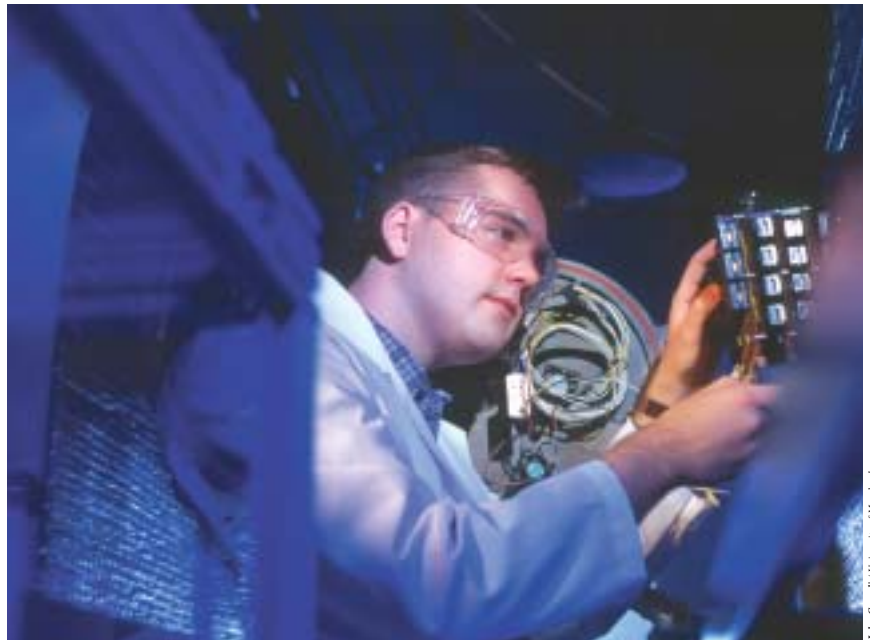




# CALCE Electronic Products and Systems Center

*Meeting the Global Need for Electronics Reliability through Physics-of-Failure*

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Since its inception in 1985 as one of the first academic centers focused on electronic packaging, the CALCE Electronic Products and Systems Center (EPSC) at the University of Maryland has evolved into the largest international academic/industrial partnership focusing on electronic product reliability, with over 100 supporting companies. These companies span the supply chain, from material suppliers, such as Merix and Sumitomo Bakelite, to component suppliers, such as Agilent and National Semiconductor, to systems integrators, such as Emerson and Seagate, to OEMs, such as Medtronic and EMC.

At the heart of the Center is the CALCE Consortium, with members located around the world, including England (BAE Systems), Germany (Siemens), France (EADS), Denmark (Grundfos), Switzerland (ABB), Finland (Nokia), India (General Electric), Singapore (Philips), Korea (Samsung), and Taiwan (Tatung). Over the past 15 years, these companies have invested over \$50 million into the CALCE EPSC to develop methodologies, models, and tools that address the design, manufacture and analysis of electronic products. Success in these areas have resulted in CALCE being recognized as a founder and driving force behind the development and implementation of physics-of-failure (PoF) approaches to reliability and life cycle prediction, as well as a world leader in reliability assessment, risk-managed insertion of lead-free products, accelerated testing, electronic parts selection and management, and failure analysis.

### The Center

The CALCE EPSC is a research center within the nationally ranked Clark School of Engineering at the University of Maryland. The Center currently employs more than 100 faculty, research staff and graduate students

from almost every engineering discipline and contains world-class simulation, failure analysis and test facilities. This collection of knowledge and equipment has resulted in ground-breaking research in a wide variety of areas, including flip chip reliability, part and system obsolescence, failure mechanisms in optoelectronics, characterization of high frequency signals in lead-free platings, and conductive filament formation. Collectively, CALCE researchers have authored over 25 internationally acclaimed textbooks, written more than 400 peer-reviewed articles, and developed an extensive set of web documents and tools for parts selection and management, obsolescence forecasting and management, and accelerated life-cycle testing.

While CALCE continually conducts research that benefits industry, it also has a strong academic component. An active research program and a wide range of dedicated and cross-disciplinary courses are complemented by a just-in-time teaching approach, whereby the latest research results and topics of significant industry interest are directly incorporated into the curricula. A semester-in-industry program allows gradu-

ate students to gain valuable industrial experience. Students at CALCE also benefit immensely from working in an ISO 9001 certified facility. CALCE was the first academic research center in the world to receive ISO 9001 certification.

### CALCE Consortium

Much of the research at CALCE is driven by the industrial partners who make up the CALCE Consortium. A virtual who's who of leading electronics, aviation, automotive, semiconductor, computer and telecommunication companies such as Nokia, Ciena, Seagate, etc., the consortium promotes research in areas that have an across-the-board impact on industry.

Consortium members pay an annual fee and in return receive access to CALCE's vast internet resources, acquire license to use CALCE's software tools, and provide input on future research directions. The Consortium also provides an organizational structure by which different sectors of the electronics industry supply chain can share information and influence practices and policies.

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Consortium research projects are performed on an annual basis. These projects are developed in collaboration with Consortium members and are designed to be consistent with the Thrust Areas developed by the Center to address the needs of the Consortium members and the Consortium as a whole. Core research proposals are presented at the Planning Meeting and become part of the next year's research agenda at the Fall Reviews Meeting.

## Reliability Assessment (calcePWA)

The need to predict reliability during the design phase has traditionally used handbook prediction methods, such as MIL-Hdbk-217 and Telcordia TR-332. These approaches do not take into consideration technology improvements, product architectures and lifecycle environments. Consequently, handbook prediction methods tend to be inaccurate, inapplicable as a predictive tool for new technologies and not well-suited for improving product design.

As a result of these deficiencies, CALCE developed the Virtual Qualification (VQ) approach to reliability assessment. VQ is a simulation-based methodology, based on physics-of-failure (PoF) principles, that assesses whether a part/system can meet defined life cycle requirements based on materials, geometry, and operating characteristics.

PoF-based assessment of product reliability is best-practice, but its use has been limited by the need to have access to material properties and to apply multiple failure models over hundreds to thousands of potential failure sites on one circuit card assembly (CCA). By implementing failure assessment

in a software solution, CALCE provides designers with the capability to rapidly identify potential life-limiting design issues, perform accurate cost-reliability tradeoffs, and reduce the traditional feedback loop in design qualification (old method: Design-Build-Test-Redesign-Rebuild-Retest; new method: Design-Qualify-Rede-sign).

The software, calcePWA and calceFAST, provides thermal analysis, vibration analysis and failure assessment at the component, product, and system level. It can import design data from Mentor Board Station, Cadence Allegro, and Zuken Visula, as well as MS Excel. It has been designed to run on Unix, Linux, Web, and Windows based platforms.

During the past three years, over 200 industry personnel have received training on how to use CALCE software for virtual qualification, reliability assessment, and accelerated test planning. For instance, CALCE software was used by General Motors to reduce the development time on a body control module by more than 10 percent and increase its first-pass success rate by more than 60 percent. Other examples include NASA using CALCE software to assess the state of the aging space shuttle fleet, and Honeywell using CALCE software in the reliability assessment of the AS 900 aircraft electronics engine control system.

## Accelerated Testing

Simulation-based failure assessment of electronic products is an integral part of meaningful and rapid product qualification. CALCE has worked closely with Boeing and Honeywell other companies in developing and demonstrating the usefulness of this pro-

cess. Most integrated circuit boards and electronic assemblies are tested in the prototype stage to determine whether they will meet their expected life-cycle. Using state-of-the-art laboratories, the Center has developed accelerated test methods that can effectively put years' worth of wear and damage on an electronic component-under controlled conditions-in just a few days or weeks.

After determining the relevant testing factors, researchers at CALCE EPSC create conditions of high temperature, high humidity, vibration, shock and impact, electrical stress and even high pressure or radiation of the electronic are to be used in avionics or spacecraft. Accelerated testing can address storage issues as well. It can answer the question of what would happen if assemblies had to remain in a warehouse in the heart of an industrial district for several years.

## CALCE EPSC Laboratory Services

As an offshoot of CALCE research, CALCE provides a full range of engineering services. These services are in the areas of supplier benchmarking, failure analysis, reliability assessment, material characterization and simulation. They are custom designed to help companies identify the causes of failure or poor performance in electronic products; assess and mitigate the risks of producing and incorporating new technologies; perform lifetime and lifecycle assessments of electronic products; design reliable components and printed wiring assemblies; improve product quality and reliability; and reduce time-to-market and time-to-profit.

Go to [www.calce.umd.edu](http://www.calce.umd.edu) for more information, or call (301) 405-5323 / email [membership@calce.umd.edu](mailto:membership@calce.umd.edu) ◆