Microelectronics Reliability, Vol. 47, No. 12, pp. 1847-1848, December 2007.

Guest Editorial

Introduction to Special Section on Electronic Systems Prognostics and Health Management

Safety critical mechanical systems and structures, such as engines, aircraft frames, and bridges, have benefited from advanced sensor systems developed specifically for in-situ fault diagnosis (often called health and usage monitoring, or condition monitoring). A considerable body of knowledge on health monitoring of mechanical systems, using various combinations of sensors that monitor loading conditions in the application environment already exists.

However, most complex systems today contain a significant portion of electronics content. In addition, studies have shown that most failures are often traced back to the electronics, not the mechanical components, of a system because electronics typically fail earlier. Therefore, the development of new health monitoring approaches that are applicable to electronics is in need. Furthermore, it is desirable to monitor the health of electronic systems and develop damage models that assess and predict the remaining life of such systems (often called prognostics) to enable advanced warning of failures and life-cycle management planning.

Prognostics and health management (PHM) is a framework of methodologies that permit the reliability of a system to be evaluated in its actual life-cycle conditions, to determine the advent of failure, and mitigate the system risks [1].

PHM methodologies are based on several key elements, as shown in Figure 1. First, prognostic sensors provide the capability to either monitor failure precursors or collect a history of environmental stresses. The data collected by prognostic sensors, in many cases, must be compressed for archival and analysis purposes while preserving the salient information contained within the data. Second, assessment methods must be employed to convert the sensor data into accumulated damage based on the relevant failure mechanisms. Third, remaining life of systems must be determined from the accumulated damage to enable a prediction of when the system will likely fail. The final key aspect of PHM methodologies is to derive value from remaining life estimations. Value can take the form of advanced warning of failures; increased availability through an extension of maintenance cycles and/or timely repair actions; lower life-cycle costs of equipment from reductions in inspection costs, downtime, inventory, and no-fault-founds; or improved system qualification, design, and logistical support of fielded and future systems [1].

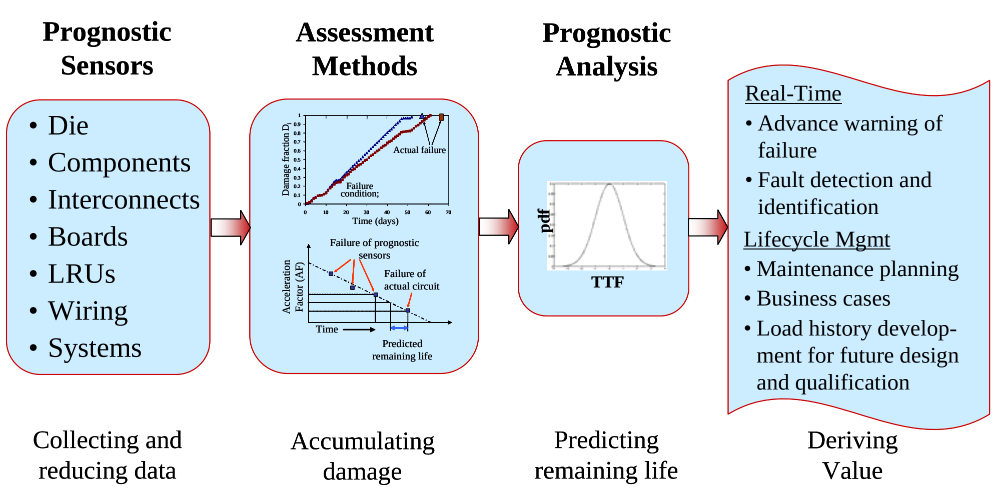

Figure 1 - Key elements of prognostics and health management (PHM)

Microelectronics Reliability, Vol. 47, No. 12, pp. 1847-1848, December 2007.

The articles in this special section present state-of-the-art research in the emerging areas of electronic systems PHM. The first four articles address the development of methodologies for performing electronics PHM: Lopez discusses an approach to PHM via system telemetry and pattern recognition methods; Gu *et al.* develop and validate a methodology for prognostics based on physics-of-failure models for electronics under vibration loading; Lall *et al.* discuss a damage precursors-based health management approach for electronic components; and Heine and Barker develop fatigue damage accumulation algorithms for use in health and usage monitoring systems for Army vehicles.

Five additional articles are included that address the application of PHM to electronic systems: Rouet *et al.* discuss the application of life consumption monitoring to printed circuit board systems; Brown *et al.* treat the application of PHM to a global positioning system; Goodman *et al.* apply PHM to switched mode power supplies; and Sandborn and Wilkinson address cost analysis and business case development for enhanced maintenance planning based on electronic systems PHM. Finally, Scanff *et al.* provide a complementary article that applies PHM-driven maintenance planning to helicopter avionics.

[1] N.M. Vichare and M.G. Pecht, "Prognostics and Health Management of Electronics," *IEEE Trans. on Components and Packaging Technologies*, Vol. 29, No. 1, March 2006, pp. 222-229.

Special Section Editors
Peter Sandborn and Michael Pecht
Center for Advanced Life Cycle Engineering (CALCE)
Department of Mechanical Engineering
University of Maryland, College Park, Maryland USA