Introduction
to
Center for Advanced Life Cycle Engineering

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http://www.calce.umd.edu

CALCE at University of Maryland
Over 30 Years of CALCE Support of the Electronic Industry

- Research, test and consulting services (contracts through UMD, lab services, consortia membership)
- Over 800 research projects, $100 million in research funding, and 1000+ published articles) for design, manufacture, life assessment and life management of electronics components, products and systems
- Continuing learning opportunities (more than 300 webinars, 100+ keynotes at conferences, 200+ short courses)
- Skilled engineers (over 300 Ph.D. and 500 M.S. degrees) with sophisticated problem solving skills for design, manufacture and test of reliable products that meet the targeted applications
- Over 500 practicing engineers working for organizations such as Apple, Dell, Google, Honeywell, Intel, Microsoft, NASA, Northrop Grumman, Samsung and Schlumberger

CALCE Clients

- ABB Switzerland Ltd.
- ACell, Inc.
- ACC Electronix
- Advanced Bionics
- Aerojet Rocketdyne
- Agilent Technologies, Inc.
- Allergan
- America II Electronics, Inc.
- American Panel Corporation
- Amazon Web Services
- Anadigics, Inc.
- Ansaldo STS USA, Inc.
- Applied Biometrics
- AprilAire
- ASML
- AST
- ATV Semapp
- Austria Microsystems AG
- Avaya Global Operations
- BAE Systems Electronics & Integrated Solutions
- Baker Hughes Inc.
- Bartlit Beck Herman
- Beijing Weibu Technology Limited Liability Company
- Bloomberg
- Boeing Co.
- Bombardier Aerospace
- Butterfly Networks
- Celestica International
- Chrysler Corp.
- Club
- CNN
- Coch
- Colli
- Cont
- Curti
- Cum
- CSX
- Dakt
- Defe Activ
- Dell,
- Delp
- Dow
- Dow
- DFR
- Edmu
- Embr
- Emerson
- Electrospec, Inc.
- EMC Corp.
- Fairchild Controls Corp.
- Finisar
- FirstTissues
- Fourth Dimension
- Fujitsu Network Communications
- GE Healthcare Technologies
- General Dynamics Advanced
- Keysight
- Microsoft Corp.
- Milwaukee Power Tools
- MKS Instruments, Inc.
- Moog Inc.
- MSA
- MDS Coating Technologies
- NASA Glenn Research Center
- NASA Goddard Space Flight Ctr
- e Center
- rp.
- Corp.
- Samsung Electronics Co.
- Sandia National Laboratories
- Savenia Labs.
- Schlumberger Oil Drilling Services
- Seagate
- Selex Electronics Systems Ltd
- Silicon Powers
- SpaceQuest
- SORAA
- Souriau
- Stratasys, Inc.
- Stryker
- Stanley Black and Decker
- Sun Metals
- Sunpower
- Team Corp.
- TEKELEC
- Telcare, Inc.
- Trilumia.
- Teradyne, Inc.
- Tessera
- Tintronics Industries
- Toyota Research Institute of N.A.
- Triumph
- TU CIC Virtuhcon
- U.S. Army ARDEC
- U.S. Army CECOM
- U.S. Army Research Lab.
- Unison Industries
- Universal Lighting Technologies
- Vertiv
- Waites
- Whirlpool
- X-Wave

- **Consumer and mobile products**
- **Telecommunications and computer systems**
- **Energy systems (generation/storage/distr)**
- **Industrial systems**
- **Automotive systems**
- **Aerospace systems**
- **Medical systems**
- **Defense systems**
- **Equipment manufacturers**
- **Government Labs and Agencies**

CALCE Mission and Thrust Areas Continue to be Critical

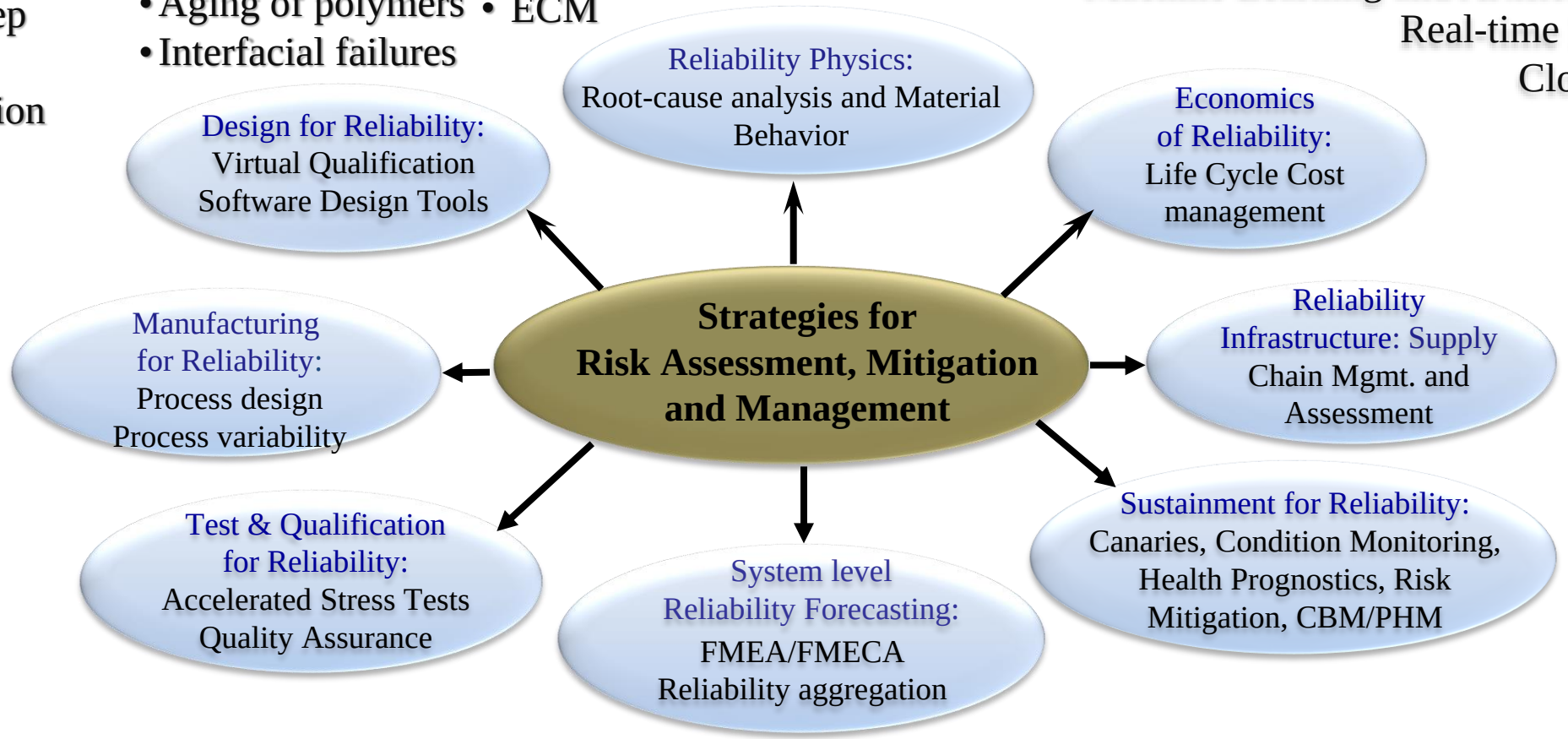
Providing a knowledge and resource base to support the development and sustainment of competitive electronic products

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

- Whiskers
- Aging of polymers
- Interfacial failures

- Corrosion
- ECM

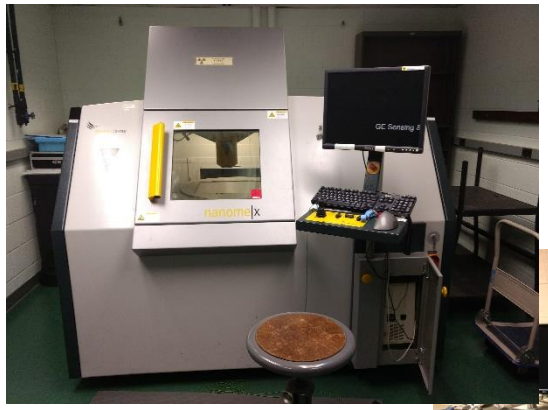
Machine Learning and Artificial Intelligence
Real-time Data Analytics
Cloud Computing
IoT



Convergence of Reliability-Physics (RP) and Artificial Intelligence (AI)

Extensive Test and Measurement Labs

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



X-ray Inspection

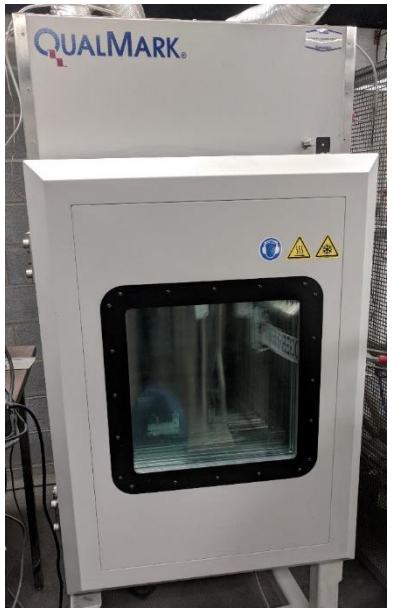
Scanning Acoustic Microscope

Scanning Electron Microscope and Energy Dispersive Spectroscopy

FTIR

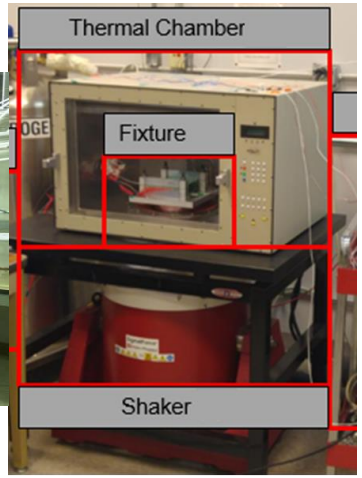
Thermomechanical Analyzer

Temperature Cycling Chambers



HALT Chamber

Mixed Flowing Gas Chamber



Combined Vib and Temperature Cycling

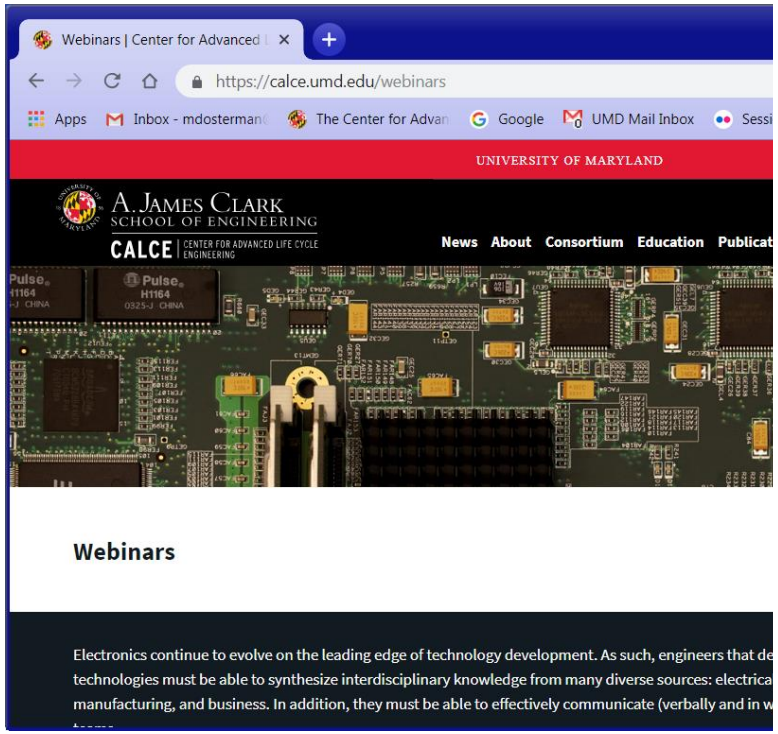
CALCE Activities

- **Education**
  - University degree programs, on-site customized professional development courses, web based seminars, workshops and symposia.
- **Standards Development**
  - Participation on standards development through societies and organizations such as IEEE, IPC, and SAE
- **Contracts**
  - Research and service contracts with negotiated terms with University.
- **Test Services and Failure Analysis**
  - Design review, simulation assisting product life assessment, material and product testing, supply chain management, and root cause failure identification.
- **Research Consortia**
  - Shared research projects, supplemental projects, access to software and seminars, consulting, and discounts on test services and failure analysis

CALCE Webinars

https://calce.umd.edu/webinars

CALCE Members have access to over 3 years of recordings and presentations.



Upcoming

On September 9, 2021, Pat McCluskey will present **Additive Manufacturing for Planar Magnetics**

On August 19, 2021, David Leslie will present **Pitfalls of Creep Indentation Testing of Sintered Silver Interconnects**

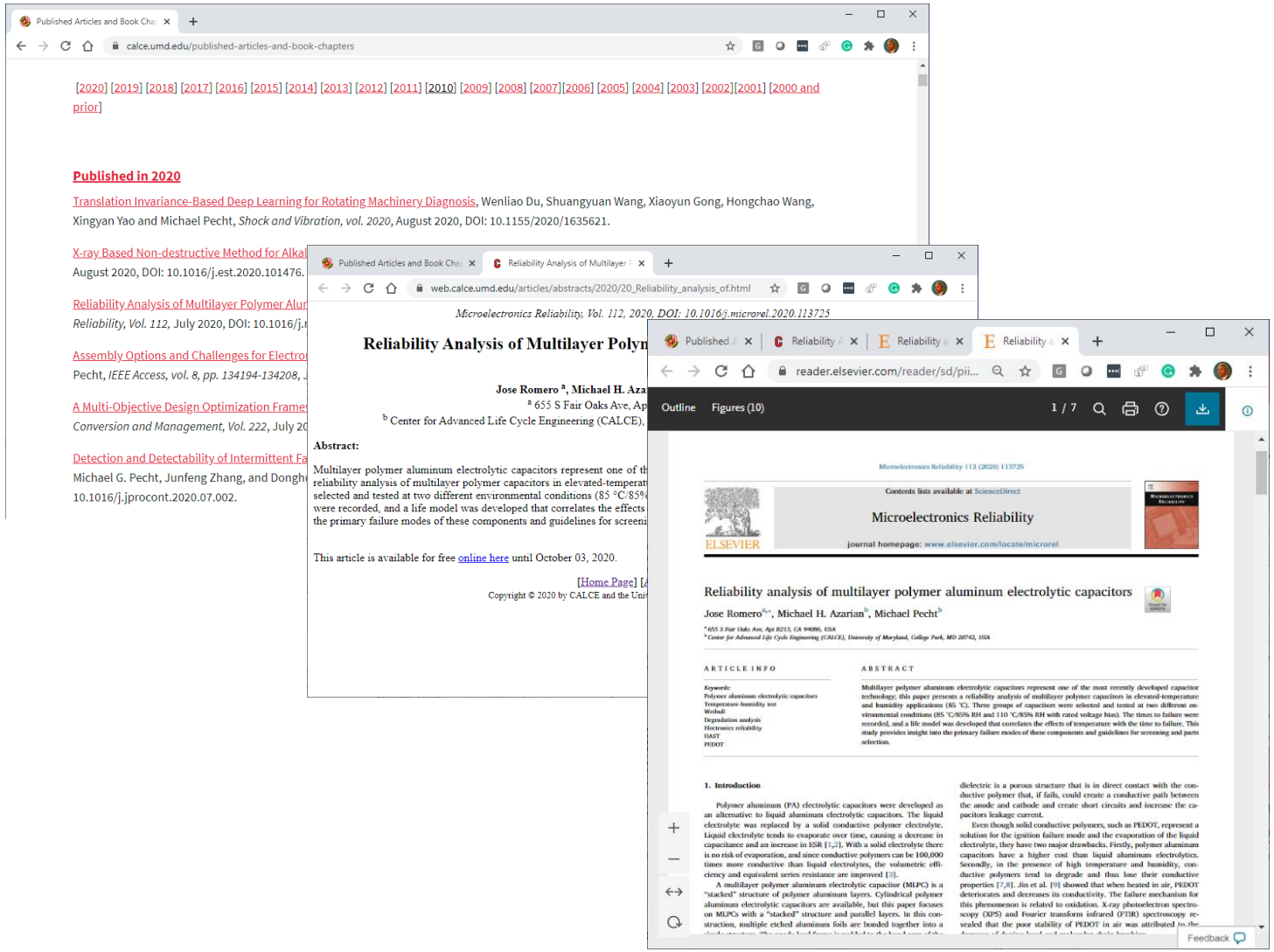
Recent

On August 5, 2021, Abhishek Deshpande presented **Why Current Approaches for Solder Joint Modeling are Inadequate and What to Do About It**

On February 16, 2021, Diganta Das presented **Are You Getting the Right Information for Your Electronic Parts?**

CALCE Publications

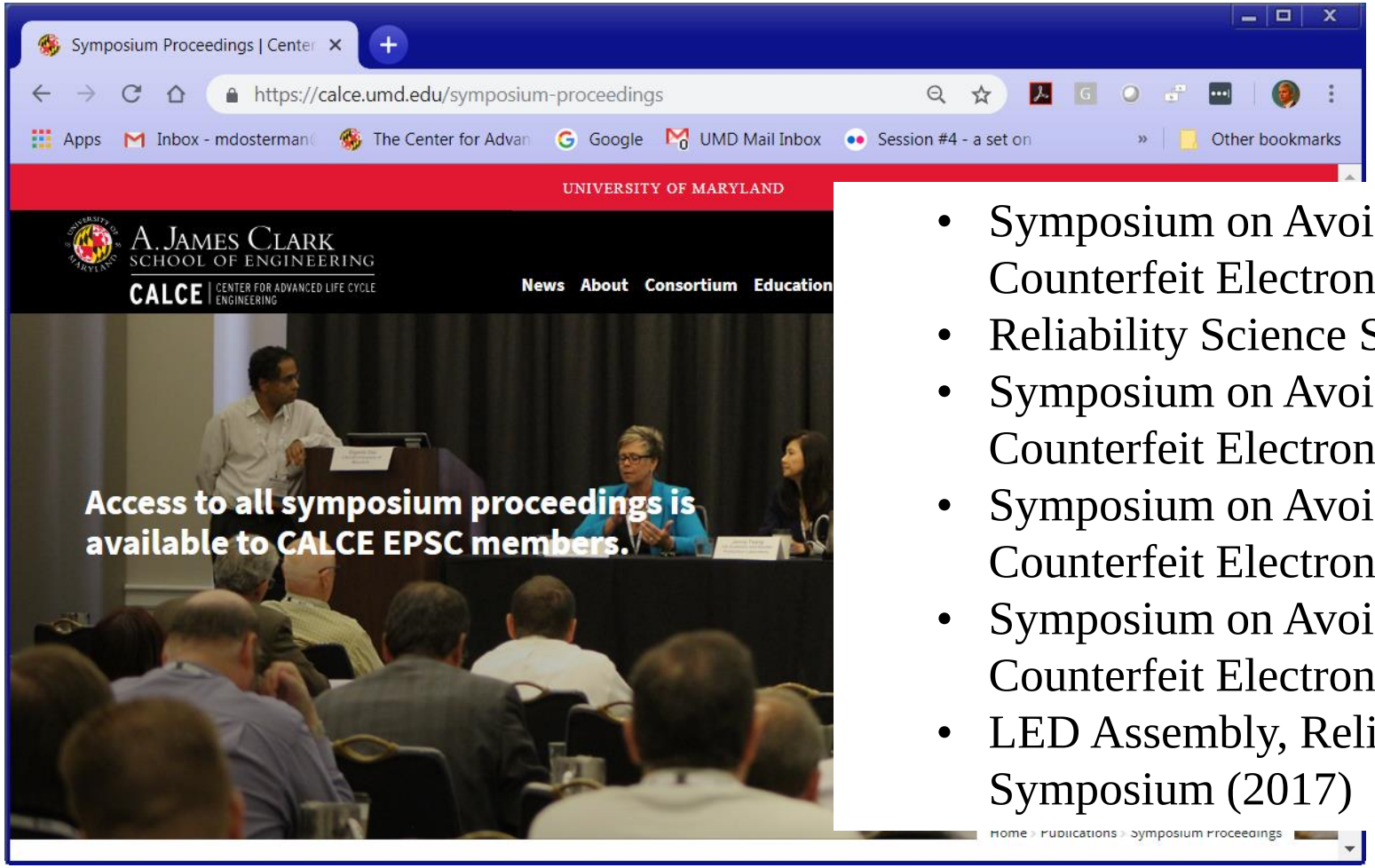
https://calce.umd.edu/published-articles-and-book-chapters



The CALCE website offers a comprehensive collection of publications by CALCE faculty and investigators. With a collection of over 1,000 publications, the CALCE Publication Archive contains a wide selection of journal articles, conference papers, book chapters and more that span the breadth of CALCE's existence, from its inception in 1985 to its most recent research.

CALCE Symposium Proceedings

https://calce.umd.edu/symposium-proceedings



- Symposium on Avoiding, Detecting, and Preventing Counterfeit Electronic Parts (2021)
- Reliability Science Symposium Spring 2021
- Symposium on Avoiding, Detecting, and Preventing Counterfeit Electronic Parts (2020)
- Symposium on Avoiding, Detecting, and Preventing Counterfeit Electronic Parts (2019)
- Symposium on Avoiding, Detecting, and Preventing Counterfeit Electronic Parts (2018)
- LED Assembly, Reliability, and Testing (A.R.T.) Symposium (2017)

Access to symposium proceedings available at this location.

USPAE DoD Lead-Free Solder Performance and Reliability Assurance Project

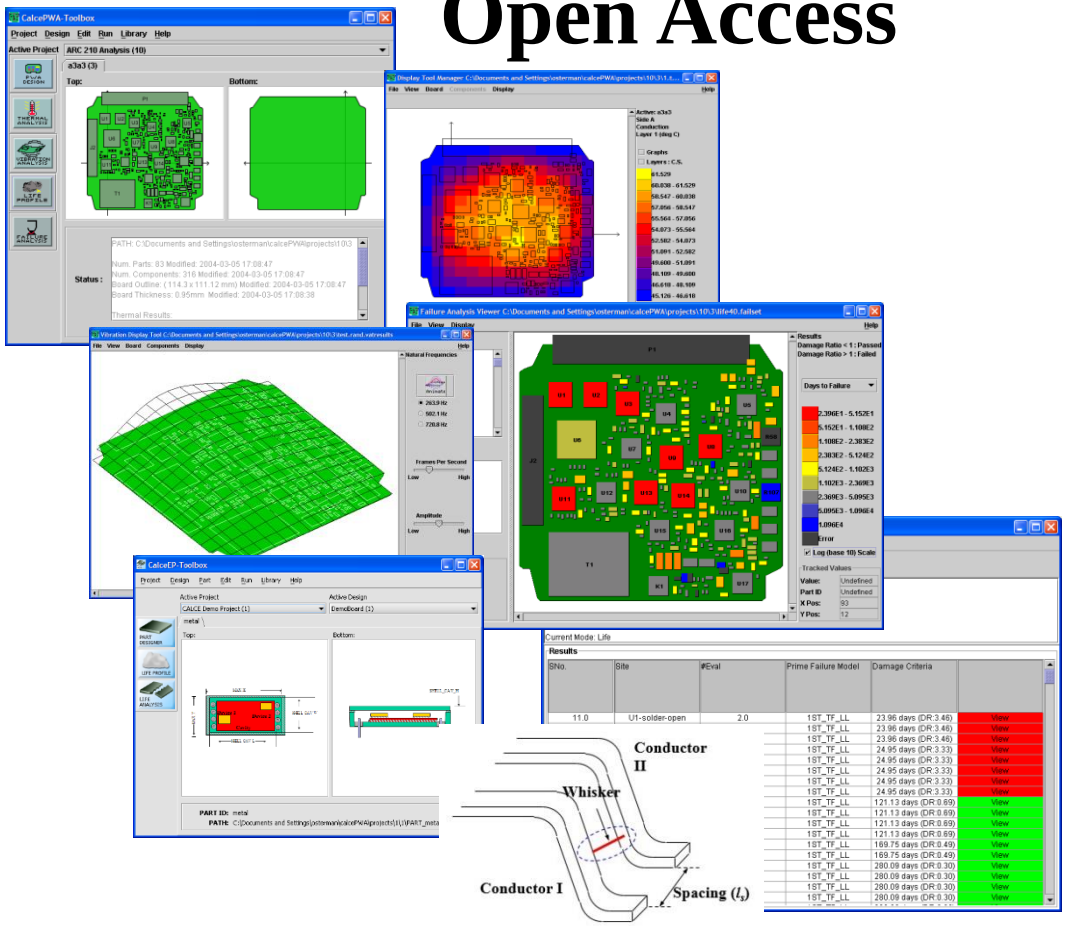
AUBURN UNIVERSITY PURDUE UNIVERSITY UNIVERSITY OF MARYLAND

- **Objective:** Provide the technical basis to compare and qualify solder alloys for select defense mission applications.
- **Funding:** $40 Million, 5 Year Effort, 2021-2025
- **Output:**
  - Solder Performance Specification
  - Solder Users Guide
- **Contact:** Michael Osterman (osterman@umd.edu) for more information

CALCE Simulation Assisted Reliability Assessment Software

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

Open Access



Assembly, Package and Device Failure Assessment Modules

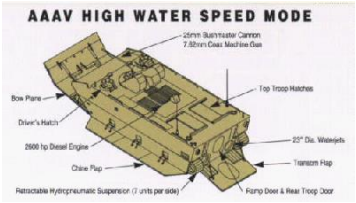
GM

83% reduction in design issues

>10% reduction in time to market

AAAV

Virtual Qualification of circuit cards providing life expectancy



Honeywell

Virtual qualification of engine Controller identified life limiting design issues

Rockwell Collins

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

Benefits of Consortium Membership

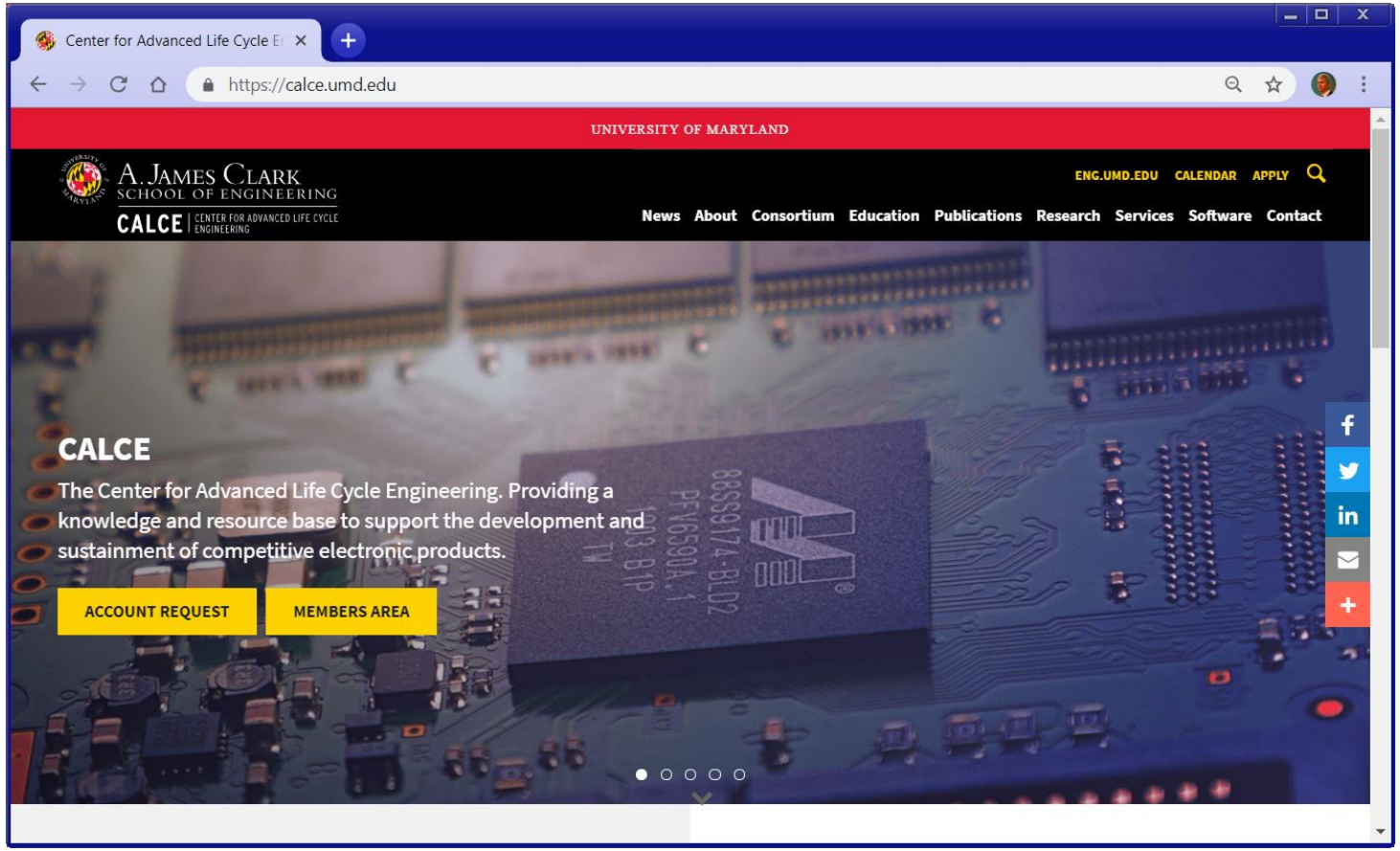
https://calce.umd.edu/join-calce-eps-consortium

- Participation in current consortium research projects
- Input into consortium research roadmap
- Shared access to results from over $100 million in research
- Technical exchange with other members
- Access to CALCE web site
- Advanced access to latest CALCE Simulation Assisted Reliability Assessment software and software support (EPSC)
- Attendance at semiannual CALCE technical meetings
- Access to CALCE instructional information
- Interaction with CALCE graduate students
- Technical consulting with CALCE Research Staff
- Involvement in the CALCE internship program
- Discount on lab services and CALCE sponsored events

CALCE Consortium 2021

- Vibration and Temperature Cycling Durability of SAC Solders: Effect of Sequential vs Simultaneous Loading
- Durability of IMC and Copper Traces under Vibration & TC loads
- Reliability of Fabrics Bonded with HAFs for Electronic Packing
- Durability of High Performance Lead-Free Solder Printed Wiring Boards
- Assembly Assessment and Durability of Low Temperature Lead-free Solder Interconnects
- Impact of Ripple Current on Multilayer Ceramic Capacitors
- Comparison of Electrical Contacts Plated with Thick Gold vs. Thin Gold over Nickel-Palladium
- Evaluation and Selection of Lubricants for Sliding Electrical Contacts
- Risk-Informed Storage Management for Electronic Components and Assemblies
- Insulated Gate Bipolar Transistor (IGBT) Reliability
- Active Device Life Assessment Methodology Development
- Prognostic Approach for Electrochemical Migration
- Lithium Ion Battery Degradation Process and Knee Point

Questions



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