Applications: Life Cycle Thinking in policy making can help substantially towards a more coherent and less complex policy making and towards an efficient and effective improvement of products and production processes: Emission limits for regionally or globally acting emissions can be jointly addressed with general environmental target settings, while leaving it to the individual product operators which approach for improvement to implement. The Environmental Technology Action Plan (ETAP) employes such an approach. Equally, monitoring indicators such as on the impacts related to resource consumption, life cycle thinking provides the appropriate frame to meaningful, decision oriented information for policy makers.

Tools: Life cycle thinking addresses these life cycle- generated impacts through the use of different approaches aiming at minimizing them such as: Life Cycle Assessment (LCA) , Life Cycle Management (LCM) ,Life Cycle .

Like any measuring system, LCA's effectiveness and accuracy depend on the correct use of the tools. There are four phases of the LCA: scoping, inventory development, impact assessment and interpretation. Each of these phases has its challenges, but the pivotal one is scoping. An LCA stands or falls based on its scoping.

When a scoping is done, there are several things that are decided:

1. The system boundary: which processes are included and which ones are excluded
2. Impact categories: which environmental concerns are included and which are excluded
3. The system function and functional unit: the economic or social good provided by the goods or services in question.
4. Technical issues such as engineering conventions and impact assessment models
5. The audience of the LCA and therefore whether it will be a public and peer reviewed document.

The inventory stage of the life cycle assessment is conducted by evaluating the inputs and outputs from unit processes. For example, let's take a generic look at power production, a key input and a major source of environmental impacts for almost all LCA's. In the mining unit process the inventory will include all fuel and electricity consumed. Ideally, it would include information about the changes to the land that are cause by the mining of coal or oil. The inventory would also include information about the emissions to the air and water and any solid waste produced. The same set of inventory information is needed when evaluating transport of fuel, and production of electricity at the power plant, in fact, for all life cycle stages.

For most LCA's all these unit processes are grouped together into a single power generation unit process, including all its upstream impacts. That allows the user to reduce the hundreds or thousands of data points down to just a few dozen, a much easier number to deal with.

Impact Assessment takes inventory data and converts it to indicators for each impact category. A typical list of impact indicators includes:

- Global Climate Change
- Stratospheric Ozone Depletion
- Smog
- Acidification
- Eutrophication
- Natural Resources (habitat, water, fossil fuels, minerals, biological resources)
- Human Toxicity
- Ecotoxicity

An impact assessment takes each impact category and models the impacts using an indicator. An indicator does not typically measure actual impacts, but instead provides a numerical result that is believed to correlate well to the actual impacts. Climate change is measured using the global warming potential of the gases released into the atmosphere. It allows one to combine information about the releases of CO2, methane, and nitrous oxide together to get an overall effect on the climate, without modeling the actual impacts on health or ecosystems caused by the droughts, flood and sea level rise, as well as the temperature changes brought about by the changes in the atmosphere.

Other impact categories are calculated in a similar fashion, yielding a numerical indicator for each impact category. The list of impact indicator results is called the ecoprofile. It marks the end of the science of LCA-subsequent steps are based on value judgments.

After calculating indicators, it is possible to combine the different impact indicator results to yield a score of a single number. Or impacts can be compared through normalization-a method that moves the results into units that can be compared more readily. One example of normalization can be found in an ecolabel that we have developed, which reports results as a percentage of the US average for those items. Normalization is useful because it helps users of information put the results into perspective.

Life Cycle Interpretation reviews results for appropriateness, completeness and accuracy and provides guidance to the users of LCA as to how they should use the LCA results. Not all LCA's include this step.

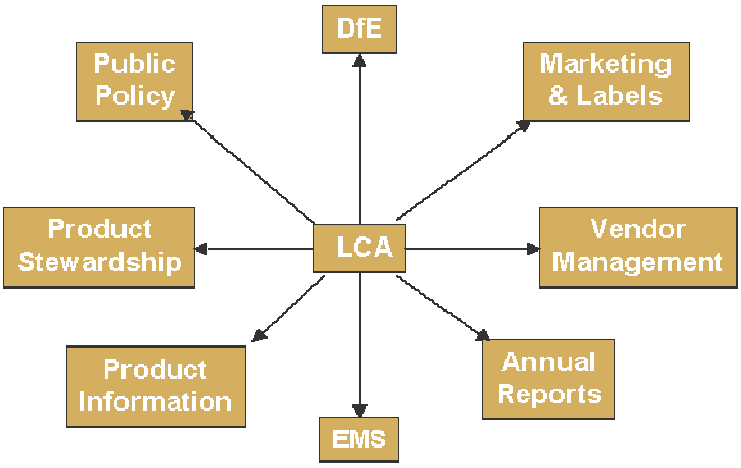
Life Cycle Assessment combines many environmental tools together: systems analysis, input-output analysis, risk assessment and environmental impact assessment. What is unique about the technique is that it reports all results in terms of the functional unit. In this way it directly links the market for goods and services to environmental improvement. It puts the fate of the environment into the hands of purchasers and specifiers of products-like all of you here. LCA gives you a good yardstick to make things get better.

If you have just picked up this book and are asking yourself, "How about Life Cycle Assessment? What is it? Is it going to be useful for me?" then this book is for you. It will explain all about Life Cycle Assessment in two–syllable words (well, mostly). You will learn how to get a Life Cycle Assessment (LCA) done, how to influence the outcome of an LCA, and how to use the results of an LCA. You'll even learn a few tricks to tell when things are going wrong and some hints on how to fix them. So read on.

First of all what is an environmental Life Cycle Assessment? A Life Cycle Assessment can be lots of different things—but all of them should include an attempt to evaluate the environmental aspects of a product or a service in a cradle–to–grave fashion. There are LOTS of things that have undergone Life Cycle Assessments: jet engines, diapers, drinking cups, computers, remediation techniques, trash disposal. You name it. If you can identify a system with a beginning and an end, you can look at what it does to the environment from beginning to end, and you can (in theory) do an LCA study.

As long as you are looking at the big environmental picture, you are doing a kind of Life Cycle Assessment. BUT (and this is important) there are now international standards that lay down rules about how to do an LCA. If you want to follow the international standards (ISO 14040 and others) you'll have pretty strict limits placed on what you can do. This book will explain most of that and will show you where to get more help if you need it.

Environmental Life Cycle Assessment is based on the very logical concept that if we knew all the environmental impacts of a product or service, we could make good environmental decisions about that product or service. The way you do an LCA (as described in ISO 14040) is you look at all the mass and energy flows from the time you extract the raw materials from the environment, through the product manufacture, its use, and its final disposal. Following all that mass and energy should tell you what the product is doing to the environment.



Some proactive companies such as AT&T and Volvo are placing LCA at the heart of their environmental strategy. You can use an LCA framework for identifying environmental aspects and impacts. LCA makes an excellent tool for communicating to management and engineering and operations inside the corporation, too. Life cycle indicators are almost tailor–built for environmental performance evaluation (the ISO 14030 series of standards). And they make a good basis for communicating to stakeholders and customers.

The Many Uses of LCA

Actually doing an LCA and understanding the results is another kettle of fish, as we'll explain later. But mere mortals (like YOU) can and have gotten very useful LCAs done, with the help of LCA practitioners. Very few organizations actually perform LCA's solely with in-house talent, for the same reason that few organizations perform their own remedial work. The focussed technical ability needed to perform an LCA is not a core competency of most organizations, and therefore is outsourced. Nevertheless, you need to understand the ins and outs of LCA's in order to manage the consultant doing the work, and this book is aimed primarily at helping you do that.

What kinds of questions does LCA answer, and what can you use it for? Lots of different kinds of things, including:

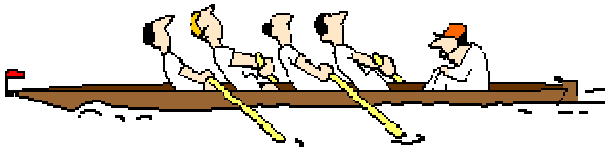
- Marketing (does this product have less impact than others?)
- Purchasing (which product has the least impact?)
- Design (what should we change to make our product more environmentally friendly?)
- Benchmarking across an industry or across divisions of a corporation (who is best/worst; where are we?)

- Year to year tracking of environmental performance (are we getting better or worse?)
- Benchmarking between industries (can my product/service accomplish the same goals with lower environmental impact?)
- Policy (where should we have regulations to get the biggest benefit?)

The most common reason that people do LCAs is for market advantage for environmentally preferable products. LCAs document the performance of products, and so they can be used for top-line advantage. Of all environmental techniques, LCA is unique in this respect. Because LCA's can influence the financial success of a company, they provide an excellent wedge for the integration of environmental systems with other systems.

One new use of LCIA's is in validating greenhouse gas emissions to have marketable credits under the Kyoto Protocol. Although the markets for carbon credits (as they are known) is just in its infancy, the opportunity for selling them is considered to be very large.

LCA has the potential to provide a new model for regulations; one based on a synoptic view of environmental impacts rather than focusing on chemical risk management. This can give us a chance to address issues like species diversity on the same page as toxic effects.



The outcome of an LCA depends to a large extent on the people involved in the study (you and your peers and your LCA consultant) and how they work together. Besides the practitioners of LCA, there are the commissioners of a study, the experts reviewing the study and the interested parties (or stakeholders inside and outside of an organization) who can have input into the study. Usually, when a study is commissioned, a team works together to decide the goals of the study and who should perform it. In the very common case where the commissioning body is a large firm, a team will manage the project. The team is usually cross–functional and includes people from engineering, manufacturing or operations, environmental, marketing, and purchasing functions. The knowledge embodied in these different groups is essential to assure a successful outcome of the study.

Most LCA's are done using outside experts (consultants). This is because to be an LCA practitioner, you need a special set of skills, including:

Understanding of industrial processes in several industries

Knowledge of data sources both public and private

Understanding of fate and transport modeling

Understanding of human and ecological toxicity

In addition, doing an LCA is time consuming, and the pace of action in most organizations means that staff does not have enough time to devote to these studies. Some organizations do perform LCA's internally, especially after they have had thorough LCA's done and have

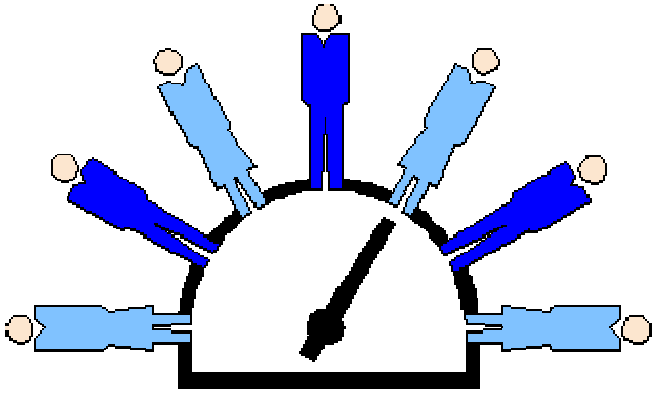
developed some internal expertise. This is most common for simplified LCA's that look at only a few issues or for partial assessments looking at only a one life cycle stage.

One of the results of the thousands of LCA's that have been performed over the last few decades is that the accumulated knowledge has made it easier and therefore cheaper to do an LCA. Early on, LCA's could take millions of dollars and years to perform. Now, depending on the scope of the project, the cost of has dropped to a few to tens of thousands of dollars to perform, and they can be completed in a matter of months.

Depending on the intended use of the study, you may or may not want to include outside stakeholders in its design and review. When studies are published and a claim that one product or service is better than another, outside review is required. If studies are intended to be internal and limited in scope, outside review is not appropriate or needed. Some studies are short engineering exercises that answer minor questions about design choices. It is just not reasonable to expect much stakeholder input in this kind of study. In between, consultation with stakeholders may or may not be a good idea.

How much stakeholders are included will depend on how confidant you are that you know which issues are the important ones, and how much of the results of the study will be made public. Publication is the key issue, but remember that if you plan to use LCA as the organizing concept for your EMS, you want to make sure you aren't leaving out anything important. Consultation with stakeholders can help you think of issues that you might otherwise miss.

If you have decided to include stakeholders, the very beginning of a study is the best time to identify stakeholders to the study. They may include vendors, customers, and competitors as well as environmental groups and academics. For potentially controversial studies, consulting with the stakeholders during the design of the study is a good idea. You have a better chance of including all the right questions, and the right data get collected when you ask everyone's opinion up front. It is less likely that the study will be discredited afterwards. You really want to avoid this very expensive and embarrassing outcome.



Each person involved in a study has a different role to play. That role will depend upon the scope of the study, but will mostly be driven by the specialized knowledge each possesses and what the job duties are. You need to decide what your role will be so you can do a good job—and also so that you can find the most important parts of this text, which will make separate recommendations for different roles.

Here are some of the roles that may play a part in an LCA study.

The environmental expert within an organization is typically the leader of the internal team managing the study. He or she serves as a technical resource, but the primary role will be coordinating the project overall. That means:

- Scheduling and coordinating all internal meetings
- Providing minutes of the meeting to all participants
- Developing internal communications as necessary
- Following up on assigned tasks
- Smoothing away problems which come up during the course of the study
- Being the primary point of contact with the LCA practitioner
- Coordinating meetings with stakeholders

This book is largely aimed at the person coordinating the project. He or she will be the person most responsible for the completion of a useful LCA. We also include some tips for others participating in the study.

The engineer within an organization supports the study by:

- Being an expert on the engineering management systems in the organization
- Coordinating access to engineering data for the study
- Assuring the data and data format is useful for internal organization use (if the study is primarily oriented towards design issues).

If the engineer does a poor job of linking the data collectors (LCA practitioners) with the data sources, the study will have a poor or incomplete data set. It is VERY hard to draw legitimate conclusions from an incomplete data set.

The manufacturing/operations function on the team:

- Provides important information about the manufacturing or operations
- Coordinates getting the operational information for the study

This role is essential to assure that the operations studied are representative of the normal operations yielding the product or service being studied. Otherwise the conclusions of the study may be plain wrong.

The purchasing representative on the team will:

- Support the team in choosing a practitioner to perform the study

If the study compares one vendor's products to another's, the purchasing representative will:

- Coordinate with vendors
- Make sure that the data collection and data format can support purchasing decisions

Needless to say, LCAs that help make a purchasing decision can be a touchy subject. It is in the best interest of the vendors to work closely with their customers to make sure a fair and high

quality assessment is done. Some LCA's are actually initiated by vendors, and they provide an opportunity to improve relationships with customers.

The marketing representative will play an important role if the study is being performed to support public statements about the environmental status of the product or service. He or she can also be very helpful in identifying and contacting potential stakeholders for the study.

The outside expert (sometimes an academic) provides a disinterested review of the study. This means:

- Reviewing the study to assure that it conforms to current best practice
- Checking that the study format is appropriate to the goal and scope of the study
- Checking that the assumptions and methods of the practitioners were correct and properly executed

Typically, a panel of outside experts reviews LCA studies that are disclosed to the public. In essence, the outside expert performs the role of an auditor.

Outside experts are sometimes used during the performance of the study if some aspects of the study are considered to be unusual or controversial. In this case, the role is to assure that the methods being used are the best available. Here the expert adds credibility to the results of the study.

A representative of the public or stakeholder (usually a non–profit (NGO) or a community group) is most likely to be interested in a study when it supports decisions that can have a local impact, for example the choice of a cleanup technique, or the installation of a power plant. The commissioner of the study solicits sometimes stakeholders, other times they have to volunteer themselves. In either case, a stakeholder should:

- Provide information on the concerns of the stakeholder
- Participate in scoping
- Provide technical review

A positive stakeholder relationship greatly strengthens the quality of the study. The earlier this participation occurs, the better will be the outcome.

Vendors are an important stakeholder in two scenarios: when purchasing decisions are being supported by the study, and when the study encompasses the environmental impacts of parts or subassemblies of a given product or service. It is clearly in the best interest of the vendor to assure that an equitable and appropriate analysis is made of its own products and services. To do this, the vendor:

- Offers advice in the scoping stage
- Provides technical data
- Coordinates vendor's internal resources with the customers'
- Participates in data quality review (if possible)

Be aware that vendor management is one of the purposes of many LCA studies. Organizations seeking to meet the requirements of other ISO standards to minimize the environmental effects of their vendor chain often use LCAs as a tool to accomplish this task. If you can support the data collection exercise of an LCA well, you have a competitive advantage versus other

potential vendors. This advantage is even greater if you can show that your product has a lower overall impact.

That about covers it. You should fit into one of these roles if you are actually participating in an LCA. If you are only reviewing the data from an LCA to see if you can use it for something else, you should be aware that a whole group of people with different agendas worked together to produce the final product. Make sure that you understand who commissioned the work and why, and pay close attention to the data quality program embraced in the study.