

Special arrangements have been made with the American Society for Quality (ASQ) to offer the ASQ Certified Reliability Engineer (CRE), Six Sigma Black Belt (SSBB) and Six Sigma Green Belt (SSGB) examinations at the 2009 RAMS Symposium. These 4 hour examinations will be held on Thursday morning, January 29. The exams are open book and any silent, hand-held, battery-operated calculator without an alphabetic keyboard will be permitted. Please note that a PICTURE IDENTIFICATION IS REQUIRED FOR ADMITTANCE. For full details about ASQ's certifications, please visit ASQ's Certification website at: http://www.asq.org/training-and-certification.html. On line registration for the exams is available at: https://secure.asq.org/certification/rams-2010-application.html. The deadline for advance registration and a guaranteed seat for the exam is January 4, 2010. Walk in registration for the CRE and SSGB examinations will be permitted up to noon on Wednesday of the Symposium on a space available basis.

Registration at the RAMS Registration Desk

Sunday 3:30 PM to 6:00 PM
Monday 7:00 AM to 6:00 PM
Tuesday 7:00 AM to 5:00 PM
Wednesday 7:00 AM to 3:30 PM
Thursday 7:00 AM to 12:30 PM

Exhibits will be adjacent to the Tutorials and Sessions.

Program Matrix

	Time	Sierra	Cascade	Siskiyou	Donner Pass
Monday	8:00 - 10:00 AM	Tutorial 1A - CORE An Introduction to Probability Models in Reliability and Maintainability	Tutorial 1B Achieving Availability Cost-Effectively in Complex Systems	Session 1C Design Actions And Solutions For Product Reliability	Session 1D Increasing Importance Of Reliability Across Program Management
	10:15 - 12:15 PM		Tutorial 2B Accelerated Reliability Demonstration and Assurance Tests	Session 2C Extending Reliability Models to New Applications	Session 2D Reliability Optimization Through Robust Assessment And Growth Techniques
	1:30 - 2:30 PM	General Chair's Welcome and Keynote Speaker			
	2:45 - 4:45 PM	Tutorial 4A - CORE Introduction to RAM Management	Tutorial 4B Dynamic Approached to Risk and Reliability in Design and Operations	Session 4C DOD Invited Papers Session on Implementation of new RAM initiatives within the Department of Defense	Workshop 4D R&M Exhibitors' Presentations and Demonstrations
Tuesday	8:00 - 10:00 AM	Tutorial 5A - CORE Introduction to Life Data Analysis	Tutorial 5B Accelerated Degradation Testing and Analysis	Session 5C MIL-HDBK-217 - Reliability Prediction, Data Analysis, Techniques, and New Methodologies	Workshop 5D R&M Exhibitors' Presentations and Demonstrations
	10:15 - 12:15 PM		Tutorial 6B Risk Management Principles and Techniques	Panel 6C Appropriate And Practical Application Of Empirical, Handbook And Physics Of Failure Reliability Modeling Methods	Session 6D Early Reliability Assessment At Conceptual Phase
	1:30 - 3:30 PM	Tutorial 7A - CORE Introduction to Fault Tree Analysis	Tutorial 7B Advances in Field Reliability Estimation and Applications	Session 7C Modeling and Analysis of Aging Systems	Session 7D ALT 1 - Advancements in Accelerated Life Test (ALT) Theory, Models and Approaches
	3:45 - 5:45 PM	Tutorial 8A - CORE Fundamentals of Failure Modes and Effects Analysis	Tutorial 8B An Introduction to Optimization Methods in Reliability and Maintainability	Session 8C Bayesian Methods in Reliability	Session 8D ALT 2 - Application of Accelerated Life Testing (ALT) Concepts and Practical Methodologies
Wednesday	8:00 - 10:00 AM	Tutorial 9A Intro to Markov-Chain Modeling, Analysis & Optimization	Tutorial 9B Empirical Methods for Process and Equipment Prognostics	Session 9C Effective Reliability Data Analysis	Session 9D Physical and Logical Simulation for Enhancement of Reliability and Risk Assessment
	10:15 - 12:15 PM	Advisory Board Panel			
	1:30 - 3:30 PM	Tutorial 11A Lessons Learned for Effective FMEAs	Tutorial 11B Reliability Demonstration: Theory and Applications	Session 11C Risk Assessment	Session 11D Advanced Reliability Analyses and Measures for Product Reliability Achievement
	3:45 - 5:45 PM	Tutorial 12A Software Reliability Applications	Tutorial 12B System Safety in a Variety of Industries	Session 12C Reliability Models for Complex Systems	Session 12D Advanced Techniques in Reliability Assessment
	6:30 - 7:30 PM	General Reception			
	7:30 - 9:30 PM	Symposium Banquet			
Thursday	8:00 - 10:00 AM	Tutorial 13A FRACAS Fundamentals, Best Practices and Practical Application	Tutorial 13B Statistical Warranty Forecasting	Session 13C Optimization and Control of Repairable Systems	Session 13D Practical Reliability Test Planning Applications
	10:15 - 12:15 PM	Session 14A Reliability and Safety Models and Assessment	Session 14B Evaluation of Risk through System Safety	Session 14C Performance Base Reliability Modeling Methods	Session 14D Condition Monitoring and Maintainability Modeling Applications

MONDAY SCHEDULE

8:00 AM — 12:15 PM, Monday

Tutorial 1A — **CORE** — **Sierra**

AN INTRODUCTION TO PROBABILITY MODELS IN RELIABILITY AND MAINTAINABILITY

C. Richard Cassady, Ph.D., University of Arkansas

This tutorial provides attendees with basic coverage of the traditional, fundamental probability models used to describe, improve, and optimize system reliability and maintainability. The course content includes a probability primer, a review of static reliability models, a random variable primer and a detailed review of time dependent "black box" reliability models.

8:00 AM — 10:00 AM, Monday

Tutorial 1B — **Elective** — **Cascade**

ACHIEVING AVAILABILITY COST-EFFECTIVELY IN COMPLEX SYSTEMS

Pierre Dersin, Ph.D., ALSTOM Transport

How does one accommodate today's ever higher demands on complex system availability targets, while remaining mindful of life-cycle cost? A method will be presented to assess the impact of testability strategies, maintenance policies, and redundancy management on system availability and LCC. Markov diagrams and Petri nets are used to that end. The impact of aging and imperfect maintenance is taken into account. The method is illustrated with communication networks and railroad industry examples.

Session 1C — **Siskiyou**

DESIGN ACTIONS AND SOLUTIONS FOR PRODUCT RELIABILITY

Moderator: Jeffrey Thomas, Raytheon Missile Systems Division

The papers present recommended and new practices, techniques, and new technical design and theoretical solutions for achievement and enhancement of reliability as it is designed into the products.

1C1 FATIGUE LIFE OF A DESIGN SUBJECT TO WIDE-BAND RANDOM LOADING

Wendai Wang, Ph.D., Applied Materials

This paper proposes a frequency-domain method to predict fatigue life or reliability of a design subject to wide-band random loading for engineering design.

1C2 INCREASING THE RELIABILITY OF A SELF-OPTIMIZING RAILWAY GUIDANCE SYSTEM

Christoph Sondermann-Wolke, Jens Geisler and Walter Sextro, University of Paderborn

In this paper we present for the first time experimental results of the proposed reliability concept for self-optimizing systems. Firstly, reliability aspects in a self-optimizing system are discussed. Secondly, the proposed reliability concept and the implementation in the active self-optimizing guidance system of a railway vehicle are described. Finally, the experimental tests are evaluated and compared to simulations.

1C3 DESIGN FOR RELIABILITY IN MEDICAL DEVICES

Vaishali Hegde, Philips Respironics, and Dev G. Raheja, PE, CRE, Patient Safety System

The challenges faced by medical device manufacturers in bringing safe, reliable, low overall life-cycle cost products to market in a timely manner is increasing rapidly. With the global recession and increasing safety recalls, a good design for reliability (DFR) program is becoming imperative. However, theoretical knowledge of DFR is not enough. This paper discusses DFR paradigms, developed from years of experience; that are necessary to ensure a successful DFR program.

1C4 SOFT ERROR FROM CONCEPT TO REALITY ALLOCATION, PREDICTION AND MITIGATION

Nematollah Bidokhti, Cisco Systems

For a number of years products are being impacted by transient faults that cause the systems to fail and returned to suppliers as returned material authorization (RMA). After further analysis, they deemed to be good and no problem found and ultimately sent back out to potential customers and replacements. These returns are most likely being caused by Single Event Upsets. The phenomenon of Single Event Upset (SEU) is a well known and documented and affects electronic circuitry.

Session 1D — **Donner Pass**

INCREASING IMPORTANCE OF RELIABILITY ACROSS PROGRAM MANAGEMENT

Moderator: Reuben Mann, Northrop Grumman Corporation

Both government and commercial organizations across the world are recognizing the importance of a strong reliability program to ensure success. This session will explore improvements and best practices for R&M implementation by the US Military, commercial entities and transportation companies.

1D1 THE IMPACT OF CHANGES IN DEFENSE POLICY ON RELIABILITY AND SUSTAINMENT

Patrick M. Dallosta, Defense Acquisition University

Government Accounting Office and other major reports have identified significant reliability problems in defense programs that are rooted in poorly defined and implemented systems engineering processes and the lack of reliability growth programs. The paper addresses DoD's governance processes and the increased emphasis on the Systems Engineering discipline, technical review processes, and Reliability Growth programs, and the impact of the Materiel Availability metric in design and sustainment.

1D2 ANALYSIS OF CUSTOMIZED WARRANTY POLICIES FOR HETEROGENEOUS POPULATIONS

Dia St. John and C. Richard Cassady, Ph.D., University of Arkansas

We consider the development of one-dimensional, non-renewing, free-replacement warranty policies for heterogeneous customer populations through individually analyzing customer groups, each with its own time to failure distribution. In addition, we analyze the possible benefits gained though the use of a customized warranty policy over a standard policy for all customers.

1D3 BEST PRACTICES FOR EFFECTIVE RELIABILITY PROGRAM PLANS

Carl S. Carlson, Georgios Sarakakis, David J. Groebel, and Adamantios Mettas, ReliaSoft Corporation

In this paper we take a comprehensive look into the practice of developing and executing reliability program plans. We present best practices concerning the process of developing and implementing a reliability program plan, we identify the common pitfalls and the lessons learned from developing reliability program plans and we present the results of a broad survey that captures and categorizes common practices and problems when developing and implementing a reliability program plan.

1D4 **MODELING AND QUANTIFICATION OF AGING SYSTEMS FOR MAINTENANCE OPTIMIZATION**

William Lair, SNCF, Sophie Mercier, Michel Roussignol, Ph.D., Paris Est University, and Rachid Ziani, SNCF

This paper deals with the maintenance optimization of an air conditioning system of a train. The air conditioning system is a parallel system consisting of seventeen aging components. For that matter, we model the system with a Piecewise Deterministic Markov Process (PDMP). The resolution of the C-K equation gives us the marginal distributions of this process. We calculate an approximation of these solutions with a finite volume algorithm and we use them to optimize a maintenance strategy.

10:15 AM — 12:15 PM, Monday

Tutorial 2B **Elective** **Cascade**

ACCELERATED RELIABILITY DEMONSTRATION AND ASSURANCE TESTS

Milena Krasich, PE, Raytheon, UIDS

This paper explains the technical and mathematical methodology for acceleration of reliability qualification (fixed duration with and without replacement) and reliability assurance tests (SPRT) using physics and engineering rationale along with an appropriately modified mathematical approach in test design and data analysis. This approach is with the intent to obtain meaningful and relevant information on reliability of products in their actual use and in a cost and schedule effective manner.

Session 2C **Siskiyou**

EXTENDING RELIABILITY MODELS TO NEW APPLICATIONS

Moderator: John Ackerman, US Army ARDEC

This session covers applying reliability tools to new products or new uses. Papers include applying Petri nets to hybrid vehicles; an efficient method to determine optimal design configurations for repairable systems; comparing classic spares tools vs. newer reliability-based tools in Performance Based Logistics; and combinatorial methods for reliability and sensitivity analysis of multi-state systems.

2C1 **APPLICATION OF ECSPN TO RAMS MODELING & ANALYSIS OF HYBRID CAR DRIVE SYSTEMS**

Steffen Nebel, Andrea Dieter, Peter Mueller, Institute of Machine Components, and Bernd Bertsche, Dr.-Ing., Universitaet Stuttgart

In our paper we will present the application of extended colored stochastic Petri nets to the modeling and analysis of hybrid drive systems, especially to the battery ageing. We will show the results of a simulation study considering a strong hybrid vehicle. The effect of different operational modes on battery discharging and charging will be shown and discussed.

2C2 **REDUNDANCY OPTIMIZATION PROBLEM WITH SHARED WARM-STANDBY REDUNDANCY**

Suprasad V. Amari, Ph.D., CRE,and Glenn Dill, Relex Software Corporation

This paper presents an efficient method to determine optimal design configurations for nonrepairable series systems where distinct groups of subsystems share a distinct common pool of warm standby components.

2C3 **FEASIBILITY OF PROVISIONING SPARES USING RELIABILITY SOFTWARE PROGRAMS**

Reuben Mann, Craig Rich, Northrop Grumman Corporation

Newer defense acquisition practices, such as Performance Based Logistics, increase the Contractors accountability for ensuring that that End User can adequately perform his mission. With this increased financial incentive, it is imperative that the Contractor accurately model the support strategy. This paper compares the spares provisioning capabilities of commonly used tools against newer reliability-based tools.

2C4 **RELIABILITY, SENSITIVITY ANALYSIS OF IMPERFECT COVERAGE MULTI-STATE SYSTEMS**

Akhilesh Shrestha, Liudong Xing, Ph.D., Univ. of Massachusetts Dartmouth, & Suprasad V. Amari, Ph.D., CRE, Relex Software Corp.

An exact & efficient combinatorial method based on multi-state multi-valued decision diagrams is proposed for the reliability & sensitivity analysis of multi-state systems (MSS) subject to imperfect coverage. The method is applicable to MSS with any arbitrary system structure specified in terms of either capacitated networks or multi-state fault trees. And it is applicable for MSS with ordered or unordered component/system states.

Session 2D **Donner Pass**

RELIABILITY OPTIMIZATION THROUGH ROBUST ASSESSMENT AND GROWTH TECHNIQUES

Moderator: Edward J. Zampino, NASA Glenn Research Center

Reliability of systems needs to be optimized through proven assessment and growth techniques during the development phase of all projects. This session will assist in formulating such techniques through successful case studies and newly developed methodologies for complex systems.

2D1 **A COMPARISON OF THE ROBUSTNESS OF RELIABILITY GROWTH ASSESSMENT TECHNIQUES**

Martin Wayne and Paul M. Ellner, Ph.D., US Army Materiel Systems Analysis Activity

This paper exams the accuracy and robustness of several widely used reliability growth assessment techniques under a number of realistic corrective action processes, to include a newly developed technique that was formulated to address cases where the accuracy of the existing methodologies is degraded. These include various corrective action processes along with cases where the number of failure modes in the system is not large compared to the number of failure modes surfaced during testing.

2D2 **OPTIMIZATION OF MULTISTATE ELEMENT REPLACEMENT POLICY FOR MULTISTATE SYSTEM**

Yu Liu and Hong-Zhong Huang, Ph.D., Univ. of Electronic Sci. & Tech. of China

Multi-state systems (MSS), which can perform their intended tasks with various distinguished levels of efficiency, widely exist in industrial engineering and have received a growing attention in recently years. In this paper, we generalize a multi-state element replacement optimization problem to multi-state systems.

2D3 **NEW ARMY AND DOD RELIABILITY SCORECARD**

Marguerite Shepler and Nancy Welliver, USAMSAA

In December 2007, the Army Acquisition Executive approved the new Army Reliability Policy. The policy was developed to cost-effectively increase the reliability of Army systems. One of the policy's key elements is an early review of reliability and testing efforts to determine if a program is on the right path for achieving the reliability requirements. The Army Materiel Systems Analysis Activity (AMSAA) and the Army Evaluation Center (AEC) developed a new Reliability Scorecard.

2D4 **SPARE PART INVENTORY CONTROL DRIVEN BY CONDITION BASED MAINTENANCE**
Haitao Liao, Ph.D., Wichita State University, and Mitchell Rausch, Cessna Aircraft Company
The availability of spare parts often becomes the bottleneck of process throughput, and sometimes expensive emergency orders of spare parts have to be placed to meet a production due date. This paper addresses a joint production and spare part inventory control strategy driven by condition based maintenance (CBM) for a piece of manufacturing equipment with a critical unit.

1:30 PM — 2:30 PM, Monday

GENERAL CHAIR'S WELCOME AND KEYNOTE ADDRESS — SIERRA

General Chair — Dr. John Healy, General Chair, 2010 RAMS, Federal Communications Commission
Keynote Speaker — Edmond Thomas, Harris, Wiltshire & Grannis

Edmond Thomas in his 40 plus year career has held senior positions in business management, R&D, satellite and cellular/land based radio system design, strategic planning, operations, regulatory matters, and telecommunication/data network design and implementation. Immediately after leaving the position of Chief Engineer of the Federal Communications Commission, on June 1, 2005 he joined the law firm of Harris, Wiltshire & Grannis as a partner specializing in technical analysis, technical policy formulation and business strategy. In 2003, for the role he played at the FCC in advancing digital wireless communication he was selected by Forbes Magazine's as one of five people in the magazine's E-gang. In the same year he was named by Wired Magazine as one of the four most influential technical people in Washington. Mr. Thomas is presently a member of the Boards of Directors of Petra Solar Inc. and Validus Corp. He is also a member of the Corporate Advisory Board of Spectrum Bridge.

Prior to joining the Commission, Mr. Thomas served as President and CEO of MMRadiolink, a manufacturer of millimeter wave digital radio equipment based in the U.K. He also served as President and CEO of RSL USA, a $500 million dollar international telecommunications company. In 1998, for his work at RSL, he was named as one of the 50 most influential people in long distance by Phone Plus Magazine. Prior to his tenure at RSL USA, Ed was President of Science and Technology at Bell Atlantic and Bell Atlantic's CTO. In this position he was responsible for the development of the firm's wire line and wireless new products and services. He also had full operational and P&L responsibilities for Bell Atlantic's large customer data products and services. He has also served on the academic advisory boards of the University of Colorado, the Polytechnic University and the State University of New York College of Technology.

2:45 PM — 4:45 PM, MONDAY

Tutorial 4A — CORE — Sierra
INTRODUCTION TO RAM MANAGEMENT
Duane L. Dietrich, Ph.D., ReliaSoft
In this tutorial a product is followed from design inception to product retirement. The appropriate location and use of 1) overstress tests; 2) design reviews; 3) FMEA; 4) reliability system analysis; 5) accelerated life tests; 6) real time life tests; 7) reliability growth tests; 8) burn-in; 9) environmental stress screens; and 10) statistical process control are discussed.

Tutorial 4B — Elective — Cascade
DYNAMIC APPROACH TO RISK AND RELIABILITY IN DESIGN AND OPERATIONS
Vitali Volovoi, Ph.D., Georgia Institute of Technology
This tutorial provides an overview of the current state of the art in system risk, reliability, and maintenance modeling using dynamic methods. The target audience of the tutorial is engineers who are familiar with the basic concepts of static (Boolean-based) system reliability modeling (RBD and/or FT) and who are unsure when (if at all) the benefits of using dynamic tools outweigh their drawbacks.

Session 4C — Siskiyou
DOD INVITED PAPERS SESSION ON IMPLEMENTATION OF NEW RAM INITIATIVES WITHIN THE DEPARTMENT OF DEFENSE
Moderator: Michael J. Cushing, PhD, US Army Evaluation Center
This session describes actions being taken within the Department of Defense to implement new RAM initiatives directed by the Under Secretary of Defense for Acquisition, Logistics, and Technology. Information is presented on the use of reliability engineering design practices; the concept, definition, and rationale for Materiel Availability (Am); and guidelines for Army T&E community use to insure RAM engineering and RAM T&E requirements remain at the forefront of T&E planning and management.

4C1 **IMPLEMENTING NEW RAM INITIATIVES IN ARMY TEST AND EVALUATION**
Ken Dalton, Kristina Diaz, and J. Brian Hall, Ph.D., U.S. Army Evaluation Center
Describes implementation guide prepared by the U.S. Army Evaluation Center for the Army's RAM acquisition workforce. Cornerstone provisions of the new implementation guide are the new GEIA-STD-00095 for developing contract language covering reliability best practices, the Army Materiel System Analysis Activity's (AMSAA) Reliability Program Scorecard for evaluation of vendors' reliability design principles and management strategies, and the use of reliability growth concepts.

4C2 **DISCUSSION OF NEW DOD INITIATIVES TO ADDRESS LIFE CYCLE SUSTAINMENT ISSUES**
Grant Schmeider, Office of the Secretary of Defense
Recent DoD acquisition policy changes intended to ensure program affordability and suitability have been met with varying degrees of acceptance throughout the services. In May 2007 the Chairman of the Joint Chiefs of Staff (CJCS) issued new guidance implementing a mandatory Sustainment Metric consisting of an Availability Key Performance Parameter (KPP) and two supporting Key Systems Attributes (KSAs): Reliability and Ownership Cost.

4C3 **ENGINEERING DESIGN ANALYSIS (PHYSICS OF FAILURE)**
Gary Drake, US Army Materiel Systems Analysis Activity
The US Army Materiel Systems Analysis Activity (AMSAA) conducts PoF analyses to support contractors, program managers (PMs) and engineers on systems in all stages of acquisition from design, to test and evaluation (T&E) and fielded systems. In the design stage system level dynamics models, component finite element models and fatigue-life models are used to reveal the underlying physics of the hardware in its mission environment.

4C4 IMPROVED RELIABILITY TESTING WITH MULTIAXIAL ELECTRODYNAMICS VIBRATION
Ed Habtour, U.S. Army Systems Analysis Activity (AMSAA)
This paper discusses the development of Physics of Failure (POF) techniques that permit developers to better capture design defects in electronic items subjected to multiaxial eletrodynamice vibration thereby enhancing the design for reliability process.

Workshop 4D
R&M EXHIBITORS PRESENTATIONS AND DEMONSTRATIONS **DONNER PASS**
Moderator: Keith M. Janasak, Raytheon Company
R&M CAE tools are critical enablers for our industries R&M processes. Our RAMS Exhibitors will highlight their latest tools and services through brief presentations and application demonstrations in a neutral setting. Use this session to get a good overview of capabilities, then focus your time on the specific Exhibitors that can help you the most!

8:00 AM — 12:15 PM, Tuesday

Tutorial 5A **CORE** **Sierra**
INTRODUCTION TO LIFE DATA ANALYSIS
Clifford H. Lange, Ph.D., Structural Integrity Assoc., Inc., and Caroline P. Lubert, Ph.D., James Madison University
This tutorial provides an introduction to key concepts and techniques used in statistical analysis of reliability, maintainability and supportability data. The rationale behind the use of qualitative and quantitative tools to advance the understanding of underlying failure mechanisms is explained. Key concepts associated with statistical analysis of data are defined and widely used analysis techniques are discussed in terms of the mechanics of analysis and interpretation of results.

8:00 AM — 10:00 AM, Tuesday

Tutorial 5B **Elective** **Cascade**
ACCELERATED DEGRADATION TESTING AND ANALYSIS
Dr. Guangbin Yang, Ford Motor Company
For many products, accelerated degradation testing is more efficient than accelerated life testing. This tutorial presents accelerated degradation test methods, degradation models, estimation of model parameters, relationships between degradation and reliability, and estimation of reliability. Several practical examples are presented for illustration.

Session 5C **Siskiyou**
MIL-HDBK-217 - RELIABILITY PREDICTION, DATA ANALYSIS, TECHNIQUES, AND NEW METHODOLOGIES
Moderator: Dan Quearry, Naval Surface Warfare - Crane Division
Members of the MIL-HDBK-217 Working Group present their ideas and thoughts on the military handbook revision progress, and accomplishments towards completion of Rev G in December 2009.

5C1 DEVELOPMENT OF PHOTONICS COMPONENT FAILURE RATE MODELS
David B. Nicholls, CRE, Reliability Information Analysis Center, John Mazurowski, Penn State University Electro-Optics Center, Anthony Avak, Michael Hackert, Naval Air Warfare Center
This paper describes work sponsored by the Naval Air Systems Command through the Pennsylvania State University Electro-Optics Center to develop photonics component failure rate models. Two model forms were developed as part of this effort. The first is compatible with, and being incorporated into, MIL-HDBK-217G. The second is compatible with, and being incorporated into, the Reliability Information Analysis Center (RIAC) 217 Plus system reliability assessment methodology.

5C2 REVISION OF MIL-HDBK-217, RELIABILITY PREDICTION OF ELECTRONIC EQUIPMENT
Jeff Harms, Naval Surface Warfare Center, Crane Division
MIL-HDBK-217 is being revised. It is the most widely known and used reliability prediction tool in the reliability engineering community and the current revision is outdated. A plan has been created to refresh the handbook and to look at adding a new approach to better reflect reliability of electronic equipment. This paper will discuss the work being performed and a roadmap of where MIL-HDBK-217 is headed.

5C3 INDUSTRY CONSENSUS APPROACH TO PHYSICS OF FAILURE IN RELIABILITY PREDICTION
Lori Bechtold, Boeing Research & Technology
Traditional reliability prediction methods are being confounded by current and near future semiconductor technologies, as gate feature sizes shrink below 100 nanometers causing the emergence of atomic level failure mechanisms and early wearout. The Physics of Failure (PoF) approach to reliability has advantages for assessing these technologies. Industry collaborative research in AVSI and VITA is being used to develop new reliability prediction approaches to meet future industry challenges.

5C4 ENHANCING MIL-HDBK-217 RELIABILITY PREDICTIONS WITH PHYSICS OF FAILURE METHODS
James McLeish, DfR Solutions
The U.S. Defense Standardization Program Office (DSPO) has initiated a multi phase effort to update MIL-HDBK-217, the military's often imitated reliability prediction bible for electronics equipment that has not been updated since 1995. This paper discusses a potential enhancement to 217 using physics of failure (PoF) methods.

Workshop 5D
R&M EXHIBITORS PRESENTATIONS AND DEMONSTRATIONS **DONNER PASS**
Moderator: Keith M. Janasak, Raytheon Company
R&M CAE tools are critical enablers for our industries R&M processes. Our RAMS Exhibitors will highlight their latest tools and services through brief presentations and application demonstrations in a neutral setting. Use this session to get a good overview of capabilities, then focus your time on the specific Exhibitors that can help you the most!

10:15 AM — 12:15 PM, Tuesday

Tutorial 6B **Elective** **Cascade**

RISK MANAGEMENT PRINCIPLES AND TECHNIQUES

Richard B. Jones, Solomon Associates

Even though risk management is not a new topic in life, science, or business, there has been a growing emphasis on applying formal risk-based methods to decision-making. This tutorial provides a foundation for scientists, engineers, and business executives to explicitly apply risk-based approaches to help solve problems in their disciplines. The emphasis in the tutorial is on understanding risk and its many attributes, using both subjective and quantitative examples.

Panel 6C **Siskiyou**

APPROPRIATE AND PRACTICAL APPLICATION OF EMPIRICAL, HANDBOOK AND PHYSICS OF FAILURE RELIABILITY MODELING METHODS

Moderator: Joseph R. Fragola, Valador, Inc

The Panel session will focus on 2 topics: 1) the methods used for reliability predictions, including the uses and misuses of empirical, handbooks and PoF Models and Methods and 2) the future improvements to MIL-HDBK-217, with new methods that should be included in a future revision of MIL-HDBK-217 to satisfy the needs for accurate field reliability assessments. This panel will discuss the potential inclusion of Physics of Failure (PoF) methods, system failure cause models, and other methods.

Panelists:

Lori Bechtold, Boeing Research & Technology
David B. Nicholls, CRE, Reliability Information Analysis Center
Jeff Harms, Naval Surface Warfare Center, Crane Division
Diganta Das, University of Maryland
James McLeish, DfR Solutions
Douglas H. Loescher, Sandia National Laboratories
Jon G. Elerath, SolFocus
Fred Schenkelberg, Ops A La Carte

Session 6D **Donner Pass**

EARLY RELIABILITY ASSESSMENT AT CONCEPTUAL PHASE

Moderator: Reuben Mann, Northrop Grumman Corporation

Early on assessment of reliability is becoming more important these days with demanding reliability requirements of advanced technology projects. This session will discuss the available tools to make intelligent high impact decisions during the proposal and selection phase of projects

6D1 RELIABILITY ASSESSMENT IN RESEARCH PROJECTS

Roland Schmidt, ABB Switzerland Ltd.

Equipment for renewable energy like wind power is requested to show low failures and a high reliability over quite a long time period, especially for off-shore wind parks. The earlier in the development phase reliability and risk assessment is performed, the easier and cheaper is a design improvement. Therefore, it is necessary to include risk assessment already in research projects. Approaches and experiences how to implement risk assessment there are shared and discussed.

6D2 TWO RECOMMENDATIONS FOR THE ACQUISITION AND GROWTH OF RELIABLE SYSTEMS

David B. Nicholls, CRE and Paul Lein, Reliability Information Analysis Center

The metrics recommended in this paper, and the corrective actions they initiate, provide benchmarks to improve both the effectiveness of acquisitions in avoiding high-risk life cycle cost decisions, and the ability of Design for Reliability (DFR) activities to proactively identify and mitigate failure modes prior to their more costly discovery during testing or field use.

6D3 THINKING OUT OF THE BOX" STRATEGY ADOPTED FOR RAPID FSS R&M IMPLEMENTATION

Sheila Stenson Prather, Northrop Grumman Corporation

Can a team transition timely enough in their analysis methodology/mindset, tool(s) usage, and team implementation to comply with this highly complex program's compressed review schedule? Can they identify 5,500-plus failure modes, model 2,000-plus unique part numbers, define 40,000-plus maintenance tasks, and deliver 28 documents in a compressed timeline? The answer is yes. Hear how this team employed their "thinking out of the box" strategy for ultimate success.

6D4 VEHICLE WIDE OPTIMIZATION OF SUBSYSTEM TRADE STUDY OPTION SELECTION

Chris Mattenberger, Valador, Inc.

The Altair Lunar Lander has recently employed a risk informed design processes to improve the reliability of the vehicle. This paper explores the optimization of subsystem trade study option selection as performed during the Lunar Design Analysis Cycle and the value added.

1:30 PM — 3:30 PM, Tuesday

Tutorial 7A **CORE** **Sierra**

INTRODUCTION TO FAULT TREE ANALYSIS

Professor John Andrews, Nottingham University

The tutorial covers the essential features of performing a fault tree assessment for a specified system failure mode. It details the construction of the failure logic diagram and its subsequent analysis. The analysis yields the minimal combinations of component failures required to cause the event (minimal cut sets), parameters that express the likelihood of the system failure event occurrence, and an indication as to where the main contributions to this event lie.

Tutorial 7B **Elective** **Cascade**

DESIGN OF EXPERIMENTS AND DATA ANALYSIS

Huairui Guo, Ph.D. and Adamantios Mettas, ReliaSoft Corporation

This tutorial will teach attendees how to plan and conduct experiments effectively and efficiently, and more importantly how to analyze data correctly. Properties of different design types will be discussed. Methodologies for modeling and analyzing different data obtained from designed experiments will be introduced. The appropriate approach for investigating censored data obtained from life testing will also be presented.

Session 7C **Siskiyou**

MODELING AND ANALYSIS OF AGING SYSTEMS

Moderator: Marcia F. P. Salgado, UFMG

This session contains a collection of papers that explore a variety of modeling and analysis approaches for repairable systems, multi-state systems, and systems that age.

7C1 NONPARAMETRIC LIFE CONSUMPTION MODELING OF HIGH END DRILLING TOOLS

Dustin Garvey, Martin John, Jorg Baumann, Baker Hughes, and J. Wesley Hines, Ph.D., University of Tennessee

This paper will include a description and demonstration of a data driven life consumption model for data collected from high end drilling tools.

7C2 RELIABILITY OPTIMIZATION IN MULTI-STATE DEPENDANT-INDEPENDENT SYSTEMS

Vahid Ebrahimipour, Ph.D., Seyed Mostafa Alem, and Mohammad Reza Skandari, Tehran University

In this multi-state system, item j has kj different performance level. The performance level of the items of this system may be dependent on those of other items of the system. The dependency between two items in a system can be of one of these four types: 1.Both independent, 2.One independent and the other dependant on it, 3.Both dependent on a common item, 4.Both dependent, but not on a common item. The items within a sub-system may be different using (UGF)to calculate the reliability of system.

7C3 DESIGN OF ACCELERATED LIFE TESTING USING PROPORTIONAL HAZARDS-PROPORTIONAL ODDS

Tingting Huang, Tongmin Jiang, Beihang University

Accelerated life testing (ALT) needs well planned in order to decrease the inaccuracy of extrapolation. This paper discusses PH-PO model based multiple stress type ALT test planning. Two types of information based optimality criteria are considered, D-optimality and A-optimality. This paper presents a distribution free test planning method based on these two optimality criteria. An example is given to verify the validity of this test planning method.

7C4 PIECEWISE NHPP MODELS WITH MLE SOLUTIONS FOR REPAIRABLE SYSTEMS

Huairui Guo, Ph.D., Adamantios Mettas, and Georgios Sarakakis, ReliaSoft Corporation

This paper proposes a piecewise NHPP model for repairable systems that experience design or operation environment changes. When the design configuration or the operation environment changes, the failure behavior of a system will also change. The piecewise NHPP model not only can reflect these changes but also considers the damage accumulated before the changes.

Session 7D **Donner Pass**

ALT 1 - ADVANCEMENTS IN ACCELERATED LIFE TEST (ALT) THEORY, MODELS AND APPROACHES

Moderator: Fred Schenkelberg, Ops A La Carte

The papers in this session explore innovations, advanced theories, and new ideas for conducting accelerated life testing. In this session, papers include a method for accelerating life of viscoelastic materials at sub-sea pressures, accelerated test designs (PRST, fixed time tests and others), modular approaches to testing, and an alternative step-stress test process.

7D1 DEVELOPMENT OF ACCELERATION LIFE TESTING MODEL OF SUBSEA PRESSURE

Amar Raja Thiraviam, Thomas Foley, Teledyne-ODI, and Linda Malone, Ph.D., University of Central Florida

Accelerated Life Testing (ALT) is an effective method of demonstrating and improving product reliability. ALT accelerates a given failure mode by testing at amplified stress level(s) in excess of operational limits. Statistical Analysis is then performed on the data, based on acceleration model to make life predictions at use level. The acceleration model thus forms the basis of accelerated life testing methodology. Well established models such as the Arrhenius model and the Inverse Power model.

7D2 ACCELERATED RELIABILITY DEMONSTRATION, RD, AND ASSURANCE, SPRT TESTS DESIGN

Milena Krasich, PE, Raytheon, UIDS

This paper explains the technical and mathematical methodology for acceleration of reliability qualification (fixed duration with and without replacement) and reliability assurance tests (SPRT) using physics, engineering rationale, and a mathematical approach in the test design and data analysis. This approach is with the intent to obtain meaningful and relevant information on reliability of products in their actual use and in a cost and schedule effective manner.

7D3 TEMPERATURE ACCELERATION MODELS IN RELIABILITY PREDICTIONS: JUSTIFICATION AND IMPROVEMENTS

Franck Bayle, Thales Avionics

Reliability predictions have been for a long time a difficult task because of the antagonism between high reliability level and the weakness of component manufacturer data. A solution to this difficulty is described in this paper using improved models.

7D4 STEP-STRESS ADT DATA ESTIMATION BASED ON TIME SERIES METHOD

Li Wang, Xiaoyang Li, Ph.D., Bo Wan, and Tongmin Jiang, Beihang University

Step-Stress Accelerated Degradation Testing (SSADT) is commonly used to evaluate the lifetime of long lifetime and high reliability products. Previous works in SSADT using deterministic function to describe the product degradation process is not adequately << database cut >>

3:45 pm — 5:45 PM, Tuesday

Tutorials 8A **CORE** **Sierra**

FUNDAMENTALS OF FAILURE MODES AND EFFECTS ANALYSIS

John B. Bowles, Ph.D., University of South Carolina

FMEA is potentially one of the most beneficial and productive tasks in a well structured reliability program. It consists of examining the modes and causes of potential item failures and determining the product response to the failure. Steps can then be taken to change the design to eliminate the failure, mitigate its effects, or develop compensating provisions if the failure should occur. This tutorial focuses on how to perform a FMEA and how it should be integrated into the design process.

Tutorial 8B **Elective** **Cascade**

AN INTRODUCTION TO OPTIMIZATION METHODS IN RELIABILITY AND MAINTAINABILITY

Thomas G. Yeung, Ph.D., Ecole des Mines de Nantes and Edward A. Pohl, Ph.D., University of Arkansas

The purpose of this tutorial is to introduce the basic concepts of optimization in R&M. We review the fundamentals of optimization theory, then explore various optimization techniques, including specific optimization models for R&M problems, methods for solving them, and provide some examples for understanding the application. This is an advanced tutorial and upon completion of the tutorial, attendees should have an understanding of optimization in general and how it applies to R&M problems.

Session 8C **Siskiyou**

BAYESIAN METHODS IN RELIABILITY

Moderator: Frank (Feng-Bin) Sun, Ph.D., Western Digital Corporation

This session will present many novel ideas and new applications of Bayesian approaches in reliability engineering, from risk assessment to design decision making to system reliability analysis to condition-based maintenance.

8C1 **DOWNWARDS PROPAGATING: BAYESIAN ANALYSIS OF COMPLEX ON DEMAND SYSTEMS**

Christopher Jackson, Royal Australian Army and Ali Mosleh, Ph.D., University of Maryland at College Park

This paper aims to deal with multiple data sets from different levels of complex on-demand systems. The paper will propose a method for incorporating overlapping higher level and lower level data in a Bayesian construct in order to update component reliability information. The technique can then be used to allow coordinated evidence sets from various system levels to reveal as much information as possible, and hence allow sensor placement optimization.

8C2 **DEVELOPMENTAL SPACE-SYSTEM ELICITATION TECHNIQUES FOR RISK-INFORMED DESIGN**

Benjamin J. Franzini, Amanda Verges, and Blake F. Putney, Valador Inc.

The expert elicitation technique discussed in this paper conveys a method of risk-informed design performed in support of NASA Lunar Surface Systems design that is guided by system design documents and based heavily on face-to-face designer interaction and elicitation. This approach has proven to be very efficient, as designers are closely engaged early in design cycles and forced to focus on reliability strategies that were heavily influenced and implemented by the designer's own expertise.

8C3 **RBF DISTRIBUTION REDUCES LIKELIHOOD ESTIMATE BIAS OF SMALL SAMPLE SIZE**

Moshe Felix Barmoav, Motorola

This paper presents a new method to address the likelihood estimates bias as a result of small sample size and the new distribution attributes and flexibility.

8C4 **Qualitative-Quantitative Bayesian Belief Networks for Risk Assessment**

Chengdong Wang, Ali Mosleh, Ph.D., University of Maryland at College Park

This paper presents a new methodology combining the quantitative and qualitative Bayesian Belief Networks together to do the risk assessment and reliability analysis.

Session 8D **Donner Pass**

ALT 2 - APPLICATION OF ACCELERATED LIFE TESTING (ALT) CONCEPTS AND PRACTICAL METHODOLOGIES

Moderator: Jon G. Elerath, SolFocus

Practical applications of accelerated life testing are considered in this session. In this session papers include shaft-seals with complex failure modes, applications to avionics, accelerated tests for software, and a case study of quartz flexible accelerometers.

8D1 **ACCELERATED TESTING OF SHAFT SEALS AS COMPONENTS WITH COMPLEX FAILURE MODES**

Benjamin Klein. Daniel Kirschmann, Werner Haas, and Bernd Bertsche, Dr.-Ing., Universitaet Stuttgart

In many cases of sealing rotating components in mechanical engineering radial shaft seals (RSS) are used. These components can still not be included in the lifetime calculation of a system. In this paper the difficulty of accelerated testing of RSS is presented. To show the complexity of this component, the fundamentals, as the concept of the RSS as a sealing system, the influences on lifetime, the definition of the failure and the failure modes, are a main part.

8D2 **A PRACTICAL APPROACH TO ACCELERATED STRESS TESTING FOR AVIONICS PRODUCTS**

Michael Zimmermann, Rockwell Collins, Inc.

Much has been published regarding the benefits of accelerated stress testing; however, it seems that much of the literature has been related to low(er) cost/complexity commercial and automotive products. This paper outlines a practical test method for high cost/performance commercial/military avionics products, while addressing the associated challenges of limited sample size and applying stresses in a manner that uncovers defects without overstressing the product too early in the test process.

8D3 **SOFTWARE RELIABILITY ACCELERATED TESTING METHOD BASED ON MIXED TESTING**

Yumei Wu, Beijing Univ of Aeronautics & Astronnautics, Yongqi Zhang, China Telecom, and Minyan Lu, Beijing Univ of Aeronautics & Astronnautics

The software reliability accelerated testing method (SRAT) is proposed to improve the efficiency of software reliability testing. The software reliability assessment model based on the SRAT is also presented, its effectiveness and validity is verified. A thorough case study done for the web based software system is introduced in this paper.

8D4 **USEFUL LIFE PREDICTION FOR QUARTZ FLEXIBLE ACCELEROMETERS USING ACCELERATED**

Huiguo Zhang, Yunxia Chen, and Rui Kang, Beihang University

This paper presents a case study of a useful life prediction for quartz flexible accelerometers. Performance degradation data under several thermal and vibration loading is obtained from an accelerated test. Accelerated degradation models are developed from test record using regression analysis. And degradation models were verified via step-stress accelerated testing by computing cumulative damage rates. Using the verified models, useful life is predicted.

WEDNESDAY SCHEDULE
8:00 AM — 10:00 AM, Wednesday

Tutorial 9A **Elective** **Sierra**

INTRODUCTION TO MARKOV-CHAIN MODELING, ANALYSIS & OPTIMIZATION

Lisa M. Maillart, Ph.D., University of Pittsburgh

Markov chains are a class of stochastic processes that can be used to model a wide variety of issues related to reliability and maintainability. This tutorial covers the fundamental concepts of discrete-time and continuous-time Markov chains and some advanced concepts related to Markov modeling and decision-making.

Tutorial 9B **Elective** **Cascade**

EMPIRICAL METHODS FOR PROCESS AND EQUIPMENT PROGNOSTICS

J. Wesley Hines, Ph.D., University of Tennessee

The purpose of this tutorial is to introduce attendees to empirical modeling techniques for process and equipment monitoring, detection, diagnostics, and prognostics. The tutorial will provide a brief background and an overview of the theoretical foundations. It will be applications oriented in that the assumptions inherent in the techniques will be explained so that the appropriate technique can be selected and applied to solve specific engineering problems. Case studies are included.

Session 9C **Siskiyou**

EFFECTIVE RELIABILITY DATA ANALYSIS

Moderator: James M. Loman, Ph.D., Space Systems Loral

Papers in this session will tell you how to read and use field data correctly, and show you some brilliant ways to estimate reliability from testing results.

9C1 **RELIABILITY ESTIMATION FOR ONE-SHOT SYSTEMS WITH ZERO COMPONENT FAILURES**

Huairui Guo, Ph.D., Sharon Honecker, Adamantios Mettas, and Doug Ogden, ReliaSoft Corporation

This paper proposes a method to estimate reliability for one-shot systems from subsystem test data when there are no observed failures in the subsystem tests. This method also can be applied to the general cases when failures are observed.

9C2 **ESTIMATING FIELD FAILURE RATE FROM THE RESULTS OF HALT**

Harry McLean, Advanced Energy and Mike Silverman, Ops A La Carte

How many of us have wanted to use the HALT data to estimate Annualized Failure Rate (AFR)? The common response is that "it cannot be done." In fact, it is possible but what is needed is a good model and good data to back the model. This paper describes a model that we developed based on HALT experience combined with field data.

9C3 **INCORPORATING PRODUCT RETIREMENT IN FIELD PERFORMANCE RELIABILITY ANALYSIS**

Ke Zhao, Duane Steffey, Ph.D., and John Loud, Exponent, Inc.

Modern consumer electronic products retire at much faster rates than previous generations of products. Neglecting to account for the shortened age of early retired units can lead to inaccurate characterization of the time-to-failure distribution. We present several case studies in which reliability estimates vary significantly, depending on whether retirement is addressed in the analysis, thus demonstrating the practical value of accounting for the product retirement of surviving units.

9C4 **FIELD FAILURE RATE, MORE THAN YOU MAY THINK**

James A. McLinn, Rel-Tech Group

Ramp up, commercialization or roll-out are all common terms for one stage of a project when it goes from a low level production rate to a high rate. During this time, it is common for new problems to arise and the time to failure remain unknown. When shipping systems without operating time clocks or serialization, only the quantities shipped and quantities replaced are known. This paper will show some common errors with these model attempts that can be avoided.

Session 9D **Donner Pass**

PHYSICAL AND LOGICAL SIMULATION FOR ENHANCEMENT OF RELIABILITY AND RISK ASSESSMENT

Moderator: Susie Go, Ph.D., NASA Ames Research Center

This session includes papers demonstrating the application of a spectrum physical and logical models to the solution of reliability and risk related problems. The physical models are developed for a variety of environments including fragmentation and pressure impulse propagation.

9D1 **APPLYING DISCRETE EVENT MODELING TO THE REAL WORLD**

Jim Owens, Scott Miller, Dow Chemical USA, and Daniel M. Deans, Millennium Engineering and Integration Co.

Application of Discrete Event Modeling to drive availability of systems and to identify areas for improvement provides program managers and reliability engineers alike a process for mission/product success, and Maintenance Cost Reductions.

9D2 **PHYSICAL SIMULATION IN SPACE LAUNCHER ENGINE RISK ASSESSMENT**

Balachandar Ramamurthy, Eliyahu Horowitz, and Joseph R. Fragola, Valador, Inc.

This paper discusses a methodology for the application of physical simulation techniques to the risk assessment of liquid propellant rocket engines, with an example of its application to a Liquid Hydrogen, Liquid Oxygen gas generator cycle engine.

9D3 **INTERMEDIATE FAILURE STATES IN SIMULATION-BASED LAUNCH VEHICLE RISK STUDY**

Ted Manning, NASA, Scott Lawrence, NASA Ames Research Center, Hamed S. Nejad, Ph.D., ELORET Corporation, and Peter Gage, Neerim Corporation

Intermediate failure states are added to a simulation-based risk assessment approach for crewed launch vehicle aborts. While minimizing analysis complexity, these common system-level failure states mark the onset of “loss-of- mission” and permit a more faithful representation of the nuances in path and timing between initial failure and final catastrophic, crew-threatening outcome. The updated model’s utility will be demonstrated in the context of using crew risk to guide abort trigger selection

9D4 **MODELING AND SIMULATION FOR NETWORK TRANSMISSION TIME RELIABILITY**

Ruiying Li, Ning Huang, and Rui Kang, Beihang University

According to the network function, network transmission time reliability is advanced as a common parameter to describe network congestion. To evaluate this parameter, structure model, route model, service mechanism model and mission model are built, as well as the simulation flow & evaluation method are expressed. Finally, the backbone of CERNET is studied as a case, and the result shows that this modeling and simulation method is effectively.

10:15 AM — 12:15 PM, Wednesday

Panel 10A **Sierra**

ADVISORY BOARD PANEL: WILL THE DESIRE FOR SUSTAINABILITY INCREASE DEMAND FOR R&M?

Moderator: C.R. Cassady, University of Arkansas

Leaders from industry and government will discuss the role of reliability and maintainability in making products, systems, and processes more sustainable. Symposium attendees may submit questions in advance to the panelists or raise them from the floor.

1:30 PM — 3:30 PM, Wednesday

Tutorial 11A **Elective** **Sierra**

LESSONS LEARNED FOR EFFECTIVE FMEAS

Carl S. Carlson, Ph.D., CRE, ReliaSoft Corporation and Ops A La Carte LLC

FMEA has the potential to be a powerful reliability tool to reduce product design and manufacturing risk in a cost effective manner. With shorter product development times, tighter budgets and intense global competition, tools such as FMEA must be applied correctly. Why is it that some companies have outstanding success in their FMEA application and others do not? The purpose of this tutorial is to share the key factors for achieving success in FMEAs.

Tutorial 11B **Elective** **Cascade**

RELIABILITY DEMONSTRATION: THEORY AND APPLICATIONS

Andre V. Kleyner, Delphi Corporation

This tutorial will provide an overview of several reliability demonstration methods and techniques practiced in industry. It will cover the pros and cons of the application of each method based on product type, reliability requirements, and cost considerations.

Session 11C **Siskiyou**

RISK ASSESSMENT

Moderator: John V. Turner, Ph.D., NASA Johnson Spaceflight Center

This session includes papers on a wide variety of risk related applications. From Lunar surface systems analysis, through the assessment of the fire risk in an historic hanger, and the assessment of a residential care facility. The session demonstrates the broad spectrum of applications that have been addressed with risk assessment models.

11C1 **ASSESSING THE FIRE RISK FOR A HISTORIC HANGAR**

Koushik Datta, Ph.D. and Richard Morrison, NASA

This paper documents a fire risk assessment performed at NASA Ames Research Center (ARC) in relation to the renovation of a historic hangar.

11C2 **POTENTIAL APPLICATION OF FORM AND SORM FOR PRA**

Edward J. Zampino, NASA Glenn Research Center and Ian Miller, N&R Engineering and Management Services

Response Surface Technique is being considered as a way to allow any computationally intense high fidelity physics-based model to generate eventual input probabilities for a PRA logic model. First order, second order, and Monte Carlo reliability methods were applied to a streamlined finite element model of a hypothetical propeller blade design. Then physical complexity was incrementally added to the test model to demonstrate when FORM, SORM and Monte Carlo begin to show differences.

11C3 **FMEA AT A RESIDENTIAL CARE FACILITY**

Karen Mohan, Duane Huffman, CRE, and George Gross, Relex Software Corporation

This paper describes a Failure Modes and Effects Analysis (FMEA) performed on an Emergency Alert System at a residential care facility. The FMEA included both the functional failures of the electronic system as well as the human factors that could cause a failure in the process. Management used the analysis to focus on mitigating the risk associated with the most critical failure modes at the facility.

11C4 **RISK ASSESSMENT SENSITIVITY STUDY FOR LUNAR SURFACE SYSTEMS**

Susie Go, Ph.D., Donovan L. Mathias, Ph.D, NASA Ames Research Center, Hamed S. Nejad, Ph.D., ELORET Corporation

The goal of this study has been to prioritize the lunar surface risk analysis activities by first identifying the major transportation and lunar surface elements' risk drivers and then quantifying the sensitivity of the surface systems' performance to various risk parameters. A dynamic Monte Carlo risk simulation model consisting of all transportation and lunar surface elements is developed for this study.

Session 11D **Donner Pass**

ADVANCED RELIABILITY ANALYSES AND MEASURES FOR PRODUCT RELIABILITY ACHIEVEMENT

Frank Straka, Andrew Corporation

The session is a combination of analytical reliability and risk modeling techniques, design-reliability cooperation, and test techniques for product reliability achievement and enhancement.

11D1 **USING ELECTRONIC DESIGN AUTOMATION TOOLS THROUGHOUT PRODUCT LIFE CYCLE**

Bryan Stallard, Mike Silverman, Ops A La Carte

Challenges routinely arise on programs for military, aerospace, telecommunication, and medical that have significant non-recurring engineering (NRE) content and have potentially severe impact on users when failures arise. In this setting, product life cycle (PLC) use of electronic design automation (EDA) tools offers an improved way to address issues in parts obsolescence, pattern failure emergences, parts-counterfeiting eruptions, and qualification of commercial off-the-shelf products.

11D2 **A LIFE CYCLE-BASED SOFTWARE RELIABILITY APPROACH FOR NASA PROJECTS**
Ying Shi, ManTech SRS Technologies, Prince Kalia, John W. Evans, Ph.D., Anthony J. DiVenti, NASA
This paper discusses a life-cycle based software reliability assurance guideline which could be used in future NASA projects. The guideline could provide a success road-map of integrated system risk management from early development phases for timely identification of valued improvement focus tasks and thus help in the informed decision making process throughout the life cycle including successful deployment of the system.

11D3 **RISK INFORMED DESIGN MODELING PROCESS & DESIGN TEAM - ANALYST INTERACTION**
Chris Mattenberger, Valador, Inc.
The Altair Lunar Lander has recently completed a Lunar Design Analysis Cycle which employed a Risk Informed Design process utilizing the Valador Reliability Tool. This paper explores the process, techniques, lessons learned, and overall experience of the project from the view point of the lead Risk Analyst.

11D4 **ADVANCEMENTS IN FAILURE DETECTION**
Gregg K. Hobbs, PE, Ph.D., Hobbs Engineering Corp.
A procedure called Modulated Excitation has been developed that has been observed to improve detection by orders of magnitude. The technique will be discussed in detail and some examples given of its use. In the author's experience, the results are that some 17x as many defects are detected than when the technique is not used. Additionally, the technique has been used on NDF (No Defects Found) field returns with great success and has essentially eliminated the problem of NDFs.

3:45 PM — 5:45 PM, Wednesday

Tutorial 12A **Elective** **Sierra**
SOFTWARE RELIABILITY APPLICATIONS
Jon R. Peterson, Raytheon, Huairui Guo, Ph.D., Adamantios Mettas, ReliaSoft Corporation
This tutorial will address practical software reliability concepts, models, and tools, and how they should be applied throughout the product life cycle. Discussions will include the Software Reliability Process, Capability Maturity Model, Rayleigh Model Analysis (Software Error Estimation Program - SWEEP), and the Computer Aided Software Reliability Estimation (CASRE) tool. The tutorial attendee will gain a basic understanding of SW Reliability and know how to get and apply pertinent tools.

Tutorial 12B **Elective** **Cascade**
SYSTEM SAFETY IN A VARIETY OF INDUSTRIES
Dev G. Raheja, PE, CRE, Patient Safety System, Huairui Guo, Ph.D., Adamantios Mettas, ReliaSoft Corporation
This tutorial is presented by a veteran of the System Safety Society. The goal is to learn the science of system safety and how to implement safety measures proactively and efficiently in any industry. It is intended for beginning level engineers and intermediate level practitioners in design and safety. Technical managers in all engineering fields will find it a good overview of system safety. Examples from aerospace, medical device, automotive, and healthcare industries are covered.

Session 12C **Siskiyou**
RELIABILITY MODELS FOR COMPLEX SYSTEMS
Moderator: Harold E. Ascher, Harold E. Ascher & Associates
This session contains several papers that explore modeling strategies and issues for complex systems. Common cause failures and dependent systems are analyzed in this session.

12C1 **APPLYING BETA AND MESH MODELS FOR COMMON CAUSE FAILURE TO TRIPLEX SYSTEMS**
Julia V. Bukowski, Ph.D., Villanova University
International standards for safety system evaluation require that common cause failures be addressed and provides a methodology using the β factor which was originally designed for use in duplex systems. This paper shows how β must be modified to be applicable to triplex systems.

12C2 **RELIABILITY ANALYSIS OF MISSIONS WITH COOPERATING PLATFORMS**
Professor John Andrews, Nottingham University, Rasa Remenyte-Prescott, Ph.D., Darren Prescott, Loughborough University
This paper describes how to calculate a mission reliability when platforms work together to achieve an objective. This type of mission is typical of military applications but is also relevant to applications such as search and rescue. Each platform has its own mission to perform which is made up of phases (tasks) which it must accomplish for its own mission. Some of these phases will contribute to the success of the whole, integrated, mission.

12C3 **EFFICIENT ANALYSIS OF IMPERFECT COVERAGE SYSTEMS WITH FUNCTIONAL DEPENDENCE**
Liudong Xing, Ph.D., Univ. of Massachusetts Dartmouth, Joanne Bechta Dugan, Pd.D., University of Virginia, and Brock Morrissette, Lockheed Martin
This paper proposes a combinatorial approach to the reliability analysis of imperfect fault coverage systems subject to functional dependence. As compared to traditional approaches based on Markov models, the proposed method can offer exact and computationally efficient solution to large-scale system analysis, and can be applicable to analyzing systems with general component failure distributions. Several case studies are presented to illustrate the basics and advantages of the proposed method.

12C4 **THE APPLICATION OF CREAM BASED ON HAZOP ANALYSIS IN USING PROCESS OF SYSTEM**
Wei Wang and Tingdi Zhao, Ph.D., Beihang University
According to the deficiency of Cognitive Reliability and Error Analysis Method CREAM in using process of weapon, this paper provides an improved CREAM based the HAZOP. Using the improved method, the whole event sequences which can be used for the retrospective and predictive analysis in CREAM can be gained. An example of the diesel engine starting underwater is discussed.

Session 12D **Donner Pass**

ADVANCED TECHNIQUES IN RELIABILITY ASSESSMENT

Sean Carter, NASA Johnson Space Center

The session compiles advanced reliability assessment techniques as applied to the specific types of modern components and systems including the lead free electronics.

12D1 AN IMPROVED MONTE CARLO METHOD IN FAULT TREE ANALYSIS

Olexandr Yevkin, Ph.D., Dyadem International Ltd

Significant improvements of Monte Carlo method are suggested for static and dynamic fault tree analysis. The variance reduction method in combination with other approaches is studied and developed for highly reliable systems. The efficiency and accuracy of the improved method is demonstrated by numerous calculations of most complex industrial benchmarks.

12D2 ANALYZING FAILURE FREQUENCY AND SEVERITY IN COMMUNICATION NETWORKS

Tatsuya Matsukawa, Nippon Telegraph and Telephone Corporation

Network reliability is a critical requirement for communication network services. In IP networks, the numbers of end users and network elements are greatly increased and the network structure is often changed after services have already been deployed. Therefore, the network availability also has to be monitored and maintained in the operation phase. This paper describes methods and examples of analyzing the failure frequency and severity in communication networks.

12D3 A GENERAL FRAMEWORK FOR MODELING EQUIPMENT AGING

Joel A. Nachlas, Ph.D., Virginia Tech and C. Richard Cassady, Ph.D., University of Arkansas

Provides general models for distinguishing between clock time and age of equipment in terms of intensity of use and operating environment.

12D4 RUGGEDNESS AND RELIABILITY OF LEAD-FREE ELECTRONICS

John Starr, CirVibe Inc

There is a broad range of ruggedization methods and screening methods used for developing a reliable product - some old, some new - some more effective than others. This paper addresses the increased needs for reliability of emerging technologies such as lead-free.

6:30 PM — 7:30 PM, Wednesday

GENERAL RECEPTION

7:30 PM — 9:30 PM, Wednesday

BANQUET

Ken Bowersox, Vice President, Astronaut Safety and Mission Assurance Department, Space Exploration Technologies (SpaceX)

Ken Bowersox is a retired US Naval Aviator, with over 19 years of experience at the National Aeronautics and Space Administration (NASA). Selected to the astronaut corps in 1987, he has flown five times on NASA's Space Shuttle, serving as pilot, commander and mission specialist, and once on a Russian Soyuz, where he served as the flight engineer during descent. During his five orbital missions, Bowersox has logged over 211 days in space, including five and a half months aboard the International Space Station (ISS), where he was the mission commander of the 6th expedition. He was also a crew member for the first two Hubble Space Telescope repair flights and two United States Microgravity Laboratory flights.

Subsequent to his mission aboard the ISS, Bowersox served as the director of the Johnson Space Center's Flight Crew Operations Directorate, where he was responsible for the NASA Astronaut Office and all aircraft operations at the Johnson Space Center. Prior to Joining SpaceX, Bowersox worked as an independent aerospace consultant, serving on the NASA standing review boards for Space Shuttle, ISS, Constellation, Orion and the Constellation Suit System.

THURSDAY SCHEDULE

8:00 AM — 12:00 PM, Thursday

Workshop 13E **<< Location >>>>**

ASQ CERTIFIED RELIABILITY ENGINEERING (CRE), SIX SIGMA BLACK BELT AND SIX SIGMA GREEN BELT EXAMS

The exams will last 4 hours. Registration closes at Noon on Wednesday for the CRE and Six Sigma Green Belt Exams. Order Refresher Booklets from ASQ at 1-800-248-1946. Refer to page 4 for more details and registration information.

8:00 AM — 10:00 AM, Thursday

Tutorial 13A **Elective** **Sierra**

FRACAS FUNDAMENTALS, BEST PRACTICES AND PRACTICAL APPLICATION

Jennifer Akers, CRE, Huairui Guo, Ph.D., Adamantios Mettas, and Ken Stillwell, Relex Software Corporation

This tutorial introduces basic information about closed loop corrective action processes and addresses several of the key obstacles to deriving a successful closed loop corrective action process. The tutorial includes best practice suggestions and a proven methodology to fully realize the benefits of a lucrative closed loop corrective action process. Several case studies are presented to highlight success stories from various groups.

Tutorial 13B **Elective** **Cascade**

STATISTICAL WARRANTY FORECASTING

Dr. Vasiliy V. Krivtsov, Ford Motor Company, Huairui Guo, Ph.D., Adamantios Mettas, ReliaSoft Corporation

This tutorial reviews probabilistic models and statistical methods used for the forecasting of warranty claims and the associated costs. The discussion is illustrated by case studies from the authors' corporate and consulting experience.

Session 13C **Siskiyou**

OPTIMIZATION AND CONTROL OF REPAIRABLE SYSTEMS

Moderator: Natesan Jambulingam, Ph.D., NASA Safety Center

In this session, a variety of optimization and control strategies are presented that are applicable for modeling and analysis of repairable systems. Heuristic optimization techniques are discussed as well as techniques for measuring performance.

13C1 DEVELOPING EFFECTIVE SPARE PARTS ESTIMATIONS RESULTS IN IMPROVED SYSTEM AVAILABILITY

Behzad Ghodrati, Dragan Banjevic, Ph.D., Andrew K. S. Jardine, University of Toronto

In the present competitive manufacturing industries reducing the total production cost is a big challenge. In this regard, the maintenance plays an important role. Spare parts availability as an issue of maintenance process could guarantee the minimum downtime while maintenance operations are in the process. Optimum number of spare parts that should be stocked can be estimated based on system/machine reliability characteristics and actual working situation. This topic has been studied here.

13C2 SOFT COMPUTING APPROACHES IN RELIABILITY MODELING OF REPAIRABLE SYSTEMS.

Marcia F. P. Salgado, Walmir Matos Caminhas, Benjamim R. Menezes, Ph.D., UFMG

This paper reviews soft computing approaches for modeling reliability of repairable systems. Albeit soft computing techniques such as neural networks and fuzzy systems and even stochastic methods have been employed for solving many different engineering complex problems, traditional approaches are still preferred by industry. Unfortunately with the increasing complexity of modern systems such techniques might not be able to capture the changes in systems features in a precise way.

13C3 RELIABILITY ANALYSIS - A TOOL SET FOR IMPROVING BUSINESS PROCESSES

Aron Brall, ManTech SRS Technologies

A presentation of reliability analysis tools applied to business processes to reduce errors and improve a business bottom line.

13C4 TRANSENDING PERFORMABILITY TO ACHIEVE CONSISTENT SYSTEM ANALYSES

Meng-Lai Yin, Ph.D., ECE, Cal Poly Pomona

For complex systems where different perspectives need to be addressed, maintaining consistency among various system analyses is a challenge. A framework that supports a "global view" to govern various analyses is critical for the integrity of system analyses. This paper demonstrates a way of transcending the traditional performability to provide a framework to achieve consistent system analyses. This mechanism has been applied in several real-life systems.

Session 13D **Donner Pass**

PRACTICAL RELIABILITY TEST PLANNING APPLICATIONS

Moderator: Julio Pulido, Ph.D., SE, Ingersoll Rand

Today's companies need to develop reliable products faster. The session will cover papers showing common product validation practices across several industries in order to achieve an expected field reliability level.

13D1 COMPLIANCE TESTING IS NOT RELIABILITY TESTING

Vaishali Hegde, Philips Respironics

The healthcare industry is expanding rapidly. Manufacturers want to be first to market with innovative products. This has led to a common (mis)belief, in the medical device industry, that successfully completing FDA mandated compliance testing, which requires less time than reliability testing, ensures a reliable product. This paper outlines the differences between compliance and reliability testing, with real life examples from the medical industry and provides tips to reduce overall compliance

13D2 RELIABILITY TEST PROCEDURES FOR ACHIEVING HIGHLY ROBUST ELECTRONIC PRODUCTS

A. Tarkan Tekcan and Barbaros Kirisken, Vestel Elektronik Sanayi ve Ticaret AS

In this paper, reliability improvement procedures for consumer electronic products in a large scale manufacturing plant are introduced. Reliability improvement process is composed by a series of reliability validation and approval tests, procedures and lastly, calculations and analysis. Also, all kind of reliability problems found by production quality, outgoing quality, third party customers and end users are well noted, and test procedures can be scrutinized.

13D3 HOW TO DESIGN A BETTER RELIABILITY TEST PROGRAM

Mike Silverman and Talmy Rauch, Ops A La Carte

More and more industries are competing on reliability, and companies need to develop more reliable products faster. However, reliability test plans are often generic or blindly following industry standards. Test plans must be tailored to fit customer use profiles. Also, reliability testing often occurs too late in the process when development is nearly complete. This presentation will offer a solution to these two fundamental issues of Testing Too Little and Testing Too Late.

13D4 INCORPORATING FIELD RELIABILITY VARIATIONS IN PRODUCTION TEST OPTIMIZATION

Bahman Honari, University of Limerick, John Donovan, Ph.D., Institute of Technology Sligo, and Eamonn Murphy, Ph.D., University of Limerick

This paper develops a reliability model that incorporates production test information with field reliability performance. This model then is integrated into a field reliability changes early detection system to allow one to regularly optimize the test duration and profile to minimize the total test-field costs directly.

13D5 THE EXTENDED CONTINUOUS EVALUATION RELIABILITY GROWTH MODEL

Larry H. Crow, Ph.D., Crow Reliability Resources

Reliability growth testing generally takes place over several consecutive test phases. At the end of each test phase delayed correction actions are incorporated into the system in order to improve the reliability. Of considerable interest to management and reliability engineering are several estimates of the reliability at the end of a test phase. One estimate is an assessment of the reliability at the end of the test phase before the delayed corrective actions are incorporated.

Session 14A **Sierra**

RELIABILITY AND SAFETY MODELS AND ASSESSMENT

Moderator: Sanford (Sandy) Liebesman, Ph.D., Consultant

This session includes a broad range of models and methods. Including, a new approach to including oil aging in reliability modeling. The use of Support Vector Machines to provide more accurate results than Artificial Neural Networks (ANN). An ANN approach that uses both failure and suspension condition monitoring histories. And a method contributing to the qualitative and quantitative safety analysis of complex embedded systems.

14A1 ESTIMATING THE LIFETIME OF GEAR LUBRICANTS

Christian Maisch, Dipl.-Ing., Daniel Kirschmann, Bernd Bertsche, Dr.-Ing., Universitaet Stuttgart

Nowadays the prediction of the system reliability is the main goal in order to minimize warranty costs, meet quality standards and ensure the customers satisfaction. In this article a new approach is presented how to include oil aging into reliability modeling.

14A2 LIFE AND RELIABILITY FORECASTING OF THE CSADT USING SUPPORT VECTOR MACHINES

Shuzhen Li, Xiaoyang Li, Ph.D., and Tongmin Jiang, Beihang University

A new model is proposed to predict the life and reliability of Constant Stress Accelerated Degradation Testing (CSADT) based on Support Vector Machines (SVM). With this model, we can avoid the building of accelerated model and complicated calculation, and get more accuracy results than Artificial Neural Networks because of the excellent prediction capability of SVM.

14A3 AN ANN APPROACH FOR REMAINING LIFE PREDICTION USING SUSPENSION HISTORIES

Zhigang Tian, Ph.D., Concordia University

Artificial neural network (ANN) methods have shown great promises in achieving more accurate equipment remaining useful life prediction. However, most reported ANN methods only utilize condition monitoring data from failure histories. In this paper, we develop an ANN approach utilizing both failure and suspension condition monitoring histories. The proposed approach is validated using real-world vibration monitoring data collected from pump bearings in the field.

14A4 DEPENDABILITY EVALUATION OF COMPLEX EMBEDDED SYSTEMS AND MICROSYSTEMS

Olaf Malasse, Gregory Buchheit, A3SI, Arts et Metiers ParisTech, Michael Pock, LRR, TU-Munchen, and Hicham Belhadaoui, A3SI, Arts et Metiers ParisTech

The evaluation of the dependability performance (RAMS) of complex embedded systems requires the development of new approaches. In software-intensive systems, the dependability structure of the functions depends on the software. The search of fault sequences must involve software and hardware. The proposed method contributes to the qualitative and quantitative safety analysis of systems and micro-systems.

Session 14B **Cascade**

EVALUATION OF RISK THROUGH SYSTEM SAFETY

Moderator: Warren Naylor, Northrop Grumman

This session will explore different system safety methodologies and how they can be used to define system risk. The presentations will cover a broad range of topics from subsystem testing up through evaluation of commercial new business decision-making.

14B1 CODE OF PRACTICES & SAFETY RELATED ITEMS LIST (SRIL) IN RAILWAY INDUSTRY

Jacques J. Durand, Alstom Transport

The so called Safety Critical Items List (SCIL) concept of our MIL-STD-882 standard has been revisited by the rail Industry to highlight the requirements for the quality inspection (in-house and/or incoming inspection), for purchasing specifications, for special care in assembling and testing subsystems and equipment, and for preventative maintenance.

14B2 USING RISK ASSESSMENT TO MITIGATE NEW BUSINESS DEMANDS UNCERTAINTIES

Luciano Gomes and Carlos Alberto Scapin, INDG - Institute for Managerial Development

To be eligible to enter in the global market, companies need to comply with legal and regulatory requirements and international norms besides of products reliability. Those requirements are regulated by contracts between companies that impose several penalties for non-accomplishment with them. This paper will explore a technique of Risk Assessment to mitigate new business demands uncertainties by integration of FTA, cut sets probabilities, Cost Risk Simulation and QFD matrix.

14B3 AN ACCIDENT ANALYSIS MODEL ORIENTED TO COMPLEX TASKS PROCESS

Xiaolei Li, Tingdi Zhao, Ph.D., Mei Rong, Beihang University

Based on summing up the existing accident models and analyzing the characteristics of complex systems, a new accident analysis model oriented to complex tasks process is presented in this paper. This model expounds the cause of the accident by analyzing the complex process and multi-factor coupling. Also, this paper proposes the systematic method on the technical level for the model, such as a new method, process breakdown structure (PBS) and the mode of multi-factor coupling.

14B4 PROBABILITY OF FAILURE OF SAFETY-CRITICAL SYSTEMS SUBJECT TO PARTIAL TESTS

Florent Brissaud, INERIS, Anne Barros, Christophe Berenguer, Ph.D., Universite de technologie de Troyes/CNRS-LM2

A set of general formulas are proposed for the availability assessment of MooN architecture (i.e. k-out-of-n) systems made up by homogeneous components and subject to partial and proof tests. Partial tests may detect only some system failures, whereas proof tests allow restoring the system to an as good as new condition. Analyses show that the average probability of system failure on demand can be improved, just by a better non-periodic distribution of partial tests.

Session 14C **Siskiyou**

PERFORMANCE BASE RELIABILITY MODELING METHODS

Moderator: Mike Silverman, Ops A La Carte

This session covers multi objective optimization, Reliability Based design Optimization, Robust Design, Markov Modeling, Shock base degradation systems, Software Reliability Predictions methods in several industrial applications

14C1 **ACCURATE MODELING OF SHARED COMPONENTS IN HIGH RELIABILITY APPLICATIONS**

Julia V. Bukowski, Ph.D., Villanova University and Chris O'Brien, Exida

International standards for safety system evaluation require that shared components either be accurately modeled or not be used. This paper shows how to accurately model shared components in safety instrumented systems.

14C2 **COMMON CAUSE FAILURES: IMPLEMENTATION OF AN ALPHA FACTOR MODEL SIMPLIFICATION**

Colie Warren, Lockheed Martin Space Systems Company

The selected methodology used to quantify the risk of common cause failures can have a large impact on both probabilistic risk assessment (PRA) model complexity and the resulting estimation of risk. This paper is intended to provide PRA analysts in space and other industries with practical guidance for implementing a simplification of the common cause Alpha Factor method that reduces model complexity while allowing the analyst to tailor risk to specific component failure criteria.

14C3 **A MULTI-OBJECTIVE MEMETIC ALGORITHM FOR RBDO AND ROBUST DESIGN**

Xiaotian Zhuang and Rong Pan, Ph.D., Arizona State University

Reliability and Robustness are two important attributes of product design under uncertainty. So it is necessary to establish a probabilistic multi-objective problem to combine reliability and robustness considerations, where the products performance and the variation of performance are simultaneously optimized, subject to probabilistic constraints for design feasibility. An efficient Multi-Objective Memetic Algorithm (MOMA) is presented here to optimize reliability and robustness simultaneously.

14C4 **DEGRADED SYSTEMS WITH MULTIPLE PERFORMANCE PARAMETERS SUBJECT TO SHOCKS**

Chun-yang Li, Xun Chen, Xiao-shan Yi, Institution of Mechatronics Engineering, and Jun-yong Tao, National University of Defense Technology

The reliability of degraded systems with multiple performance parameters subject to random shocks is predicted in this paper when the degradation processes of performance parameters are independent and dependent. The system performance and shock magnitude must be not less than zero, so the effect caused by ranges of the system performance and shock magnitude is discussed.

Session 14D **Donner Pass**

CONDITION MONITORING AND MAINTAINABILITY MODELING APPLICATIONS

Moderator: Claudio Spano, CRP, ReliaSoft Brasil

The session deals with condition-based maintenance and sensitivity analysis for maintenance of a gradually deteriorating systems under an environment or operational condition.

14D1 **THE ASSESSMENT OF MAINTENANCE SUPPORT CAPABILITY OF AIRCRAFT RESEARCH**

Qing Li and Suping Zhang, Beihang University

The objective of this paper is to review the assessment of maintenance support capability of aircraft and sensitivity analysis based on BP Neural Networks. An assessment index system for maintenance of the aircraft helps in the evaluation of maintenance support capability and is valuable for improving the life cycle cost competitiveness.

14D2 **OPTIMAL SAFETY-CRITICAL PARTS REPLACEMENT IN AGING FLEETS**

Peng Wang, Ph.D., Hamilton Sundstrand Power Systems and Tongdan Jin, Ph.D., Texas A&M International University

This paper attempts to propose a practical approach to solving a maintenance optimization problem with uncertain utilizations. This problem is associated with the determination of optimal replacement times for safety-critical parts used in aircraft systems by considering both safety requirements and cost benefits. Specifically, a fleet of aircrafts installed with a type of turbine engine have been in operation for several years.

14D3 **VALUE OF CONDITION MONITORING INFORMATION FOR MAINTENANCE DECISION-MAKING**

Tuan Khac Huynh, Anne Barros, Christophe Berenguer, Ph.D., Universite de technologie de Troyes/CNRS-LM2 ,Inmaculada Torres-Castro, Escuela Politecnica

This paper develops the mathematical cost models for two maintenance policies (i.e. block replacement and periodic inspection/replacement) for a one-unit deteriorating system whose failures are due to the competing causes of accumulated wear and traumatic "shock" events. The value of the condition monitoring information obtained through the inspections is investigated by comparing on numerical examples the costs of both policies.

14D4 **ASSESSMENT OF MAINTENANCE POLICIES FOR A MULTI-DETERIORATION RATES SYSTEM**

Amelie Ponchet, Mitra Fouladirad, and Dr. A. Grall, Universite Technologie Troyes

This paper deals with condition-based maintenance of a gradually deteriorating system or device which undergoes a change in its deterioration rate due to e.g. an environment condition. The change is modeled by covariates which impact the degradation rate and lead to its sudden increase in a life cycle. The main aim of the work is to develop models which allow to assess the interest of change mode monitoring from the maintenance decision-making point of view.

Call For Papers & Tutorials

Year 2011 Annual Reliability and Maintainability Symposium (RAMS)

If you wish to present a paper or tutorial at RAMS 2011 you must submit an abstract of your paper or tutorial prior to April 21, 2010.

The abstract must follow the format as specified in the Call For Papers & Tutorials. The Call For Papers & Tutorials is available in the 2010 Symposium Proceedings, and will be e-mailed to sponsoring society members and prior attendees to this Symposium. Copies of the Call For Papers & Tutorials or additional information may be obtained by contacting:

AR&MS - 2011
c/o IPS Group, Inc.
4405 Tarpon Lane
Alexandria, VA 22309-3136 USA
1-703-360-0480
e-mail: webmaster@rams.org

Again, the deadline for receiving the abstract is April 21, 2010 and the abstract must follow the format as specified in the Call For Papers. The full Call For Papers is included in your registration packet and can be accessed on the world wide web at *http://www.rams.org*.

Publications From This & Previous Symposia

Each year has a separate Proceedings and Tutorial Notes.
(Publications not listed here are not available.)
Copies of all listed publications shown on the right are available from:

Annual Reliability & Maintainability Symposium
c/o IPS Group, Inc.
4405 Tarpon Lane
Alexandria, VA 28309 USA
E-Mail: sales@rams.org
Web: www.rams.org/proceedings

Year and Price

Proceedings (1 book for each year)	
1975, 1976, 1977, 1978, 1981, 1982	$24 each
1984, 1985, 1986, 1987, 1988, 1989	$40 each
1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997	$50 each
1998, 1999, 2000, 2001, 2002, 2003, 2004	$50 each
Proceedings on CD-ROM	
2003, 2004, 2005, 2006, 2007, 2008, 2009	$50 each
Tutorial Notes (1 book for each year)	
1992, 1993	$40 each
1995, 1996, 1997, 2000, 2001, 2002, 2003, 2004, 2006, 2007	$55 each
Tutorial Notes on CD-ROM	
2003, 2008, 2009	$55 each

Payment in US currency, credit card, or check (displaying US banking system transit number) MUST accompany your order. Make checks payable to "Reliability and Maintainability Symposium" or "RAMS". Postage by surface mail for copies mailed within the USA is $5.00 for each copy of the *Proceedings* or *Tutorial Notes*. There is an additional charge for delivery to international addressess - contact, IPS Group first to determine shipping costs. Show exact mailing address in form suitable for address label, including country, (if not USA), in USA, include a street address for shipment.

RAMS Advisory Board Panel Questionnaire

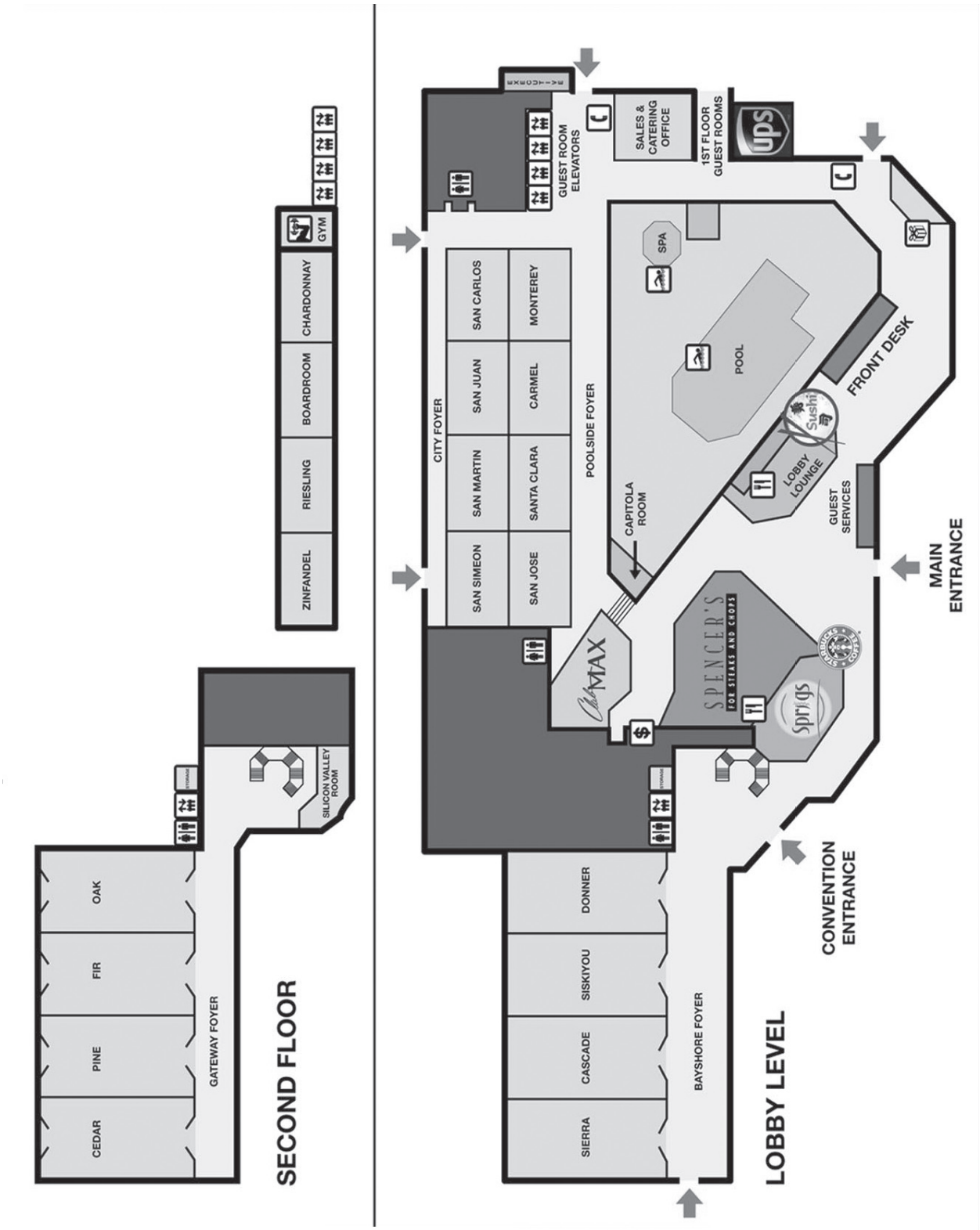
WILL THE DESIRE FOR SUSTAINABILITY INCREASE DEMAND FOR R&M?

Wednesday, January 27, 10:15 AM - 12:15 PM

Please use the following space to provide your question(s) for the panel and return it to the *RAMS* Registration Desk no later than 9:00 A.M., Wednesday, January 27.

Name and Affiliation (Optional)

Floor plan of The Doubletree Hotel



MANAGEMENT COMMITTEE

GENERAL CHAIR — J.D. Healy, *Consultant*

Vice General Chair — C.R. Cassady, *University of Arkansas*

Secretary
R.L. Harper, Jr., *Florida Institute of Technology*

Treasurer/Advance Registration
R.W. Sears, Jr., *Retired*
W. Willing, *Northrop Grumman Corp.*

PROGRAM COMMITTEE
CHAIR
E.A. Pohl, *University of Arkansas*

Vice Chairs
C. Deepak, *Halliburton Co.*
D. Fernald, *US Army Developmental Test Cmd (DTC)*
J.R. Fragola, *Valador, Inc.*
L.J. Gullo, *Raytheon*
T.W. Hartline, *NASA Glenn Research Ctr.*
M. Krasich, *Raytheon*
J. Pulido, *Ingersoll Rand*
W. Wang, *Applied Materials*
C.P. Lubert, *James Madison University*
K.M. Janasak, *Raytheon*
C.H. Lange, *Structural Integrity Assoc., Inc.*
J. Swider, *Pratt & Whitney Rocketdyne, Inc.*

PUBLICITY COMMITTEE
CHAIR
D.M. Deans, *Millennium Engineering & Integration Co.*

Vice Chairs
J. Durand, *ALSTOM Transportation, Inc.*
M. Jiang, *Medtronic, Inc.*
W.H. Horner, *Consultant*

ARRANGEMENTS COMMITTEE
CHAIR
A. Brall, *ManTech International*

Vice Chairs
D. Oberhettinger, *NASA/Caltech Jet Prop. Lab.*
P.M. Dallosta, *Defense Acquisition Univ.*
R.K. Dalton, *U.S. Army Evaluation Center*
J. Wasiloff, *DoD, US Army TACOM LCMC*
M. Yin, *Raytheon, California State Polytechnic*

REGISTRATION COMMITTEE
CHAIR
F.M. Schenkelberg, *Ops A La Carte, LLC*

Advance Registration
R.W. Sears, Jr., *Retired*

Vice Chairs
J.B. Bowles, *University of South Carolina*
S.V. Amari, *Relex Software Corp.*
W. Willing, *Northrop Grumman Corp.*

PROCEEDINGS COMMITTEE
CHAIR
J.A. Nachlas, *Virginia Tech.*

EXHIBITION MANAGER
D.F. Barber, Jr., *Scien-Tech Associates, Inc.*

WEBMASTER
J.A. Hess, *IPS Group, Inc.*
K.C. Hess, *IPS Group, Inc.*

BOARD OF DIRECTORS

CHAIR — Richard B. Jones, *Solomon Associates*

Co-Sponsors

American Institute of Aeronautics and Astronautics (AIAA)
V.W. Wessel, *NASA Glenn Research Center*
C.N. Butler, *Lockheed Martin Aeronautics Co.*

American Society for Quality — Electronics & Comm. Div. (ASQ/ECD)
C.W. Plotkin, *Ford Motor Company*
D.E. Onalfo, *IBM Global Services*

American Society for Quality — Reliability Division (ASQ/RD)
T. Gurunatha, *Warranty Warriors*
A.M. Stevens, *Lockheed-Martin (retired)*

Institute of Electrical & Electronics Engrs — Reliability Society (IEEE/RS)
T.L. Fagan

Institute of Environmental Sciences and Technology (IEST)
D. Aldridge, *Raytheon Company, Raytheon Missle Systems*
L.H. Crow, *Crow Reliability Resources, Inc.*

Institute of Industrial Engineers (IIE)
O.G. Okogbaa, *University of South Florida*
J.R. English, *Kansas State University*

Society of Automotive Engineers (SAE)
R.M. Adib, *RMA Consulting Group, LLC*

SOLE - The International Society Of Logistics
L.H. Wolfe, *Raytheon*
M.A. Pinard

Society of Reliability Engineers (SRE)
C.N. Meese, *US Army PM-Soldier Warrior*

System Safety Society (SSS)
B. Moriarty, *Northrop Grumman Corp*
D.G. Raheja, *Design for Competitiveness, Inc.*

L.M Rabon, *Mantech/SRS*
A.M. Stevens, *United Space Alliance (retired)*
H.N. Hartt, *Consultant*
T.L. Fagan, *Stellar Services, Inc.*

J.E Anderson, *Anderson Consulting Co.*
I.A. Feigenbaum, *Consultant*
J.R. English, *Kansas State University*
J.L. Wollner, *MOOG, Inc.*

ADVISORY BOARD

Brian R. Humes, *Emerson Process Management*
Andrew K S Jardine, *University of Toronto*
John C. Karjanis, *NOKIA, Inc.*
Alan H. Phillips, *NASA Safety Center*

Dr. Randolph G. Phillips, *Baker Hughes INTEQ*
Dr. Ernest A. Seglie, *Office of the Secretary of Defense, DOT&E*
Dr. William L. Vantine, *The ARES Corporation*
Bruce Weaver, *Xerox Office Group*

RAMS 2010 Registration Options and Rates

All Symposium registration MUST be done through the RAMS website at www.rams.org
Hotel reservations MUST be made with the hotel.

Symposium Registration- All Symposium registration must be completed no later than 24 hours before arrival at the Symposium. Payment by credit card may be made on the web site any time prior to arrival at the Symposium or upon arrival. Payments by cash, check, or travelers check must be made upon arrival. All payments are nonrefundable after January 9, 2010. Please contact RAMS as shown below to arrange other payment options.

Registration Fee –The Symposium registration fee is $1025 and includes (except as noted below) admission to all sessions, tutorials, exhibits and the banquet; as well as a copy of the *Proceedings* and the *Tutorial Notes* (each on one CD). Discounts are available as follows:

Participant Discount – Presenting authors, panelists, moderators, special guests, members of the RAMS management team, and exhibitors will receive specific information on discount eligibility and specific instructions on how to register. Failure to follow these directions will void this discount.

Student Discount – Full time students paying by credit card on or before January 9, 2010 are eligible for a discount of $845. Those paying by other means or after January 9, 2010 are eligible for a discount of $822. Those taking advantage of this discount will not receive a banquet ticket.

Member Discount – Members of one or more of our sponsoring societies, not eligible for Participant or Student discounts, are eligible for a discount of $100.

Advance Credit Card Discount – Registrants paying by credit card on or before January 9, 2010, not eligible for Participant or Student discounts, are eligible for a discount of $50.

One Day Discount – Individuals wishing to attend for one day only are eligible for a discount of $450. Those taking advantage of this discount will not receive a banquet ticket.

Group Discount – Groups of six or more using a single credit card and registering on or before January 9, 2010 are eligible for a discounted registration fee of $600 for members of the group who are not eligible for Student or Participant Discount. Registrants taking advantage of Participant or Student Discounts may be included in the group to meet the requirement of 6 members but will receive no additional discount. Please contact r.w.sears@ieee.org for more details.

Corporate Registration – Organizations wishing to send different individuals to different sessions may purchase a Corporate Registration for $1100. This registration provides access to papers, tutorials and exhibits for one individual at a time but does not include the banquet. Please contact r.w.sears@ieee.org for more details.

Doubletree Hotel Reservations

Hotel reservations must be made directly with the Doubletree San Jose before January 4, 2010 to qualify for the RAMS discount rate. The RAMS Registration web page *www.rams.org/registration* contains the following link to the Doubletree's RAMS reservation site:
http://doubletree.hilton.com/en/dt/groups/personalized/JOSE-DT-RMS-20100121/index.jhtml.
The "Special Accounts" Promotion/Offer Code is "RMS". If you need further information for symposium registration please contact:

Hotel Information:

Doubletree Hotel San Jose
2050 Gateway Place
San Jose, CA 95110 USA

Phone: 1-800-222-8733
1-408-453-4000
Fax: 1-408-437-2898

Earliest check-in: January 21, 2010, latest check-out: January 31, 2010
Rate $139/night plus taxes
Hotel provides a free shuttle from the San Jose International (SJC) Airport.
Call guest services at 1-408-437-2155 to arrange free shuttle service.

Dr. Raymond W. Sears, Jr.
23 Fairway Drive
P.O. Box 1407
Grantham, NH 03753-1407 USA

Reliability AND Maintainability Symposium (RAMS)

Sponsored by:

AIAA ASQ/ECD ASQ/RD IEEE IEST
IIE SAE SOLE SRE SSS

An Invitation To:

RAMS®

The Annual Reliability and Maintainability Symposium

www.rams.org

OUR 56th YEAR

January 25 - 28, 2010
Doubletree Hotel San Jose
2050 Gateway Place
San Jose, CA 95110 USA
1-800-222-8733
1-408-453-4000
Fax 1-408-437-2898