

Center for Risk and Reliability : Structure, Philosophy and Research Activities

Mohammad Modarres

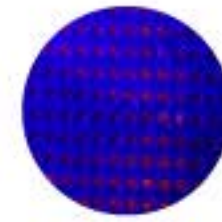
Director, Center for Risk and Reliability
Department of Mechanical Engineering

January 20, 2015

Presented at the Departmental Retreat
Mechanical Engineering
University of Maryland



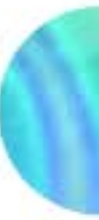
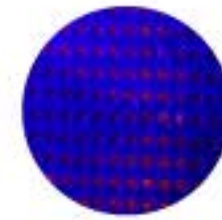
History and Mission of CRR



- Formed in 1985 by Dean. George Dieter as the umbrella organization for risk and reliability research at the College of Engineering.
- Covers research in risk and reliability of structure, systems and processes with applications to space missions, military and civil aviation, nuclear energy, petroleum facilities, medical devices, information systems, and civil infrastructures.
- Research arm of the Reliability Engineering educational program-- largest and most comprehensive degree granting graduate program in reliability engineering.



CRR Faculty



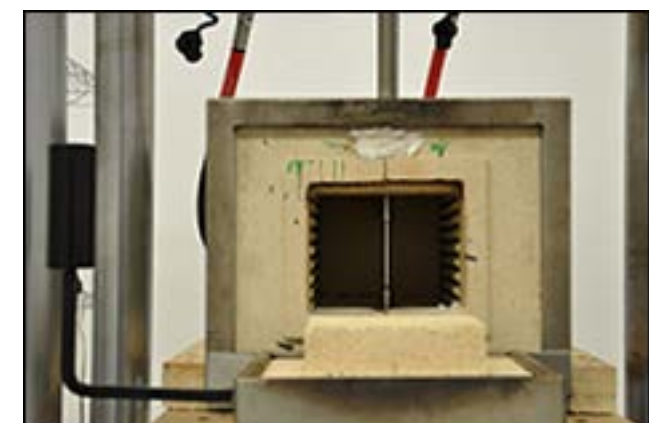
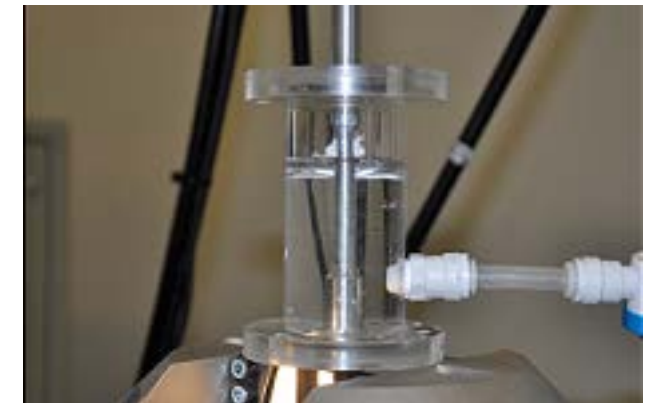
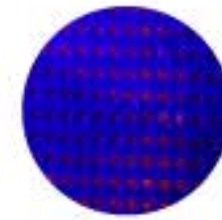
- **Modarres, Mohammad**, Nicole Y. Kim Eminent Professor and Director
- **Ayyub, Bilal M.** Professor, Civil & Environmental Engineering
- **Baecher, Gregory B.**, Glenn L. Martin Institute Professor, Civil and Environmental Engineering
- **Christou, Aris**, Professor, Mechanical Engineering
- **Cukier, Michel**, Associate Professor of Reliability Engineering, Director, Advanced Cybersecurity Experience for Students (ACES)
- **Droguett, Enrique**, Associate Professor, Reliability Engineering
- **Herrmann, Jeffrey**, Associate Professor, Mechanical Engineering and Institute for Systems Research
- **Kim, Jeong H.**, Professor of Practice, Clark School of Engineering
- **Mosleh, Ali**, Professor Emeritus, Reliability Engineering
- **Roush, Marvin**, Professor Emeritus, Reliability Engineering
- **Pertmer, Gary**, Associate Professor Department of Mechanical Engineering
- **Stamatelatos, Michael**, Adjunct Professor, Reliability Engineering
- **Vaughn-Cooke, Monifa**, Assistant Professor Mechanical Engineering

Research Areas

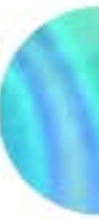
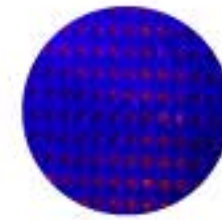
- Hybrid Systems Reliability (Systems of Hardware, Software and Human)
- Probabilistic Physics of Failure of Mechanical Systems
- Simulation-based Probabilistic Risk Assessment
- Bayesian Data Analysis and Predictive Models
- Uncertainty Characterization and Assessment
- Human Reliability and Socio-technical Systems Risk
- Software Reliability Microelectronics Reliability
- Prognostics and Health Monitoring of Complex Systems and Structures
- Healthcare Systems Risk Management and Medical Device Reliability
- Risk Based Design

Laboratories

- Cybersecurity Quantification
- Hybrid Systems Integration and Simulation
- Probabilistic Physics of Failure and Fracture
 - ✧ MTS uniaxial fatigue testing
 - ✧ Optical Microscopy of fatigue growth
 - ✧ Acoustic Emission and Fatigue
 - ✧ Creep testing
 - ✧ Corrosion testing
 - ✧ Environmental Chamber (Salt/Hot/Cold/Humidity/Cycling)

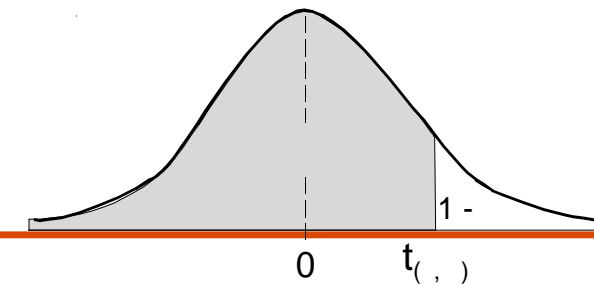


Distribution of Research Efforts



Structural and System Reliability Models

Component Reliability Models



55%

10%

35%

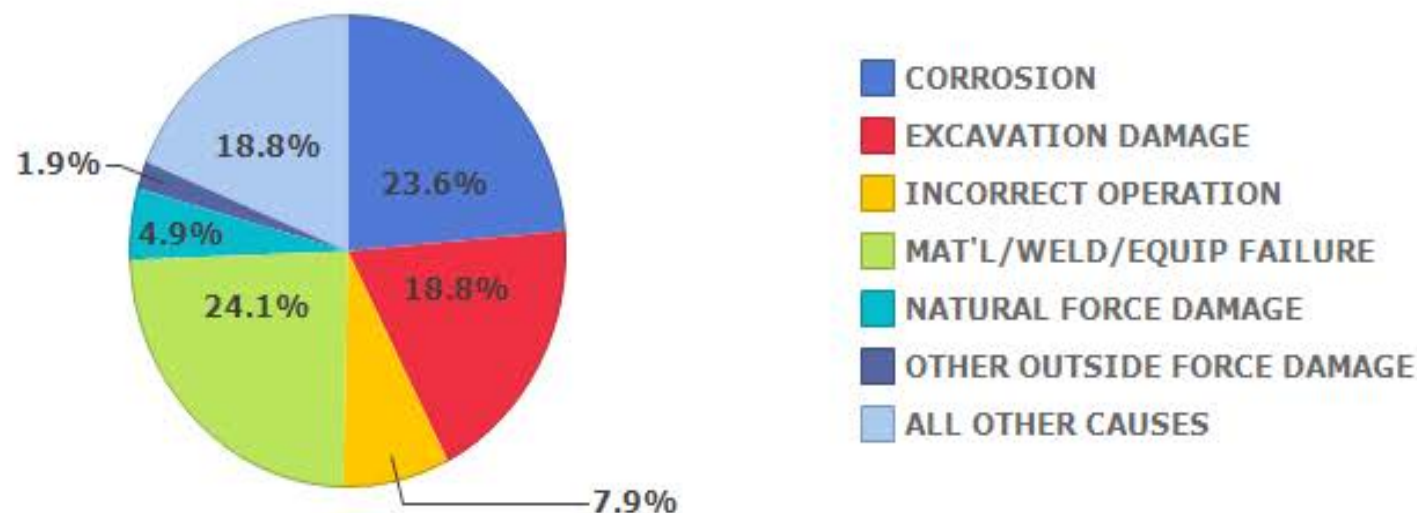
**Proximate Causes/ "Macroscopic" Causes
Root Causes / "Microscopic" Causes
Probabilistic Physics of Failure**

See: Celebrating Fifty Years of Physics of Failure, K. Chatterjee, M. Modarres, J. Bernstein, D. Nicholls, Proceedings of the 2013 Reliability and Maintainability Symposium (RAMS), Jan. 2013, Orlando, FL.

CRR's New Initiatives

- Create a PHM center of excellence to support the petroleum industry
 - Plans include development of industrial partnerships
- Reliability research in robotic systems

Significant Incident Cause Breakdown
National, Hazardous Liquid, 1992-2011



Source: PHMSA Significant Incidents Files, December 31, 2012

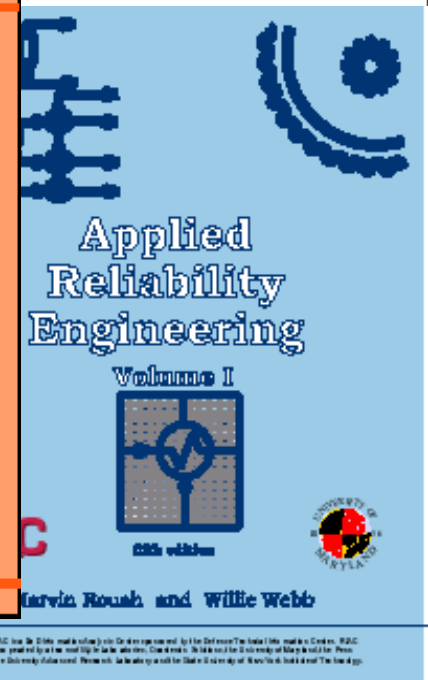
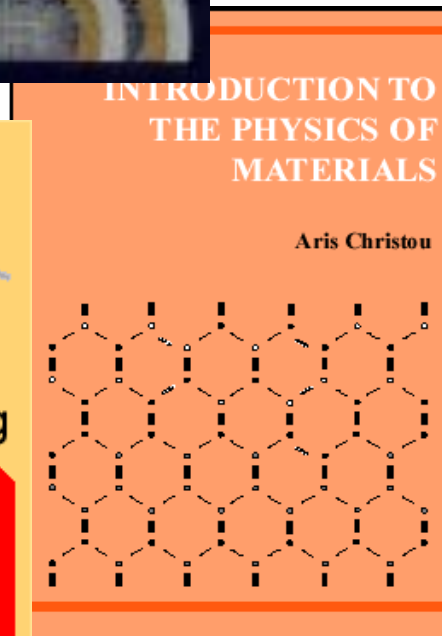
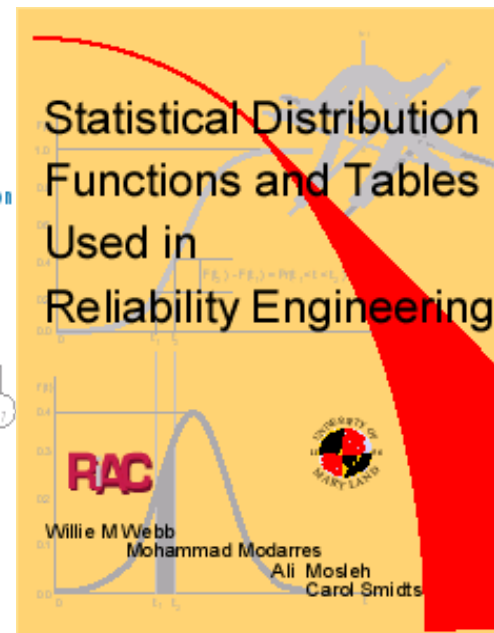
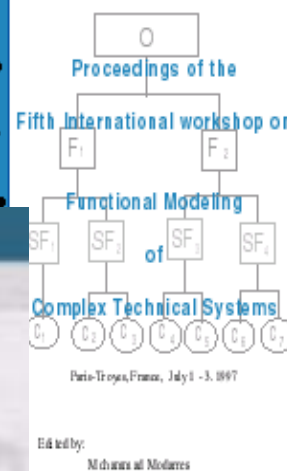
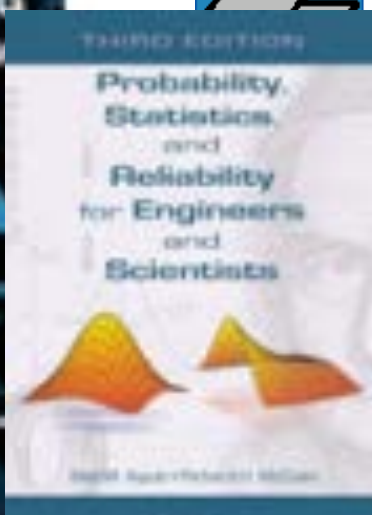
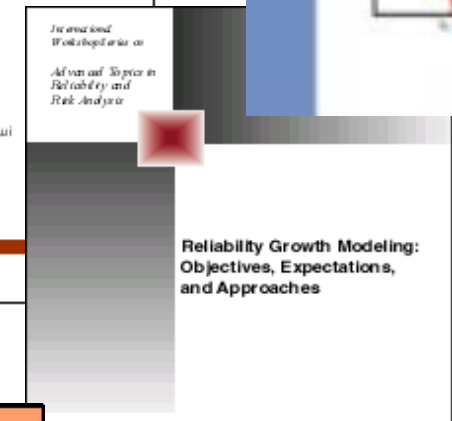
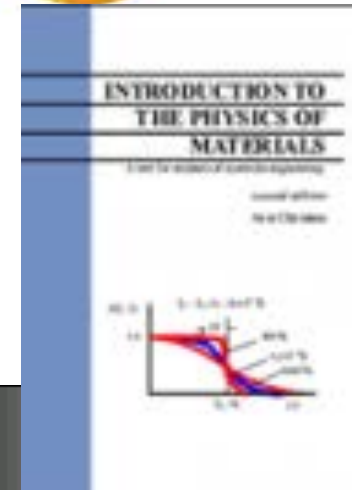
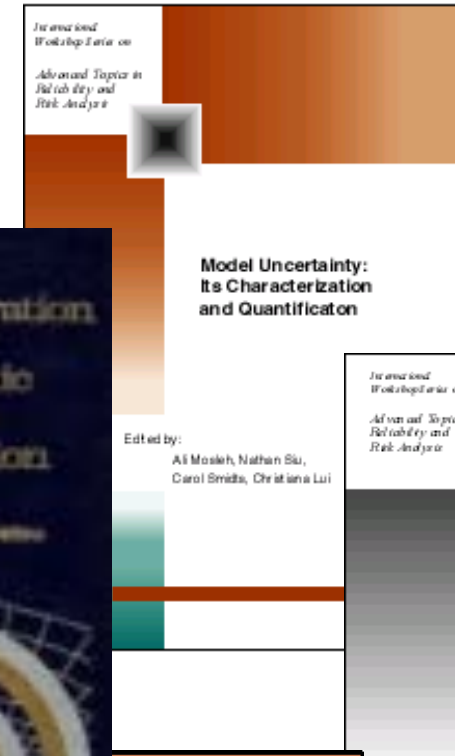
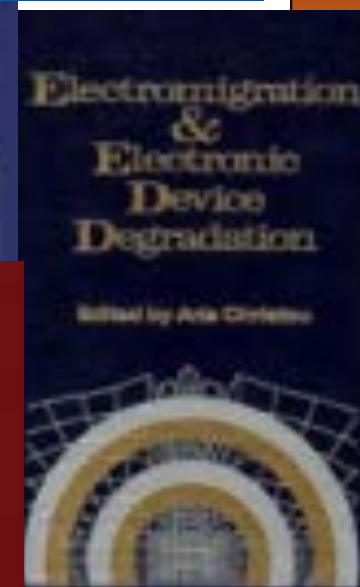
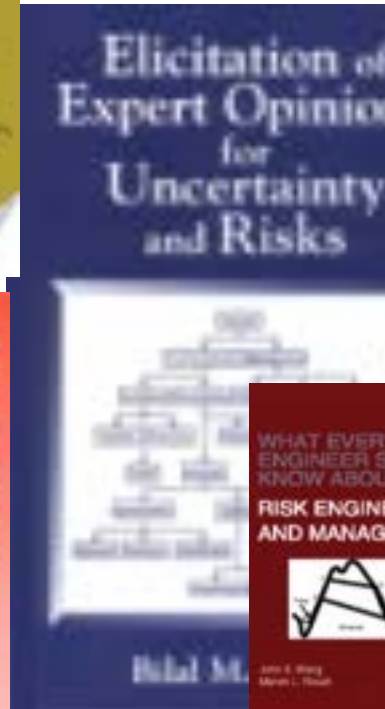
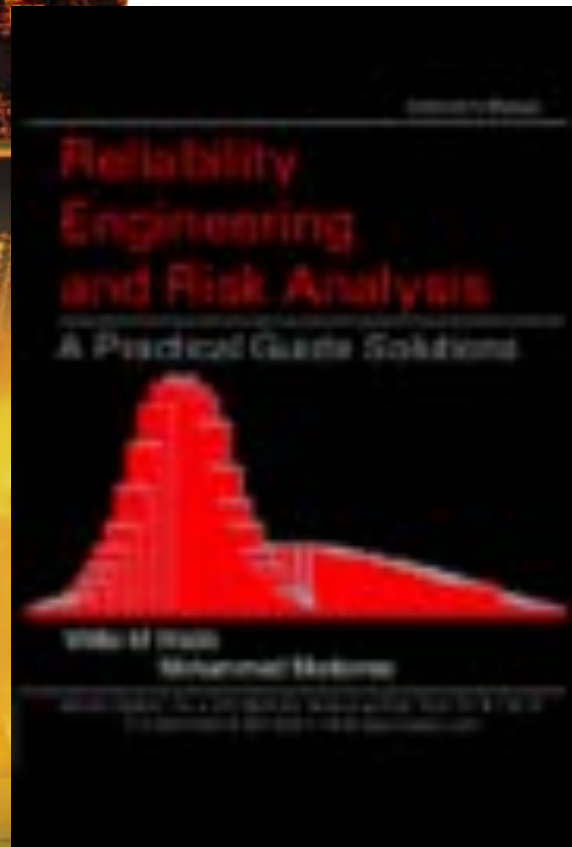


CRR Research Partnerships

- Recent and Present *Cooperative Research Agreements* with government agencies:
 - US NRC
 - ONR
 - NAVAIR
 - NASA
 - USDA
 - EC Halden Research Center, Norway
 - EEC Joint Research Center, Italy
 - Norwegian Institute of Technology
 - Monash University
 - Paul Scherrer Research Institute, Switzerland
- Partnership with industry:
 - Wyle Labs (DoD's DTIC)
 - ARES Corporation
 - Corning Corp.

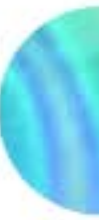
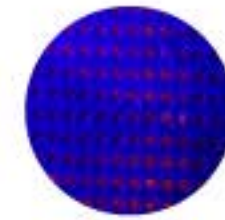


Samples of Publications



Educational Program

Major Courses Offered



- Worldwide Leader in Reliability Engineering Education (Certificate, MS, PhD and Professional Masters)
- Established over 30 years ago, first under Nuclear Engineering and for over 25 years as an independent program

CORE AND INTERMEDIATE COURSES

- Fundamentals of Failure Mechanisms
- Reliability Analysis
- Fundamentals of Reliability Engineering
- Mathematical Techniques of Reliability Engineering
- Probabilistic Physics of Failure and Accelerated Testing
- Advanced Methods in Reliability Modeling

Research Courses

- Independent Studies in Reliability Engineering
- Master Thesis
- Ph.D. Thesis

TECHNICAL ELECTIVES

- Collection and Analysis of Reliability Data
- Reliability Engineering Management
- Microelectronics Device Reliability
- Probabilistic Risk Assessment
- Risk Management for Engineers
- Software Reliability and Integrity
- Information Security
- Other Interdisciplinary elective tracks meet needs of engineering community (i.e. take electives in Systems Engineering, Project Management, etc.)

Distance education income is one of the main sources of independents CRR R&D

25TH ANNIVERSARY SYMPOSIUM

*Promise of a Discipline: Reliability
and Risk in Theory and Practice*

AGENDA

WEDNESDAY, APRIL 2, 2014

University of Maryland Reliability Engineering
Symposium

*Promise of a Discipline: Reliability
and Risk in Theory and Practice*

8:30 a.m. – 5:00 p.m.

Samuel Riggs IV Alumni Center
University of Maryland

University of Maryland Reliability Engineering
25th Anniversary Reception and Alumni Reunion
5:00 – 7:00 p.m.

Samuel Riggs IV Alumni Center
University of Maryland

TWENTY FIVE YEARS AGO, Maryland established the first degree-granting reliability engineering education program in the country and today it is one of the largest and most comprehensive graduate programs in the field of reliability and risk analysis of engineered systems and processes. The program offers MS, PhD, and Graduate Certificates in Reliability Engineering and Risk Analysis. All courses are available through traditional on-campus and online delivery modes.



*The Center for
Risk and Reliability*

www.crr.umd.edu

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UNIVERSITY OF
MARYLAND
Department of Mechanical Engineering
2181 Glenn L. Martin Hall
College Park, Maryland 20742
USA



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RELIABILITY
ENGINEERING

1989-2014

*Promise of a Discipline: Reliability
and Risk in Theory and Practice*

25TH ANNIVERSARY SYMPOSIUM



APRIL 2, 2014

Samuel Riggs IV Alumni Center
University of Maryland
College Park, Maryland



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Thank you

