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International
Applied Reliability Symposium

Frankfurt, 2007

Global Issues, Local Perspectives!℠

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Program Highlights

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

◆

22 PRESENTATIONS: Twenty-two results-oriented presentations by actual practitioners in industry and government. Topics include: Reliability Growth Analysis, Accelerated Life Testing, FMEA, Design for Reliability, Reliability Demonstration Testing, System Reliability and Maintainability, Life Cycle Cost Analysis, Risk Management, and much more.

◆

2 TUTORIALS: Two tutorials by experts in the field of reliability analysis. Topics include: Repairable System Modeling and Reliability Growth Data Management and Analysis.

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RECEPTION: You are invited to attend a hosted reception from 6:00 p.m. to 9:00 p.m. on Thursday, April 12, 2007. Specific details on the location and menu will be announced at the event.

◆

VENUE AND HOTEL ACCOMMODATIONS:
The event will be held in Frankfurt, Germany. A special Symposium rate has been negotiated for hotel accommodations at the ArabellaSheraton Congress Hotel.

Sponsors

The 2007 European Symposium is organized by **ReliaSoft Corporation**.

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:

Chennai, India
April 19 - 20, 2007

MG, Brasil
May 9 - 11, 2007

San Diego, California
June 20 - 22, 2007

Singapore
October 25 - 26, 2007

http://www.ARSymposium.org/europe/

Register Now...

International Applied Reliability Symposium

Europe 2007

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 22 presentations and 2 tutorials cover a range of subjects, such as:

- Warranty reduction
- Specifying reliability and reliability metrics
- Data collection, management and analysis
- Design for Reliability
- Reliability, safety and risk
- Reliability and market share
- Reliability testing
- Manufacturing reliability
- Life cycle cost analysis
- Maintenance planning

April 11 - 13, 2007
Frankfurt, Germany

http://www.ARSymposium.org/europe/

The 2007 event is organized by ReliaSoft Corporation (www.ReliaSoft.com).

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PROGRAM MATRIX

The 2007 Symposium program matrix consists of 2 concurrent tracks with 11 presentations per track. **You can attend presentations from either track.** With 2 options for every session, you can configure the Symposium experience to meet your specific interests and needs! Two expert tutorials are also included.

2007	Wednesday - April 11		Thursday -
	Track 1	Track 2	Track 1
7:00-8:00	**Registration**		**Registration**
8:00-8:40	**Welcome Address**		
8:40-8:50	**10 Minute Break**		
8:50-10:00	Know Your Customer: Incorporating Customer Understanding into a Test Program **Bibin Daniels *Black & Decker*** **T1-S1** ☐	Unreliability: The Gap Between Bottom-Up and Top-Down **John van Schendel *RELIA-EASY*** **T2-S1** ☐	A Closed-Loop Process for Technical Risk Management in Development Projects **Klaus Denkmayr *AVL*** **T1-S5** ☐
10:00-10:20	**20 Minute Break**		
10:20-11:30	Application Lessons for Effective FMEAs **Carl S. Carlson *ReliaSoft Corporation*** **T1-S2** ☐	Estimating Reliability Parameters and Demand Availability for Well Emergency Shut-Down Systems **Geoffrey F. Hampden-Smith *Process Physics Limited*** **T2-S2** ☐	Basic Methods and Guidelines for Reliability Validation of Automotive Components at High Mileage **Paul Schimmerling *Renault*** **T1-S6** ☐
11:30-1:10	**1 Hour 40 Minute Lunch Break**		
1:10-2:20	Reliability Engineering: Are We Really Making Progress? **Albertyn Barnard *Lambda Consulting*** **T1-S3** ☐	Application of Reliability Demonstration Testing to the Product Development Life Cycle **Richard B. Ramirez *Cardinal Health*** **T2-S3** ☐	Design for Reliability: Best Practices and Lessons Learned **Xijin (Bill) Tian *Hewlett-Packard Co.*** **T1-S7** ☐
2:20-2:40	. **20 Minute Break**		
2:40-3:50	Design for Reliability: Engaging Your Development Process and Your Engineering Culture **Daniel Farley** ***Delphi Corporation: Thermal Systems Division*** **T1-S4** ☐	Risk Management of Warranty Contracts in Machine Building Industry **Marc Wawerla *wbk Institute of Production Science Universität Karlsruhe (TH)*** **T2-S4** ☐	Highly Accelerated Testing in the Aerospace Environment **Daniel Goulet *Thales Aerospace Division*** **T1-S8** ☐
3:50-4:00	**10 Minute Break**		
4:00-5:30	Repairable System Modeling **Edward A. Pohl** ***University of Arkansas: Department of Industrial Engineering*** **Tutorial 1** ☐		Reliability Growth Management and **Dr. Larry Crow** ***Crow Reliability Resources, Inc.***
5:30-6:00			
6:00-9:00			**Reception**

International Applied Reliability Symposium Europe 2007

April 12	Friday - April 13	
Track 2	**Track 1**	**Track 2**
	8:00-9:10	
	Comparison of Statistical Methods to Analyze Failures and Degradations: Effect on Life and PM Predictions **Emmanuel Remy** ***EDF R&D*** **T1-S9** ☐	Incorporating Reliability, Availability and Maintainability into Process Synthesis **Qiying Yin (Scarlett)** ***University of Manchester - Centre for Process Integration*** **T2-S9** ☐
	9:10-9:20	**10 Minute Break**
Repairable Systems: Data Analysis and Modeling **Adam Mettas** ***ReliaSoft Corporation*** **T2-S5** ☐	**9:20-10:30**	Operational Readiness of German Federal Police Ships Insured by High-Grade Procurement and Maintenance **Bernd Nöthel** ***German Federal Police (Retired)*** **T1-S10** ☐
		On-Line Vibration Monitoring as a Tool for Preventive Maintenance and Troubleshooting **Hannu Rautiainan** ***Metso Automation*** **T2-S10** ☐
Estimation of RAM-Related Financial Impact in HSL-Zuid Project (High Speed Railway Line, The Netherlands) **Dietmar Wegner** ***Siemens*** **T2-S6** ☐	**10:30-10:40**	**10 Minute Break**
	10:40-11:50	The Life Cycle Cost Paradigm Shift in Maintenance **Andrea Bottazzi** ***ATC S.p.A. Bologna*** **T1-S11** ☐
		Reliability Assessment of Croatian Power Network Using State Enumeration Method **Srete Nikolovski** ***University of Osijek Faculty of Electrical Engineering*** **T2-S11** ☐
A New Methodology for Industrial Equipment Analysis Based on RAMS: A Practical Application **Luís Ferreira** ***Faculdade de Engenharia da Universidade do Porto*** **T2-S7** ☐		
Impact of Testability and Logistics and Rail System Availability and Maintenance Cost **Pierre Dersin** ***ALSTOM Transport*** **T2-S8** ☐		
Data Analysis **Tutorial 2** ☐		

You can use this matrix to mark the presentations/tutorials that you plan to attend. It is not necessary to pre-register for selected sessions.

+48 22 322 76 31 (Polish or English) or +48 22 322 70 19 (German)

Wednesday April 11, 2007

After registration from 7:00 to 8:00 a.m., the **2007 International Applied Reliability Symposium, Europe** kicks off on Wednesday April 11, 2007 with a brief welcome from the Symposium's organizer. You can then choose any 4 of the 8 presentations that are offered on the first day. The day's program concludes with an informative expert tutorial from 4:00 to 5:30 p.m.

Welcome - 8:00 to 8:40 a.m. Wednesday April 11, 2007

To begin the Symposium program, Pantelis Vassiliou will represent the Symposium's organizer by delivering a brief welcome address. Mr. 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 ReliaSoft's founder. He holds an M.S. in Reliability Engineering from the University of Arizona.

Session 1 8:50 to 10:00 a.m. Wednesday April 11, 2007

Know Your Customer: Incorporating Customer Understanding Into a Test Program

Bibin Daniels ***Black & Decker*** **T1-S1** ☐

The most effective way to design a product is with an understanding of the customer. It is not enough to know the customer's likes and dislikes, but you must also understand how the customer will use the product. Incorporating this customer understanding into a test program is the cornerstone of meeting the customer's needs.

This presentation focuses on the processes and techniques of obtaining customer information for two market structures, the consumer and industrial markets. It also examines how to apply this information into test plans that can correlate customer usage and field failure modes. Highlighted areas include:

- milestone process
- market research (consumer vs. industrial markets)
- analysis methods of warranty and product life specifications
- test categories

Unreliability: The Gap Between Bottom-Up and Top-Down

John van Schendel ***RELIA-EASY*** **T2-S1** ☐

Companies may be confronted year after year with too many costs of non-quality, especially during warranty. Despite all reliability improvement programs and top-down priority, there is no sustainable improvement and it looks more like fire fighting than fire prevention. If the *reliability* problems still exist for a long period without a sustainable reliability improvement then the hardware and software are probably not the primary causes. They may be just the consequences of something else, which is called *unreliability*! The primary causes for unreliability might be a possible reliability knowledge gap somewhere between top-down management and bottom-up designers. Unfortunately, the top-down management is not aware of that gap and no actions are planned to build the required bridge. Therefore all reliability improvement actions are doomed to fail because they happen at the cutting edge while being blind. *Reliability* is built in by the *bottom-up designers* but the *top-down management* decides the *unreliability* level. It sounds too simple to be true but Unreliability is not just the opposite of reliability. It is far more. This session explains this gap and why $R_{(t)}=1-F_{(t)}$ is not true if such a gap exists.

Session 2 10:20 to 11:30 a.m. Wednesday April 11, 2007

Application Lessons for Effective FMEAs

Carl S. Carlson ***ReliaSoft Corporation***

T1-S2 ☐

Quality and Reliability tools must be applied correctly to get optimum results and Failure Mode & Effects Analysis (FMEA) is no exception. Yet many companies continue to accept less than effective results from their FMEA applications.

Given the increasing importance of uniformly achieving high reliability, it is imperative that FMEA is done correctly and effectively to improve product and process designs early in the product development cycle, and support manufacturing and maintenance applications. What are the specific FMEA lessons that separate best practice from poor quality? How can we make FMEA live up to its potential for product and process improvements? How can FMEAs get done in a timely manner with full support from subject matter experts and management?

This presentation examines a variety of applications. Attendees will understand the primary pitfalls that generate less than effective outcomes and learn the "vital few" keys to successful FMEAs.

Estimating Reliability Parameters and Demand Availability for Well Emergency Shut-Down Systems

Geoffrey F. Hampden-Smith ***Process Physics Limited***

T2-S2 ☐

The valves activated by the Emergency Shut-Down (ESD) system on an offshore platform act to shut off the flow of oil or gas from the wells in the event of a breach of the topsides process equipment, downstream of the flow wing valve. Reliability-wise, each well forms a 3-component parallel system with the platform reliability being given by up to 40 wells comprising a series system. The ESD system is a Safety Instrumented System (SIS) to which the general requirements of IEC 61508 may be applied. This presentation analyses the ESD test data from a large platform consisting of 35 wells showing the issues around the estimation of the component failure rates, specifically the valves. Failure rates from well test histories are calculated using parametric, non-parametric and Bayesian methods and the results are compared with failure rates published in industry databases. The test interval and the next test date, given the valve failure rates and the ESD availability at the platform level to meet Safety Integrity Level (SIL) 3, are predicted using spreadsheet functions. A spreadsheet simulation of the combined well ESD testing is used to validate the ESD availability calculations for the platform.

Session 3 1:10 to 2:20 p.m. Wednesday April 11, 2007

Reliability Engineering: Are We Really Making Progress?

Albertyn Barnard *Lambda Consulting*

T1-S3 ☐

Notwithstanding the development and use of reliability engineering practices by organizations, it is not uncommon to observe many instances of low reliability in products and systems. This presentation discusses possible reasons for the apparent failure of reliability engineering, especially as practised by the defence industry. It argues that incorrect practices are often applied, frequently performed by incorrect departments in the organization and at the incorrect time during the product or system life cycle. The differences in approach to reliability engineering as followed by the defence and commercial industries, especially as far as electronic product development is concerned, are discussed. It argues that the defence industry is placing too much emphasis on the quantification of reliability as performance requirement. This focus necessitates the continued use of incorrect and misleading "industry standard" practices, especially for reliability specification, prediction and demonstration. Commercial industries follow an approach that rejects the accounting activities of specification, prediction and demonstration in favour of engineering activities. These activities include well-known techniques such as FMEA and FTA, thermal and derating analysis, and new techniques such as HALT and HASS.

Application of Reliability Demonstration Testing to the Product Development Life Cycle

Richard B. Ramirez *Cardinal Health*

T2-S3 ☐

Reliability Demonstration Testing (RDT) is an effective process to identify and predict top field failure modes and to predict product Annual Failure Rate % (AFR%) during the product development cycle. An efficient RDT process allows product development teams to be proactive during design development rather than reactive after the product release to costly design warranty issues in the customer field.

This presentation discusses where and how the RDT process fits within a product development Reliability/Quality plan applied to medical instruments developed at Cardinal Health. Five key RDT product development cycle areas are reviewed:

- Component or Subsystem RDT process
- System Reliability Block Diagram (RBD) Model
- System Level RDT process
- Product reliability metrics and warranty/repair cost impacts
- RDT process feedback from 1st year field warranty/repair data analysis

Session 4 2:40 to 3:50 p.m. Wednesday April 11, 2007

Design for Reliability: Engaging Your Development Process and Your Engineering Culture

Daniel Farley *Delphi Corporation: Thermal Systems Division*

T1-S4 ☐

Reliability engineering is a function within product and process development that is dedicated to problem prevention. Many business leaders and product engineers fail to see the linkages between reliability engineering and product development. Therefore, it is the responsibility of reliability engineers and leaders to provide a reliability program that is integral to the standard work of the development process. It is only when reliability becomes standard work that the business will recognize it as a key element of its strategy for improving customer satisfaction and profitability.

In this presentation, Delphi Thermal Systems will share how they are re-energizing reliability through their Design for Reliability initiative. Delphi will share their experiences (mistakes and successes) in their decade long journey of developing and deploying a reliability function within the division's global product engineering organization. Delphi will also share how Design for Reliability is linked to its Design for Six Sigma program and how they plan to use Design for Reliability to develop, certify and maintain the core competency of reliability engineering.

Risk Management of Warranty Contracts in Machine Building Industry

Marc Wawerla and Jürgen Fleischer *wbk Institute of Production Science Universität Karlsruhe (TH)*

T2-S4 ☐

Recently, the increasing customer demand for longer and more extensive warranties has caused additional expenses to the machine building industry. Several risks arise from this situation especially because new warranty types are required such as Reliability-Improvement-Warranties (RIW). In order to control these risks, it is necessary to quantify them first through the calculation of the warranty cost probability function. Therefore deterministic as well as stochastic input elements need to be considered. In this presentation, Weibull Analysis and Failure Modes Effects and Criticality Analysis (FMECA) are used for the reliability evaluation. The system's cost estimation applies the Monte Carlo Simulation approach. Once quantified, the risks are reduced through two approaches: bid optimization using a sensitivity analysis and efficient machine optimization during the life cycle based on the FMECA. The presentation concludes with a critical reflection on the calculation accuracy and demonstrates the applicability of the procedure by its usage in a machine tool manufacturing company.

Tutorial 1 4:00 to 5:30 p.m. Wednesday April 11, 2007

Repairable System Modeling

Edward A. Pohl *University of Arkansas: Department of Industrial Engineering*

Tutorial 1 ☐

Professionals in all industries and the military are faced with the problems of performing maintenance actions on, and optimizing maintenance planning for, their repairable systems. Constructing mathematical models of their repairable systems and using these models to optimize maintenance strategies require a basic understanding of several key reliability and maintainability concepts and mathematical modeling approaches. The literature on maintenance modeling and optimization is extensive and includes a wide variety of assumptions and modeling approaches. Therefore, our objective for this tutorial is to present the fundamental concepts and modeling approaches.

Thursday April 12, 2007

Thursday's activities will begin with another registration period (for anyone who did not register on Wednesday). You can then choose any 4 of the 8 presentations that are offered on the second day. The day's program concludes with an informative expert tutorial from 4:00 to 5:30 p.m. In the evening, you are cordially invited to attend a hosted reception from 6:00 to 9:00 p.m. Specific details on the location and menu will be announced at the event.

Session 5 — 8:50 to 10:00 a.m. Thursday April 12, 2007

A Closed-Loop Process for Technical Risk Management in Development Projects

T1-S5 ☐

Klaus Denkmayr and Nikolaus Haselgruber ***AVL***

An overall process is presented that allows efficient risk management in development projects. It encompasses risk assessment, various types of FMEAs and an optimized validation. This process allows the systematic inclusion of robust design and analytical results such as Finite Element Analysis (FEA) tasks. Monitoring techniques such as Reliability Growth applied during the testing phase give insight into the product's maturity on a system level.

This process has been successfully applied in various projects. Experiences are presented, pros and cons are discussed and an outlook is given on the planned further development of this process.

Reliability Analysis for Repairable Systems

Adamantios Mettas ***ReliaSoft Corporation***

T2-S5 ☐

Data obtained from repairable systems must be analyzed differently than data from non-repairable systems. For non-repairable systems, the failure data is collected and a representative distribution is fitted in order to perform reliability estimations. For repairable systems, the analysis is not as straightforward since a stochastic process is in place. Different approaches are available depending on the data and the objective of the analysis. For example, the engineer can analyze the data "directly" by fitting the NHPP-Power Law model or the Generalized Renewal Process model. Another approach is to break down the system into its Lowest Replaceable Units and failure modes, obtain the failure distributions of these, and then create and analyze the Reliability Block Diagram of the system. Each method and model has its underlying assumptions and it is imperative for the analyst to be aware of them. In this presentation, the different approaches of treating repairable system data are reviewed, and the available models for each approach are explained and demonstrated. In addition, a variety of additional considerations and results pertaining to repairable systems are presented.

Session 6 — 10:20 to 11:30 a.m. Thursday April 12, 2007

Basic Methods and Guidelines for Reliability Validation of Automotive Components at High Mileage

Paul Schimmerling ***Renault***

T1-S6 ☐

Reliability tests realized on a limited number of vehicles or components cannot guarantee that the cumulative failure rate will be lower than 1% at a given high mileage, which is not an ambitious reliability objective. A more efficient approach consists in conducting accelerated tests, combined eventually with numerical simulations. This approach raises a difficulty: how to forecast the future reliability of the component in the field from test/simulation results? The assessment method must take into account two important sources of variability: the manufacturing scatter and the variability of customer use. We present four basic methods that enable the analyst to establish the relationship between field reliability and test/simulation results. Due to its wide range of applications, the practice of the Stress-Strength method is particularly detailed. The implementation of these methods is illustrated by several applications on power train components. Their limits and success conditions are discussed. From the experience acquired, we deduce some guidelines for the design and the interpretation of reliability validation tests.

Estimation of RAM-Related Financial Impact in HSL-Zuid Project (High Speed Railway Line, The Netherlands)

T2-S6 ☐

Dietmar Wegner, Thomas Roellecke, Mario Spira and Josef Hoellbacher ***Siemens Transportation Systems***

In this session, we present a sensitivity/uncertainty-based approach for the estimation of commercial risk due to deviation in the cash-flow-balancing caused by a) the stochastic nature of non-conformity with penalized reliability, maintainability and availability targets and related payments, and b) the deviation of expected maintenance costs. This discussion is based on experience with "Product/System Assurance" in the PPP high speed railway project "HSL Zuid," including overall system optimization during the execution phase and preparation of the maintenance plan for the operation phase. An integral part of this was the specification and implementation of a performance monitoring process as the basis for a) demonstrating project performance, b) controlling the availability payment regime, c) controlling the cash-flow balance during the 25 year maintenance window, and d) analysis of RAM-relevant and commercial risk-relevant impact factors for future projects, considering the stochastic character of reliability, availability, maintainability and maintenance related events and processes.

Hotel Accommodations

The 2007 European Symposium will be held at the ArabellaSheraton Congress Hotel in Frankfurt, Germany. Through a special arrangement with the hotel, the reduced rate of €109 (single) or €144 (double) per night is available for Symposium participants. **Rooms must be reserved by March 27, 2007 to be eligible for this rate.** Please refer to the Applied Reliability Symposium and/or ReliaSoft when making your reservations.

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http://www.ARSymposium.org/europe/

Thursday April 12, 2007

Session 7 1:10 to 2:20 p.m. Thursday April 12, 2007

Design for Reliability: Best Practices and Lessons Learned

Xijin (Bill) Tian *Hewlett-Packard Co.*

T1-S7 ☐

In today's highly competitive world market, it is crucial to deliver highly reliable products fast and at low cost. The old, traditional reliability practices, such as reliability prediction, burn-in/ESS or reliability demonstration, are not effective or cost efficient for today's products and market. Reliability must be designed in and built into a product from the very beginning of the product development cycle. This session will present a suite of Design-for-Reliability (DFR) best practices to deliver reliable products faster and cheaper. These best practices include robust design and fault prevention techniques (probabilistic margin design, stress analysis, and derating design), fault discovery and removal techniques (FMEA/FTA, HALT/HASS, and SCA analysis) and fault tolerance design techniques. These techniques will be embedded into a product development process. The lessons learned in the author's engineering practice will also be presented.

A New Methodology for Industrial Equipment Analysis Based on RAMS: A Practical Application

Luís Ferreira and Ludovico Morais *Faculdade de Engenharia da Universidade do Porto*

T2-S7 ☐

All equipment needs maintenance to perform the required function with the desired level of performance in proper conditions of safety and operation. Thus, this presentation presents a 13-step methodology for the maintenance analysis of industrial equipment based on RAMS elements. Applying it, it is possible to define the system, divide it and carry out the analysis using tools such as FMECA, HAZOP, RCM and others to select the critical components and define the required maintenance tasks. Considering the method's application to the electrostatic precipitators of the recovery boilers existing in paper mills, it is possible to conclude that the methodology allows the selection of the critical subsystems and their components in a structured, objective and complete way, and also allow the definition of the required maintenance tasks. Using this method, it is also possible to identify the components and subsystems that can be improved when new equipment is developed.

Session 8 2:40 to 3:50 p.m. Thursday April 12, 2007

Highly Accelerated Testing in the Aerospace Environment

Daniel Goulet *Thales Aerospace Division*

T1-S8 ☐

In this presentation, we plan to describe the experience of Thales-Avionics with issues of operational reliability improvement through highly-accelerated testing methods.Thales-Avionics has undertaken implementation of Highly Accelerated Tests (known as HAT or HALT/HASS). After a "Pilot" period, Thales Aerospace decided to deploy HAT and Highly Accelerated Environmental Stress Screening (HA-ESS) throughout Thales. Today HAT and HA-ESS are an integral component of Thales' reliability programs with 24 HAT / HASS systems distributed on ten industrial sites throughout France and the United States.

Impact of Testability and Logistics and Rail System Availability and Maintenance Cost

Pierre Dersin and Alban Péronne *ALSTOM Transport*

T2-S8 ☐

In this presentation, we plan to describe the experience of ALSTOM Transport Information Solutions with issues of testability, maintenance strategy and logistics, on both main lines (ERTMS) and mass transit applications. High availability and low maintenance cost (or more generally low life cycle cost) are key requirements in today's complex rail systems, both in mass transit and main line applications. This is especially true for signaling and train control systems. A usual approach to achieving high availability is through redundancy. However, a number of questions related to testability, maintenance strategy and logistics arise. In this session, various maintenance policies will be compared, using Markov and other models, and a sensitivity analysis of system availability with respect to technical and logistical factors will be presented. In particular, using Markov models, the very high sensitivity of availability to failure detection probability will be demonstrated.

Tutorial 2 4:00 to 5:30 p.m. Thursday April 12, 2007

Reliability Growth Management and Data Analysis

Dr. Larry H. Crow *Crow Reliability Resources, Inc.*

Tutorial 2 ☐

In order to attain reliability objectives, early system prototypes are often subjected to reliability growth testing. This testing may be specifically dedicated to reliability or the testing may be integrated into existing engineering development tests. When failure modes are uncovered during the testing they are either corrected or not corrected in accordance with the reliability growth management strategy. For a particular program, the management strategy is a key factor in whether or not the desired reliability is attained. To properly manage the reliability growth process, the reliability currently achieved and the projected reliability impact of proposed future corrective actions must be appropriately measured for a particular strategy. If the projected reliability is not on track to meet the desired goal then the management strategy can be changed.

This tutorial will present a structure for assessing the management strategy together with proven models and methods for evaluating the reliability growth based on test data and other engineering input. This tutorial addresses modern principles of reliability growth management and analysis, including techniques and models to analyze data from time-based tests where corrective actions may be implemented during the test, after the test, or a combination of both, and from various one-shot success/failure tests. The models and methods presented in this tutorial are designed for real-world applications and are useful to reliability engineering and program management.

FRIDAY APRIL 13, 2007

Session 9 8:00 to 9:10 a.m. Friday April 13, 2007

Comparison of Statistical Methods to Analyze Failures and Degradations: Effect on Life and PM Predictions

Emmanuel Remy, Francois Billy and Marie-Agnes Garnero *EDF R&D*

T1-S9 ☐

Components that are important for power delivery can be checked through non-destructive testing. Preventive maintenance tasks that avoid failures can also be conducted. Related historical experience data and expertise are available for reliability estimation. Several statistical modeling choices must be made: frequentist or Bayesian inference, taking into account influence variables if available (*e.g.* pressure, temperature), modeling of preventive maintenance effects on reliability, etc.

This presentation aims at showing and measuring the interest of using methods that allow a modeling which is as close as possible to what is known from the field. It is illustrated by two examples taken from the energy industry.

Incorporating Reliability, Availability and Maintainability into Process Synthesis

Qiying Yin (Scarlett) *University of Manchester - Centre for Process Integration*

T2-S9 ☐

In process industries when a new process needs to be designed, the common approach is to find the optimal design from a superstructure which embeds all feasible options in respect to the objective of minimizing cost or maximizing profit. In this approach, the reliability, availability and maintainability (RAM) is studied after the flowsheet is fixed. It is not uncommon that the optimal flowsheet found in the first step is sub-optimal when considering RAM issues in the second step. The business owner faces a difficult choice: to spend money on modifying the fixed design as the result of the RAM study or to accept the sub-optimal design reluctantly and produce products at a higher cost. This presentation proposes a new approach that can design a new process while considering the RAM issues simultaneously. The optimization procedure can give the minimum cost or maximum profit, and it avoids the profit loss due to an initial non reliability-wise design.

Session 10 9:20 to 10:30 a.m. Friday April 13, 2007

Operational Readiness of German Federal Police Ships Insured by High-Grade Procurement and Maintenance

Bernd Nöthel *German Federal Police (Retired)*

T1-S10 ☐

To the German Federal Police, execution of its orders given by law depends, in many cases, on availability and operational readiness of technology. Although the police can be called a “special consumer,” because of the high aim of the utilization capacity for its ships, there are definite parallels to private companies. In this presentation all steps needed for procurement of ships to be accepted by the German Federal Police and measures to observe warranty claims, rotational maintenance and, finally, unplanned repairs will be demonstrated. Supporting IT programs used by maintenance specialists also will be addressed.

On-Line Vibration Monitoring as a Tool for Preventive Maintenance and Troubleshooting

Hannu Rautiainan and Erkki V. Jaatinen *Metso Automation*

T2-S10 ☐

Vibration measurements have taken the biggest market share in machinery condition monitoring. An on-line monitoring system is a tool that can help mechanical maintenance personnel and also production personnel to discover the slowly developing changes in machinery and process. The early warning gives time to react early enough to these changes so that maintenance tasks can be planned in advance and carried out during planned shutdowns. This helps to minimize the unplanned shutdown time and on the other hand to maximize the production time - to keep up the “runnability” of the production machinery. Through practical cases found in customer systems, this presentation demonstrates on-line monitoring as a tool for predictive maintenance, applied both for long-term maintenance planning and short-term troubleshooting.

Session 11 10:40 to 11:50 a.m. Friday April 13, 2007

The Life Cycle Cost Paradigm Shift in Maintenance

Andrea Bottazzi *ATC S.p.A Bologna Italy*

T1-S11 ☐

In the past, the objectives of the maintenance strategy were continuous improvement of the maintenance activity merged with a feedback based on maintenance registration. The new approach concerning maintenance strategy based on a Life Cycle Cost (LCC) approach consists of integral adoption of the maintenance plan, given by the constructor and its verification in operations. The quality of the relationship between customer and supplier is the improvement of the product in the time.

The work described in this presentation is part of the result of a project of many years in ATC S.p.A. Bologna, a big public transport operator, for its vehicle fleet. This project is in progress and has made it possible to cut the maintenance cost in a significant way.

Reliability Assessment of Croatian Power Network Using State Enumeration Method

Srete Nikolovski and Predrag Maric *University of Osijek Faculty of Electrical Engineering* and **Zoran Bauss** *SIEMENS d.d. Croatai*

T2-S11 ☐

The liberalization of the electricity market in transition countries will force electricity companies to view their power plants, transmission networks and distribution systems in a new light. Currently in Croatia there is only one electricity company, which is forced to change and survive in the open European electricity market through reduced costs, maximized returns on investments and improved reliability and security of the existing power system. Power system reliability can be evaluated using analytical and simulation methods. This presentation uses Markov three-state models for generators (operational state, derated state and outage state) and two-state models for all other components of the power system. Historical data from HEP TSO Company were analyzed as input data for component reliability. A set of system and load point related reliability indices were calculated using state enumeration model simulation. The analysis was performed on a Croatian National Grid Company transmission system.

The 2007 International Applied Reliability Symposium, Europe

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