



Reliability Science Symposium
Spring 2026
March 25, 2026

Welcome to the CALCE Reliability Science for Electronics Symposium

Michael Osterman
osterman@umd.edu

CALCE Thanks its Sponsors

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- Unison Industries
- Universal Lighting Technologies
- Vertiv
- Waites
- Whirlpool
- X-Wave

- Consumer and mobile products
- Telecommunications and computer systems
- Energy systems (generation/storage/distribution)
- Industrial systems
- Automotive systems
- Aerospace systems
- Medical systems
- Defense systems
- Equipment manufacturers
- Government laboratories and agencies

- Fourth Dimension
- Moog Inc.
- Fujitsu Network Communications
- MSA

CALCE at the University of Maryland

Over 40 Years of CALCE Support of the Electronic Industry

- Research, test, and consulting services (contracts through the University, lab services, consortia membership)
- Over 850 research projects, \$120 million in research funding, and 1500+ published articles on design, manufacture, life assessment, and life management of electronics components, products, and systems
- Continuing learning offerings (more than 300 webinars, 100+ keynotes at conferences, 200+ short courses)
- Graduated skilled engineers (over 300 Ph.D. and 500 M.S. degrees) with sophisticated problem-solving skills for the design, manufacture, and test of reliable products that meet the targeted applications
- Hundreds of practicing engineers working for global organizations such as the US Government, Apple, Dell, Google, Honeywell, Intel, Microsoft, NASA, Northrop Grumman, Samsung, and SLB

CALCE Mission and Thrust Areas Continue to be Critical

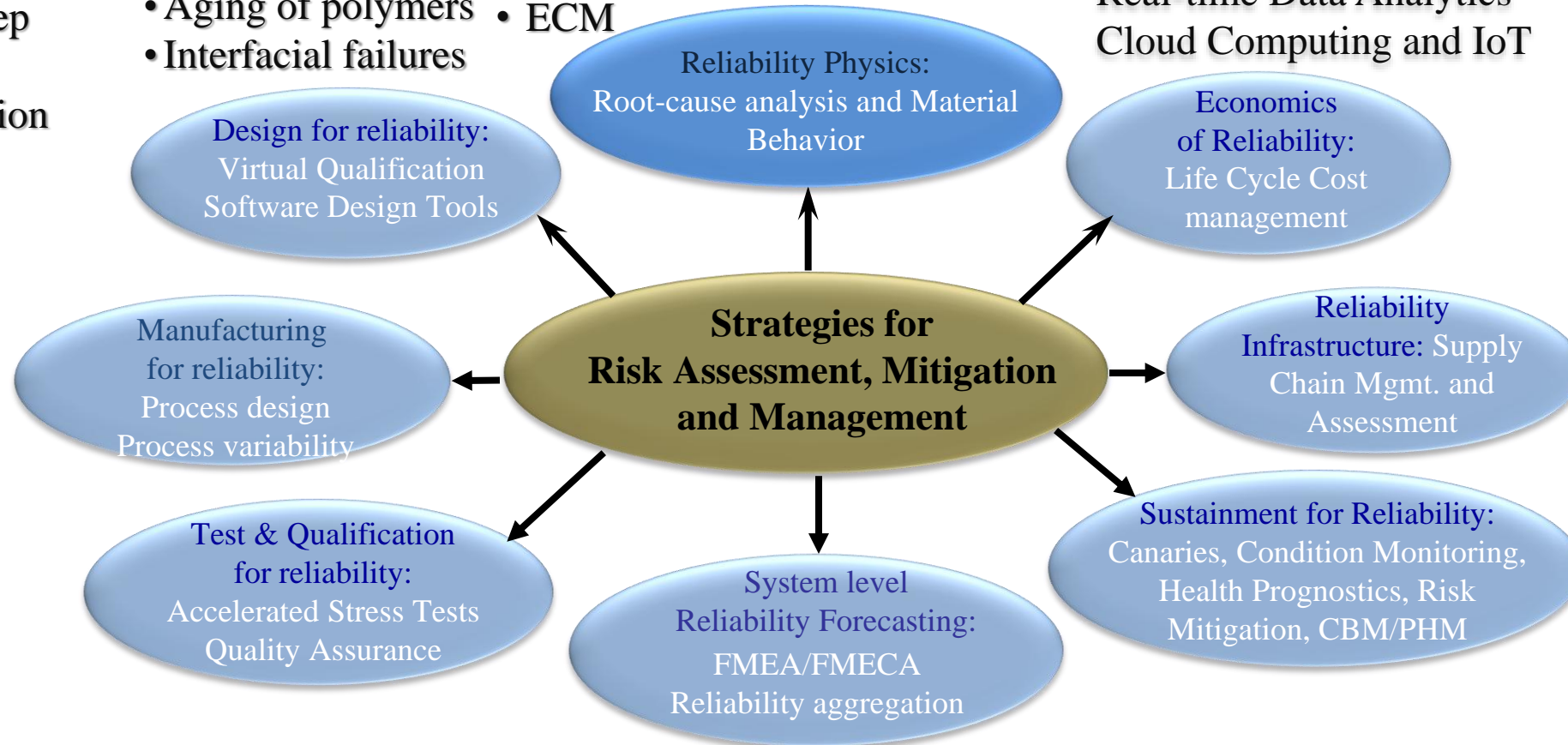
Providing a knowledge and resource base to support the development and sustainment of competitive electronic products

- Fatigue and Fracture
- Plasticity, creep
- Wear/fretting
- Electromigration
- ESD/EOS
- TDDDB

- Whiskers
- Aging of polymers
- Interfacial failures

- Corrosion
- ECM

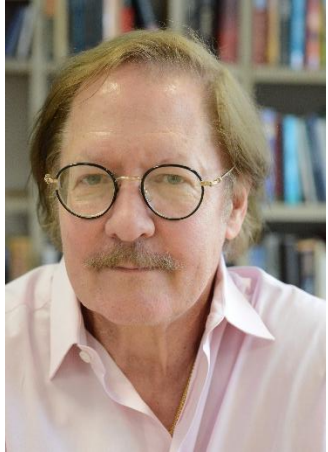
Machine Learning and Artificial Intelligence
Real-time Data Analytics
Cloud Computing and IoT



Convergence of Reliability-Physics and Artificial Intelligence

Technical Consulting with CALCE Principal Investigators

Expertise list at <https://calce.umd.edu/our-team>



Michael Pecht



Michael Osterman



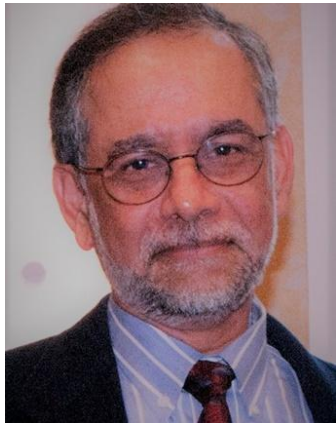
Michael Azarian



Diganta Das



Robert Utter



Abhijit Dasgupta



Patrick McCluskey



Bongtae Han



Peter Sandborn



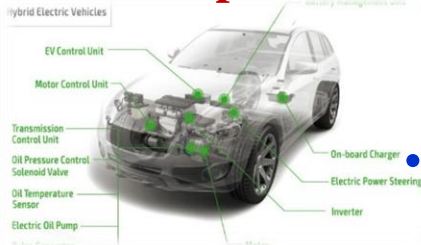
Damena Agonafer



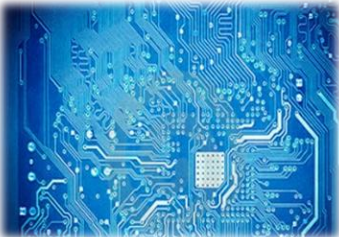
Siddhartha Das



Military & Aerospace



Automotive



Computing and Data Systems



Servers and HPCs

CALCE Activities

Reliable, Safe, Secure Microelectronic Systems

• Research Consortia

- Shared basic research projects, software access, seminars, consulting, discounted test services, and failure analysis

• Test Services and Failure Analysis

- Design review, technical consulting, simulation-assisted and testing-based qualification, material and product testing, supply chain management, root cause assessment

• Education

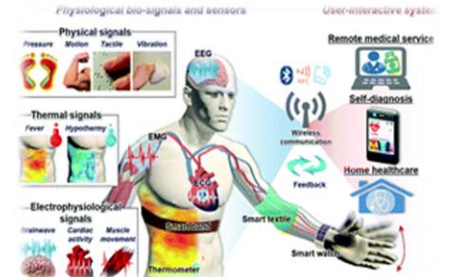
- Degree and certificate programs, on-site customized professional development courses, web-based workshops, internships, community college outreach, and regional consortia

• Standards and Roadmaps Development

- Standards and roadmap development through societies and organizations such as IEEE, ASME, SEMI, IPC, US Military, and SAE



Industrial Systems



Healthcare Systems



Communications



Energy Systems

CALCE Electronics Life Cycle Focus

Design for Reliability and Safety

- Parts selection
- Failure modes and mechanisms
- Derating
- Multiphysics analysis
- Materials metrology
- AI-assisted design

Manufacturing

- Process modeling and yield mgmt.
- Process monitoring and control
- Process metrology
- Industrial AI
- Screening and burn-in strategies
- Manufacturing metrology

Testing and Verification

- AI - physics of failure based accelerated test planning
- Failure metrology
- Uncertainty assessment
- Safety evaluation
- Security assessment
- Life assessment

Deployment

- Performance metrology
- Anomaly detection
- Diagnostics and classification
- Health monitoring
- RUL assessment
- Warranty analysis

Maintenance

- Fault diagnostics
- Root cause analysis
- Prognostics
- Predictive and condition-based maintenance
- Sustainment

End-of-Life

- Recycle
- Reuse
- Repurpose
- Disposal

Disruption management
(Supply chain risk, Allocation, Security)

Supply-chain and life cycle cost management

Compromise management
(Obsolescence, Counterfeit)

Test and Measurement Laboratories

CALCE has a sophisticated test and failure analysis laboratory to support research and industry needs.



Scanning Acoustic



Scanning Electron
and Energy

Spectroscopy

Analyzer

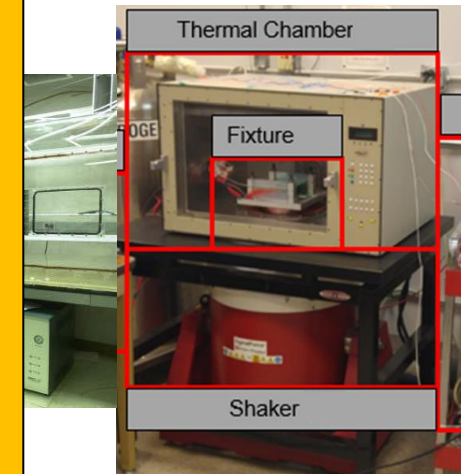
Analyzer



Gas Chamber



ing HALT Chamber



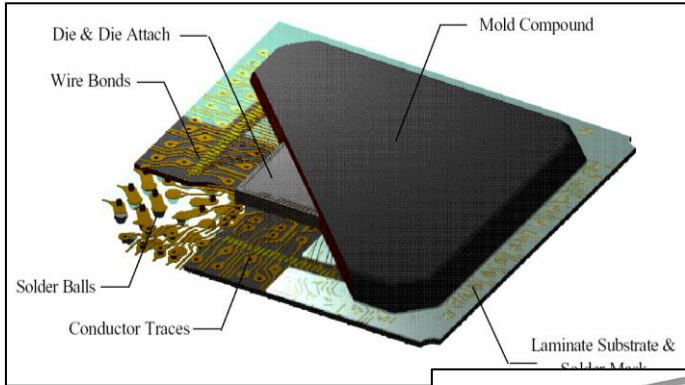
Combined Vib and
Thermal Cycling

- **Materials characterization (including Micro/Nano-Scale)**
- **Accelerated Environmental Testing**
- **Failure Analysis**
- **Electrical Characterization and Diagnostics**
- **Modeling and Simulation**
- **Thermal Management**

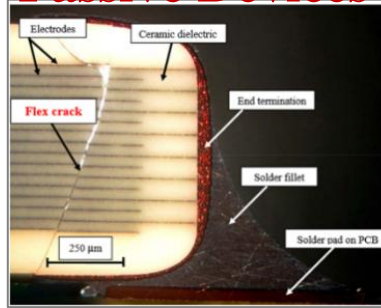
Physics of Failure Based Reliability of Electronic Devices

and Interconnects

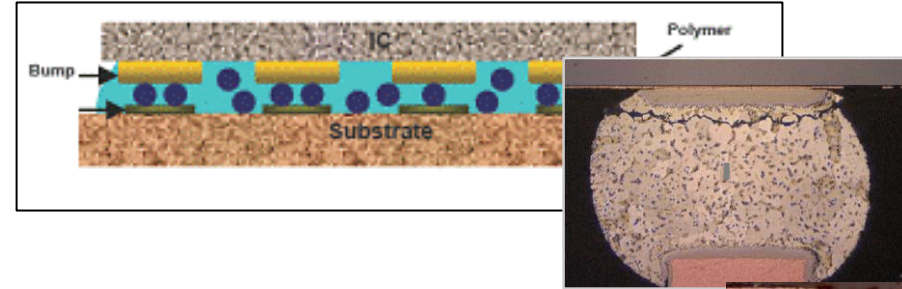
Active Devices



Passive Devices



Interconnects



Reliability models and acceleration models can use physics-based and data-based models



Batteries



Adhesives

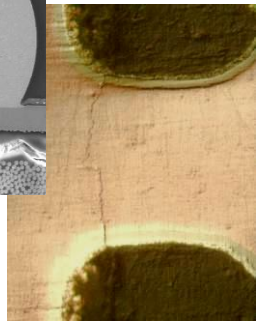
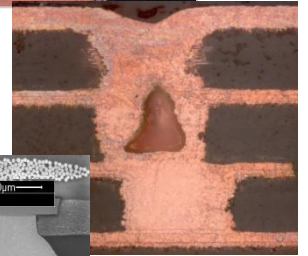
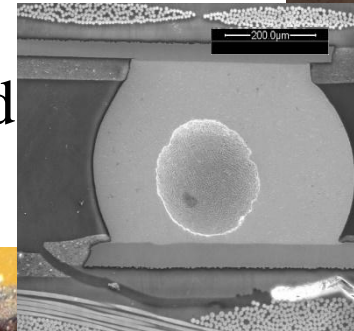
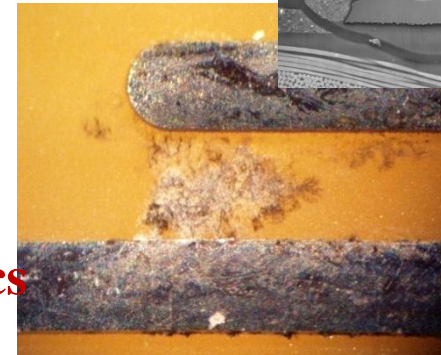
Cables & Connectors



Printed Electronics



High-Density Substrates

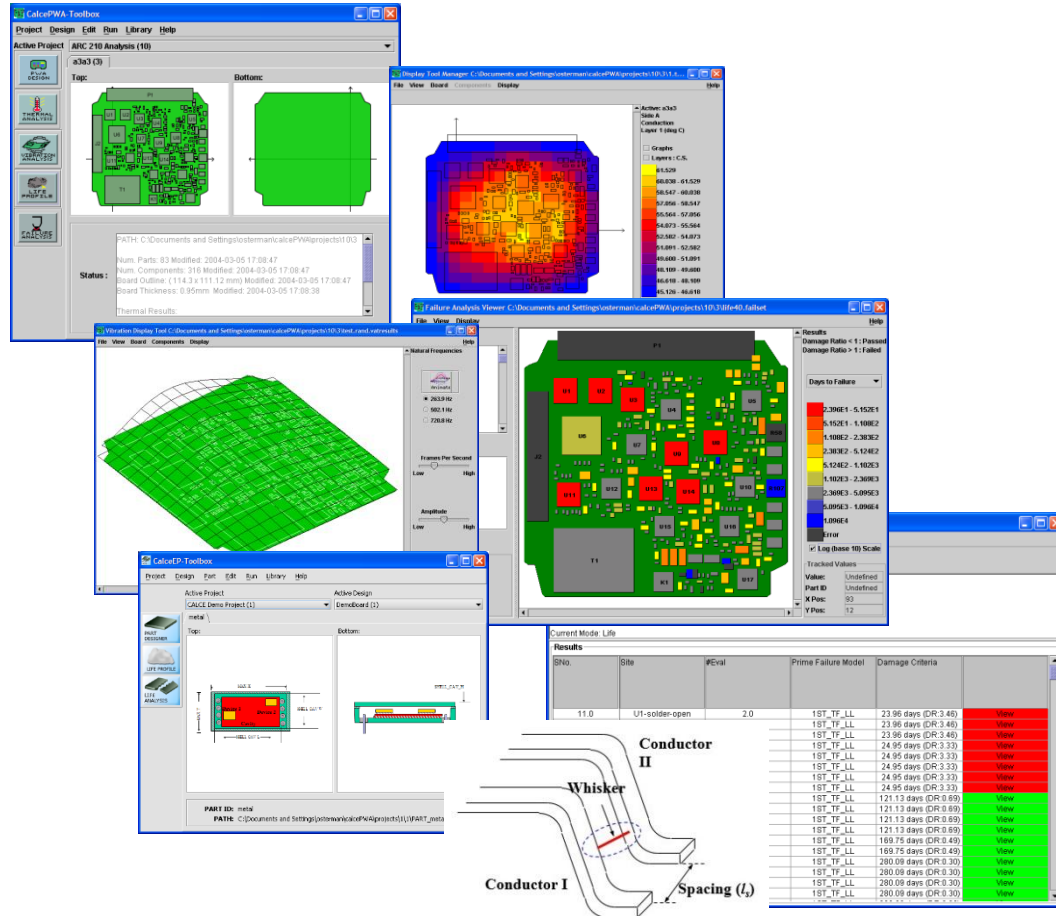


$$TTF = F(\text{geometry, material, environment})$$

CALCE Simulation Assisted Reliability Assessment Software

<https://calce.umd.edu/calce-simulation-assisted-reliability-assessment-sara-software>

Downloads/Activation since October 15, 2025: 60



Assembly, Package and Device
Failure Assessment Modules

Body Module Computer

83% reduction in design issues
>10% reduction in time to market



Engine Controller

Virtual qualification of engine
Controller identified life limiting design issues



Radio System

Identified design life issue saving customer
an estimated \$27 million dollars



Software is available for free.

Members get early access to new features and data sets.

Training is available.

CALCE Professional Development Courses

<https://calce.umd.edu/professional-development-courses>

Review the general course outlines and background information from the list on the right then select the course or courses that you would like to be offered at your company using this link. Tell us the date(s), locations and any additional information about your needs. We prefer a lead time of at least three weeks for planning.



Accelerated Product Qualification. Accelerated stress testing is one of the key resources in the PoF approach and helps simulate product life cycles over compressed time periods by accelerating the damage accumulation rate for relevant wearout damage mechanisms. If done early in the development phase, in conjunction with reliability science design, accelerated testing can enhance process and design maturity and enable early introduction of mature products with robust design



- Accelerated Product Qualification.
- Counterfeit Parts Detection Using SAE AS6171.
- Component Documentation and Supply Chain Management for Counterfeit Avoidance.
- Critical System Sustainment.
- Electronics Derating
- Electronic Part Obsolescence Forecasting, Mitigation, and Management.
- Electronic Product and System Cost Analysis.
- Failure Analysis of Electronics.
- High-Temperature Electronics.
- Lead-Free Readiness.
- Light Emitting Diode (LED) Reliability.
- Lithium-Ion Battery Testing and Reliability
- Reliability Science.
- Prognostics and Health Management
- Uprating
- Virtual Qualification and Reliability Assessment

CALCE Consortium Members 2026

- Dell
- General Electric¹
- Honeywell
- L3Harris^e
- Lockheed
- Google^e
- Keysight
- Microsoft
- Medtronic
- NXP
- Rolls Royce
- Sandia National Labs
- Schlumberger Oil Drilling Services
- Stryker
- Woodward

e – Enterprise, 1- Site

Access to CALCE Consortium Project Archive

<https://web.calce.umd.edu/members/>

Projects

Next Year Proposals (2027)

Current Projects (2026)

Last Year Projects (2025)

Consortium Meetings

Spring 2026

Fall 2025

Articles

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Software

calceSARA

Webbooks

Webbook Links

Access to CALCE Consortium Project Archive

<https://web.calce.umd.edu/members/projects/>



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CALCE EPS Consortium Research

Below you will find the archive of past CALCE individual project to list project investigator. EPSC.

- [FY26 Research](#)
- [FY25 Research](#)
- [FY24 Research](#)
- [FY23 Research](#)
- [FY22 Research](#)
- [FY21 Research](#)

ID	Title
C26-03	Microstructure-sensitive Reliability Assessment for PHM Digital-Twins of HI Interconnects
C26-07	Thermal Cycle Reliability Models for Lead-free High-Performance Solder and Wafer Level Packages Solder Interconnect Tests
C26-08	Reliability of Low Temperature Solder Interconnects
C26-11	High-Density Interconnect (HDI) Laminate Reliability: Technology Status and Implementation Concerns
C26-12	Feature Size-based Dimensional Data for Component Reliability Assessment
C26-19	Ripple Current Testing of Multilayer Ceramic Capacitors (MLCCs) for Correlation with Selection Criteria
C26-20	Rapid Assessment of Electronic Assemblies Using Side-Channel Power Modulation Analysis
C26-22	Modeling and Physical Analysis of Lubrication in Lightly Loaded Contacts Undergoing Fretting
C26-26	Coating Durability in Electronic Products

Access to CALCE Consortium Proceedings

<https://web.calce.umd.edu/consortium/meetings/>

CALCE EPS Consortium Research

Below you will find the archive of past CALCE EPSC meeting presentations organized by year. Please direct questions regarding individual project to list project investigator. For general inquiries, please contact **Michael Osterman, Director CALCE EPSC.**

March 25, 2026 (Wednesday)

FY26 Research	Spring	
FY25 Research	Spring	9:00 am - Opening Presentations I CALCE Overview 9:30 am - Session I
FY24 Research	Spring	Ripple Current Testing of Multilayer Ceramic Capacitors (MLCCs) for Correlation with Selection Criteria (Members' Only) Modeling and Physical Analysis of Lubrication in Lightly Loaded Contacts Undergoing Fretting (Members' Only) Rapid Assessment of Electronic Assemblies Using Side-Channel Power Modulation Analysis (Members' Only)
FY23 Research	Spring	
		11:00 am - Session II
		HDI Laminate Reliability Concerns (Members' Only) Feature Size-based Dimensional Data for Component Reliability Assessment (Members' Only) Online Diagnostics and Predictive Maintenance for Electronic Products (Members' Only)

Access to CALCE Publications

<https://calce.umd.edu/published-articles-and-book-chapters>

Published in 2024

[Effect of Isothermal Aging on Anisotropic Creep Properties of SAC305 Si Crystals](#), Aniket Bharamgonda, Johnathan Martin, Yongrae Jang, Abhij Dasgupta, Torsten Hauck, and Yaxiong Chen, 2024 23rd IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm), Aurora, CO, USA, 2024, pp. 1-6, DOI: doi.org/10.1109/ITherm55375.2024.10709443.

[Quantile-based Long Short Term Memory Remaining Useful Life Prediction of Metal-Oxide-Semiconductor Field-Effect Transistor](#), Yonatan Saadon, N Auslander, and F. Patrick McCluskey, 2024 23rd IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm), Aurora, CO, USA, 2024, pp. 1-7, DOI: [10.1109/ITherm55375.2024.10709525](https://doi.org/10.1109/ITherm55375.2024.10709525).

[A Novel Technique for Multiple Failure Modes Classification Based on Deep Learning](#), John Taco, Pradeep Kundu, and Jay Lee, *Journal of Intelligent Manufacturing*, Volume 35 Issue 7 Page:3115-3129, DOI: doi.org/10.1007/s00178-023-02185-2.

2024 23rd IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm), Aurora, CO, USA, 2024, pp. 1-7, DOI: [10.1109/ITherm55375.2024.10709525](https://doi.org/10.1109/ITherm55375.2024.10709525)

Quantile-based Long Short Term Memory Remaining Useful Life Prediction of Metal-Oxide-Semiconductor Field-Effect Transistor

Yonatan Saadon^a, Noam Auslander^b, and F. Patrick McCluskey^a

^a CALCE/Department of Mechanical Engineering, University of Maryland, College Park, MD, USA

^b The Wistar Institute, Philadelphia PA, USA

For more information about this article and related research, please contact [Prof. Patrick McCluskey](#).

Abstract:

Accurate prediction of the remaining useful life (RUL) of a degrading component is crucial to prognostics and health management for electronic systems, to monitor conditions and avoid reaching failure while minimizing downtime. However, the shortage of sufficiently large run-to-failure datasets is a serious bottleneck impeding the performance of data-driven approaches, and in particular, those involving neural network architectures. Here, we develop a new data-driven prognostic method to predict the RUL using an ensemble of quantile-based Long Short-Term Memory (LSTM) neural networks, which represents the RUL prediction task to a set of simpler, binary classification problems that are amenable for prediction with LSTMs, even with limited data. We demonstrate that this approach obtains improved RUL estimation accuracy for power MOSFETs, especially with a small training dataset that is characterized by a wide range of the RUL.

This article is available [online here](#) and to [CALCE Consortium Members](#) for personal review.

Access to over 1000 published articles

CALCE Webinars

<https://calce.umd.edu/webinars>

Upcoming

CALCE/SMTA Counterfeit Symposium in its Twentieth Year - 4/9/2026

Harmonic-Vibration Durability of Low Temperature Solders - 5/12/2026

Thermal Cycling Fatigue of Additively Fabricated Conductive Silver Traces - 6/16/2026

Archive

Impact of Dwell Time on Thermal Cycle Fatigue of Third Generation Lead-free Solders - 2/24/2026

Rapid Detection and Quantification of Microelectronic Degradation - 1/27/2026

Will Your Product Meet Its Life Requirement? CalceSARA can help! - 12/9/2025

Fretting Wear in Electrical Contacts: Can Electroless Gold Replace Electroplated Finishes? - 9/9/2025

Current Contracts

- Multi-Objective Simulation Tool for Cooling Optimization and Operational Longevity – ARPA-E Contract – CALCE Lead: McCluskey -Team: NREL, LBNL, Univ. of Arkansas, Trane
- Cooling System Reliability Evaluation – Flexnode with ARPA-E Contract - CALCE Lead: D. Das – Team: Flexnode
- Advanced Packaging Reliability in Heterogeneous Integration, Government of Israel, Lead: D. Das, Team: Defense Security Cooperation Agency
- Side-Channel Based Methods for Detection of Counterfeit Microelectronics - Air Force Research Laboratory STTR – CALCE Lead: D. Das and Azarian - Team Chiplytics
- Multichip Module Interconnect Evaluation – STEAM PIPE 23 POWER-UP – CALCE Lead: Dasgupta - Team: Northrop Grumman
- Solder Performance and Reliability Assurance – USPAE Contract - CALCE Lead: Osterman - Team: Auburn University, Purdue University, Collins, Plexas, STI Electronics
- Substrate-based Heterogeneous Integration Enabling Leadership Demonstration for the USA - NIST CHIPS NAPMP-1 – DECA/IBM, ASU/UMD(CALCE-ISR); CALCE Lead: Dasgupta
- Advanced Materials and Additive Manufacturing of Printed Electronics for Harsh Environment, FlexTech-ARL, CALCE Lead: Dasgupta
- Additively Manufactured Printed Hybrid Electronics for Extreme Shock/Drop at Elevated Temperature, ARL, CALCE Lead: Dasgupta
- Development of Three-Dimensional Hard X-Ray Photoelectric Polarimeter Assembly Using Additive Manufacturing Technology, NASA APRA, CALCE Lead: Siddhartha Das
- Reliability of Printed Hybrid Electronics under Temperature and Moisture Environments, LPS, CALCE Lead: Abhijit Dasgupta

SYMPOSIUM ON COUNTERFEIT PARTS & MATERIALS

CALCE
CENTER FOR ADVANCED
LIFE CYCLE ENGINEERING



JUNE 23 - 25 2026
COLLEGE PARK, MD, USA

The Symposium on Counterfeit Parts and Materials is organized by SMTA in conjunction with CALCE at the University of Maryland. Contact **Dr. Diganta Das** (diganta@umd.edu) for more information on the Technical Program and Professional Development Courses and **Karlie Severinson** (karlie@smta.org) about the event, exhibition opportunities, accommodation, and registration.

College Park Marriott Conference Center
College Park, MD

Abstracts Due: March 31, 2026

Questions on speaker responsibilities and/or requirements? Please contact counterfeit@smta.org



Reliability Science Symposium at University of Maryland College Park, MD, USA

October 14-15, 2026



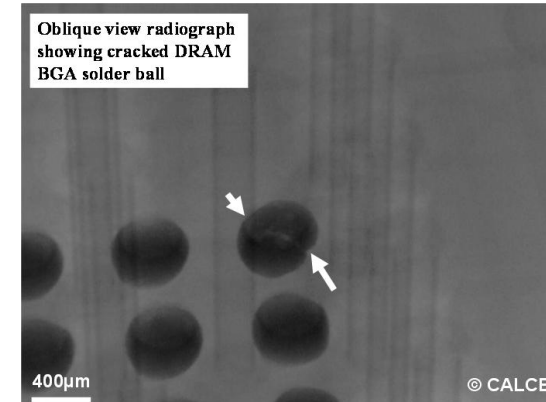
The reliability of electronic products and systems is increasingly critical for autonomous vehicles and vehicle safety systems. The reliability science symposium will present risk assessment, management, and mitigation techniques for heterogeneous integration, additive manufacturing, electrical contacts, life models, prognostics, battery failure mechanisms and life prediction.

Short Course on Failure Analysis of Electronics

University of Maryland
College Park, MD, USA

Tentative Dates: November 17-20, 2026

1. Failure analysis techniques
2. Failure mechanisms of electronic products
3. Physics-of-failure and root cause analysis
4. Hands-on laboratory sessions



Course fee: \$3000 (\$2500 for CALCE Members)

For more information, please contact:

Michael Osterman: +1 (301) 405 3498, osterman@umd.edu

calce

Reliability Science for Electronics Symposium - Morning

Session 1

- Ripple Current Testing of Multilayer Ceramic Capacitors (MLCCs) for Correlation with Selection Criteria
- Modeling and Physical Analysis of Lubrication in Lightly Loaded Contacts Undergoing Fretting
- Rapid Assessment of Electronic Assemblies Using Side-Channel Power Modulation Analysis

Session 2

- HDI Laminate Reliability Concerns
- Feature Size-based Dimensional Data for Component Reliability Assessment
- Online Diagnostics and Predictive Maintenance for Electronic Products

Reliability Science for Electronics Symposium - Afternoon

Session 3

- Reliability of Low Temperature Solder Interconnects
- Reliability of Lead-free High-Performance Solder Interconnects
- Effect of Aging and Recrystallization on Performance of Oligocrystalline SAC Solder Joints
- Coating Durability in Electronic Products

Session 4

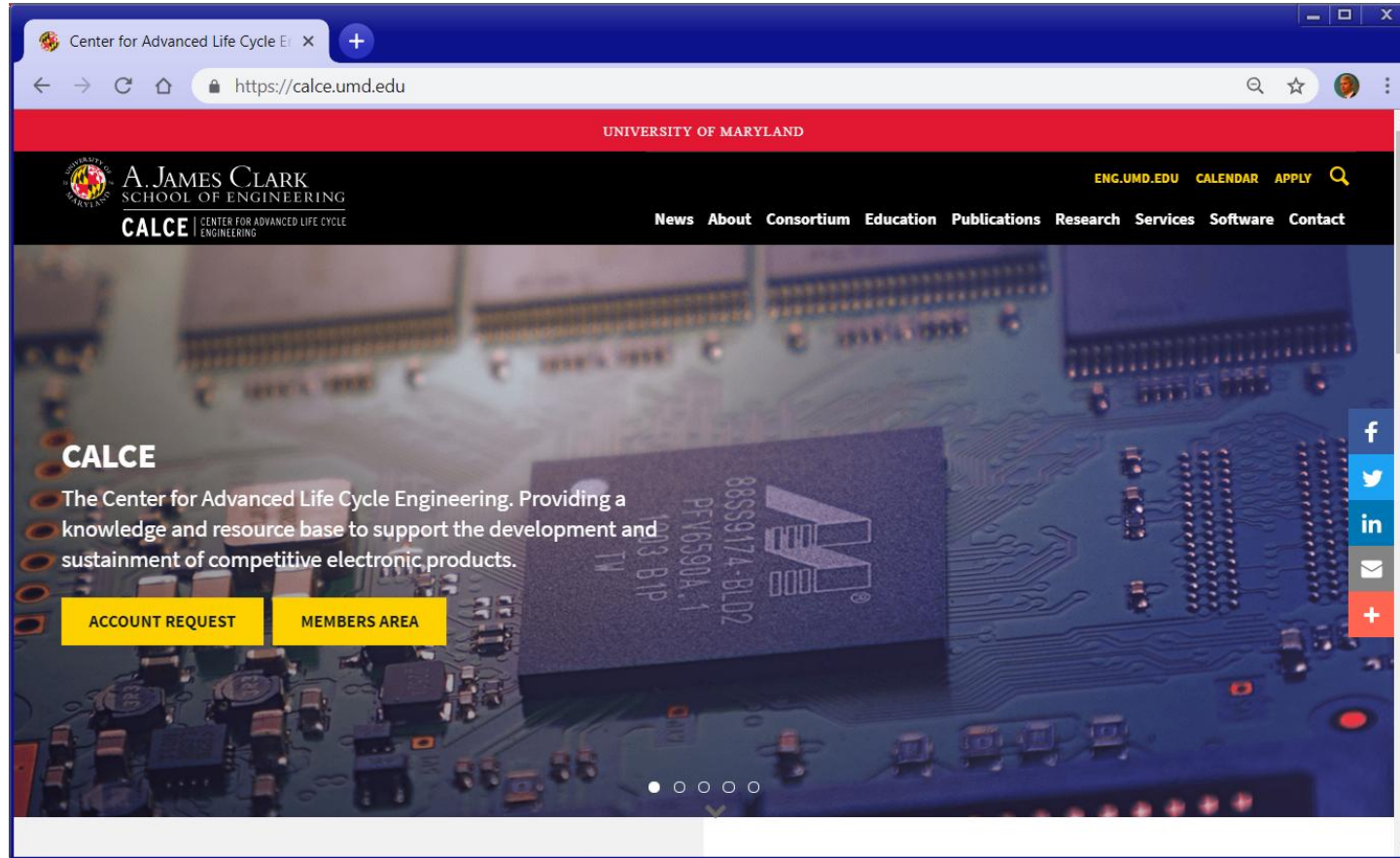
- Strain Based Measures for Identifying Precursor for Thermal Runaway
- Internal Shorting Conditions Required for Thermal Runaway
- Comparative Analysis of Reliability Prediction Methods for Telecommunication Systems
- Reliability and Availability Aware Design of Data Center Thermal Management Systems

Consortium Membership Benefits

<https://calce.umd.edu/join-calce-eps-consortium>

- Input into annual consortium research projects and roadmaps
- Shared access to results from over \$120 million in previous research
 - Research projects and proceedings
 - Publications
 - Webinars
- Advanced access to latest CALCE Simulation Assisted Reliability Assessment software and software support
- Technical exchange with other members and leveraging your research dollars
- Interaction with CALCE graduate students and potential internships
- Technical consulting with CALCE Research Staff and insight into non-consortium research
- Discount on CALCE short-courses, CALCE fee-for-services and CALCE sponsored events

Questions



<https://calce.umd.edu/>
Michael Osterman
osterman@umd.edu