Event Program

International Applied Reliability Symposium

June 15 - 17, 2010
Reno, Nevada

Global Issues, Local Perspectives!℠

South America • North America • Asia Pacific • Europe • India

Program Highlights

THEME: Sharing applications, success stories and lessons learned in reliability and maintainability engineering.

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39 PRESENTATIONS: The program offers thirty-nine results-oriented presentations by actual practitioners in industry and government. Topics include: Reliability Planning and Management, Design of Experiments, Accelerated Testing, Life Data Analysis, Reliability Growth, FMEA, Repairable System Modeling, RCM, Asset Management, Risk Analysis and much more.

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6 TUTORIALS: The program also includes six tutorials by experts in the field of reliability analysis:

Understanding Quantitative Accelerated Life Testing by Pantelis Vassiliou of ReliaSoft Corporation

Methods for Planning and Continually Assessing a Multi-Phase Reliability Growth Program by Larry H. Crow of Crow Reliability Resources, Inc.

How to Develop an Effective Reliability Plan by Carl Carlson of ReliaSoft Corporation

DOE for Reliability and Optimization of Multiple Performance Characteristics by Allise Wachs of Integral Concepts, Inc.

Optimization in Reliability and Maintainability Applications by Ed Pohl of the University of Arkansas

Fundamentals of Life Data Analysis Concepts and Applications by Sharon Honecker of ReliaSoft Corporation

Venue

The 2010 ARS, North America will be held **Grand Sierra Resort** in Reno, Nevada. Participants must make hotel reservations on their own, either at the Grand Sierra or at another hotel of their choosing.

For details, please see page 4.

Industry and Government Sharing Success Stories and Lessons Learned

Other Symposia

The Symposium is held annually at locations throughout the world. Other scheduled events include:

Europe
April 2010

South America
May 2010

India
October 2010

Asia Pacific
October 2010

http://www.ARSymposium.org

2010 International Applied Reliability Symposium - North America

The **International Applied Reliability Symposium** provides a forum for expert presenters from industry and government to come together with reliability practitioners from all over the world to discuss the application of reliability principles to meet real-world challenges. The majority of the presenters have been applying reliability, maintainability and related techniques in their day-to-day work for years, and the Symposium has been designed to encourage results-oriented presentations with interactive discussions about best practices, success stories and lessons learned.

Symposium Theme: "Sharing applications, success stories and lessons learned in reliability and maintainability engineering."

The Symposium's 39 presentations and 6 tutorials cover a range of subjects, such as:

- Reliability Planning and Management
- Design for Reliability (DFR)
- Design of Experiments (DOE)
- Accelerated Testing
- Failure Mode and Effects Analysis (FMEA)
- Life Data Analysis
- Reliability Growth Analysis
- Repairable System Modeling
- Reliability Centered Maintenance
- Risk Analysis

June 15 - 17, 2010
Reno, Nevada

http://www.ARSymposium.org/northamerica/

The 2010 event is organized by ReliaSoft Corporation (www.ReliaSoft.com) and the System Reliability Center (SRC.AlionScience.com).

ReliaSoft®

SRC SYSTEM RELIABILITY CENTER

2010 ARS, North America

2010	Tuesday - June 15th			
	Track 1	Track 2	Track 3	Track 1
7:00-8:00				
8:00-9:00	**Check-in and Registration (You also have the option to register or check-in on Monday from 4 - 7 p.m.)**			Competitive Prototyping: A Valuable Process for Assessing Performance and Reliability **Darrell Quarles** ***U.S. Army*** **T1-S5** ☐
	Welcome Address (in Track 2 Room)			
9:00-9:10	**10 Minute Break**			
9:10-10:10	The Reliability Sleuth: A Proposal for a Troubleshooting Process **Peder Andersson** ***Tetra Pak Packaging Solutions AB*** **T1-S1** ☐	Application of DFMEA and FTA in Subscriber Radio Product Engineering for Reliability Improvement **Shri Gupta** ***Motorola*** **T2-S1** ☐	Air Force RCM: Reliability Centered Maintenance Applied to Combat and Training Aircraft **Jeremy Trotter** ***Wyle*** **T3-S1** ☐	Augmenting Standard Forecasting Methods by Leveraging Warranty Data to Inform Call Center Staffing Models **Jason Overstreet** ***A.O. Smith Water Products*** **T1-S6** ☐
10:10-10:30	**20 Minute Break**			
10:30-11:30	High Reliability and Systemic Risk: Predicting Rare Events and Failures in Modern Technological Systems **Romney B. Duffey** ***AECL*** **T1-S2** ☐	Key to Reliability Success Means Understanding the Supplier's Capability **Jon M. Quigley** ***Value Transformation LLC, Volvo 3P*** **T2-S2** ☐	Distributing Reliability Analysis **Daniel Weed** ***Emerson Network Power - Embedded Computing*** **T3-S2** ☐	The Life-Stress Slope: The Key to Accelerated Life Testing **Harland MacKenzie** ***Dana Thermal Products*** **T1-S7** ☐
11:30-1:00	**1 Hour 30 Minute Lunch Break**			
1:00-2:00	Design of Experiments Used as a Design Tool and as a Test Tool **Larry J. Gonzalez** ***Raytheon Corporation*** **T1-S3** ☐	RAM Dependence Counts in Production Simulation **Laurence L. George** ***Problem Solving Tools*** **T2-S3** ☐	Iterated Growth Testing of the ColorQube 9200 **Greg Rybarczyk** ***Xerox Corporation*** **T3-S3** ☐	Alternative Methods for FMEA in Lean Product Development **John J. Paschkewitz** ***Watlow*** **T1-S8** ☐
2:00-2:20	**20 Minute Break**			
2:20-3:20	A Practical Reliability Trade Study Process for Efficient System Design Reliability Selection **John Bieda** ***General Dynamics Land Systems*** **T1-S4** ☐	Design for Six Sigma (DFSS) for Reliability **Kim H. Pries** ***Stoneridge Electronics - North America*** **T2-S4** ☐	Challenges and Solutions for Practical Service Life Determination and Condition Based Monitoring of Ammunition **Jason L. Cook** ***U.S. Army Armament RD&E Center*** **T3-S4** ☐	Reliability Analysis in Risk-Informed Performance-Based Asset Management Applications **James K. Liming** ***ABSG Consulting, Inc.*** **T1-S9** ☐
3:20-3:30	**10 Minute Break**			
3:30-5:00	Understanding Quantitative Accelerated Life Testing **Pantelis Vassiliou** **T1 - Tutorial 1** ☐ ***ReliaSoft Corporation***	Methods for Planning and Continually Assessing a Multi-Phase Reliability Growth Program **Larry H. Crow** **T2 - Tutorial 1** ☐ ***Crow Reliability Resources, Inc.***		How to Develop an Effective Reliability Plan **Carl Carlson** **T1** ***ReliaSoft Corporation***
6:30-9:00				

You may attend sessions from any track.

Wednesday - June 16th

Track 2

Check-in and Registration

Weibull Analysis of Perplexing Field Data
James A. McLinn
Rel-Tech Group
T2-S5 ☐

10 Minute Break

Photovoltaic System Reliability and Maintainability Data Collection and Analysis Using a FRACAS Tool
Michael Mundt
Sandia National Laboratories
T2-S6 ☐

20 Minute Break

Investigation of Weibull Behavior of a Simulated Engine Fleet
Douglas C. Kemp
Rolls-Royce Corporation
T2-S7 ☐

1 Hour 30 Minute Lunch Break

Reliability Engineering in a Knowledge Based Development Environment
Julio E. Pulido
Ingersoll Rand
T2-S8 ☐

20 Minute Break

A Case Study of Medical Device Risk Assessment Using Exponentially Distributed Failure Data
Greg Lancaster
Philips Medical Systems
T2-S9 ☐

10 Minute Break

T2 - Tutorial 2 ☐

DOE for Reliability and Optimization of Multiple Performance Characteristics
Allise Wachs
Integral Concepts, Inc.

Track 3

It's Not Just a Number: The Application of Reliability Analysis in Real World Design
Michael E. Epperly
SRI
T3-S5 ☐

10 Minute Break

Managing Uptime by Design
Dave Darley
GE Healthcare Technologies
T3-S6 ☐

20 Minute Break

Bridging the Gap: Building Effective Reliability Partnerships with Customers
Amar Thiraviam
Teledyne ODI
T3-S7 ☐

1 Hour 30 Minute Lunch Break

Integration of Various Tools into a Reliability Assessment Process for Power Plant Equipment
S. Rao Palakodeti
Sigma Energy Solutions, Inc.
T3-S8 ☐

20 Minute Break

Robust Design: An Experiment-Based Approach to Design for Reliability
Robert G. Batson
University of Alabama
T3-S9 ☐

10 Minute Break

T3 - Tutorial 3 ☐

Optimization in Reliability and Maintainability Applications
Ed Pohl
University of Arkansas

Thursday - June 17th

Track 1

Attendance Certificates Distributed from Registration Desk

10 Minute Break

HALT/HASS System Design
Dave Vaughan
Chart Inc.
T1-S10 ☐

20 Minute Break

HALT Calculator: New Fast Method for Determining Product MTBF
Mike Silverman
Ops A La Carte LLC
T1-S11 ☐

1 Hour 30 Minute Lunch Break

Equivalency: The Key to Developing Good Weibull Life Models
Stan Stephenson
Halliburton
T1-S12 ☐

20 Minute Break

Improving Electronic and Power System Reliability Through Prognostic Methods
Douglas L. Goodman
Ridgetop Group, Inc.
T1-S13 ☐

10 Minute Break

Fundamentals of Life Data Analysis Concepts and Applications
Sharon Honecker
ReliaSoft Corporation
T3 - Tutorial 3 ☐

Track 2

Why Do We Need Markov Analysis?
Vito Faraci Jr.
VFJ Consultants
T2-S10 ☐

20 Minute Break

Process Flow Diagram: The Foundation of Process FMEA
Jim Davis
General Dynamics Amphibious Systems
T2-S11 ☐

1 Hour 30 Minute Lunch Break

Extended Life Cycle Management of an Aging Platform Through Simulation Modeling and Predictive Analysis
Peter Figliozzi
Clockwork Solutions, Inc.
T2-S12 ☐

20 Minute Break

Making Change an Integral Component of an Advanced Design Methodology
James A. Crowder
Raytheon Company
T2-S13 ☐

10 Minute Break

Hosted Awards Dinner
(in Track 2 Room, the "Reno Ballroom")

Track 3

KBR Maintenance Optimization and Readiness Engineering (MORE™) Program
Mark Felscher
KBR (Kellogg Brown & Root)
T3-S10 ☐

20 Minute Break

Objective Bayesian Reliability Modeling for a Surface Missile Safety and Arming Device
Sam Tam
NSWC Corona Division, U.S. Navy
T3-S11 ☐

1 Hour 30 Minute Lunch Break

Insights from the Altair Lunar Lander Risk Informed Design Process
Blake Putney
Valador, Inc.
T3-S12 ☐

20 Minute Break

Design for Reliability (DFR) Practice in Photovoltaic Inverter Design
Janet Ma
Schneider Electric, Renewable Energies Business
T3-S13 ☐

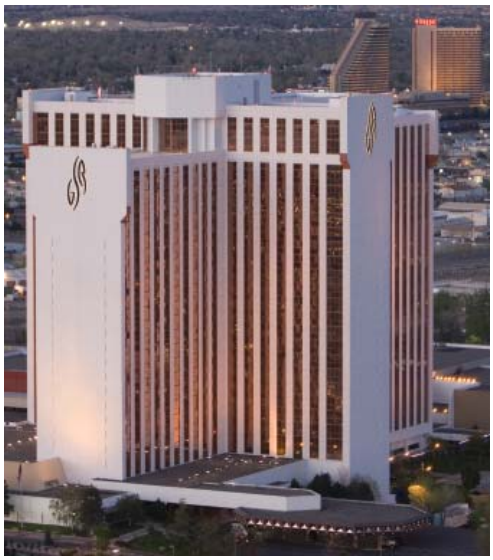
10 Minute Break

T3 - Tutorial 3 ☐

Fundamentals of Life Data Analysis Concepts and Applications
Sharon Honecker
ReliaSoft Corporation

It is not necessary to pre-register for selected sessions.

Event Location and Hotel Accommodations



The 2010 North America Applied Reliability Symposium will be held at the **Grand Sierra Resort** in Reno, Nevada.

Please make hotel reservations on your own, either at a hotel of your choosing or at the Grand Sierra Resort. A rate of US$85.00 for Single/Double is available to Symposium participants, with a US$20.00 per person charge for additional guests over two. To be eligible for this rate, rooms must be reserved by **May 15, 2010**. Please refer to "ReliaSoft Corporation" and/or the "Applied Reliability Symposium" when making your reservations. *NOTE: Given seasonal occupancy rate conditions, the hotel might engage in promotions that occasionally offer a lower rate. Be sure to check the online rates before booking to take advantage of any additional discounts that may be available.*

For more information about the hotel, please visit the Web site at:

http://www.ARSymposium.org/2010/ars2010_location.htm

Contact Information and Reservations:

- **Web Site:** http://www.GrandSierraResort.com
- **Telephone Reservations:** +(800) 648-5080

Tuesday June 15, 2010

Welcome Address — 8:30 to 9:00 a.m. on Tuesday, June 15th

To begin the event program, Pantelis Vassiliou will represent the Symposium's organizers by delivering a brief welcome address.

Pantelis Vassiliou is President and CEO of ReliaSoft Corporation. He directs and coordinates ReliaSoft's R&D efforts to deliver state-of-the-art software tools for applying reliability engineering concepts and methodologies. He also consults, trains and lectures on reliability engineering and related topics to Fortune 1000 companies worldwide. Mr. Vassiliou is the original architect of ReliaSoft's Weibull++ software and is ReliaSoft's founder. He holds an M.S. degree in Reliability Engineering from the University of Arizona.

Session 1 — 9:10 to 10:10 a.m. on Tuesday, June 15th

Track 1 — **Peder Andersson** - ***Tetra Pak Packaging Solutions AB***

The Reliability Sleuth: A Proposal for a Troubleshooting Process

The traditional view of reliability engineering involves the analysis of life data for launched products or the search for possible future failure modes in products that are under development, along with prognostication of the risk of occurrence of those same failure modes by means of accelerated life testing. However, the practitioner is often faced with the problem of understanding the true mechanisms behind known failures; information that is needed in order to attend to the problem properly. Knowing why the problem occurs is often the difference between a quick fix and the permanent elimination of its cause. This presentation discusses a real customer claim and how it eventually was resolved using methods based on factorial design experiments and structured problem analysis.

Track 2 — **Shri Gupta** - ***Motorola***

Application of DFMEA and FTA in Subscriber Radio Product Engineering for Reliability Improvement

Use of tools such as Design Failure Modes and Effects Analysis (DFMEA) and Fault Tree Analysis (FTA) helps reduce system development time by both preventing failures and then resolving issues quickly when they occur unexpectedly. Both FMEA and FTA are very powerful Design for Six Sigma (DFSS) tools that help to preempt failures early in the design cycle and also help in root cause analysis of major failures seen during the development life cycle of a product. In this session, I will be presenting different situations where these tools have been utilized very effectively as part of the DFSS methodology during development of Motorola's new subscriber products.

Track 3 — **Jeremy Trotter, Andrew Hinkle, Giuseppe Messina and Richard Boyd** - ***Wyle***

Air Force RCM: Reliability Centered Maintenance Applied to Combat and Training Aircraft

Reliability Centered Maintenance (RCM) is a proven process in various industries, including commercial aviation. However, the U.S. Air Force has only seen the benefits of RCM in recent years. Wyle is currently performing RCM analyses on three aircraft platforms: the T-38 Talon, the F-15 Eagle and the A-10 Warthog. This presentation outlines some of the challenges associated with applying RCM to combat aircraft, the processes Wyle has developed to improve RCM application and the cost avoidance and manpower savings realized by these programs. Additionally, we will show several small side efforts highlighted by our analyses that have yielded significant gains outside the traditional RCM-based maintenance package.

Session 2 — 10:30 to 11:30 a.m. on Tuesday, June 15th

TRACK 1 — **Romney B. Duffey** - ***Atomic Energy of Canada Limited (AECL)***

High Reliability and Systemic Risk: Predicting Rare Events and Failures in Modern Technological Systems

As an investor, owner, operator, manager or designer, the reduction of system failures and the prediction of reliability are key goals and attributes, thus reducing risk to the minimum achievable. But occasional events or outcomes still may occur and the probability of major loss is not negligible even when we have little or no prior data or experience. Such rare events are widely misunderstood. We already know from the world's event data that the standard statistical distributions and methods used for probability and frequency of occurrence do not work for rare events, simply because the impact of learning, forgetting, randomness and experience are not properly accounted for. The events we experience include spectacular plane, train, space shuttle or stock market crashes; or may be more mundane auto collisions and medical errors. The rate of such events covers the whole spectrum from the frequent to the rare, so that they are unexpected. Rare events and/or limited data sets pose a special problem with highly uncertain or unknown outcome rates. In this presentation, we provide a new method to predict the future probability of such rare events based on the extreme case of insufficient learning. We compare the predictions against data for rare events and establish the uncertainties as an explicit function of future risk exposure.

TRACK 2 — **Jon M. Quigley** - ***Value Transformation LLC, Volvo 3P*** **and** **Kim H. Pries** - ***Stoneridge Electronics***

Key to Reliability Success Means Understanding the Supplier's Capability

It is not practical to expect that the delivery of the product (as you want it and need it) will happen simply because you signed a contract. Yet this is often how it seems businesses want to handle supplier management. Hands-off supplier management – without accounting for the needs of expertise, time, communications and collaboration tools – means you are doomed to fail! Or, at best, you are subject to random chance and occasionally hitting the target. It is possible (and necessary!) to account for supplier weaknesses. However, this becomes increasingly difficult under time and cost pressures. If the supplier is missing any key attributes, then those must be developed and that will lead to time impacts. This presentation will discuss how you can push your way into the supplier selection process to avoid being left to the mercies of the purchasing department. You will see the key areas you must pay attention to, as well as the trade-offs.

TRACK 3 — **Daniel Weed** **and** **Harry Weber** - ***Emerson Network Power - Embedded Computing***

Distributing Reliability Analysis

The rapidly changing economic landscape has resulted in organizational changes that impact reliability engineering. Reliability expertise was originally well established with a central team and at least one expert at each design site. But some design centers have closed, others have been created and design work is being distributed across the globe. We responded to these challenges by separating standard reliability tasks for design from specialized analysis, and distributing the standard tasks to each design center through the use of common internally-developed tools and processes. Tools were developed using Microsoft Excel® for the standard tasks of failure rate estimation, service life estimation and FMECA. Standard reliability engineering now takes place across the globe with oversight by only a few experts. This allows the few remaining reliability experts to focus on more complex activities such as availability modeling. Moving reliability tasks to the design teams also moves the ownership, providing increased awareness of quantitative impacts of design decisions on product reliability.

Session 3 — 1:00 to 2:00 p.m. on Tuesday, June 15th

TRACK 1 — **Larry J. Gonzalez** - ***Raytheon Corporation***

Design of Experiments Used as a Design Tool and as a Test Tool

Design of Experiments (DOE) is normally associated with the design environment but it is also an extremely powerful tool that can be used in the test environment. The testing of hardware, software and firmware can be difficult, at best, to accomplish. When the DOE methodology is used, the task is made simpler and it saves money in terms of time and resources. This presentation will discuss which method should be used, and why, for both the design environment and the test environment.

TRACK 2 — **Laurence L. George** - ***Problem Solving Tools***

RAM Dependence Counts in Production Simulation

For the work described in this presentation, the objective was to simulate new production line alternatives for design optimization. The new line would use the same processes with presumably the same RAM statistics as existing workstations. Mechanics know that a short time-between-failures (TBF) often is followed by a short time-to-repair (TTR) and vice-versa (long-long). A positive correlation of TBF and subsequent TTR reduces the asymptotic variance of workstation availability even though asymptotic availability remains MTBF/(MTBF+MTTR). A positive correlation also reduces the time to steady state. Using the bivariate lognormal TBF and TTR captured more dependence than the alternative bivariate distribution models. Production line simulations also show that dependence reduces throughput uncertainty and time to converge to the asymptotic throughput rate. This result can be exploited by increasing dependence. If it has been a long time between failures, then make more repairs. If TBF is short, look for a quick fix; perhaps the previous repair failed again. Consider opportunistic maintenance to combine repairs when workstations are unavailable. Reliability of production lines could be as important as product reliability.

TRACK 3 — **Greg Rybarczyk** - ***Xerox Corporation***

Iterated Growth Testing of the ColorQube 9200

The development of Xerox's ColorQube 9200 multifunction solid-ink printer was a major project involving hundreds of scientists, engineers and other business professionals. During this multi-year effort, this "clean-sheet" product went through more than ten major design iterations and countless minor revisions before it was finally able to demonstrate the achievement of its demanding reliability goals. Coordinating this huge endeavor, which involved engineering work in four major sites on three continents, required the effective use of innovative methods of product development, testing and communication. The details of this remarkable design effort offer useful insight to any company that faces the difficult task of designing an entirely new product to world-class standards with a distributed development team and under tight schedule constraints.

Tuesday June 15, 2010

Session 4 — 2:20 to 3:20 p.m. on Tuesday, June 15th

Track 1 — **John Bieda** - ***General Dynamics Land Systems***

A Practical Reliability Trade Study Process for Efficient System Design Reliability Selection

The reliability trade study process and methodology involves a systematic and efficient approach to evaluate a design using specific system reliability attributes and provides a scorecard to help direct the selection of the best design concept. This process aids in early concept design selection where an expeditious yet comprehensive process is necessary to isolate the best design needed from a reliability perspective. A measurement system is applied based on a qualitative ranking of the design across each of eight guideline attributes (complexity, redundancy, failure event potential, design margin, quality level, maturity, environmental impact and surge protection). A calculation is performed to determine a Design Reliability Adequacy (DRA) measure. This DRA measure allows for a relative assessment of each system design's reliability potential. Further, these DRAs are translated to a risk management trade study score (1 to 5 ranking) for total system risk management evaluation.

Track 2 — **Kim H. Pries** - ***Stoneridge Electronics*** **and** **Jon M. Quigley** - ***Value Transformation LLC, Volvo 3P***

Design for Six Sigma (DFSS) for Reliability

This presentation describes techniques for using Design for Six Sigma (DFSS) to enhance robustness of the product. Clearly, the use of designed experiments is a large part of this activity. Some of the topics discussed during this presentation include: 1) Types of designed experiments. 2) How to use designed experiments during design. 3) Other tools such as DFMEA, fault trees and prototypes. 4) Test, analyze and fix regimes. 5) Laboratory work. The goal is to design in reliability early on to increase leverage with both cost and time. The presentation will touch on whether tests really are a search for a better product and how to get to robustness without spending a million dollars.

Track 3 — **Jason L. Cook** - ***U.S. Army Armament RD&E Center***

Challenges and Solutions for Practical Service Life Determination and Condition Based Monitoring of Ammunition

The U.S. Army's Armament Research, Development & Engineering Center (ARDEC) provides more than 90% of the lethality for the Army. Thus, it is the critical center of excellence for weapons and ammunition for the Army and also for the Department of Defense, as they also provide the engineering support for many joint service and NATO programs. To that end, they have advanced the application of accelerated life testing to efficiently identify life-limiting components and their failure modes and to predict life in the varied environments of storage and service. This presentation will outline the advances and applications of methodologies and infrastructure for service life determination and predictive stockpile management through application of quantitative accelerated life testing methods and degradation analyses. Additionally, it will depict an approach based on condition indicator exploitation to provide in-situ condition based monitoring (CBM).

Tutorial 1 — 3:30 to 5:00 p.m. on Tuesday, June 15th

Track 1 — **Pantelis Vassiliou** - ***ReliaSoft Corporation***

Understanding Quantitative Accelerated Life Testing

Accelerated testing can be divided into two areas: qualitative accelerated testing and quantitative accelerated life testing. In qualitative accelerated testing, the engineer is mostly interested in identifying failures and failure modes without attempting to make any predictions as to the product's life under normal use conditions. In quantitative accelerated life testing (QALT), the engineer is interested in predicting the life characteristics of the product (such as MTTF, B10 life, etc.) at normal use conditions from data obtained in an accelerated life test. This tutorial introduces the basic principles and concepts behind quantitative accelerated life testing data analysis.

Track 2 — **Larry H. Crow** - ***Crow Reliability Resources, Inc.***

Methods for Planning and Continually Assessing a Multi-Phase Reliability Growth Program

For most reliability growth testing programs, corrective actions would be expected to be incorporated into the system at several predetermined times during the testing. Generally, the testing is stopped at these times and several corrective actions are incorporated into the system as a group. These stopping points often define the test phases and there are usually interim reliability goals to be met for each test phase.

This tutorial discusses the Extended Reliability Growth Planning model for determining these interim goals and the test time necessary in order to meet the final reliability goal or requirement. Once a reliability growth testing program has started, we want a model that will utilize all the data across the test phases to best use the entire data set for valid assessments.

This tutorial also discusses the Extended Continuous Evaluation reliability growth model for conducting reliability assessments multiple times during the test program and, in particular, at the end of each test phase. Each time an analysis is conducted, the Extended Continuous Evaluation model allows for several key metrics to be calculated, including growth potential and projections that support the intent of the 2008 Defense Science Board Task Force recommendations. At the end of each test phase, the Extended Continuous Evaluation model uses all test data to date for these analyses and consequently provides timely and valid metrics to better manage the reliability growth test program. The practical, real-world applications of these models and concepts are illustrated by numerical examples.

Session 5 — 8:00 to 9:00 a.m. on Wednesday, June 16th

TRACK 1

Darrell Quarles and **Raymond Pickering** - ***U.S. Army***
Dave Dylis - ***Alion Science and Technology*** and **Barry Price** - ***Cobham Research***

Competitive Prototyping: A Valuable Process for Assessing Performance and Reliability

This session covers the application of competitive prototyping and its use to determine the status of the industrial base in meeting program requirements for performance and reliability. The presentation will address the processes used and the results from testing. The presentation will conclude with the lessons learned and how the results were used to influence the program direction.

TRACK 2

James A. McLinn - ***Rel-Tech Group***

Weibull Analysis of Perplexing Field Data

The analysis of field data can be a bigger problem in some situations than many people realize. Analysis is easy when production rates and customer use are fairly steady. However, when ramping-up from low manufacturing rates to higher ones or when customers increase or change their system usage, more care is required during the analysis. Early in the history of a new product or system, everyone is closely watching the early field results. This group includes design, field service, project management and major customers. A system that would exhibit a constant failure rate (constant hazard rate) in the test laboratory often will not appear to be constant in these changing field situations. It is exactly at these early deployment times when calculations are being made and failures and future costs are being projected. Learn how to recognize this situation and prevent miscalculations in these situations.

TRACK 3

Michael E. Epperly, Michael McLelland and **Buddy Walls** - ***Southwest Research Institute (SRI)***

It's Not Just a Number: The Application of Reliability Analysis in Real World Design

Too often, even in high reliability space applications, the reliability analysis is a chore performed near the end of the design cycle to create a meaningless number that is dropped into an even larger reliability analysis. The main goal is to check off a contractually required deliverable and move on. I have actually heard a designer in a design review joke about what number did the panel want it to be. Reliability analysis is a tool that should be applied early in the design phase, ideally estimated during Phase A and proposal efforts. The results of that analysis can then be used to support system level architectural decisions and ultimately feed other analyses such as the FMEA and probabilistic risk assessment. It can even be used to support make/buy decisions. This presentation argues that parts count reliability analysis is more than a silly number reported at the critical design review and is actually a tool that, when properly asserted, provides cost savings, risk reduction and an optimal high reliability design. In general, the presentation is a light-hearted, slightly irreverent look at reliability analysis with some serious conclusions.

Session 6 — 9:10 to 10:10 a.m. on Wednesday, June 16th

TRACK 1

Jason Overstreet and **Sankaran Mahadevan** - ***A.O. Smith Water Products***

Augmenting Standard Forecasting Methods by Leveraging Warranty Data to Inform Call Center Staffing Models

The management of staffing levels by qualified personnel is critical to the success of any customer relationship management (CRM) program. One type of customer service operation found in many industries is call center operations. In organizations where a formalized CRM exists, call center operations will usually fall under this domain. This presentation demonstrates the importance of call center staffing and how warranty analysis can be a valuable tool in informing the call center operations. Working under a proposed baseline scenario, a plausible set of modeling conditions are identified and subsequently varied within the boundaries of the design space. Factors of interest were as follows: 1) Time series analysis. 2) Warranty analysis that imposed differing hazard functions following the two-parameter Weibull distribution (infant mortality, random failures and wearout) and was used in the context of how warranty data are typically collected. 3) Inclusion of inventory lag values. 4) Use of Erlang_c as a basis for staffing levels for given constraints.

TRACK 2

Michael Mundt, Jeff Mahn and **Elmer Collins** - ***Sandia National Laboratories***

Photovoltaic System Reliability and Maintainability Data Collection and Analysis Using a FRACAS Tool

This presentation describes a comprehensive approach to developing reliability and availability estimates for a photovoltaic system. Failure and repair data spanning up to seven years from an operating photovoltaic facility were collected using a FRACAS software tool. Field failures and repairs were documented using incident reports directly in a database that can be queried later to automatically organize the data into a suite of complementary software tools for life data analysis, reliability growth analysis and failure modes and effects analysis. Next, component failure distributions and off time distributions (corrective maintenance, preventive maintenance, grid disturbances) are linked to a system simulation tool for predicting reliability and availability and for facilitating sensitivity analyses.

TRACK 3

Dave Darley - ***GE Healthcare Technologies***

Managing Uptime by Design

This presentation describes a systematic approach to managing system uptime by designing control of reliability and serviceability features to meet predetermined uptime requirements using design methods to balance reliability and serviceability requirements. Too often in our products we are left to deal with whatever reliability and serviceability was convenient, or left to the designers who lacked direction from customers and/or key stakeholders. This presentation proposes a method to capture, incorporate and validate these key features.

Wednesday June 16, 2010

Session 7 — 10:30 to 11:30 a.m. on Wednesday, June 16th

Track 1 — **Harland MacKenzie** - ***Dana Thermal Products***

The Life-Stress Slope: The Key to Accelerated Life Testing

The underlying relationship between the variation of the life of a component or system to changes in field loads/inputs is the fundamental basis for accelerated life testing. Unfortunately, much confusion surrounds the application and how to determine an appropriate life-stress curve for a particular test program. At times, this lack of detail becomes a key factor for poor outcomes from accelerated life testing programs. Through a combination of basic theory and case studies, this presentation will discuss the background in developing life-stress relationships for component, subsystem and system level testing. The inverse power law model will be highlighted as a general relationship that can be applied to many different stressors. Factors that affect prediction and consistency of experimental determination of life-stress will be examined. The case studies will highlight areas where sensitivity to the accuracy of life-stress relationships may be a concern.

Track 2 — **Douglas C. Kemp** - ***Rolls-Royce Corporation***

Investigation of Weibull Behavior of a Simulated Engine Fleet

Rolls-Royce's business model is evolving from a manufacturing focus to a services focus. Long-term service agreements transfer the financial risk of unreliability from the customer to Rolls-Royce. Fleet 50th percentile (B50) time to first shop visit is an important fleet statistic for financial planning and fleet logistics. Conventional fleet statistics, such as MTBF, are not efficient predictors of inherent product reliability, especially in the case of an emerging fleet where dilution by new product overwhelms any early failures. Weibull statistics have been traditionally employed by Rolls-Royce to model mature fleet behavior. This presentation outlines an investigation of the best method of estimating Weibull parameters of a simulated emerging engine fleet created using Monte Carlo simulation.

Track 3 — **Amar Thiraviam** and **Jeremy Lucas** - ***Teledyne ODI***

Bridging the Gap: Building Effective Reliability Partnerships with Customers

A well designed reliability program will both help improve the reliability of a product and demonstrate/assure the reliability of existing products to potential and existing customers. Therefore, one key step in building a successful reliability program is to communicate effectively and exchange reliability data with the customer. This communication will help the customer relate reliability issues back to the manufacturer. Additionally, this communication will both prove the reliability of the existing product to the customer and assure that future products will take into account the lessons learned from past failures and, therefore, be more reliable. This presentation will detail the struggles and successes one organization has had in setting up such partnerships in the reliability-critical subsea industry.

Session 8 — 1:00 to 2:00 p.m. on Wednesday, June 16th

Track 1 — **John J. Paschkewitz** - ***Watlow***

Alternative Methods for FMEA in Lean Product Development

Although some industries have specific standards for performing Failure Modes and Effects Analysis (FMEA), many companies do not have specific requirements and do not use FMEA effectively. Today's move to lean product development, reduced costs and shorter development time makes it even harder to use traditional FMEA approaches. This presentation offers some alternative methods to achieve the core benefits of FMEA: focusing resources on the highest risk issues and preventing reliability problems. Methods for focusing FMEA efforts and reducing the negative perceptions of FMEA include identifying what is known and what is new or changed and then targeting the analysis on the highest risks rather than grinding through a form line by line. The alternative FMEA draws on Toyota's Design Review Based on Failure Modes (DRBFM), parameter diagrams, boundary diagrams, critical characteristic matrix and unknowns identified with lean product development requirements tools. By narrowing the focus of the FMEA and drawing on the knowledge base of current products and processes, effective risk assessment and task/resource allocation can be accomplished with less pain and more impact on the product.

Track 2 — **Julio E. Pulido** - ***Ingersoll Rand***

Reliability Engineering in a Knowledge Based Development Environment

Critical to any successful product development process is having the right knowledge at the right time to make the right decision. Early knowledge about product design and producibility facilitates informed decisions and reduces the risk of costly design changes later in the life cycle when they are most expensive. Programs that follow a knowledge-based process have a higher probability of successful cost and schedule outcomes. Problems occur when knowledge builds more slowly than commitments to proceed. If a decision is made to commit to manufacture a product before critical technology, design and manufacturing knowledge is captured, problems cascade and may become unmanageable, costs and schedules increase, and performance and quality may be degraded. This session will review how reliability techniques can be used in a set based design, motivating the organization to develop new processes and a faster development process.

Track 3 — **S. Rao Palakodeti** and **Christopher Barella** - ***Sigma Energy Solutions, Inc.***

Integration of Various Tools into a Reliability Assessment Process for Power Plant Equipment

There has not been a good single tool for predicting reliability of equipment in process industries, particularly in the power industry. As funds are dwindling and competition is increasing between utilities, the utilities are looking for ways to improve the reliability of their equipment. Unfortunately, engineers and managers use many different methods and tools to develop their reliability projections and budgets. Sigma Energy Solutions, Inc. has developed a process for performing reliability assessments, particularly on power plant equipment, by integrating various software tools. Sigma has modeled the units in Weibull++® using GADS event history along with CMMS data to predict the probability of equipment failures. This failure data is then fed into the BlockSim® model to generate reliability of the system and components. In addition, Sigma has performed throughput analysis to predict "loadability" and bottlenecks.

Session 9 2:20 to 3:20 p.m. on Wednesday, June 16th

TRACK 1 — **James K. Liming** - ***ABSG Consulting, Inc.***

Reliability Analysis in Risk-Informed Performance-Based Asset Management Applications

Reliability analysis is an important engineering discipline that often fits ideally within a larger, comprehensive decision support framework, such as risk-informed performance-based asset management (RIPBAM). RIPBAM is a systematic, rigorous approach that supports effective and efficient enterprise resource planning (ERP). This presentation describes the RIPBAM process and focuses on how reliability analysis supports this process. RIPBAM applies probabilistic risk assessment (PRA) tools and techniques in the realm of physical and financial asset management for complex systems or facilities. This process can be applied across the full spectrum of product and process design, manufacturing, construction, start-up, operations, maintenance and decommissioning. The RIPBAM process applies a tiered set of models and supporting performance measures (or metrics) that can ultimately be applied in supporting decisions affecting the allocation and management of system or facility resources (*e.g.* funding, staffing, scheduling, etc.). In general, the ultimate goal of the RIPBAM process is to continually support decision making to maximize the target system's or facility's operational availability, net present value (NPV), long-term profitability and/or return on investment (ROI) for its owner/operators. This presentation provides some real-life examples of RIPBAM applications, including how reliability analysis was employed within these applications.

TRACK 2 — **Greg Lancaster** - ***Philips Medical Systems***

A Case Study of Medical Device Risk Assessment Using Exponentially Distributed Failure Data

ISO 14971 defines risk as the probability of occurrence of harm and the severity of that harm. This presentation is a case study that demonstrates the application of risk assessment to a rare occurrence of Automated External Defibrillator (AED) failures due to a stackup of tolerances in the device and an unusual user stimulus. An analysis of the AED internal device history log from recalled devices showed the device failures followed the exponential distribution. Analyzing both the use profile of the AEDs and the estimated failure rate provided an estimate of the probability of occurrence during a critical life-saving situation. This probability estimate was then applied to the population at large to estimate the risk of potential harm to the user population.

TRACK 3 — **Robert G. Batson** - ***University of Alabama***

Robust Design: An Experiment-Based Approach to Design for Reliability

Robust design uses the parameter design approach of Genichi Taguchi to optimize the design of products and processes with the objective of "building in" insensitivity to noise. Noise is any kind of uncontrolled variation in the operation environment of the product or process that could affect performance. If we recognize how variation in the environment (*e.g.* energy source, raw materials, heat and humidity, dirt and dust) and internal deterioration degrade reliability, then robust design offers an innovative way to "build reliability in" rather than depend on maintenance to assure reliability. In the introduction, this presentation identifies and reviews the better known methods to design for reliability in order to put robust design in context. Another objective of this presentation is to provide engineers with a background in robust design and to describe how it is adapted to design for reliability. A final objective is to provide several examples of successful applications from the literature.

Tutorial 2 3:30 to 5:00 p.m. on Wednesday, June 16th

TRACK 1 — **Carl Carlson** - ***ReliaSoft Corporation***

How to Develop an Effective Reliability Program Plan

Every organization or company desires to be a leader in achieving high reliability for its products and processes throughout the service life. This objective can be difficult, given cost and timing pressures experienced by companies around the world today. In order to achieve the highest possible reliability, it is often necessary to develop and implement a Reliability Program Plan. Developing good reliability plans is part of the body of knowledge called "Reliability Management," which is a separate subject from "Reliability Engineering" and requires additional skills. This naturally brings certain topics and questions into view: What is a Reliability Program Plan and how should it be developed? When should a Reliability Program Plan be originated, who should be involved and what approvals are required? What are the skills needed to develop effective Reliability Program Plans? How do you ensure that your Reliability Program Plan is successfully implemented to the desired results? Is it a good idea to use a template? What are the industry lessons learned in developing and implementing effective Reliability Program Plans? These questions and more will be covered in this comprehensive tutorial.

TRACK 2 — **Allise Wachs** - ***Integral Concepts, Inc.***

DOE for Reliability and Optimization of Multiple Performance Characteristics

Design of Experiments (DOE) can be a valuable tool to solve complex problems and optimize multiple aspects of product designs and manufacturing systems. Multiple product performance requirements (including reliability requirements) must be jointly satisfied, but it is rarely obvious how to simultaneously meet all requirements without risky trade-offs.

DOE, when properly applied, provides an efficient approach to developing product/process understanding using predictive math models and allows the identification of optimal solutions (product design specifications and/or process specifications). Unfortunately, when DOE is utilized, it is often misapplied. This tutorial will present the most common misapplications and misunderstandings of DOE. A case study will be presented to illustrate successful application of DOE to optimize a product design in order to achieve reliability and other product performance requirements.

Thursday June 17, 2010

Session 10 — 9:10 to 10:10 a.m. on Thursday, June 17th

Track 1 — **Dave Vaughan and Alan Elyousfi - *Chart Inc.***

HALT/HASS System Design

There are many ways to design a system that will support HALT/HASS chambers. Some ways are better than others and this presentation will cover all important considerations that should be made in the system design — from understanding liquid nitrogen and the costs associated with supplying a chamber with LN2 to actually sizing the right storage tank for your system and designing the vacuum jacketed pipe. We will discuss the importance of utilizing vacuum insulation technology and the cost savings associated with it. Transferring liquid at -300°F to ensure good quality cooling power is instrumental in the operation of the HALT/HASS system and using vacuum technology ensures the chamber will see cold liquid. This presentation is focused on reducing the overall cost of ownership of the HALT/HASS system.

Track 2 — **Vito Faraci Jr. - *VFJ Consultants***

Why Do We Need Markov Analysis?

This presentation focuses on Markov Analysis (MA) vs. Fault Tree Analysis (FTA) as applied to System Reliability Analyses (SRA). It provides a review of some FTA, MA and SRA basics and answers the question of why and when MA is required. MA is compared with FTA and their advantages and disadvantages are discussed. In order to better understand MA, a discussion on combinatorial vs. non-combinatorial logic is presented, along with some samples of combinatorial vs. non-combinatorial type problems. Failure effects of combinatorial and/or non-combinatorial configurations should not be confused with failure effects of constant vs. non-constant failure rate devices. To highlight and stress the distinction, the differences in the failure effects of constant and non-constant failure rate devices are also discussed. Solutions of non-combinatorial type problems typically involve solutions to simultaneous differential equations. Therefore, a review of some mathematical methods for solving these equations is also presented.

Track 3 — **Mark Felscher and Darrell Bourgeois - *KBR (Kellogg Brown & Root)***

KBR Maintenance Optimization and Readiness Engineering (MORE™) Program

During the last ten years, KBR has developed a program to help ensure that maintainability is designed into Greenfield and Brownfield capital projects. This program has evolved to include a systematic approach to ensure that other necessary operations and maintenance (O&M) and reliability programs, philosophies, strategies and processes are implemented during the proper phase of the capital project's life cycle. This program is the KBR Maintenance Optimization and Readiness Engineering (MORE™) program. The MORE™ program is designed to be used either as a stand-alone component of the capital project or it may be used in conjunction with or as a supplement to similar owner-developed programs. Designs developed using this program will contribute to the reduction of plant downtime by optimizing the time it takes to repair and maintain plant equipment. They also will minimize infant mortality by assuring that the proper maintenance and reliability programs are in place and implemented prior to plant start-up.

Session 11 — 10:30 to 11:30 a.m. on Thursday, June 17th

Track 1 — **Mike Silverman - *Ops A La Carte LLC***

HALT Calculator: New Fast Method for Determining Product MTBF

How many of us have wanted to use HALT data to estimate the 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. Now there is a model that exists that combines HALT experience with field data. Previous attempts by individuals to derive a model were unsuccessful because the approach was to determine an acceleration factor for HALT using a physics-of-failure approach, and that is impossible to do accurately because the time at each stress is too short and it is difficult to account for all of the interactions. The new model is based on experiential data rather than physics-of-failure.

Track 2 — **Jim Davis - *General Dynamics Amphibious Systems* and Bill Haughey - *ReliaSoft Corporation***

Process Flow Diagram: The Foundation of Process FMEA

This presentation defines the importance of well defined process flow steps within the PFMEA process. The new AIAG and SAE guidelines stress the importance of understanding the intended product and process characteristics of each step. Attendees will understand the linkage between DFMEA and PFMEA as a result of this presentation. They also will understand the linkage between Process Flow Diagram, PFMEA and Process Control Plans. The detailed process steps help enable companies to understand value added versus non-value added steps within their process. This detail will also enable companies to target planned maintenance at critical process operations. The case studies will highlight examples of how detailed process flow diagrams became success factors in improving quality and reliability.

Track 3 — **Sam Tam - *NSWC Corona Division, U.S. Navy***

Objective Bayesian Reliability Modeling for a Surface Missile Safety and Arming Device

It has been a challenge to missile communities to utilize all available test data to develop credible reliability models because ground and flight testing consist of different levels of reliability information. In general, the flight data are more informative than the ground test data. Integration of all available test data taken from different sources requires sophisticated reliability modeling. This presentation will demonstrate how to develop an objective Bayesian reliability model for a surface missile safety and arming device by integrating both non-destructive (QE Testing) and destructive (Flight Testing) test data. It will cover the ground rules and assumptions, reliability model form, Bayesian statistical methodology and results. The computational tool used to generate the results was WinBUGS/SAS.

Session 12 — 1:00 to 2:00 p.m. on Thursday, June 17th

TRACK 1 — **Stan Stephenson, Tim Freeney and Brice Hughes - *Halliburton***

Equivalency: The Key to Developing Good Weibull Life Models

How much is your product life increased by operating at conditions lower than maximum operating conditions? An equivalency equation that answers this question will enable development of a more accurate Weibull life model. This presentation will trace the development of two different product life models. One model applies to a pump component undergoing high cycle fatigue where every stress cycle elastically deforms the component. The other model applies to low cycle fatigue of tubing where every stress cycle plastically deforms the tubing. For the pump, an initial equivalency equation is developed directly from fatigue test data of coupons of the same material as the pump component. This equivalency equation is then fine tuned with actual usage data. For the tubing, an equivalency equation is developed based on the physics defining the failure and then fine tuned with surrogate test data. Details of how the data are captured for both cases will be presented.

TRACK 2 — **Peter Figliozzi - *Clockwork Solutions, Inc.***

Extended Life Cycle Management of an Aging Platform Through Simulation Modeling and Predictive Analysis

The Marine Corps Light Armored Vehicle (LAV) family of vehicles is essential in combat and support operations. The LAV end-of-service is in 2025. The LAV service life extension program (SLEP) extended the program service life by ten years. LAVs will be 42 years old in 2025. The LAV Program Manager requires a decision tool to assist in analyzing technology and processes for platform total life cycle management (TLCM). Clockwork Solutions, Inc. (CSI) supports this predictive modeling effort by developing and maintaining TLCM-AT™ simulation models. CSI data preparation, mining utilities and analysis provide the LAV Program Manager with the capability to quickly and accurately: 1) Predict future reliability, availability, maintainability and sustainability impacts due to changes throughout field operations, depot overhaul, repair programs, supply, support operations and system configuration updates. 2) Predict life cycle supportability metrics when considering dynamic factors including equipment aging, diverse operational usage and environments and proposed modernization initiatives.

TRACK 3 — **Blake Putney - *Valador, Inc.* and Randolph Rust, Bradley Irlbeck and Scott Winter - *NASA***

Insights from the Altair Lunar Lander Risk Informed Design Process

Streamlined risk modeling enabled the Altair design team to include quantitative risk insights in the system designs and vehicle integration decision making process for the Altair Lander. The quantitative process provided the designers with the ability to envision quantitative risk on a co-equal basis with quantitative performance considerations to create a risk-balanced design for a given mass allocation. This was accomplished with fewer resources than traditional qualitative methods, while thoroughly engaging the designers and stakeholders in the modeling process, resulting in higher quality models and an improved understanding by the design team of the risk implications of their design.

Session 13 — 2:20 to 3:20 p.m. on Thursday, June 17th

TRACK 1 — **Douglas L. Goodman, Tom Dudgeon and Chris Lynn - *Ridgetop Group, Inc.***

Improving Electronic and Power System Reliability Through Prognostic Methods

Aggressive design for reliability goals have resulted in lower defects and longer MTBFs, yet systems still fail for a variety of reasons. The pervasiveness of electronics in medical, aerospace and industrial control applications has compelled the development of advanced prognostic methods to determine key parameters such as state of health (SoH) and remaining useful life (RUL). These prognostic methods can be non-intrusively detected or determined algorithmically using existing sensors or data buses. The SoH and RUL parameters provide the foundation for an effective condition-based maintenance (CBM) system. The early detection of degradation through electronic prognostics can provide significant benefits for overall operational readiness in critical systems. With a focus on high efficiency power converters and electromechanical actuator drives, this presentation will provide examples of extracting SoH and RUL and discuss how this information can improve overall system reliability objectives and fit within a performance based logistics (PBL) system to reduce field support costs.

TRACK 2 — **James A. Crowder - *Raytheon Company***

Making Change an Integral Component of an Advanced Design Methodology

Change in engineering is no less a conundrum than change in politics; hence the need for wisdom. But change we must, as technology will transform our surroundings despite us. The areas of change that we will discuss are: 1) New organizations are required to take advantage of new technology environments. We will discuss the transition into fully operational Integrated Product Teams, utilizing software and computer technologies to facilitate seamless collaboration and the proper use of automated tools to facilitate an automated design and test process to increase reliability and quality in all of our products. 2) New technology for harnessing communications and automated design/test methodologies. The effects on COTS software will be reviewed with an emphasis on hypermedia concepts to ensure correct algorithm and code design. 3) New methodologies for increasing quality and reliability to reduce wasted time and material. We will discuss robust design algorithms to guarantee the best performance of both the product and the overall design process.

TRACK 3 — **Janet Ma and Spyridon Thomas - *Schneider Electric, Renewable Energies Business***

Design for Reliability (DFR) Practice in Photovoltaic Inverter Design

The solar power market is booming. Large numbers of photovoltaic (PV) systems are being installed throughout the world. The PV inverter is a critical sub-system in the PV system. In order to increase the availability and secure the maximum return on investment, a grid-tied PV system requires high reliability of inverters to reduce downtime and ensure power generation. Where PV modules have expected lifetimes of up to 20 years, the PV system requires that the inverter has a comparable expected lifetime, or at least a predictable lifetime. This presentation will focus on how to improve the quality and reliability of PV inverters in the design phase. The major points to be covered are: 1) PV inverter reliability current status study and main failure mode. 2) A standard usage model of the PV inverter. 3) DFR practice in PV design phase, with an emphasis on component sizing and useful life analysis. 4) A proactive maintenance plan for PV inverter long-term reliability.

Thursday June 17, 2010

Tutorial 3 — 3:30 to 5:00 p.m. on Thursday, June 17th

Track 1 — **Ed Pohl** and **Richard Cassady** - ***University of Arkansas***

Optimization in Reliability and Maintainability Applications

Optimization is an extremely valuable tool in the area of reliability and maintainability. It is optimization that actually allows us to obtain the best possible system designs and maintenance policies. Without optimization, all that exists is a model with no solution. Optimization exists in a wide variety of fields other than R&M so we will focus only on those methods most applicable to R&M itself. We will provide some key models to demonstrate the application and formulation of various optimization methods. The remainder of this tutorial seeks to address the following topics: 1) What is optimization? 2) Introduction to optimization theory. 3) Overview of the optimization techniques most often used in R&M. 4) Reliability optimization models and solution procedures. 5) Maintenance optimization models and solution procedures.

Track 3 — **Sharon Honecker** - ***ReliaSoft Corporation***

Fundamentals of Life Data Analysis Concepts and Applications

Life data analysis is a general term that encompasses all the different activities and modeling of reliability data. The term "Weibull analysis" also has been extensively used to describe the analysis of life data. However, life data analysis goes beyond the Weibull distribution and it includes the analysis of recurrent events data (*e.g.* repairable systems), accelerated testing, comparing data sets, etc. In this tutorial, we will review the different types of data, the different analysis models used when modeling life data, the most common mistakes in the analysis of life data and the most common results. Case studies will demonstrate the analysis, the results and how these results can be used to perform further calculations such as predicting warranty costs, obtaining the optimum time for preventive maintenance and making design selections.

Hosted Awards Dinner — 6:30 to 9:00 p.m. on Thursday, June 17th

There will be a hosted awards dinner in the Reno Ballroom (Track 2 Room) from 6:30 to 9:00 p.m. on Thursday, June 17th. You are welcome to bring a guest to this event, which provides an opportunity to interact with colleagues in a comfortable and relaxed setting. This is also your final chance to submit your vote for the best presentations that you attended during the Symposium. During the evening, awards will be granted to the top three presentations, as voted by attendees. As with the rest of the Symposium, the typical style of dress will be "business casual."

Make the Most of Your Symposium Experience

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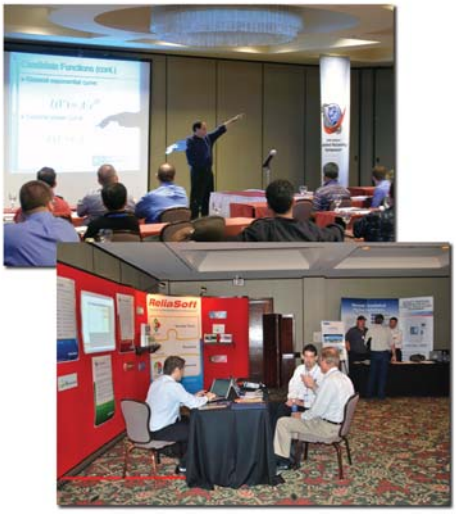
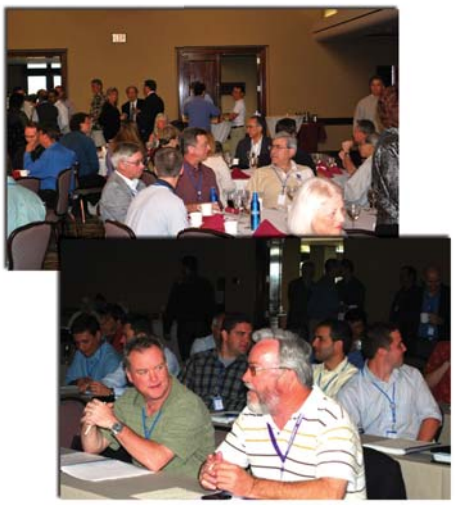
Choose the sessions that you will attend...
The Symposium offers a choice of 39 presentations and 6 expert tutorials. You can use the matrix on pages 2 and 3 to mark the presentations and tutorials that you plan to attend. It is not necessary to pre-register for selected sessions.

Take advantage of opportunities to converse with colleagues...
The catered breaks between sessions and the hosted dinner on Thursday evening provide good opportunities to talk with and learn from fellow reliability practitioners.

Learn about available software tools and services...
We encourage you to spend some time visiting the exhibit booths to learn about a variety of available products and services.





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Additional Details

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The registration fee includes your choice of presentations and tutorials, copies of the *Proceedings* and any other handouts, the Thursday night dinner and refreshments provided during the breaks. A certificate of attendance will be provided. Attendees are eligible for 1 CRP Course Credit and 1.8 CEUs.

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