Chapter V
Sustainable Electronic Product Design:
A Comparison of Environmental Performance Assessment Tools Derived from Life Cycle Thinking

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ABSTRACT

The ability to concretely and quantitatively measure the environmental performance of a product system is essential to support the establishment of objectives, the selection among alternatives, and continuous improvement in environmental management. Integration of the life cycle perspective into the assessment tools is one of the key challenges. On the basis of an extensive literature review, the authors describe the state-of-the-art of assessment tools available for product systems in the electronics industry. The intent is to enable the informed use of these product assessment tools with life cycle thinking so that a tool is chosen for the optimal application given specific goals. Furthermore, the classification scheme, the business initiatives, the economic, geographical, legislative factors, and the methodological challenges of the emerging industrial practice are thoroughly examined. Through these discussions, the authors hope to facilitate the methodological development that moves beyond discrete product boundaries toward system optimization and standard guidelines that best meet the needs of corporations in a global and societal context.

BACKGROUND

In the past 2 decades, the logic of life cycle thinking within environmental impact assessment (EIA) and the concept of sustainability have extended beyond the traditional focus of specific projects with long service life, such as infrastructure construction for transportation, to the field of consumer products with short life cycles. Taking environmental aspects into consideration creates new challenges for managers accustomed to focusing on engineering performance and cost elements. Such strategic and life cycle orientations need new measurement tools or quantitative indicators to simultaneously assess environmental, technical, and economic performance of products and product systems. Although there are many existing management methods and engineering tools, they do not allow the cross-functional integration to evaluate trade-offs between environmental performance, technical characteristics, and economic impact for product systems. An important quantitative analytical tool, life cycle assessment (LCA), has been developed and utilized for the evaluation of potential environmental impacts of product systems. Although the conceptual "from cradle to grave" framework is widely acknowledged, LCA has some methodological limitations to constrain its widespread application in industrial sectors, such as the expensive purchase price of LCA commercial software, the time-consuming procedure, the complexity of assumptions, the involvement of uncertainties in each evaluation process, the dependence on extensive databases, and the failure to satisfy the special requirements and priorities of individual companies. Because, thus far, industry employs different approaches to fulfill various objectives, there is a clear need to summarize the innovations and development in currently available tools and to discuss their strengths and limitations so that we can improve the overall implementation of a consistent set of operational tools by integrating the discrete approaches and better address the challenges associated with this field of study.

MOTIVATIONS FOR METHODOLOGICAL DEVELOPMENT

- **Legislative compliance:** Rapid technological advances have led to dramatic reductions in the time-to-market for new electronic products. The consequential reduction in useful product life can cause long-term environmental impacts associated with the disposal of electronic wastes. The European Union (EU), China, Japan, and various states within the United States, have announced new environmental protection laws aimed at the electronics industry (Schoenung, Ogunseitan, Saphores, & Shapiro, 2005). Accordingly, the companies need to adjust their strategies in the field of product design, selection of raw materials, and availability of re-use or recycling options for end-of-life products. The integration of environmental considerations into the design of product systems is difficult without standard reference systems or metrics to assess environmental performance of products. Concrete and quantitative measurement of product performance at all stages of the life cycle will facilitate legislative compliance and provide a foundation for establishing policy targets.
- **Benchmarking products and company activities:** Benchmarking activities for environmental management in industry means the process of identifying the best practice and the external reference with which to carry out the product performance assessment. To evaluate the current business performance and improve competitiveness by adapting the best practice, performance needs to be quantified into a single value indicator for comparison purposes. Few