Life-cycle assessment: background and update[1]

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A tool for evaluating the environmental attributes of a product.

Life-cycle assessment (LCA) is a process or tool for evaluating the environmental attributes associated with a product, process or service and can be applied conceptually or systematically in a more quantified manner.[2] All applications of LCAs include the impacts along the entire continuum of a product's life (i.e., from cradle to grave, earth to earth). If the assessment does not include the entire continuum, it may be a sound system or component study, but should not be misrepresented as an LCA.

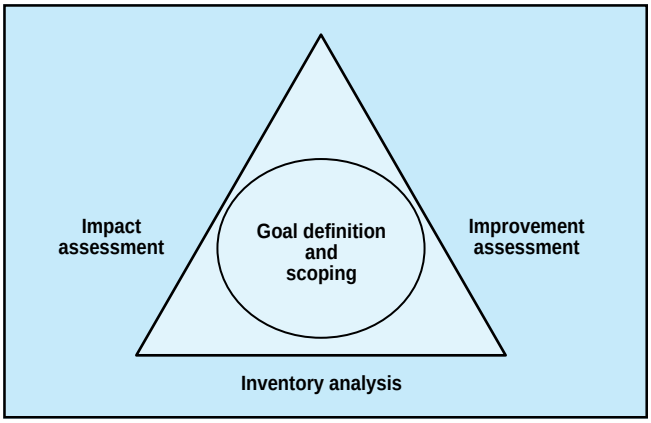
The Society of Environmental Toxicology and Chemistry (SETAC) has taken an active role in developing the science and practice of LCA. In addition, the International Standards Organization (ISO) has an active standardization effort ongoing to harmonize the practice of LCA. Both organizations subscribe to a four-component model for LCA which includes goal definition and scoping, inventory analysis, impact assessment, and improvement assessment.

LCA is not a new idea. Inventory methods were first developed in the late '60s to early '70s as a way of understanding the energy implications (and potential savings) of systems under study. However, in 1990, an expanded view of LCA was developed by participants at the first SETAC sponsored workshop to include the components outlined in Fig. 1.

ISO and SETAC further define the components of the LCA process as follows:

- The *Goal Definition* component of an LCA includes a clear and unambiguous reason for carrying out the LCA, the intended use of the results, the intended audience for the result, the initial data quality goals, and the type of critical review process to be employed. The *Scope* of the LCA study includes the system definition, the system boundaries, data requirements, assumptions, and limitations.
- The *Inventory Analysis* component of the LCA is where the relevant data are compiled and analyzed to identify all the environmental burdens associated with a product, package, process or activity under study. This is accomplished by identifying and quantifying the energy and material usage and environmental release throughout the life cycle from raw material acquisition to final waste management.
- *Impact Assessment* is the component of the LCA aimed at a technical, quantitative and qualitative classification, characterization, and valuation of the magnitude and significance of environmental impacts based on information provided from the inventory analysis.
- *Improvement Assessment* is the component of the LCA process in which the findings of all previous components are examined to identify opportunities for reducing the environmental impact of the system.

1. Life-cycle assessment technical framework (SETAC)



Today, LCA is used worldwide in both the public and private sectors. Public sector applications include the use of LCA to guide the development of EcoLabeling criteria in Europe. In the United States, LCA is being utilized by the Environmental Protection Agency (EPA) to guide the development of Environmentally Preferable Products to help carry out President Clinton's Executive Order. Perhaps of more importance to the nonwovens industry, the EPA is using LCA in a

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[2]Consoli, F., *et al.* (Eds.), *Guidelines for Life-Cycle Assessment: A "Code of Practice,"* Society of Environmental Toxicology and Chemistry (SETAC), 1993.

number of case studies as input to craft specific regulations. One notable example is the LCA of industrial laundry practices in which laundered shop towels will be compared with disposable alternatives.

Within the private sector, LCA has been utilized internally to help shape strategy or to identify product or process improvements. Interestingly, LCA provides a good framework for identifying cost savings opportunities as well as environmental improvements. In addition, LCAs have been used externally by the private sector to communicate environmental benefits of a product or to attempt to influence stakeholders such as regulators or legislators. Effective external use of LCA almost always requires the review of an impartial peer or critical review panel.

Individuals and agencies from all areas are now actively involved in the development and application of LCA. Within the United States, major agency involvement includes the EPA, the Department of Energy (DOE), and the Department of Defense (DOD). The private sector is actively involved in LCA on an individual company basis and through major trade associations such as the American Forest and Paper Association (AF&PA) and the Chemical Manufacturers Association. Academic representatives such as those from UCLA, MIT and the University of Tennessee are actively involved. Finally, a range of environmental activist and other nongovernmental organizations as well as a range of consultant firms are involved.

Net, LCAs have emerged as a useful tool employed by all sectors to help identify and reduce the environmental burdens of products, processes or activities. Because of this interest, LCA is actively undergoing development to both improve and standardize the tool and to develop data bases.

SETAC LCA efforts

SETAC is recognized worldwide as having the lead in developing the science and practice of LCA. SETAC has conducted five expert workshops (each 1 week long) to help in the development of the LCA tool and to identify further research and development needs. The SETAC workshops include:

1990—A Technical Framework for Life-Cycle Assessment

1992—A Conceptual Framework for Life-Cycle Impact Assessment

1992—Life-Cycle Assessment Data Quality: A Conceptual Framework

1993—Guidelines for Life-Cycle Assessment: A "Code of Practice"

1994—Application of Life-Cycle Assessment to Public Policy.

Proceedings from each of these expert workshops are available from the SETAC office in Pensacola, FL.

In addition to expert workshops, SETAC has established LCA Advisory Groups in the United States and Europe with the mission to advance the science and practice of LCA. The SETAC LCA Advisory Groups are composed of leading experts in the field of LCA representing all sectors. SETAC's advisory groups have established committees in several LCA topic areas of interest and hold technical training courses and educational forums. The work of SETAC in the LCA area is outlined in a monthly newsletter.

ISO LCA efforts

ISO established Technical Committee (TC) 207 "Environmental Management" in June 1993. As defined by ISO, "the overall success in the work of ISO TC 207 will be determined by its contribution to environmental improvement." To achieve this objective, the scope of the work of TC 207 is limited to standardization "in the field of environmental tools and systems."

The initial organization of the TC followed the recommendations made to ISO by the Strategic Advisory Group on the Environment (SAGE) established in 1991. At present, TC 207 has six subcommittees (SCs) and one Working Group (WG) assigned to various member countries for leadership as follows:

- SC 1 Environmental Management Systems—UK
- SC 2 Environmental Auditing—The Netherlands
- SC 3 Environmental Labeling—Australia
- SC 4 Environmental Performance Evaluation—USA
- SC 5 Life-Cycle Assessment—France
- SC 6 Terms and Definitions—Norway
- WG 1 Environmental Aspects of Product Standards—Germany.

Within this overall TC structure, SC5 Life-Cycle Assessment has the following leaders:

- SC 5 Secretariat: France, AFNOR, Pascal Poupet
- SC 5 Chairperson: Germany, BAYER, Manfred Marsmann.

SC 5 has met three times since the organizational meeting of the TC in 1993. Key actions to date include the adoption of the SC workplan that established five work groups, resolution of a number of issues involving other SCs or the TC, and the decision to accept the work of the general principles working group and to elevate this work to a committee draft document for comment and balloting by all members. If approved, this document would represent the first standard developed by this SC.

SC 5 has established the following initial working groups and leadership positions:

- Work Group 1: General Principles & Practices; Convener—USA, Frank Consoli
- Work Group 2: Inventory Analysis—General; Convener—Germany, Hans-Jurgen Kluppel
- Work Group 3: Inventory Analysis—Specific; Convener—Japan, Isashi Ishitani

- Work Group 4: Impact Assessment; Convener—Sweden, Sven Olof Ryding
- Work Group 5: Improvement Assessment; Convener—France, Henri Lecouls.

Representatives from the United States are actively involved in all aspects of the work of TC 207 and SC 5. The U.S. official member standards body to ISO is the American National Standards Institute (ANSI). Within the United States, ANSI has established a U.S. Technical Advisory Group (TAG) made up of representatives from all sectors. The TAG is organized in a similar way to the TC to allow members to develop specific U.S. input and perspective to the work developed by TC 207.

Within SC 5, the work of Work Group 1 is the most advanced. This group has met five times and has produced a committee draft document that is out for further comment to all member bodies. The draft is a general guideline document meant to introduce the concept and methodology of LCA, yet it does not specify LCA techniques. Future documents in each of the LCA component areas will provide additional and needed details.

The other SC 5 working groups are in various stages of document development. The Inventory work groups should have initial draft documents ready for SC consideration by late 1995. However, the work of WGs 4 and 5 is not nearly as advanced since both the Impact Assessment field and the Improvement Assessment field are still in early stages of scientific development. In fact, some member bodies have questions whether the work of WG 4 and 5 are ready for standardization.

There is no doubt that ISO TC 207 will continue to advance its work on a fairly rapid pace. Modeled after the ISO 9000 series, this set of environmental standards (numbered ISO 14000) is likely to have as great an impact on the field of environment management as the ISO 9000 series did on quality management.

Issues for the nonwovens industry

As the development and practice of LCA evolve in both the scientific community and the standardization community, the nonwovens industry needs to remain involved in the debate in order to provide technical and practical expertise. Some areas that warrant attention by the industry include:

Detail of Standards Documents: One of the many questions to be addressed by standards writers is the level of detail necessary in each document. Since a myriad of judgments are necessary in the conduct of any LCA, a number of countries involved in the standardization debate favor a rigid, more prescriptive approach to the documents. While this approach provides greater clarity, it limits flexibility and may prove to be burdensome to future users of LCA.

Cost to Implement LCA Standards: Directly related to the prior point, the total cost to implement the LCA standards in industrial settings may be high and limit the use of this standard only to organizations that have adequate resources. Clearly, the more rigid and prescriptive the approach, the greater the potential for adding costly auditing or review steps to the LCA process. These additions could drive up the cost of implementing these standards to potential users. (This issue is a common one across all standards in this area and is not unique to LCA.)

Technical Issues: Because LCA is still an evolving science and technique, a number of technical areas still require attention. Notable areas of interest to the nonwoven community include the way that the LCA practitioner treats the subject of renewability, both the material itself and energy. In addition, modeling and treating the flow of carbon (i.e., the carbon cycle) within the system is an important issue in this industry. Finally, the whole area of Impact Assessment is rapidly evolving and the tools and techniques developed to convert inventory results to impact categories and in turn to assess and value these impact categories is likely to attract considerable debate.

Critical Review Issues: LCA is far from a certain quantitative science today and as such, the results of LCA studies are dependent upon the practitioner's ability to adequately model systems and gather information regarding those systems. The process requires a number of fundamental choices and assumptions to both make the study practical and to adequately interpret the results. Obviously, the values of the practitioner and the commissioner of the study can dramatically influence the results. To combat these issues (especially on public studies), peer review or critical review panels have been utilized to provide a third party objective view of the study. Questions of interest for the nonwovens industry include when is a peer review necessary and who decides the composition of the panel?

Public Policy Applications of LCA: As the application of LCA moves from the industrial setting to the public policy arena, a number of important issues to the nonwovens industry regarding the practice and use of LCA in a public setting emerge. To determine the viability of LCA as a policy tool, a number of LCA pilot studies commissioned by Federal and State agencies are under way now. If these studies are successful, LCA could become one of the vital tools used for future policy initiatives. Obviously, it is important for the nonwovens industry to stay involved in these pilot programs to both monitor the direction and to help shape the results.

Conclusions and recommendations

Environmental tools like LCA are emerging and have the power to change the way we evaluate and measure the environmental impacts of our products, processes, and services. Demonstration projects for various LCA applications are rapidly occurring both within the private sector and, more recently, in the public policy arena. Worldwide groups have formed or are forming, to shape and develop the LCA tool. The work of two groups, SETAC and ISO, has been discussed in this paper.

For the nonwovens industry, the time to get involved in the LCA debate is now in order to have a proactive role in shaping and developing this potentially important tool.

On the basis of all we know, LCA will definitely touch your business in the future!

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