

ENVIRONMENTAL

Life Cycle Management

*A Guide for
Better Business
Decisions*



Canada



Environment
Canada

Environnement
Canada

Authors

This publication was written for Kevin Brady and Andie Paynter of Environment Canada

*by Marbek Resource Consultants
with Consoli Consulting Company
and the Pembina Institute for Appropriate Development*

Acknowledgements

The authors would like to thank the following reviewers of an early draft of this document for their constructive ideas and suggestions:

Tom Armstrong, Manager, Environment, Health and Safety, Xerox Canada Ltd.
Trevor Batte, Environmental Coordinator, Astra Canada
Phil Fleming, Senior Policy Advisor, Environmental Affairs Branch, Industry Canada, and other colleagues
Mike Miller, Director of Research and Development, CFC/INX LTD
Lorne Morey, Industry, Economics and Programs Branch, Canadian Forest Service

Canadian Cataloguing in Publication Data

Main entry under title :

Environmental life cycle management : a guide for
better business decisions

Issued also in French under title: Cycle de vie
environnementale.

ISBN 0-662-25636-0

Cat. no. En21-161/1997E

1. Industrial ecology — Handbooks, manuals, etc.
2. Industrial management — Environmental aspects —
Handbooks, manuals, etc.
3. Product life cycle — Environmental aspects —
Handbooks, manuals, etc.

I. Canada. Environment Canada.

HD9720.E68 1997 685.4'08 C97-980134-6



ISBN: 0-662-25636

Catalogue No.: En21-161/1997E

Printed in Canada on recycled paper.

Table of Contents

About this Guidebook	ii
1. An Introduction to Environmental Life Cycle Management	
The Life Cycle Concept.....	1
Environmental Life Cycle Management	2
Why LCM?...The Business Advantage	3
Why LCM?...Staying in Step with Important Policy Trends.....	5
Life Cycle Management in Context.....	5
2. Life Cycle Management in Action	
A Life Cycle Management Framework.....	7
LCM on the Job	8
Job Function #1: Strategic Management	8
Job Function #2: Product Design	10
Job Function #3: Procurement.....	13
Job Function #4: Management Accounting.....	16
Job Function #5: Marketing and Communications.....	18
3. Making Life Cycle Management a Corporate Habit	
A Corporate Action Plan for Life Cycle Management	21
Step 1: Adopt a Corporate Policy Statement	21
Step 2: Raise Awareness and Build Commitment	22
Step 3: Train Employees	23
Step 4: Provide Infrastructure	23
Step 5: Measure Success and Provide Feedback	23
Additional Keys to Success.....	24
Some Concluding Thoughts.....	24
A Life Cycle Management Toolkit	
Tool #1: Product Life Cycle Mapping	28
Tool #2: Identifying Inputs and Outputs	31
Tool #3: Design Checklist	35
Tool #4: Engaging your Suppliers.....	38
Tool #5: Life Cycle Assessment and Related Methodologies.....	42
Tool #6: Priority-Setting Criteria.....	44
For More Information	45

About this guidebook

What is Life Cycle Management?

In brief, life cycle management (LCM) is about minimizing environmental burdens throughout the life cycle of a product or service. The life cycle includes all activities that go into making, using and disposing of a product. (LCM is explained in more detail in Chapter 1.)

Why should I be interested in LCM?

Adopting a life cycle perspective helps ensure that a company's choices are environmentally sound — and that's in everybody's interest. Companies implementing life cycle management may also benefit from competitive advantages, including cost reductions and enhanced public image.

Who can use the guidebook?

The guidebook is designed primarily to help managers and other employees in small- and medium-sized companies take a life cycle approach in their business decision-making. But it should be of interest to other audiences as well. Larger companies may find the concepts and suggestions useful in moving life cycle management out across their organizations. The guidebook may also be helpful to government agencies and non-governmental organizations interested in supporting effective environmental action by industry, or in minimizing the environmental burdens and costs of their own purchases and practices.

Although life cycle management can be applied to virtually any system or activity, the focus to date has been mostly on products, both commodities and manufactured goods. The concepts and approaches introduced in this guidebook are therefore directly relevant to processors (resource and energy companies) and manufacturers, but most can also be used by service companies. So where the term "product" is used, it can usually be interpreted to include "service".

How the guidebook is organized

The first chapter of the guidebook gives an overview of the concept of life cycle management and its associated business advantages. Chapter 2 offers a framework for life cycle management, and includes examples applying the framework to five different job functions. Chapter 3 provides step-by-step guidance for integrating life cycle management throughout all levels of an organization.

The second part of the guidebook is a life cycle management toolkit. Chapters 2 and 3 include cross-references to the six tools that make up the kit, where appropriate. The toolkit is the core element of the guidebook for those who wish to develop a working knowledge of, and begin to apply, life cycle management.

Finally, there is a list of resources at the end of the guidebook, for those who would like more information.

1

An Introduction to Environmental Life Cycle Management

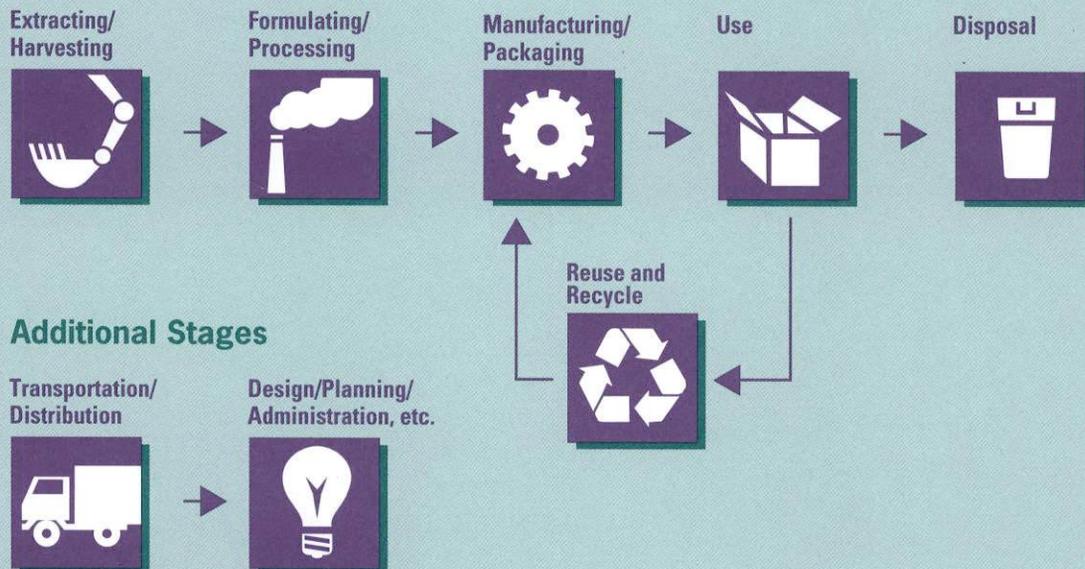
The Life Cycle Concept

A product's life cycle is made up of the activities that go into making, using, transporting and disposing of that product. The life cycle is commonly shown as a series of stages, as illustrated in the figure below.

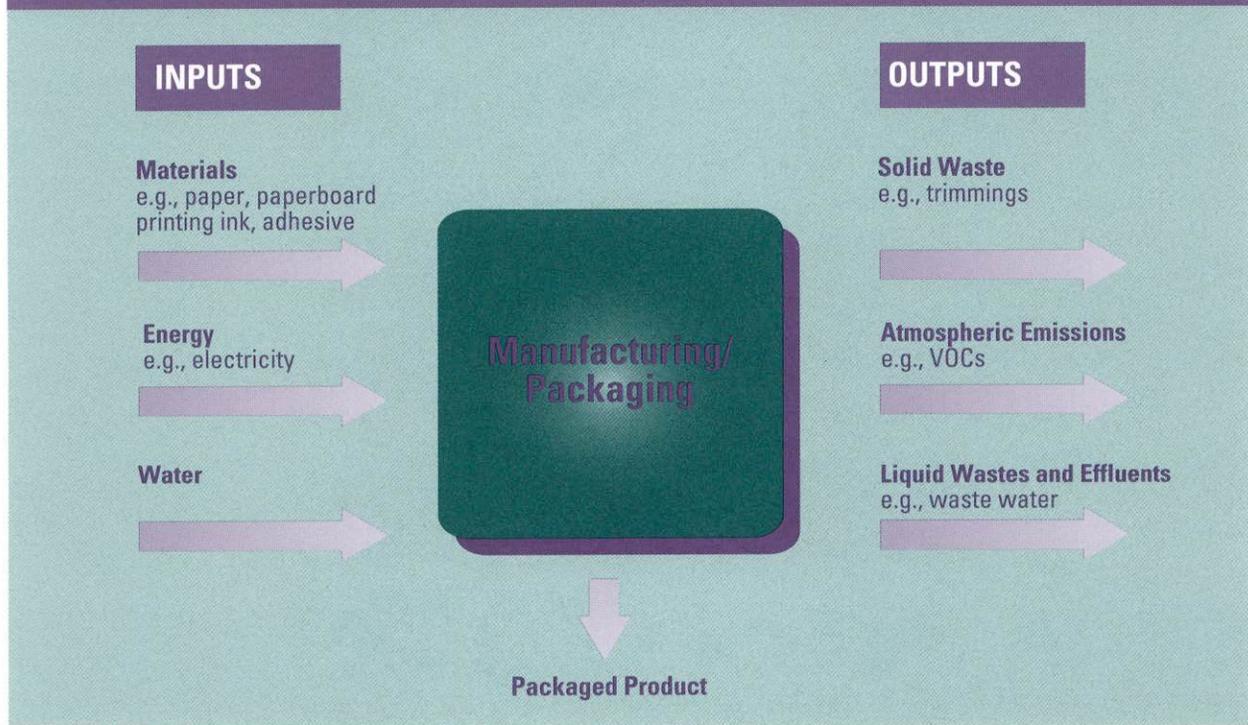
Your company is likely to be directly involved in one — or perhaps more — of the stages shown. Life cycle stages that the product goes through before your company becomes involved are referred to as “upstream” stages. The stages that follow your involvement are “downstream”.

Why is the life cycle concept relevant to the environment? The environmental problems associated with a given product can be traced back to the *inputs* that go into the product (land, materials, water, energy), and the *outputs* generated (e.g., air emissions, liquid effluents, solid wastes), at each stage in the life cycle.

Basic Life Cycle Flow Diagram



Sample Inputs and Outputs Associated with a Single Life Cycle Stage



Environmental Life Cycle Management

Life cycle management is an integrated approach to minimizing the environmental burdens associated with a product or service over its life cycle. Does this mean that your company should take on the environmental management challenges of your suppliers, recyclers or other actors in the product life cycle? No. But adopting a life cycle perspective can help ensure that choices made by your company are environmentally sound.

How does this happen? All companies make decisions that can influence the inputs and outputs of upstream and downstream stages of the life cycle. Examples of such decisions include:

- which product(s) to manufacture
- design of the product(s)
- types of feedstock to be used
- sources of supply of the feedstock
- sources of energy to be used
- type and amount of packaging
- management of manufacturing wastes
- instructions given to users
- management of post-use wastes.

Taking an LCM approach can change the decision-making process and result in different outcomes. As illustrated by some of the case examples in Chapter 2, life cycle considerations are already influencing these kinds of decisions in many businesses. Life cycle management is simply about making this happen in a more deliberate and systematic way. Because it is applicable to a wide range of decisions, LCM is *not* a task to be assigned to one individual or office in the company. It is a commitment, mindset and approach to be adopted throughout the company.

Why LCM?...The Business Advantage

LCM makes sense from a business perspective as well as an environmental one. Because LCM puts better information in front of decision makers, it can contribute to the development of competitive advantages. Benefits will vary from company to company, but most businesses can expect to experience at least some of the advantages described in the box on the following page.



Life cycle management is...

- A practical approach for improving product-based decision-making
- A means of linking environmental improvements with economic efficiency
- A basis for identifying mutual opportunities among companies at different stages in the product life cycle
- A better way to conceptualize and structure the environmental work that companies are already doing.

Life cycle management is not...

- A specific methodology, technique or “add-on” environmental requirement
- A substitute for an environmental component in your corporate strategy
- An alternative to action on clear and specific environmental issues
- A basis for making general claims about the environmental superiority of a product.

Life cycle management is not life cycle assessment

Life cycle assessment (LCA) is a specific method for systematically identifying, quantifying and assessing inputs and outputs (i.e., sources of environmental impact) throughout a product's life cycle. It is one of a range of tools that support life cycle management, but is not a prerequisite for life cycle management. An overview of LCA is provided in the Toolkit (Tool #5).

LCM BUSINESS ADVANTAGES

Lower Costs

Cost savings can result from design and process changes that reduce material and energy consumption, emissions and wastes. Lower quantities and reduced toxicity of wastes and emissions also mean less risk of fines and penalties for non-compliance with health and environmental regulations.

Improved Liability Management

The risk of future liabilities may also be diminished, because LCM can help minimize environmental, health and safety problems associated with the production, use, servicing and disposal of the product.

Improved Strategic Decision Making

By providing a clearer picture of product-related inputs and outputs, LCM can create a basis for a more complete financial assessment of investment options. The implications of capital investments, operating expenses and future liabilities can be assessed together.

Better Product Design and Value

A fresh and comprehensive perspective on product characteristics and production requirements can result in improved product and process design. In particular, LCM can trigger product improvements that add value for the user. Designing a product that consumes less energy, water or material resources during its use is one obvious example.

Identification of New Business Opportunities

Because LCM encourages consideration of the product function, or the service provided by the product, as well as the associated life cycle environmental burdens, it opens doors to new ideas for providing the same service with reduced environmental burdens through new products or services. In addition, development of services, techniques or technology related to decreasing or eliminating environmental burdens associated with a product may translate into new business lines or new markets.

Increased Market Share

Most of the advantages noted above contribute to the competitive position and appeal of a company and its products. This should translate into increased market share. Products designed with life cycle considerations in mind are also more likely to appeal to the substantial and growing "green consumer" market.

Improved Public Relations and Communication

A commitment to LCM demonstrates a proactive approach to environmental management. A company that applies LCM is more likely to be a top environmental performer, and to be perceived as a good corporate citizen. LCM can also lead to better communication amongst different units within a company, and with other companies along the life cycle.

Why LCM?...Staying in Step with Important Policy Trends

In addition to these business advantages, companies applying life cycle management are in step with important environmental policy trends.



For instance, many countries that belong to the Organization for Economic Cooperation and Development (OECD) already have legislation making producers bear a degree of responsibility for downstream management of a wide range of products. Some also have, or are considering, more comprehensive product-oriented environmental policies addressing upstream environmental burdens (e.g., outputs associated with processing the materials used to manufacture the product) as well as downstream wastes.

Trade agreements among nations are also beginning to reflect environmental life cycle issues. For example, The North American Free Trade Agreement (NAFTA) includes a side agreement dealing with environmental issues. This North American Agreement on Environmental Cooperation identifies “the environmental implications of goods throughout their life cycles” as an area for further consideration.

In Canada, voluntary approaches to product stewardship are currently in favour. One example is Canada’s National Packaging Protocol, which seeks to reduce packaging waste and minimize the life cycle impacts of packaging. There is also growing use of a range of specific policy instruments, including deposit-refund programs and disposal charges, to ensure that companies bear some of the real costs of managing the downstream waste from their products and packaging.

Voluntary approaches give companies the flexibility to develop strategies that are economically efficient and realistic. Companies that take a voluntary, proactive approach to life cycle management are more likely to have good relationships with regulators, and be better able to contribute to sound public policies.

Life Cycle Management In Context

LCM can strengthen and enrich other environmental management approaches already in use. For example, environmental management systems (EMS) are being developed by many organizations to make their environmental policy and implementation plans explicit, and to help integrate these into the overall corporate management system. The focus has tended to be on *operations within the company*. But a growing number of companies are making a policy commitment to address the environmental implications of their *products*, using a *life cycle* approach.

LCM and Environmental Management Standards



New national and international standards support the integration of a life cycle perspective within broad environmental management initiatives. A key example is the series of standards being drafted by the International Organization for Standardization (the ISO 14000 Series). The ISO’s draft standard on environmental management systems promotes a life cycle perspective (refer to Chapter 3 for more information). There is also an ISO draft standard on life cycle assessment.

Life cycle management complements many other environmental management initiatives. For example:

- *Pollution Prevention* involves a shift away from “end-of-pipe” controls, towards actions that avoid the creation of pollution. The original focus on problems and solutions at the production stage is now being broadened to include issues and opportunities in a life cycle context.
- *Design for the Environment* (DFE) is about designing products and processes to minimize environmental burdens. The focus has traditionally included both production and downstream environmental issues. Increasingly, upstream stages of the life cycle are also being considered.
- *Environmentally responsible procurement*, or green procurement, is itself a demonstration of life cycle thinking. It involves choosing materials, products and systems (i.e. inputs) that offer environmental advantages. Also, green procurement criteria are rapidly evolving from single-issue concerns (e.g., recyclability) to comprehensive life cycle considerations.

The broader theme reflected in the growing interest in sound environmental management is “sustainable development”. The need for development that meets current needs without jeopardizing the future is now widely accepted. As our economies change to become more sustainable, companies that have moved toward life cycle management can expect to benefit.

Pollution Prevention Update



The Government of Canada recently released a Pollution Prevention Strategy and a Toxic Substances Management Policy. Through the Canadian Council of Ministers of the Environment (CCME), all provincial and territorial governments have also affirmed their commitment to pollution prevention. Both the federal and CCME initiatives are guided by the principle that “prevention should apply to the entire life cycle of a product.”

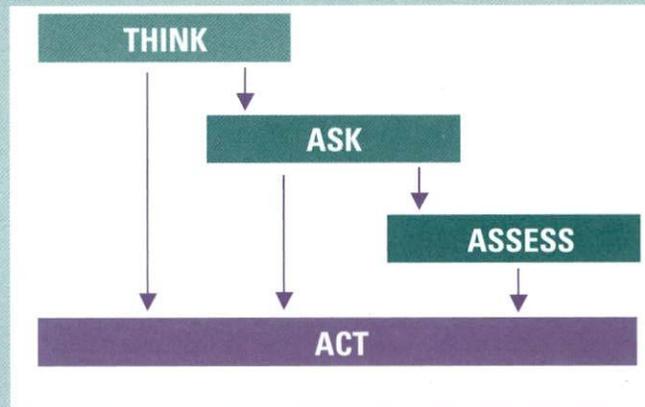
2 Life Cycle Management In Action

A Life Cycle Management Framework

Effective life cycle management means tailoring the approach to the situation. It involves consideration of needs and opportunities, available resources, and other factors. The approach can range from simply being more aware of the upstream and downstream effects of decisions, to undertaking a rigorous assessment. The basic LCM framework can be graphically illustrated as follows:

A Life Cycle Management Framework

THINK: At the simplest level, life cycle management occurs when individuals or groups in a company actively apply their own knowledge to identify life cycle issues relevant to the decisions they make. In some cases, this can point directly to opportunities for improvement, which in turn can be translated into action(s) to reduce the life cycle environmental burdens of the product in question. Simple aids, such as the life cycle map and the design checklist described in the Toolkit, can be helpful (see Tools #1 and #3).



ASK: Where the knowledge or expertise of the individual(s) involved is insufficient to guide the life cycle management activity, the next step is simply to ask — seek the basic information or guidance required to support life cycle-based decision-making. Questions can be posed within the company, or externally to suppliers or others with relevant information. For example, gathering information on inputs and outputs might be necessary in order to identify opportunities for improvement (see Tools #2 and #4 in the Toolkit).

ASSESS: Where simpler approaches are insufficient, a more detailed assessment may be required. Assessment of the life cycle environmental implications of a product can be done at different levels of complexity, depending on need. At one end of the spectrum are low-cost approaches that give a focused but primarily qualitative picture of the key life cycle burdens of a product. At the other end of the spectrum is full-scale life cycle assessment, which provides quantitative and detailed information, and impact analysis (see Tool #5 in the Toolkit). Again, based on the information obtained, key areas for improvement can be identified and ranked (see Tool #6 for one approach to priority setting).

ACT: Thinking, asking and assessing are steps toward an end point: action designed to improve the environmental profile of a company's products. The actions can range from modest changes, such as selection of a new supplier for a particular input, to more extensive measures — perhaps even the complete redesign of a product.

LCM On the Job

Life cycle management is not a task to be assigned strictly to one individual or one central office. All staff members can contribute to corporate life cycle management by adopting a life cycle “mindset” within their areas of responsibility. Many employees can go a step further, actively seeking out information to better understand and address life cycle environmental issues. Depending on company type and size, it may also be appropriate for some employees to develop specific life cycle management skills, and apply specific life cycle tools to the company’s products.



The following pages offer some ideas and examples for applying life cycle thinking in the day-to-day functions of a company. Specifically, the following common job functions are addressed:

- Strategic management
- Product design
- Procurement
- Management accounting
- Marketing and communications.

LCM certainly does not require that all the ideas presented for each job function be applied, and some job functions themselves may not be applicable within a given company. Conversely, opportunities for involvement in life cycle management are not restricted to these five job functions, and the descriptions on the following pages do not cover all LCM opportunities. The intention is to show that LCM is “doable” by a wide range of employees, and that LCM is a better way of doing business.

Job Function #1: Strategic Management

Profile

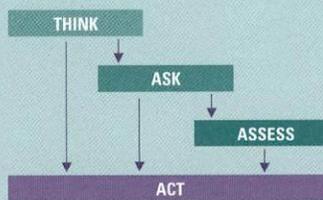
Strategic managers establish corporate direction, striking a balance between longer-range considerations and day-to-day operational demands. They rely on knowledge of financial, technical, and marketplace conditions and trends.

More specifically, strategic managers set the long-term strategic direction of a company through the preparation of corporate business and financial plans, and they often interact with principal corporate stakeholders. Strategic management may also involve implementing corporate review and communication processes, as well as playing an active leadership role.

Current Practice

Environmental considerations may influence strategic management decisions, but are typically seen as stand-alone or “add-on” cost factors. Strategic managers may also be involved in planning responses to critical stakeholder environmental issues (e.g., forestry practices).

Applying the LCM Framework to Strategic Management



THINK: Based on direct experience and knowledge of stakeholder concerns, consider what kinds of environmental issues might become significant at various points in the life cycle of the company’s product(s)

ASK: When making decisions regarding product mix or other investments, ask for additional life cycle information, such as life cycle maps (Tool #1) with key environmental issues identified at relevant life cycle stages. Seek input from stakeholders and environmental experts.

ASSESS: Where specific investment decisions are being made, consider authorizing more detailed life cycle studies (Tool #5), and fuller cost accounting (refer to Job Function #4).

ACT: Invest in measures that address significant life cycle issues for key products. Adjust the company’s existing product mix in light of life cycle issues. Apply life cycle considerations in choosing new products or production systems.

Moving Towards A Life Cycle Approach

Strategic managers often have the power to broaden the typical criteria used in strategic planning by including life cycle environmental considerations. Taking life cycle issues into account shows environmental commitment. It also reduces the risk of being broadsided by unforeseen liabilities or stakeholder environmental concerns, and may prevent losing ground to a competitor.

Strategic managers can use life cycle thinking:

- To support strategic planning about the company’s product mix (e.g., deciding on new products, and choosing between investing in product improvement or exiting from the market).
- To identify and address environmental concerns which may be associated with a product, recognizing that products are open to scrutiny at any stage of their life cycle (e.g., campaigns against sanitary products have been launched based on the use of chlorine at the pulp processing stage).

Related Strategies

LCM is not an alternative to an Environmental Management System (EMS), but it can be a complement to an existing EMS or an approach to developing one. Developing environmental policy, setting goals, and tracking progress towards those goals, are all part of an EMS. A company with an EMS that embraces

LCM will benefit from a better understanding of the product's life cycle and associated environmental impacts. This awareness can help focus improvement efforts, provide a framework for measuring and tracking results, and guide continuous improvement and communication of results.

Strategic managers can build corporate commitment to life cycle management by ensuring that it is reflected in the company's corporate policy and strategic direction. Refer to Chapter 3 for additional ideas.

LCM In Action...Strategic Management

New Product Investment

A consumer products company was planning to leap-frog the competition by investing in one of several new products. The strategic manager asked for the environmental profile of the candidate products, as one basis for product selection. Life cycle information was gathered or quickly estimated, and interpreted into potential environmental impacts.

Stakeholder perceptions related to environmental impacts were assessed using a stakeholder panel.

This information influenced the selection of a product with relatively low environmental impacts and operating costs. The information also influenced ongoing R&D efforts on the product system, since the overall environmental profile of the product was now understood. The result for the company was a more competitive position, and recognition for environmental leadership.

Sustainability Assessment*

Shell Canada Chemical Company has developed a life cycle-based Product Line Sustainability Assessment Tool. The key feature is an advisory panel of environmental experts who collectively represent a broad range of experience and perspectives. Panel members identify potential impacts and risks (environmental burdens and drawbacks, resource conservation, human health and safety) for each life cycle stage. They then evaluate these impacts and risks, using a numerical scoring system that reflects their severity, geographical extent and trends.

In addition to environmental life cycle considerations, the panel considers external influences (e.g., society's risk tolerance), and product attributes (e.g., end use value, potential for substitution). Shell applies this tool to: 1) help identify the best place along the product life cycle to invest in environmental improvements; 2) assist decisions about acquisitions and divestitures; and, 3) identify which product stewardship initiatives will yield the best long-term benefit.

**Drawn from a presentation made by Joe Hilliard, PDA Partners, at the April 1995 Ottawa workshop on Life Cycle Management sponsored by Environment Canada.*

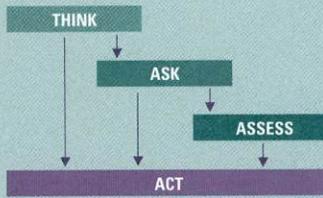


Job Function #2: Product Design

Profile

Designing and redesigning products requires consideration of many factors, including quality, performance, user requirements, legal requirements, safety, market appeal, manufacturability, cost, and environmental implications. Since it is rarely possible to optimize all of these factors in a single design, the designer must make trade-offs.

Applying the LCM Framework to Product Design



THINK: Reflect on the possible life cycle implications of the product being designed. A life cycle map (Tool #1) and a life cycle design checklist (Tool #3) can help.

ASK: Where necessary, ask colleagues, suppliers and other experts for additional information that is not readily available. Again, the life cycle map and design checklist can guide this activity.

ASSESS: Where there are major environmental concerns, or where design trade-offs are very difficult, consider assessing the life cycle issues in more detail, by means of a detailed life cycle review or assessment (Tool #5).

ACT: In all cases, the goal is to act to minimize life cycle environmental impacts through improved product design.

Increasingly, product design involves multidisciplinary teams, and is a highly interactive process. Key design activities include initial concept development, consultation with marketing and technical/production staff, selection of design parameters, prototype development, and testing and redesign.

Current Practice

Consideration is often given to environmental issues during the design process, but usually in response to regulatory requirements or high-profile issues (e.g., solid waste). Specific environmental attributes, such as recyclability, may be required. Product designers focus primarily on the production stage of the life cycle, and to some extent on product use and disposal. Because other life cycle stages are often not considered, opportunities to develop more environmentally sound products may be lost.

Moving Towards a Life Cycle Approach

Life cycle thinking can be introduced into all design activities. Asking basic questions at each step of the design process is a good starting point. For example:

- Can the product design be modified to “do more with less” (i.e. reduce the use of materials and/or energy)?
- How can reuse and recycling of the product be encouraged through its design?
- Can design changes result in avoiding the use or release of environmentally harmful materials, at all life cycle stages?

Related Strategies

An LCM approach allows designers to focus their efforts toward addressing the key environmental concerns in the product life cycle — not just the environmental concerns associated with the immediate operations (which may or may not be significant in consideration of the entire life cycle). Common terms for the improvement of a product's environmental performance through design or re-design include *design for the environment* (DFE), *green design*, *design for recyclability*, and *design for disassembly*. The following points can help guide product design toward an LCM approach.

- *Think in terms of product function.* It sometimes pays to return to the basics. What is the service that your product provides? There may be alternative ways of providing that service that are more efficient than any improvements that might be achieved through product redesign.
- *Focus on product performance.* Better performance can often reduce environmental burdens as well as improve marketability. Consider changes in design or formulation that might allow performance expectations to be met with lower quantities of product per use, or with lower consumption of energy, water or material resources.
- *Extend the service life of your product.* Longer-lasting products also mean less material consumption and waste generation per use. Service life may be extended by using more durable materials and components, and by designing the product for ease of maintenance and upgrading.
- *Consider material substitution and reformulation.* Work with your suppliers to find alternative materials that both reduce life cycle impacts and provide a market advantage. Also, design your product to facilitate reuse or recycling at the end of the product's useful life.

LCM In Action...Product Design

- NCR Canada Ltd.* designed an optical image processor with modular components that can be configured to meet specific customer needs, reducing material input requirements. The technology also incorporates recycled materials, and can readily be disassembled for servicing and post-use recovery of parts and materials.
- Northern Telecom's "value chain analysis tool" aims to help designers identify cost-saving and business opportunities in the life cycle of products. A key goal is to reduce the burdens and enhance the benefits associated with taking back their products for reuse/re-manufacturing/ recycling.
- An increasing number of architectural firms and developers in Canada and the U.S. are specializing in "green" home designs. The approach takes life cycle considerations into account through: 1) selecting materials that have low embodied energy or are recycled; 2) using systems and design approaches that minimize energy and water consumption in the occupancy phase; and 3) employing modular elements for easier and less-wasteful renovation.
- In developing an environmentally superior printing ink, Canadian Fine Color (now CFC/INX Ltd.) considered both upstream resource implications and downstream environmental impacts. Bio-Tech Gloss ink uses renewable, vegetable-based oils (as opposed to the non-renewable, petroleum-based oils), and no heavy metal pigments. Benefits in use include lower volatile organic compound (VOC) emissions, no requirement for additional energy input for drying, and less waste due to reduced press start-up runs. In the recycling stage, de-inking is as easy as with more conventional products.

*U.S. Congress, Office of Technology Assessment. Green Products by Design: Choices for a Cleaner Environment. OTA-E 541. Washington, DC: U.S. Government Printing Office, 1992.



Job Function #3: Procurement

Profile

Procurement involves all aspects of the purchase of goods or services. Major procurement decisions usually take into account a range of qualitative and quantitative considerations such as: product performance, quality and availability; supplier experience, reliability and service; and cost.

The responsibilities of procurement staff may include interacting with company personnel to determine needs, drafting specifications, conducting bidding processes, and selecting suppliers. They may also be required to inform the selected supplier about company procedures and expectations, and implement supplier review processes.

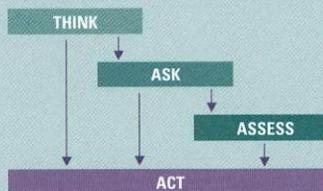
Current Practice

Although there is a significant degree of variability in current procurement practices, it is generally true to say that if environmental considerations are included at all, it is usually in the form of a single criterion (e.g. a minimum percentage of recycled content).

Sometimes, procurement managers include other personnel in the selection process. For example, a packaging review team might include package development and manufacturing personnel, and perhaps also environmental management staff.

Applying the LCM Framework to Procurement

THINK: Develop a set of life cycle considerations for procurement decisions, and review these before buying. Consider, for example, the quantity of materials and energy consumed to make and use the product or material; the toxicity of inputs used to make the item; the durability of the product or material; the quantity of packaging used; and the shipping distance.



ASK: When a potentially significant life cycle issue(s) has been identified, but differences between competing products or services are unclear, ask suppliers for additional information. This information can be requested in the tender package, or through a separate request (refer to Tool #4).

ASSESS: Undertake more detailed supplier assessments for decisions on major purchases with significant life cycle implications, or where long-term commitments are being made. Where issues are particularly significant, consider a detailed life cycle assessment of procurement options.

ACT: Introduce the life cycle environmental considerations as a factor in procurement decision-making. Work with suppliers to help identify areas for improvement.

Moving Towards a Life Cycle Approach

The broadening of procurement decisions to include environmental considerations has been called "environmentally responsible procurement" (ERP). Effective ERP requires consideration of key life cycle issues. ERP does not require compromises with respect to the quality and performance of the goods

purchased, and need not cost more. In fact, ERP can reduce costs by reducing on-site environmental burdens and downstream wastes. It can also lead to identification of new business opportunities, by working with suppliers to develop new or modified materials, equipment, or products.

Related Strategies

- *Adopt a corporate position on ERP.* An explicit corporate position on ERP can be a strong signal to employees, suppliers and others. The Canadian Standards Association has developed a guideline to help companies develop and implement such a position (refer to the back cover for more information).
- *Use the EcoLogo.* Canada's Environmental Choice Program (ECP) labels environmentally preferable products. The ECP considers product life cycle in developing labelling criteria for each product category. The EcoLogo is usually prominently displayed on qualifying products. The ECP publishes information on the labelling criteria for each existing product category, as well as a list of products which have been awarded the EcoLogo. (See the inside back cover.)
- *Use existing guides.* Numerous directories or lists of "green" products are available, and some organizations have developed green procurement guides. Most lists and guides do not take a full life cycle approach, but many do integrate some life cycle considerations.
- *Consider how you order.* How often you order, and in what quantities, can influence life cycle burdens associated with transportation, storage and packaging.
- *Promote ERP within your company.* Procurement of some day-to-day items used in a business may not be centralized. The concept and some of the basic strategies for ERP can be communicated to administrative and operations staff who make purchases. Alternatively, a list of preferred products can be provided.
- *Engage your suppliers.* Suppliers can be asked to provide information on the environmental issues associated with the product(s), material(s) or equipment you purchase from them. Asking for this kind of information signals to suppliers a commitment to ERP, and is an opportunity to push for specific goals (e.g., maximum recycled content). In the case of major acquisitions, there may be an opportunity to work with the chosen supplier to promote life cycle thinking in design and development.

External Environmental Costs

Over their life cycle, products create environmental problems whose costs are not borne by the companies involved in their production. For example, mining may damage habitat, causing declines in wildlife populations. Smelting may release SO_2 , with the resulting acidification affecting fish stocks. The recycling or disposal of final products also imposes environmental burdens. These problems are called "externalities" because they have no material economic consequences for the firms involved in the life cycle of the product, and hence are not reflected in the product price.

It is not realistic to expect companies to factor all externalities into their financial management systems (i.e., to do full environmental cost accounting). But as the concept of product stewardship and the user/polluter pay principle take hold, companies will increasingly pay for ("internalize") the environmental costs of their products.

LCM In Action...Procurement



A Corporate Position on ERP

Xerox Canada Ltd has adopted the following corporate position on procurement: Xerox Canada Ltd. will seek to make its purchases from preferred suppliers...all elements of value will be assessed including...environmental soundness.

This policy is supported by a statement of Procurement Practices, including: XCL will purchase environmentally sound products wherever possible...Further, XCL expects its suppliers to be...able to demonstrate their commitment to environmentally responsible practices.

Xerox plans to monitor implementation of its commitment to ERP as part of its Environmental Management System.

Engaging the Supplier

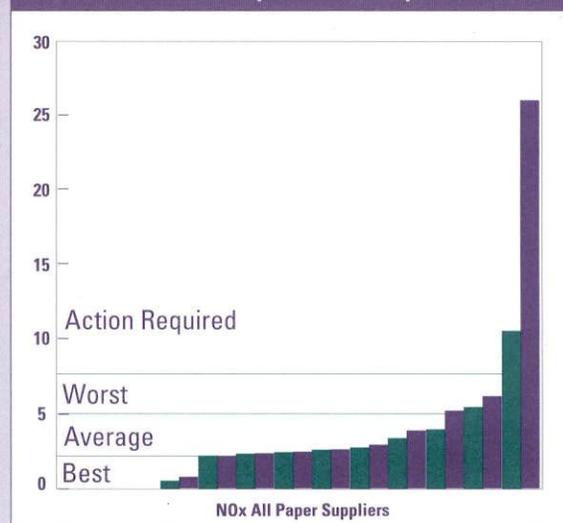
Participants in the Canadian Automotive Manufacturing Pollution Prevention Project are encouraging their suppliers to reduce or eliminate 65 targeted persistent toxic substances. As one example, General Motors of Canada worked with a paint supplier to reformulate the paints for a higher solids content, resulting in reduced volatile organic compound (VOC) emissions and improved appearance and durability of the paint finish.

Screening Existing Suppliers

Scott Limited's environmental policy includes a commitment to *understand life cycle impacts*, and to undertake supplier assessments to enable the company to *incorporate environmental performance criteria when selecting suppliers*. As one step in applying this policy, Scott undertook a supplier assessment program for pulp purchasing. All suppliers in North America and Scandinavia were required to complete a detailed questionnaire covering emissions, energy use and type, manufacturing process, and forestry practices. Analysis revealed considerable variation between suppliers in terms of manufacturing emissions (see bar graph), with the worst-ranking suppliers tending to have highest emissions in all categories. As a result, Scott dropped the two lowest-ranking of its thirty suppliers.

In addition, the assessment demonstrated improvement opportunities for suppliers. This and other LCM initiatives have also given Scott a business advantage. The company has improved its public image through a proactive approach to environmental management. Scott has also moved from issue-by-issue reactions, towards a more comprehensive understanding of issues and improvement opportunities.

Example of Scott Supplier Assessment Results
Pollution per Ton of Pulp



Job Function #4: Management Accounting

Profile

Management accounting involves preparing financial information to support financial management, decision making, and product pricing. Key accounting activities include: establishing management information and financial systems; identifying, collecting, interpreting and presenting financial information; and, developing and implementing better accounting and analytic tools and techniques. Working with other professionals in the organization to identify “hidden” costs is another important activity.

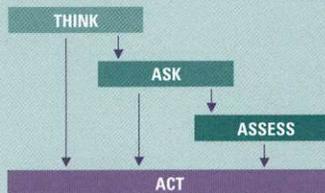
Current Practice

Obvious and immediate environmental costs are usually accounted for. However, costs such as compliance monitoring and reporting, legal support, and waste management are often rolled in with general overhead. This conceals the costs from those who may be in the best position to control them (e.g., plant managers, production engineers). Formulas applied to allocate such costs rarely result in a realistic distribution.

Other important environmental costs are often overlooked because they are less direct, less tangible and/or longer term. Examples of commonly overlooked costs include increased future service costs on equipment due to emissions/deposits, long-term site monitoring costs, and future remediation costs. As noted by the Society of Management Accountants of Canada, a company that ignores foreseeable environmental costs will continually under-cost its products, and reduce future corporate profitability.

Applying the LCM Framework to Management Accounting

THINK: Reflect on potentially significant environmental costs, including upstream and downstream costs, associated with a product or proposed investment.



ASK: For potentially significant life cycle environmental costs, request input from staff involved in the development of investment options, and/or from company personnel responsible for environmental management. Solicit ideas on possible LCM approaches to reducing environmental costs.

ASSESS: For major product decisions with significant implications for the future of the company, consider initiating a more formal life cycle assessment to identify inputs, outputs and impacts. This will provide a basis for more comprehensive costing of the various options.

ACT: Include at least a qualitative description of possible life cycle environmental costs in reporting to decision makers. Where warranted, provide more detailed life cycle costing.

Moving Towards A Life Cycle Approach

Implementing LCM in management accounting means identifying, assessing and reporting on a broader range of environmental costs. This includes overlooked internal costs, and costs that are currently external but will likely begin to accrue to the company. LCM also requires increased effort to allocate costs to individual product lines. The level of effort, rigour and detail applied should relate to the importance of the decisions that will be affected by the information, and the significance of the environmental issues in question.

Related Strategies

Consideration of life cycle environmental costs in accounting is referred to as *life cycle costing* or *full cost accounting*. Key steps to these approaches include the following:

- *Integrate life cycle environmental considerations in ongoing financial analysis and decision making.* A data set on environmental costs can be built over time, based on the findings of individual cost accounting exercises. For recurring costs that are difficult to quantify, consider developing an internally defined set of environmental prices, to help shift decision making toward environmental objectives. As more experience is gained, methods can be formalized and standardized.
- Assess costs on a product-specific basis, where possible. A life cycle inventory (see Tool #5), which identifies and quantifies life cycle inputs and outputs (i.e., energy, material and waste flows), is a basis for identifying a broader range of product-specific environmental costs. This in turn will support more comprehensive cost accounting of the material and energy inputs associated with a product.
- Look into methods that have been developed to support more comprehensive cost accounting. There are now numerous accounting methods (e.g., full cost accounting, total cost assessment) that provide a good base for bringing life cycle costs into accounting practice. A resource guide on environmental costing tools, with a focus on life cycle costing concepts, is available on the Internet. (Refer to the inside back cover for details.)

LCM In Action...Management Accounting

Field staff at TransAlta Utilities, a Canadian private-sector utility, believed that underground cable might be a better long-term choice than overhead line. The barrier was initial capital cost, which made overhead lines the preferred choice of regional managers and customers. However, the company's life cycle value assessment process indicated that there were significant environmental benefits from going underground, and also that total capital, operating and emergency repair costs were often lower.



Job Function #5: Marketing and Communications

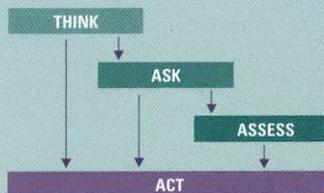
Profile

Marketing and communications personnel are responsible for external relations with many groups, including customers, shareholders, potential investors and consumer organizations. Areas of responsibility can include corporate reporting, advertising and promotion, and customer liaison.

Current Practice

In response to increasing stakeholder interest, some information on corporate environmental performance or product environmental attributes may be included in company reports. In addition, efforts may be made to engage environmentally conscious consumers through advertising. However, the focus often remains narrow, and may not satisfy investors, customers or interest groups looking for a broader and more proactive approach.

Applying the LCM Framework to Marketing and Communications



THINK: Consider market and communications opportunities with key groups such as consumers, suppliers, stakeholders, etc., that may arise through discussions and/or projects related to improving a product's environmental performance.

ASK: Inquire about current projects or efforts that might provide opportunities to promote environmental improvements in products.

ASSESS: Research the likely market advantages resulting from particular LCM activities.

ACT: Encourage LCM within the company so that you will be better informed and able to communicate a broader perspective on environmental concerns related to the product. Promote projects and products that result in reduced environmental burdens. Assist staff engaging in LCM studies with the external and internal communications required to obtain more information on a product's life cycle and associated environmental burdens.

Moving Towards A Life Cycle Approach

There are often opportunities for marketing and communications personnel to promote positive life cycle attributes of existing products and initiatives, even in companies where there is no explicit commitment to LCM. By focusing on the environmental life cycle of products, communications and marketing personnel can promote a new aspect of the company's environmental record. This may also help the company to see LCM's value and potential more clearly.

Communications and marketing personnel can also play a life cycle role by sharing environmental information with both suppliers and customers. Over the longer term, there may be opportunities to engage suppliers, distributors, retailers and consumer groups in strategic alliances to advance environmental life cycle initiatives.

Related Strategies

Taking the following steps will help integrate LCM ideas into current marketing and communications activities.

- *Focus on efforts and specific achievements.* When profiling the environmental performance or attributes of a particular product, focus on what the company is doing to reduce life cycle environmental impacts, and on specific achievements. Avoid general claims that your product is environmentally superior. Bear in mind that qualitative information (e.g., a decision to switch to a more energy-efficient supplier, and the anticipated benefits) can be very important.
- *Seek examples of environmental life cycle thinking or benefits.* Ask product managers, operations staff and others what life cycle issues they have considered in product and process design, procurement, and other facets of the business. Similarly, ask them to reflect on life cycle benefits that may be associated with specific environmental achievements. There are likely to be some “hidden” achievements that deserve to be communicated. For example, if your company has recently made gains in efficiency of energy and material use, or eliminated or reduced packaging, it may be worth profiling some of the associated upstream and downstream benefits.
- *Employ a life cycle perspective in environmental performance reporting.* Corporate reporting on environmental performance is now commonly included in the company’s annual report, or even published separately. Some elements are fairly standard (e.g., information on corporate environmental policy and goals, and on compliance with regulations). However, life cycle information can also be presented. Clear reporting is made easier when performance is tracked in a consistent manner. Life cycle indicators (e.g., life cycle energy consumption) can serve as the basis for evaluating current performance, identifying trends, and evaluating progress towards goals and targets.
- *Promote the consumer’s role in life cycle management.* Inform consumers that their use of the product is an important part of the life cycle (using available avenues such as advertising, and product labels, as appropriate). Focus on ways for consumer behaviour to help minimize environmental burdens (e.g., by increasing product life, minimizing energy and materials consumption associated with use, etc.).

LCM In Action...Marketing and Communications

Home Depot, a retail home improvement center in the U.S., recognized that its customers were interested in the environmental profile of its products. No other home improvement outlet was providing this information, and the retailer felt there would be competitive advantage in doing so. After careful consideration, the retailer developed a simple life cycle-based questionnaire that was sent to all suppliers. This information was then reduced to key considerations and provided to customers at on-shelf locations. Providing the information was positioned as a necessary requirement for doing business with the retailer.

The results of this program have been enhanced overall corporate image for the retailer, and greater customer loyalty and market share. The program has also directly influenced suppliers to voluntarily improve product environmental performance. Finally, the program has reduced the retailer's cost through reduced waste, sharing of information-gathering responsibility with suppliers, and reduced need to respond to consumer or government concerns after the fact.



3 Making Life Cycle Management a Corporate Habit

A Corporate Action Plan for Life Cycle Management

While life cycle management is applicable at any level within the organization, the potential for effective LCM is greatest when there is broad corporate commitment to it. Offered below are a number of key steps to help establish LCM in an organization.

These steps are presented in a logical order, but some actions can and should proceed in parallel. It is also important to remember that there are opportunities for employees to get involved in LCM, even if the overall corporate process is not far advanced.

Step 1: Adopt a Corporate Policy Statement

A corporate policy statement on life cycle management, adopted by the company's Board of Directors or senior management, is a key building block. It confirms the organization's commitment to LCM, establishes overall direction, and guides the actions taken by company staff. It provides both an impetus and support for life cycle management activity throughout the company.

A "stand-alone" policy on life cycle management is a step in the right direction. However, if life cycle management is to be fully integrated into the ongoing management of the company, it should be explicitly integrated into the larger corporate strategy. As noted in Chapter 1, this can be accomplished by positioning life cycle management as a key element of a company's environmental management strategy (EMS).

Some Pointers from the ISO's Standard on Environmental Management Systems (EMS)



The international effort that has gone into drafting the ISO standard on EMS demonstrates a growing conviction that companies should develop an explicit and comprehensive approach to environmental management. An EMS is described as that part of the overall management system that deals with the structure, responsibilities, practices, and resources needed to develop, implement and review the company's environmental policy. According to the draft standard:

- An EMS provides order and consistency for organizations to address environmental concerns; and
- An organization whose management system incorporates an EMS has a framework to balance and integrate economic and environmental interests.

The ISO draft standard points to the life cycle dimension of EMS. For example, key principles for managers implementing an EMS include encouraging environmental planning throughout the product or process life cycle, and encouraging contractors and suppliers to establish an EMS.

Step 2: Raise Awareness and Build Commitment

Life cycle management is new to most people. Before a company can move forward in this area, the people in the company must understand what LCM is, and recognize its importance. Above all, interest and commitment to the life cycle approach are required — especially from senior decision-makers.

Raising awareness is the first step towards commitment. An information program to introduce life cycle management concepts could include:

- Briefings and information sessions for senior management and other staff, outlining the benefits and opportunities provided by a life cycle approach
- Distribution of information materials concerning life cycle management (such as this guidebook)
- Most importantly, identification and promotion of the bottom line benefits that are available through life cycle management.

Life Cycle Knowledge and Skills:

Levels Appropriate for Various Target Groups

Characteristics		Target Groups*
Level 1	Basic understanding of the life cycle concept and ability to apply elementary life cycle thinking to routine decisions (e.g., purchasing of office supplies).	Clerical staff "Shop floor" labourers Customer service representatives
Level 2	Level 1 plus ability to: assess needs/opportunities for more in depth life cycle research; and understand and contribute to product life cycle mapping.	Senior management Plant operators Purchasing staff
Level 3	Level 2 plus ability to: understand formal life cycle methodologies (e.g., LCA); contribute to life cycle research; translate findings into useful information for decision makers and for direct areas of responsibility; and promote an understanding of life cycle thinking to level 1 and level 2 employees.	Technical/engineering staff Design staff Business case analysts Production managers Some marketing staff
Level 4	Level 3 plus ability to: select, co-ordinate, supervise, or conduct appropriate life cycle studies; access life cycle information from a wide range of internal and external sources; understand relationships between inputs/outputs and environmental impacts; and dialogue with external stakeholders.	Dedicated environmental management staff

**These are examples of possible target groups. Target groups will vary depending on the type of organization.*

Step 3: Train Employees

As with any new responsibility, life cycle management may require some specialized knowledge and skills. As suggested in the table on the previous page, the needs of individual employees will vary depending on their responsibilities. Most personnel will not require extensive training, but over time it will be valuable to build the expertise of some staff members.

Training can be done in-house, through seminars and on-the-job support. In addition, various workshops, conferences, and some training opportunities are available externally, particularly dealing with specific life cycle tools, such as LCA. Many general information resources are also available in the life cycle field (see page 45 for selected information sources).

Over time, many companies will choose to develop in-house procedural guidelines relating to the application of life cycle management within certain key responsibility areas. In some cases, life cycle management responsibilities may be introduced as an integral part of certain job descriptions, and the required job skills will be more clearly defined.



Step 4: Provide Infrastructure

As experience and information are gained, it is desirable to establish systems for supporting ongoing life cycle management activities. For example, it may be useful to provide general information on life cycle activities and their results, such as product life cycle maps, information on unit processes, input/output database(s) for various key materials and sub-systems, and information on how life cycle perspective has influenced decisions. Some organizations may find it worthwhile to establish a life cycle management reference library with selected publications and information about other key resources and sources of information (refer to page 45).

Step 5: Measure Success and Provide Feedback

To maintain momentum, reinforce commitment, and ensure that the expected benefits are being achieved, it is important to measure the impact of the company's life cycle management activities. Specifically, it is important to assess the impact of life cycle management on:

- The market for the company's products
- The company's costs (taking account of direct costs of life cycle management, plus other costs and savings in areas such as purchase of inputs, management of wastes, emission control, marketing, distribution, etc.)
- The environment — has the initiative produced demonstrable environmental benefits?

It will also be important to assess the more intangible benefits of the program — for instance the impact of the life cycle management program on the company's image, and any benefits with respect

to regulatory or liability considerations.

It is not enough simply to measure the success of the program — it is also essential to provide feedback to employees, management, and in some cases, the company's suppliers and customers. Positive reinforcement is the key to an ongoing commitment to life cycle management.

Additional Keys to Success

Life cycle management will be most successful if there is at least one “champion” in the company who actively promotes and supports the implementation process, and if senior managers make it clear that they expect life cycle information as an input to decision making. But it is also important to remember that life cycle management is a way of doing business, and requires the involvement of many employees.

Life cycle management can help employees to deliver positive results for the company; provide opportunities to contribute to decision making; and help build better communication among different production units and company operations. However, if LCM is implemented in a manner that burdens employees with an unmanageable workload or unattainable objectives, these benefits will not be attained. Life cycle management should take employee needs and responsibilities into account — it should *not* be imposed as an extra responsibility.

While some specific life cycle management activities may require a significant investment, many can be undertaken at little or no cost. Initial efforts should be targeted at those areas of the company where greatest benefits are likely to arise with modest effort. An opportunity to introduce life cycle thinking also arises whenever a product or process review is required for other reasons. As experience is gained, more demanding life cycle initiatives can be undertaken, bearing in mind that the level of effort should always be commensurate with the expected benefits.

Some Concluding Thoughts

LCM is not an “all or nothing” proposition. It is a concept and attitude that can be adopted by personnel at different levels throughout an organization, as appropriate. Life cycle management will flourish best in companies recognizing that the environment is truly a business priority. It requires a commitment to product stewardship, and the acknowledgement that all life cycle stages of the company's products have associated environmental impacts.

The business rewards of such a commitment can be substantial, and need not be difficult or costly to attain. The time to start is now!

Making Life Cycle Management a Corporate Habit: One Company's Approach



TransAlta Utilities, a private-sector electric utility in Alberta, has been very proactive in promoting life cycle management throughout the company. A first step involved introducing the concept through a one-day workshop that was delivered to approximately 2000 employees over a six-month period. The next steps involved more focused development of life cycle management capabilities.

Specifically, in collaboration with the Pembina Institute for Appropriate Development, TransAlta developed a customized approach to applying life cycle thinking in business decisions. This approach, termed Life Cycle Value Assessment (LCVA), addresses environmental and financial issues on a life cycle basis. Staff training in applying LCVA begins with a two-day "hands-on" workshop — staff come with a specific issue (business decision) to address. Coaching support is also provided following the workshop, to help staff complete their LCVAs. To date, about 70 staff members have participated in the workshop, and the assessments have influenced a wide range of business decisions. The following is just one example.

Transformer Pad Selection

Customer Services staff in several TransAlta Utilities field offices identified some possible alternatives to the traditional choice of pre-cast concrete pads for siting commercial power transformers. Of these alternatives, fibreglass pads appeared to be the most promising. Staff then dedicated about four person days, along with some support from staff in the company's Sustainable Development Department, to do a streamlined life cycle value assessment of fibreglass versus concrete pads. Based on preliminary knowledge of the production processes of the pad materials, air emissions and toxic volatiles were identified as the key burdens to be investigated.

Assuming the average of 550 transformer pads installed by TransAlta each year, the analysis indicated that a switch to fibreglass pads would significantly reduce life cycle greenhouse gas emissions (by 28 tonnes per year), sulphur dioxide emissions (by 0.5 tonnes per year), and nitrogen oxides (by about 2 tonnes per year). On the other hand, the switch would increase volatile organic compound releases, in particular styrene (by 0.062 tonnes per year). As styrene is also an air toxin, additional investigation was conducted to assess whether there were labour or regulatory concerns associated with the resin production or manufacturing processes involved.

It was judged that the environmental trade-offs implied by the relatively minor increase in release of styrene and related volatile organic compounds (VOCs) were outweighed by overall reductions in air emissions. The life cycle approach to the analysis also revealed that along with capital cost savings, a switch to fibreglass pads would yield savings in storage, installation and removal costs. Total net savings would be in the order of \$75,000 annually. The use of fibreglass transformer pads is now becoming widespread across TransAlta's service area.

A Life Cycle Management Toolkit

This toolkit is an integral part of the guidebook. The earlier chapters aimed to provide a good understanding of the *concept* of life cycle management — what it's about, the business advantages, and some ideas for applying an LCM framework. This section offers tools to help you put this understanding into *action*, in a way that is tailored to your organization.

The following is a brief description of each of the tools in the kit.

#1 Product Life Cycle Mapping...page 28

Tool #1 offers guidance in creating an important cornerstone for life cycle management. A product's life cycle map is a clear picture of the life cycle of that product. It also serves as a basis for understanding and communicating about LCM, both within a company and with other actors in the life cycle. The map can also be used as a basis for identifying opportunities, and as a springboard to a more detailed assessment.

#2 Identifying Inputs and Outputs...page 31

Tool #2 consists of two parts: a set of "prompts" to help identify the inputs and outputs associated with the product life cycle, and forms for recording the inputs and outputs.

#3 Design Checklist...page 35

Tool #3 can be used by product designers, process engineers and others, to think about environmental improvements to the product and product system within a life cycle context. Use of the design checklist does not necessarily require structured research to define life cycle stages or quantify inputs and outputs.

#4 Engaging Your Suppliers...page 38

Tool #4 consists of a sample letter to suppliers and a supplier reporting form. This tool is intended to help obtain information needed for LCM decisions; in particular, more detailed identification and/or quantification of upstream inputs and outputs. It will also help engage suppliers in life cycle management.

#5 Life Cycle Assessment and Related Methodologies...page 42

Tool #5 offers a brief review of life cycle assessment (LCA) and related methodologies. The summary does not provide step-by-step guidance for applying these methodologies. Rather it offers an overview of these tools, as an aid to deciding whether and when to consider their use.

#6 Priority-Setting Criteria...page 44

Tool #6 is a decision matrix, incorporating criteria to help focus on those inputs and outputs that require priority attention.

For More Information

Following Tool #6 there is a guide to additional sources of information, including available publications and a listing of selected Internet sites.

Tool #1: Product Life Cycle Mapping

A product life cycle map (also referred to as a process flow chart) depicts the sequence of activities associated with a product, from raw material extraction through to disposal. This kind of map helps employees understand the life cycle and identify potential opportunities for environmental improvement.

Two sample life cycle maps are shown on the following page. As these examples show, the life cycle map for any given product can be produced at various levels of detail. The level of detail in your life cycle map will depend on a number of factors. For example, you will need to consider your purpose, resource limits and what you know about the various input materials. As a general rule, a higher level of detail may be needed for those processes that:

- occur in-house and directly upstream or downstream
- are associated with key materials
- are associated with significant environmental burdens.

The starting point for creating a map is the life cycle stages shown in the box on the right. Developing the map involves identifying the *unit processes* associated with each life cycle stage. Unit processes are reasonably discrete activities or functions (e.g., processing, production or servicing actions) that have direct energy and material inputs and outputs.

Life Cycle Stages Six Basic Stages



Extracting/Harvesting of Raw Materials

Primary extraction of resources by mining or harvesting



Formulating/Processing

Refining, smelting, milling or other processing of raw materials



Manufacturing/Packaging

Forming, combining and/or assembling finished materials into end-use products; includes primary packaging



Use

Operation of the product, including maintenance/repair (servicing)



Reuse and Recycling

Management of useful components/materials remaining at the end of the product's life



Disposal

Final disposal of waste remaining at the end of the product's life

Additional Stages



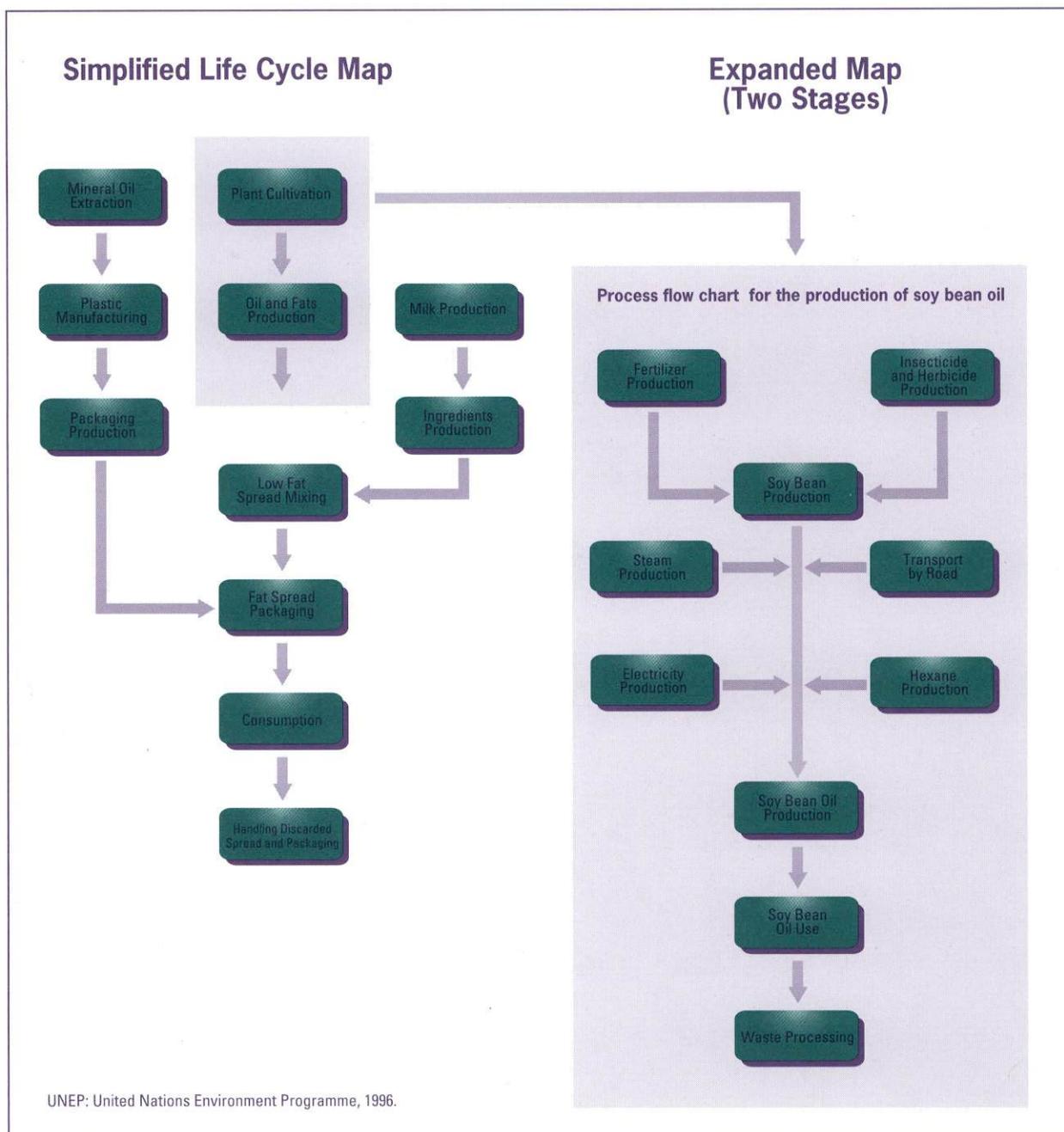
Transportation and Distribution

Transportation, warehousing and retailing, as well as other activities required to get the materials or product to market, may occur at various points in the life cycle.



Design/Planning/Administration/etc.

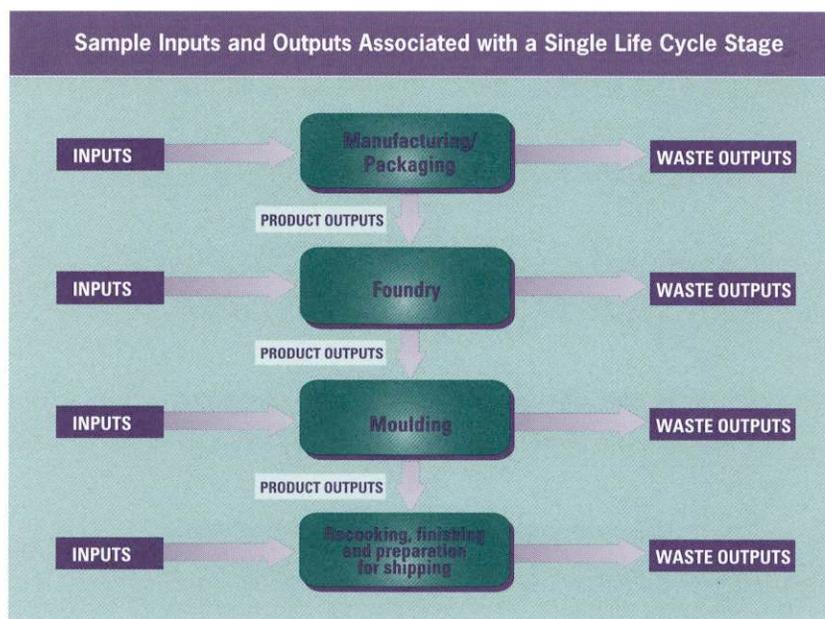
Major design, planning and administration activities related to the product should be considered if these are associated with significant inputs or outputs.



There is no one correct way to develop a life cycle map, but the tips on the following page can assist in the process, and help ensure that the resulting map is practical.

Step 1: Identify unit processes within your company

A logical first step is to consider all of the unit processes within your company that are related to the product. At the same time, identify the *main* inputs to these unit processes. The figure below shows four unit processes and the associated main inputs for a manufacturing stage.



Step 2: Identification of inputs and outputs

Identify the main inputs and outputs associated with each unit process. Tool #2 provides guidance for this activity.

Step 3: Work upstream and downstream

Next, work progressively upstream, delineating additional unit processes for each of the main inputs. Then work downstream, outlining the use and disposal activities for the product itself.

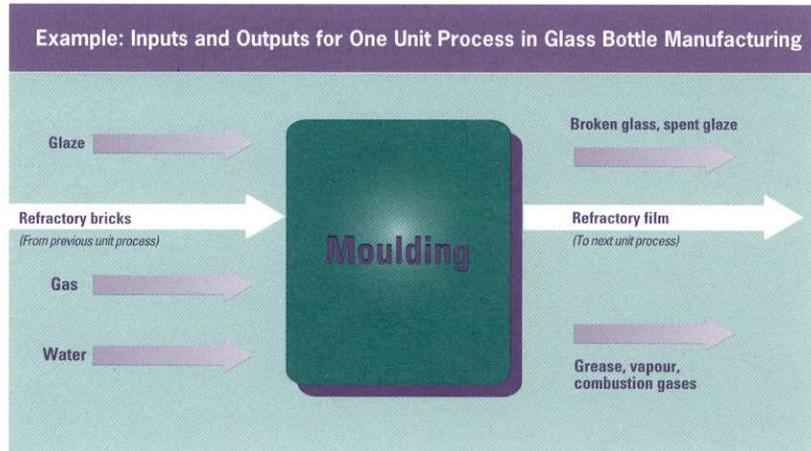
Step 4: Refine the unit processes

As you move further upstream or downstream from your company's stage(s) of the life cycle, it may be reasonable to combine some activities together in a single unit process. But, unit processes should be kept separate where an important environmental burden could be missed, or be difficult to isolate, within a broader unit process. Transportation is often best considered as an input (see Tool #2), rather than as a distinct unit process.

The level of detail and the extent to which you research the upstream and downstream stages of the product life cycle will depend on the goal and scope of the particular activity or project.

Tool #2: Identifying Inputs and Outputs

Identifying the inputs and outputs for each of the unit processes in the life cycle map can provide valuable information about the environmental burdens associated with a product, and potential environmental issues. This will contribute to more informed decision making about purchases, products and processes.



The following list of prompts will help you identify a detailed list of inputs and outputs.

Inputs include...

- **Main materials, products and equipment** used to produce the intended output
- **Supplementary materials** such as packaging for inputs, consumable operating components (e.g., lubrication and engine oil), or replacement parts that wear out (e.g., filters)
- **Energy** needed for the unit process, including electricity and/or fuels
- **Transportation-related energy** to bring in major materials or move people
- **Water** for industrial processes, steam, cooling, potable use, cleaning or irrigation.

Outputs include...

- **Marketable products**, both main products and useful co-products (e.g., material by-products or marketable waste heat)

Sources of Information for Identifying Inputs and Outputs

Internal Operations

Direct observation
 Discussion with operations staff
 Purchasing records and accounts payable
 Equipment specifications
 Metered data (e.g., water flow)
 Environmental, energy or waste audits
 Environmental compliance reports

Upstream and Downstream

Discussions with suppliers, users and waste handlers
 Responses to questionnaires (e.g., Tool #4)
 Industry associations
 Other life cycle studies
 Life cycle databases
 Government reports
 Technical reports (e.g., industrial engineering reports) and other literature.

- **Air emissions** from fuel combustion, electricity generation or industrial process “stack” releases (Emissions include greenhouse [climate change] gases, acid forming or ozone/smog generating gases, toxic [hazardous] air pollutants, and particulates. Radioactivity, odour and noise/vibration may also be included here.)
- **Water effluents** discharged to lakes, rivers or groundwater (Effluents may include specific regulated pollutants, acidic compounds, nutrients, heavy metals, domestic sewage, oxygen demanding organic materials, “colour”, or general site run-off water. Waste heat may also be included.)
- **Solid and liquid wastes** which are collected and disposed of in landfills or hazardous waste facilities, or which accumulate and will eventually require disposal
- **Land/wilderness/wildlife** disturbances such as wildlife habitat damage, soil disturbances, land clearing, vegetation control, or opening up wilderness areas to increased recreational pressure
- **Accidental releases** which may have significant environmental, health or safety implications, and may require emergency response training, planning or equipment.

Significance

It is important to consider all the inputs or outputs to the unit process, at first — no matter how small. A particular input, for example, might seem insignificant in terms of quantity compared to other inputs, but it may result in more environmental burdens than all the other inputs combined.

Recording Forms

Whether life cycle thinking is being supported by a relatively quick and qualitative identification of inputs and outputs, or a more comprehensive and detailed life cycle inventory, it is important to record the information on inputs and outputs in a systematic and accessible manner. The following two forms can be used to record information at any level of detail.

The first form, “Unit Process Inputs and Outputs”, offers a basis for recording inputs and outputs for a single unit process. One of these forms should be completed for each unit process that is being considered.

The second form, “Summary of Inputs and Outputs”, allows for a summary of key inputs and outputs for multiple unit processes. Recording information in this way provides a life cycle overview, helping identify the most potentially significant life cycle issues.

Recording Form: Summary of Inputs and Outputs

Within each cell, record the key input(s) or output(s). Be as specific as possible. Individual cells should be expanded as required.

Input/ output	UNIT PROCESS			
	Unit Process #1	Unit Process #2	Unit Process #3	Unit Process #4
Inputs:				
Materials				
Energy				
Water				
Environmental Outputs:				
Air Emissions				
Water Effluents				
Energy				
Solid Wastes				
Liquid Wastes				
Land Disturbances				
Accidental Releases				

Input/ output	UNIT PROCESS			
	Unit Process #5	Unit Process #6	Unit Process #7	Unit Process #8
Inputs:				
Materials				
Energy				
Water				
Environmental Outputs:				
Air Emissions				
Water Effluents				
Energy				
Solid Wastes				
Liquid Wastes				
Land Disturbances				
Accidental Releases				

Tool #3: Design Checklist

This checklist can be used by employees involved in product or process design. It can help identify improvements that will usually result in lower environmental impacts over the life cycle. The checklist can be used even where a life cycle map and detailed information on inputs and outputs are not available. For a more detailed checklist, refer to the Canadian Standard Association's *Design for the Environment* (DFE) guideline (Z762). (See "For More Information" section.)

Minimize Consumption		Already Optimal	Needs Investigation	Room to Improve
Material Efficiency	Can the size of the product or any of its component parts be reduced?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Can thin-walling or other light-weighting techniques be used to reduce the quantity of material required?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Energy Efficiency	If the product consumes energy in the use stage, are there ways to reduce energy demand without increasing material consumption or introducing toxic materials?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Do production processes/facilities incorporate energy-efficient technologies (e.g., motors, drive systems, energy-management controls, lighting systems, HVAC)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Packaging and Shipping	Has all unnecessary primary and secondary packaging been eliminated?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Is the secondary packaging reusable?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Have options for reducing the volume of the packaged product (e.g., shrink-wrapping) been explored?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Are systems associated with warehousing and shipping (e.g., pallets) reusable?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Do storing and shipping systems minimize wasted space?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Reuse and Recycle		Already Optimal	Needs Investigation	Room to Improve
Recycled Content	Has maximum possible recycled content been specified for material inputs?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Design for Recycling	Have efforts been made to limit the number of different materials used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Can product and packaging be easily disassembled into separate single materials that meet the requirements of recycling brokers?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Are homogenous materials coded for recycling?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Closed-loop Recycling	Can process waters, solvents, catalysts etc. be recirculated within the process?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Open-loop Recycling	Are there uses for the "waste" output materials elsewhere in your system, or is there an external market available or easily created for the output?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Second-hand Equipment	Can good quality second-hand materials or equipment be substituted for new purchases in areas where efficiency improvements in new technologies are not a factor?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Maximize Durability		Already Optimal	Needs Investigation	Room to Improve
Longevity	Can the durability of the product be improved?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Are there simple tips that can be communicated to the consumer to help extend the useful life of a product, and/or to maintain the quality of performance over the full life of the product?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maintainable, Repairable, and Upgradable	Are as many elements as possible standardized? Are parts requiring repair and cleaning easily accessible?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Can most components be repaired or replaced in a practical manner?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Can technical improvements be easily retrofitted, or new modules be easily added?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Equipment	Is more durable production equipment available?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Minimize Toxic Outputs		Already Optimal	Needs Investigation	Room to Improve
Substitution	Are there alternative input materials that lead to lower use/release of toxic substances without significantly increasing resource and energy consumption over the life cycle?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Can less toxic process chemical/consumable maintenance products be substituted for more toxic ones?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Source Reduction	Have your suppliers taken all practical steps to ensure that there are no toxic contaminants in the raw materials entering your process?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Containment	Can closed-loop recycling of process waters or streams containing toxic substances be utilized?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Have steps been taken to maximize the potential for total containment and clean-up of possible spills (e.g., minimal handling near water bodies, secure and impermeable containment areas)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Ensure Efficient Utilization of Equipment		Already Optimal	Needs Investigation	Room to Improve
Capacity	Is equipment being utilized to its full capacity?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Optimum Sizing	Has capacity been selected to balance between the convenience of adequate capacity for a few peak periods of use, and the environmental and economic costs of having excessively large equipment and unused capacity?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Peak Demand Shaving	Are system changes or activity scheduling options possible that will reduce the peak period demands for use of equipment (i.e., more steady use of smaller capacity)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leasing	If equipment is only used occasionally, can satisfactory arrangements be made for leasing equipment as needed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Collective Use	Can the enterprise share the costs of a piece of occasionally used equipment with two or three other users through a pool or collective arrangement?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Tool #4: Engaging your Suppliers

Some information for life cycle management can be obtained from generic sources (e.g., data on industry average inputs and outputs associated with the raw materials you use). But it can be valuable, and sometimes necessary, to obtain information for LCM directly from your suppliers.

For example, recognizing that the life cycle burdens of your product depend to some extent on your suppliers' environmental management practices, you may want information on these practices. The case study on Scott Limited, in Job Function #3, shows how one company used a detailed supplier assessment process to make decisions about procurement. (Note that where information from suppliers is to be used as a basis for choosing among suppliers, it is important that the information be verified.)

As another example, some of the information needed to map your product's life cycle, and/or to identify and quantify inputs and outputs, may best be provided by your suppliers. Engaging your suppliers in your LCM initiatives may also open up opportunities for working together to reduce the environmental burdens associated with the materials they supply, or even developing new and more environmentally appropriate materials.

A sample letter to a supplier is provided on the next page, to help you in engaging your suppliers. The letter is accompanied by a sample supplier data form for providing information. You will likely want to tailor the letter to suit your interests and needs. It is useful to indicate the level of detail you would like the supplier to provide.

Unless you are a major client, or the supplier has already developed an input/output inventory for the material in question, the supplier may not want to provide detailed information on inputs and outputs. Under these circumstances, you may wish to invite the supplier to base the response on easily available information. However, you may want to ask for detail on certain issues (for example, the use or generation of hazardous substances).

The sample form can also be modified. For example, columns may be added for transportation-related information for inputs (e.g., transportation type/average distance/load), or information on data quality (e.g., source, uncertainty). In some cases, you may need to provide specific instructions on how to collect the data and complete the form.

Sources of Information for Identifying Inputs and Outputs

energy inputs:	fuel oil, kerosene, gasoline, natural gas, propane, coal, biomass, electric
air emissions:	dust/particulate, hydrocarbons, other organics, Cl ₂ , CO, CO ₂ , F ₂ , H ₂ S, H ₂ SO ₄ , HCl, HF, N ₂ O, NH ₃ , NO _x , SO _x , Hg, Pb, other metals
water effluent:	BOD, COD, suspended solids, acids, detergent/oils, hydrocarbons, organo-chlorines, phenols, metals, phosphate, NH ₄ , NO ₃ , other N, F, Na, SO ₄
solid wastes:	mineral waste, mixed, industrial, municipal solid waste, toxic wastes

Sample Letter to Supplier Requesting Life Cycle Information

Dear :

We are writing to you as our supplier of XXX, used in making our product(s) YYY. We are seeking to engage all our major suppliers in our efforts to minimize the environmental burdens of the products we make. This initiative is part of our evolving life cycle management (LCM) program. As you may know, LCM requires that consideration be given to product-related environmental burdens that occur not only within our own operations, but also upstream and downstream from our own plant.

We would therefore like to work with our major suppliers to better understand the life cycle of our products, and to explore opportunities to reduce our product's life cycle environmental burdens (e.g., alternative materials, or modifications to existing materials). The environmental profile information we are seeking includes a listing of products/co-products made, materials used, and environmental outputs released. Enclosed is a set of blank forms outlining the information we are seeking.

We will use the results of our study to identify improvement opportunities. Further, this information will give each of us the ability to work more closely together in identifying opportunities in the future. We believe that this initiative underscores our strategic commitment to each other and enhances our business relationship. We will of course hold as confidential any information that you wish to be so treated.

We would be pleased to provide you, or a member of your technical staff, with additional guidance and materials. Please give me a call if you have any questions. I will be in touch after we receive your response, so that we can mutually plan next steps.

Sincerely,

Enclosure

Sample Form for Supplier: Life Cycle Inventory Information

Company:	Material or Product:
Brief description of production process:	
Does this process produce any co-products (i.e. additional products or by-products that you market)?	

Note: The information requested below should be provided *per unit of material or product supplied to us* (e.g., per 1000 kg or per 1000 litres). Please indicate the units used: _____

Please indicate time period to which the data applies: ____ / ____ / ____ to ____ / ____ / ____

Inputs (including materials, water and energy)	Quantity (indicate units e.g., kg., l., m ²)

Outputs (including air emissions, water effluents, solid wastes and liquid wastes)	Quantity (indicate units e.g., kg., l., m ²)
<p>Are there any other types of outputs (e.g., radiation, odour, waste heat, vibration, noise)?</p>	

Please briefly describe your environmental management system/approach (e.g., policy, goals and objectives, implementation mechanisms, resources allocated, recent specific initiatives) or attach available documents.

Tool #5: Life Cycle Assessment and Related Methodologies

This tool is designed to provide a better understanding of life cycle assessment (LCA) and related methodologies. It is not intended to be a guide for applying these methodologies, but rather an aid to deciding whether and when to consider their use.

Life cycle assessment is the original, and still the best known, environmental life cycle method. Some aspects of the method were developed and applied in the 1970s, but a comprehensive technical framework for LCA has evolved only in the last several years. This evolution has largely been led by the Society of Environmental Toxicology and Chemistry (SETAC). Numerous other organizations have contributed to the development and refinement of the methodology, including several European government and private-sector agencies, the U.S. Environmental Protection Agency, the Canadian Standards Association and Environment Canada. As mentioned in Chapter 1, an international standard for LCA is now being produced by the International Organization for Standardization (ISO) as part of the ISO 14000 Standards for Environmental Management Systems (EMS).

Through ongoing development and adaptation, LCA and related methods are increasingly able to accommodate different needs and capabilities. The body of available data is growing, as is experience in applying these methods to a wide variety of products and services, including petrochemicals, electronics, printing, carpets, packaging and automobiles. There is also a wide range of supporting tools now available or under development. Key amongst these are data bases for inventory work, and software packages that can lead the user through a life cycle assessment. A review of software packages for LCA, and information about the Canadian Raw Materials Data Base is available from Environment Canada. (*See back cover.*)

Life Cycle Assessment

LCA consists of four main activities: initiation, inventory, impact assessment and improvement.

Key steps in *initiation* include:

Goal definition

- Establish the reason for doing the study, the intended audience(s), and the expected uses of the information by each audience

Scoping

- Define the "functional unit"*
- Establish the study boundaries (i.e., parts of the product system within the study), data requirements (e.g., level of detail, precision, time-span), assumptions and limitations, etc.

*The function served by a product, rather than the product as sold, is a better basis against which to measure environmental burdens and impacts. The functional unit for laundry detergent might be the quantity of detergent required to clean 10 average cold-water loads; for a battery, it might be five hours of play time on a standard tape recorder.

The life cycle *inventory* (LCI) is an accounting of all mass and energy flows (inputs and outputs) associated with a product system, calibrated to the defined functional unit.

The *impact assessment* involves classifying, characterizing (i.e., linking inventoried inputs and outputs to actual environmental problems) and weighing (evaluating) the environmental significance of identified burdens.

The *improvement analysis* involves the systematic evaluation of needs and opportunities for reducing environmental burdens — that is, identifying improvements in the product system to minimize the most critical environmental impacts.

Life Cycle Review*

Life cycle review (LCR) is meant to address the needs of small- and medium-sized businesses by providing a less-detailed alternative to LCA. In sum, LCR differs from LCA in three principal respects.

- *Screening of environmental burdens:* In LCR, the initiation phase includes an explicit screening component, in which environmental burdens known to be of limited significance are eliminated from further consideration.
- *Use of qualitative information:* In the inventory phase of an LCR, qualitative information is used where reliable quantitative information is not readily available. Detailed quantitative information is often available for the portion of the product life cycle directly controlled by the organization commissioning the LCR; for other life cycle stages, a greater reliance on qualitative information is required.
- *Simplified impact assessment and improvement analysis:* In LCR, the impact analysis and improvement phases include use of general guidelines, “rules of thumb”, and simplified approaches.

Environmental Profiling

An environmental profile involves the identification of inputs and outputs, the categorization of the associated environmental burdens, and the identification of improvement options — but only for those stages in the product life cycle for which the company is directly responsible.

Although a profile does not consider the entire life cycle, it is similar to LCA in that it involves consideration of all inputs and outputs of the part of the system under study. It can serve as a good stepping stone to LCR and/or LCA.

*This description of LCR is drawn from the Canadian Standards Association’s PLUS 1115 information document, *Life Cycle Review (LCR)*.

Tool #6: Priority-Setting Criteria

In some cases, LCM will lead directly to clear decisions and actions. In other cases, it will be more challenging to set priorities based on the information gained. The following chart is a tool to help focus on those inputs and outputs within the life cycle where greatest gains can be made. Common decision criteria are listed, but there may be a need to tailor the chart to different circumstances.

The shaded rows in the form are examples of how the form might be completed for a sample input and output. These examples are purely for illustrative purposes and are not necessarily pertinent to any real product or situation.

Priority-Setting Criteria							
Life Cycle Input or Output	Decision Criteria						
	Relative Size/Quantity of Input or Output	Significance/Stakeholder Concern	Legal Liability	Ability to Address Without Increasing Burdens*	Apparent Technical Feasibility of Action	Probable Benefit Ratio	Focus on Input or Output?
Example: Water use	low	low	low	medium	medium	low	Yes
Example: VOC emissions	high	medium	medium	high	high	high	No

*Include consideration of increasing environmental burdens to other media or life cycle stages.

For More Information

Environment Canada

Publications and Manuscripts:

Ecocycle a biannual newsletter on life cycle tools, LCM and product policy.

Evaluation of Life Cycle Assessment Tools provides a review of software for LCA.

Review of Life-Cycle Assessment Internet Sites (unpublished report)

Life Cycle Management Approaches in Canadian Industry (unpublished report)

Internet site: <http://www.ec.gc.ca/ecocycle> web site featuring the Ecocycle newsletter and links to various sites world-wide on LCM and LCA.

Contacts:

Kevin Brady, Sr. Advisor, Sustainable Production and Product Policy

National Office of Pollution Prevention

Tel: (819) 953-1112 and e-mail: kbrady@pobox.com

Andie Paynter, Program Officer, Life Cycle Management and Product Policy

National Office of Pollution Prevention

Tel: (819) 994-6128 and e-mail: andie.paynter@pobox.com

Environment Canada Enquiry Centre: (819) 997-2800

Canadian Council of Ministers of the Environment (CCME)

Publications:

Environmental Profiles: Guidelines to help industry meet the goals of the National Packaging Protocol provides a step-by-step guide to conducting an environmental profile.

Environmental Choice Program

For information on the EcoLogo[®] and EcoLogo certified products:

Tel: (819) 247-1900 or Fax: (819) 247-2228



Canadian Standards Association (CSA)

Publications:

- Competing Leaner, Keener and Greener: A Small Business Guide to ISO 14000 (Cat. #PLUS 1117)
- Environmental Management in Canada (Cat. # 5618)
- First Steps to Environmentally Responsible Management: A Comprehensive Workbook for Environmental Policy Development (Cat. # PLUS 1113)

- User's Guide to Environmental Life Cycle Assessment: Conceptual LCA in Practice (Cat. # PLUS 1107)
- Life Cycle Review (LCR) (Cat. # PLUS 1115)
- Life Cycle Assessment (Cat. # Z760-94)

- Design for the Environment (Cat. # Z762-95)
- Guideline for Pollution Prevention (Cat. # Z754-94)
- Environmentally Responsible Procurement (ERP) (Cat. # Z766-95)
- Guideline on Environmental Labelling (Cat. #Z761-93)
- Environmental Terminology for Canadian Business (Cat. # PLUS 1109)

These documents can be ordered from the CSA at 1-800-463-6727.

International Organisation for Standardisation (ISO)

ISO 14000 Series of Standards on Environmental Management Systems includes documents on the following subjects:

- Environmental Management Systems
- Environmental Auditing
- Environmental Labelling
- Environmental Performance Evaluation
- Life Cycle Assessment
- Terms and Definitions
- Environmental Aspects of Product Standards

These documents are available through the Canadian Standards Association (see above) or the Standards Council of Canada at 1-800-267-8220.