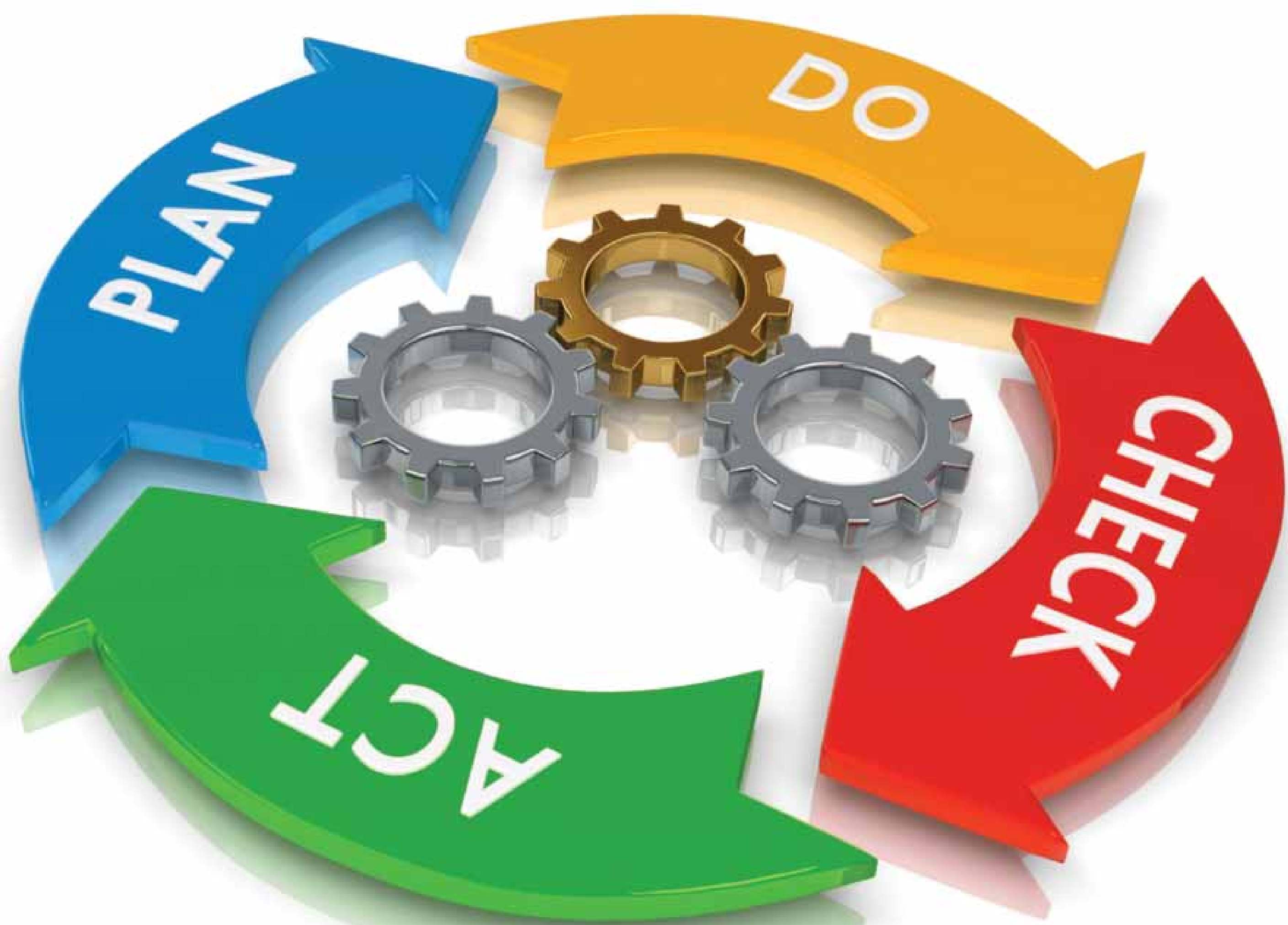
Managing Your Company's LCA Process

by George Pavlovich and Shen Tian

George Pavlovich and **Shen Tian** are both with Product Safety & Regulatory Affairs, Bayer MaterialScience LLC, Pittsburgh, PA. E-mail: george.pavlovich@bayer.com; shen.tian@bayer.com.

Life cycle assessment (LCA) is becoming increasingly popular in the United States as more organizations focus on sustainability and look for tools to decide on where to focus limited resources. However, many organizations still are struggling to understand the benefits and limitations of LCA as a tool for analysis and decision-making, as well as how to manage this tool effectively. This article provides guidance to those desiring to better organize and manage their LCA function. Although it is based on the authors' experience in conducting LCAs for manufactured products, the approach outlined also can be used for establishing an effective LCA process in organizations that provide services. In addition, the article provides some practical tips for applying LCA to the real business world.



The Challenge

LCA is a "compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle."[1] It is being recognized increasingly as a tool for developing environmental strategies, marketing sustainability of products, and identifying environmental improvement opportunities. Since the LCA approach identifies stages in a product's life cycle that contribute most to environmental impacts, it helps to focus efforts on environmental improvements that count. However, it is not always clear to some organizations how LCA programs should be managed, and when resources required for detailed LCAs are justified.

The International Organisation for Standardisation (ISO) published two standards in 2006 for conducting LCAs: ISO 14040 and ISO 14044.[1,2] These standards provide the framework and requirements for performing credible LCAs. The standards define the LCA process, including defining the LCA purpose and scope; performing a data inventory analysis; conducting an assessment of environmental impacts associated with life cycle energy, raw materials, and emissions; identifying representative technology for relevant geographical areas; and defining data quality needs. However, the standards do not provide guidance on managing an LCA process. Moreover, in everyday practice, it is more practical to apply ISO 14040/44 requirements relevant to a specific LCA's purpose and scope due to time and resource constraints.

Getting Started

A good way to begin is by developing a structured process. For many companies with quality or environmental management systems, such as ISO 9001 and ISO 14001,[3,4] this means incorporating procedures for LCA activities into ongoing certifiable management systems. For other companies, the simple yet powerful "plan-do-check-act" (PDCA) cycle still can be applied. The PDCA cycle provides a framework to manage and use LCAs effectively and efficiently. A comprehensive discussion of all the processes and tools needed for managing LCAs, and LCA use and limitations, is beyond the scope of this article, but some key aspects from an overall systems and day-to-day operational level are summarized on the following pages.

Systems Level

This refers to managing the overall process, and provides a map to key program elements. Examples of elements within the PDCA cycle are shown in Figure 1.

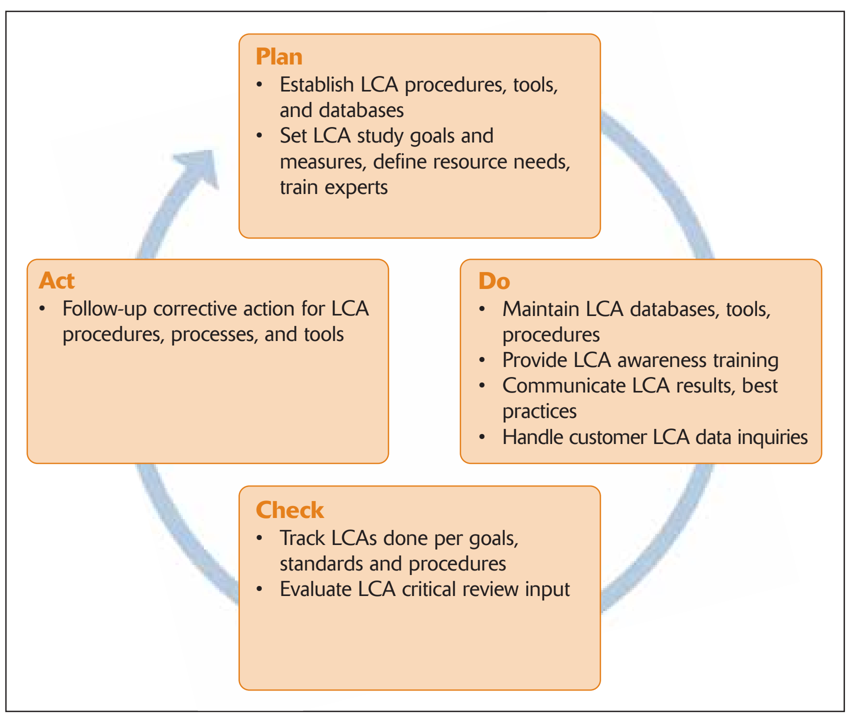
Plan

Planning includes the identification of procedures, tools, and data needed to conduct LCAs. Procedures can be viewed as an "internal standard" for a company-specific LCA process. Tools may include anything from spreadsheets to sophisticated commercial modeling software. Life cycle inventory data typically include a combination of data sources such as relevant public/commercial databases, LCA studies in the literature, and primary data from a company's own operations. Planning for the ongoing process includes establishing goals, priorities, and resources, with input based on business needs.

Do

This stage refers to ongoing activities needed to complete the LCAs, including maintaining a databank of life cycle inventory data sources relevant to

Figure 1. PDCA cycle.



It is not always clear to some organizations how LCA programs should be managed, and when resources required for detailed LCAs are justified.

the company's products and alternatives used for comparisons. Sharing best practices is especially useful, and one of the most critical needs for credible LCAs is quality life cycle inventory data. Implementing a best practice for data quality assessment raises the quality of an entire organization's LCA studies.

When customers request life cycle inventory data related to your company's products, having a process for responding to inquiries and supplying the representative data for your products pays dividends. Thus, the databank developed for internal LCA studies is useful for supplying data to customers as well.

Other ongoing activities should include LCA awareness training, as those working within your company in product development, sales, and marketing can help identify applications that add business value. A process for effective internal/external communication is essential, and LCAs should have a communications plan, which may include targeted audiences, e-mail alerts, presentations at trade shows, and so forth.

Check

This involves reviewing LCAs to check that they have been conducted according to company procedures and ISO 14040/44. A process for compiling feedback and regular review is essential for determining whether LCAs have been conducted effectively. For example, compiling comments from external LCA critical reviews is a good source of objective information useful for identifying improvement opportunities in areas such as data collection, data quality analysis, application of ISO 14040/44, and justification of LCA assumptions.

Act

Based on the analysis of input from regular reviews of LCAs conducted, the improvement opportunities should be prioritized and a plan for follow-up, tracking, and closure should be developed. For example, if input from critical reviews shows trends in deficient data quality analysis, then corrective actions could include improving the data quality evaluation process. Such a process includes a standard approach for measuring representativeness of data, assessing uncertainty of data inventory data used, and statistically evaluating the precision of inventory data used in LCA studies.

Operational Level

The operational level looks at tasks required for conducting specific LCAs. Internal procedures define various types of LCAs, internal responsibilities, review and approval processes, and reference to data sources. In everyday practice, it helps to create processes needed for efficient and effective application of LCAs. The experience gained from the operational level provides feedback to the system's PDCA cycle. Based on the authors' experience, three major types of LCAs summarized in Table 1 can be applied in practice.

G&S Definition

LCAs often are initiated when quantitative information on environmental benefits of products are useful for demonstrating competitive advantage. A literature search is first done to determine whether LCAs are available for similar applications. The literature search also identifies availability of LCA data for major life cycle phases, such as raw material manufacturing, product manufacturing and assembly, use phase, and end-of-life.

Plant operations and customers typically provide fundamental information on materials and applications, including a description of processes, formulation data, and potential applications. The LCA team drafts a Goal and Scope (G&S) document based on ISO 14040/44. This document includes the goal of the study, intended audience, the functional unit (e.g., performance of a product that is quantified, such as thermal resistivity of building insulation for a defined area and service life), identification of alternative materials if comparisons are made, the system boundary (e.g., cradle to gate, cradle to end-of-life), data availability, impact assessment categories (e.g., climate change, resource depletion, acidification), and methodologies. The G&S document is the basis for the LCA, and time spent up front on development is well worth the effort.

Screening LCA

When the G&S document is approved, the LCA team starts a preliminary screening LCA. Only data from internal, commercial, or publicly available databases are generally used. Plant-specific data are typically not used, as this may require weeks or months to obtain and verify. Assumptions are made to get a rough estimate, and identify critical life cycle phases. A two- or three-page report is generated and peer-reviewed internally. Because of limited time and resources, the accuracy of results is generally low in screening LCAs and such studies should not be used in comparative assertions or external publications. If this level of analysis satisfies business needs, no further action is needed. However, if more accurate or detailed information on environmental impacts are needed, the LCA team begins an internal streamlined LCA.

Streamlined LCA

This often begins with a plant data survey for internal/external customers for collecting energy/material usage and associated air/water/solid waste emissions from manufacturing products. Data collected from the plant are subjected to quality checks. The LCA team also conducts more in-depth searches in databases and literature for life cycle data. In addition, cut-off rules, as defined by ISO 14044 (i.e., justification that certain inputs/outputs can be excluded) are applied.

A data quality check using accepted criteria is applied to assess data reliability, completeness, temporal, geographical, and technological correlation. The draft internal streamlined LCA is reviewed and it is decided whether there is value in publicizing the results. If so, an LCA for external use is conducted, sometimes by including more impact assessment categories and methodologies, but always with a more detailed analysis, data check, and detailed report, including critical review per ISO 14040/44 for comparative assertions.

Full LCA

If the LCA results are intended to be published and a comparative assertion is made regarding the environmental benefits of one product over another, then a thorough external critical review is needed. At this level, a full LCA is compliant with ISO 14040/44 and addresses major environmental impacts. For comparative assertions used in external publications, a three-expert panel should be formed and at least one member should be an LCA expert, the other two typically being experts in the design, use, and manufacturing of the product. The LCA team responds to comments and revises the final LCA report until it is approved. Also, it is advisable to include a legal review before any report is published.

Case Study–Composite Floors

The following case study example summaries key steps in conducting a comparative LCA of composite flooring versus wood alternatives (e.g., plywood). A customer developing lighter weight composite flooring desires comparative information for marketing the product's energy savings and carbon footprint advantages. The LCA experts work with

Table 1. Types of LCA

LCA Type	Use	System Boundary	Environmental Impacts[a]	Data Quality	Critical Review Required?
Screening	Internal	Limited	Limited	Low	No
Streamlined	Internal	Limited/Complete	Limited/Complete	Medium	No
Streamlined	External	System boundary/environmental impacts are not complete		High	Yes[b]
Full	External	Complete	Complete	High	Yes[b]

Notes for Table 1:

a Complete environmental impacts are defined by the authors for purposes of practical applications as the following six impact categories: resources depletion, global warming, acidification, eutrophication, photochemical ozone creation, and stratospheric ozone depletion;

b Critical review per ISO 14040/44 required for published comparative assertions only.

Establishing a practical and efficient LCA management system that fits your organizational structure makes sense for your business, your customers, and the environment.

the customer to develop a clear G&S document that includes:

1. **Goal of the study:** demonstrate environmental benefits from lighter weight composite floors in transportation applications (e.g., truck bed flooring, container flooring).
2. **Intended audience:** Logistics companies.
3. **Functional unit:** floor with defined dimensions, service life, and vehicle transport distance.
4. **System boundary:** cradle to end-of-life.
5. **Data availability:** sufficient information on composite floor composition and energy consumption versus weight during transportation; limited data on wood alternative composition and weight, sparse data on end-of-life information.
6. **Impact assessment methodologies selected:** energy consumption and global warming.

After the G&S document is approved, a screening LCA starts with data searches. Examples of publically available life cycle data sources include the U.S. Life Cycle Inventory (National Renewable Energy Laboratory), PlasticsEurope, and Building for Environmental and Economic Sustainability (BEES; National Institute of Standards and Technology). Additional studies and energy use correlations are searched using various online databases.

LCA calculations are performed for three major life cycle phases likely to have the greatest impact on the life cycle: floor raw materials, transportation use phase, and end-of-life. Detailed information such as plant-specific data typically is not collected at this point, as the intent is to estimate whether the study's results are useful for marketing the benefits of the composite floor.

If the study has merit, a streamlined LCA begins by collecting data from composite floor manufacturers for on-site (gate-to-gate) energy/material usage and associated air/water/solid waste emissions. Data on raw material transportation modes/distances are obtained, as well as detailed data on floor installation, disposal options, and so on. As detailed data are obtained to refine previous calculations, cut-off criteria are applied also. Certain components under the cut-off criteria (e.g., 1% of mass, energy and environmental relevance) are excluded from the calculations after thorough evaluation. In the meantime, data quality and uncertainty are assessed. A method developed by Weidema (2011)[5] was found to be useful for data quality and uncertainty analysis.

Since this study involves a comparative assertion that may be published, a critical review is required by ISO 14040/44. The authors address dozens of questions and comments from the critical review panel. One major revision is adding a Monte-Carlo Analysis (MCA), which considers variations in alternative wood floor weight and transportation distances. Statistical distributions of energy savings and GHGs prevented are generated as results of the MCA. After all issues are addressed to ensure the study meets the requirements in ISO 14040/44 for report transparency, appropriate data, and reasonable assumptions, the report can be published.

Conclusion

At an overall LCA management system level, using the simple but effective PDCA methodology facilitates use of appropriate planning and tools needed to conduct LCAs, and it promotes continual LCA process improvement based on real-world feedback from critical review panels and customers. At the operational level, the "step-wise" approach assures systematic review and justification prior to assigning more resources for detailed LCAs. Establishing a practical and efficient LCA management system that fits your organizational structure makes sense for your business, your customers, and the environment. **em**

References

1. ISO 14040: *Environmental Management—Life Cycle Assessment—Principles and Framework, Second Edition;* International Organisation for Standardisation, 2006.
2. ISO 14044: *Environmental Management—Life Cycle Assessment—Requirements and Guidelines, First Edition;* International Organisation for Standardisation, 2006.
3. ISO 9001: *Quality Management Systems—Requirements;* International Organisation for Standardisation, 2008.
4. ISO 14001: *Environmental Management Systems;* International Organisation for Standardisation, 2004.
5. Weidema, B.P.; Bauer, C.; Hischier, R.; Mutel, C.; Nemecek, T.; Vadenbo, C.O.; Wernet, G. *Overview and Methodology—Data Quality Guideline for the Ecoinvent Database Version 3;* Ecoinvent Report No.1 (v3): St. Gallen, 2011: pp 81-84.