UNEP/SETAC Life Cycle Initiative

Draft Final Report of the LCM Definition Study

Version 4.0, November 18, 2003

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Executive Summary

Life Cycle Management is a new framework to meet our present global challenges towards more sustainable patterns of production and consumption. In this context, LCM is offering a platform for the private and public sector. Thinking in systems and along product/service life cycles offers insights into how decisions should be made to improve a systems performance.

The LCM concept has emerged out of industrial practice, but offers also opportunities for the public sector. In a new global understanding all market actors, policy makers, industry and consumers are essential players that need to find common platforms to achieve triple bottom line success - for all actors.

In so far, LCM is rather opportunity driven as risk management or risk aversion driven. The LCM framework build on factual information and uses a variety of procedural and analytical tools, which themselves serve as underpinning of programs, management systems and, finally, corporate and policy strategies.

The LCM Definition study positions existing tools, concepts and strategies in one overall framework, that allows sufficient flexibility to meet specific needs and thus also allows for flexibility for implementation. LCM is not a new “super”-tool that superimposes a new approach over existing successful practice. Opposite, LCM offers for the first time an umbrella framework, where tools that had been used in isolation before, can become mutually reinforcing and thus maximize their respective use.

LCM is broad and flexible and reaches out to the public and private sector equally. The global challenges ahead of us require all market actors, and in particular industry and governments to align concepts and approaches to achieve the respective aims for all parties. Governments and the public sector need to provide the “right” framework and guidance under which the private sector then can realize its business objectives. Then this happens in a coordinated fashion.

The product/service life cycle view is different from more traditional approaches in so far, as it goes beyond a single site and single substance regulation – an approach that has come to the end of its effectiveness and has lead to burden shifting within media or along product life cycles. Managing product/service life cycles acknowledges the need for the private sector to implement sustainable change, at the same time meeting business objectives. All market actors have specific roles and responsibilities and use specific tools and approaches. Life Cycle Management aims to provide a uniform umbrella where today´s complementary approaches can emerge into a new sustainable practice.

Based on an extensive outreach, user needs assessments, workshops and multi-stakeholder dialogues, a series of activities are being undertaken, organized through task forces under the Life Cycle Management Programme of the UNEP/SETAC Life Cycle Initiative:

- Topic Area 1—**Life Cycle based product development:** Innovation of products and services: the role of Life Cycle thinking in product development, innovation, including approaches such as Design for Environment (DfE), product to service, product service systems, etc.;
- Topic Area 2—**Communication of Life Cycle information**: labeling, product declarations, reporting, certifications;
- Topic Area 3—**Management along the Life Cycle:** Product-oriented environmental management systems (POEMS), supply chain management, material data sheets and restrictions, procurement;
- Topic Area 4 —**Stakeholder responsibility along the Life Cycle:** stakeholder analysis, product stewardship, extended producer responsibility programs;
- Topic Area 5—**Capacity building** for developing countries and small to medium sized enterprises.

Two additional themes were identified as being of key importance in the near future:

- Integration of economic aspects, tools and interfaces with LCM
- Integration of social aspects in LCM

Preferred delivery routes include workshops, consultations and result in deliverables, such as reports, handbooks, and into capacity building efforts.

The definition study report discusses the overall aims of the programme, as well as the state-of the art in the major areas of interest, and introduces the LCM framework and its supporting tools. It also discusses general drivers for LCM, both from the industrial, as well as from the policy view. The report concludes with a work plan, based on the user needs.

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1. Introduction

Life Cycle Management (LCM) is for integration of the life cycle perspective and economic, social and environmental considerations into the overall strategy, planning, and decision-making processes of organizations concerning their product portfolio. The LCM framework refers to managing the total life cycle performance of goods and services in order to promote more sustainable production and consumption. LCM can be used for industrial organizations and others that require a system-oriented platform for implementing a preventive improvement and sustainability-driven approach to managing product systems. LCM can help business to comply with or more easily overcome future requirements arising from product-oriented governmental policy making such as integrated product policy (IPP) and extended producer responsibility (EPR).

The overall objective of the Life Cycle Management Program is to develop a strategic framework to assist industry in reaching a more sustainable product development, production and use of products. In the same time that framework will help governments developing policies for more sustainable production and consumption. In line with this goal, the program intends to educate relevant stakeholders about the value of a systems and life cycle perspective for decisions and decision-making processes, such as policy making, corporate strategy development, product design, production changes, purchasing and marketing.

The program aims to provide practical guidance for integrating various life cycle based concepts and tools for more environmentally friendly products and services into general environmental management practices and decision making. In addition to the traditional environmental considerations, the program will recommend best practices for integrating socio-economic aspects of sustainability into decisions and decision-making processes from a life cycle perspective. Wherever possible, relevant and meaningful indicators for all three dimensions of sustainability (i.e., economic, environmental and social) will be examined and recommended for use, to allow for internal, as well as external comparability, such as for benchmarking. Finally, based on the underlying multi-stakeholder approach, communication strategies applicable for life cycle information will be examined.

In this document LCM is described as a framework based on life cycle thinking with associated concepts and tools - e.g., eco-efficiency, product stewardship, Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and supply chain management.

The UNEP/SETAC Life Cycle Initiative was officially launched in April 2002 during UNEP's 7th International High-level Seminar on Cleaner Production, in Prague. It is a co-operation between UNEP's Division on Technology, Industry and Economics (UNEP DTIE) and the Society of Environmental Toxicology and Chemistry. The main aim is to bring sound Life Cycle approaches into practice. For the achievement of this overall aim, three programs are developed within the initiative.

The first program concerns Life Cycle Management (LCM). The second and the third program focus on LCA, the second program dealing specifically with Life Cycle Inventory (LCI) databases and methods, the third program with Life Cycle Impact Assessment (LCIA) data and methods. In addition, the initiative initiates joint activities that exceed the subject of the individual topic areas.

1.1 General Aims of the Life Cycle Management Program

Unlike LCA, LCM is still at an early stage of development, with no universally agreed-upon definition[1]. While this is clearly a weakness, it also presents, at the same time, a great opportunity: the Life Cycle Initiative is in a position to develop/refine a definition of Life Cycle Management that meets user needs.

LCM is an integrated framework for managing the total Life Cycle performance of goods and services towards more sustainable forms of production and consumption. It compromises both existing analyses (analytical tools, checklists, methods and techniques) and practice (policy/corporate programs, policy/corporate instruments, and procedural tools), and provides an opportunity for proactively managing the economic, social and environmental performance of products and services in an integrated manner.

The Life Cycle Management Program intends to educate all relevant stakeholders about the importance of a using a systems and Life Cycle perspective to inform decisions and decision making processes, e.g., policy making, corporate strategy development and product design, purchasing decisions and consumption. These stakeholders include organizations of all sizes and across all regions.

The LCM Program is of central importance to the goals of the Life Cycle Initiative, whose mission is to "develop and disseminate practical tools for evaluating the opportunities, risks, and trade-offs associated with products and services over their whole Life Cycle", particularly with respect to putting Life Cycle thinking into practice and positioning LCA among other tools and concepts, as well as for disseminating findings and developing training programs—the outreach piece of the initiative.

[1] However, the elaborations of the SETAC Working Group on LCM (Hunkeler et al. 2003) may serve as a basis.

The LCM program serves a double function: to help governments promote an integrated approach for changing unsustainable patterns of production and consumption and to stimulate industry in proactively meeting the challenges of sustainable development. — More concretely, the program intends to help companies implement and governments disseminate Life Cycle thinking and practices in the value-chain, by that providing input into the development of an overarching policy/corporate framework, and to encourage the development of centers for disseminating recommended practice and success stories and encouraging dialogue, training, and information exchange.

The Life Cycle Management Definition Study started with six original aims:

- LCM Aim 1—Identify needs for Life Cycle assessment and Life Cycle thinking;
- LCM Aim 2:—Discuss the different applications of Life Cycle assessment and Life Cycle thinking in business and policy decision making; identify examples of successful applications; identify success and failure factors; and provide guidance on using Life Cycle assessment and Life Cycle thinking;
- LCM Aim 3—Discuss and clarify the roles of the various analytical and procedural tools, both detailed and simple, in Life Cycle management;
- LCM Aim 4—Investigate opportunities for including the social and economic dimensions of products and services in Life Cycle assessment and Life Cycle thinking;
- LCM Aim 5—Discuss and clarify the relationship of the present Life Cycle initiative to other programs and initiatives;
- LCM Aim 6—Educate stakeholders on the uses or the importance of LCA and Life Cycle thinking in promoting sustainable development Life Cycle assessment and Life Cycle thinking.

1.2 Process Followed to Develop This Report

This draft report was prepared based on input from a series of different activities, including:

a) A user needs survey was widely distributed and published through the Life Cycle Initiative´s web site to allow input from stakeholders worldwide, in the form of proposals, suggestions and constructive criticism. The user needs survey was complemented with telephone interviews and discussions at numerous conferences, meetings and personal interactions.

b) The Life Cycle Management Program was formally introduced and discussed at seven international conferences and workshops on four continents. Two of these events dealt specifically with the LCM Program.

- 1st Life Cycle Management Workshop, Copenhagen, Denmark, August 2001
- Workshop of the Life Cycle Initiative, Tsukuba, Japan, February 2002
- ISO Workshop on LCM practice and user needs in the developing countries, Johannesburg, South Africa, June 2002
- ACE Study Mission LCM, Sweden, June 2002
- Life Cycle Management Workshop on the LCM framework and implementation success factors, Chicago, USA, August 2002
- World Summit on Sustainable Development (WSSD) Side Event on LCA/LCM in South Africa, Pretoria, South Africa, September 2002
- OECD Workshop—Chemicals Product Policy, Tokyo, Japan, September 2002
- Workshop of the Life Cycle Initiative on the LCM framework and user needs, Barcelona, Spain, December 2002
- Workshop of the Life Cycle Initiative at the SETAC Congress in Hamburg, May 2003.
- Workshop on Management and Stakeholder Responsibility along the Life Cycle, Seattle, USA, September 2003
- Plus other events and speaking opportunities, where important information could be exchanged with many different audiences.

c) A team of authors collaborated in drafting this report.

d) A peer review team under the leadership of Kevin Bradley provided an excellent feedback and helped improving the quality of the report.

e) An ongoing consultation with the executive committee and leadership of the LC Initiative.

1.3 Context: State of the Art

LCM is a relatively new approach that brings together different elements of long-term existing practice. LCM provides a unique opportunity to bridge the activities of industry and governments. One of the major challenges of the Life Cycle Management Program is therefore to further develop and refine a definition of Life Cycle management that is generically applicable, globally relevant, practice-oriented, technically valid, scientifically sound and accepted by all stakeholders.

Life Cycle Management (LCM) is life cycle thinking into practice. It is elaborated differently in different activity fields. The following examples show different uses:

- In the chemical industry, years of experience with product safety and risk assessment are used in conjunction with life cycle thinking, product stewardship and eco-efficiency to inform decision-making processes.

- In raw material industries, particularly in metals and mining, Life Cycle thinking is part of integrated material management strategies, and LCA is used in complementary to Substance Flow Analysis (SFA) and Material Flow Analysis (MFA).
- For durable consumer products, current regulatory pressures, such as end of life regulations in Europe, drive the application of Life Cycle thinking in conjunction with either recycling assessments, design for recycling or design for environment. In addition, material restrictions and supply chain management are used jointly with, or supported by, LCA.
- For capital goods and in the retail industry, life cycle thinking is often used with Total Cost Assessment or Life Cycle Costing.

Across many sectors, the following observations on the use of Life Cycle thinking can be made:

- Life Cycle thinking can also be found behind the day-to-day business activities and decisions of organizations. These include: The use of Life Cycle applications to support the formulation of corporate policy and strategy, the development of sustainability initiatives and the implementation of sustainability programs;
- The integration of Life Cycle thinking and tools into environmental management systems (EMS)—for example, product-oriented environmental management systems (POEMS);
- The integration of Life Cycle thinking and tools into environmental reporting—for example, green accounting and environmental reporting;
- The integration of Life Cycle thinking and tools into integrated management systems —for example, by combining quality, occupational health and safety, risk, environmental management into one system;
- The integration of Life Cycle thinking and tools into product design and development processes;
- The integration of Life Cycle thinking and tools into purchasing decisions and (public, retail and private) green procurement;
- The use of Life Cycle thinking and tools in communications programs, including marketing and product labeling and declarations;
- The use of Life Cycle thinking and tools in conjunction with total cost assessment or Life Cycle Costing approaches and financial accounting.

Finally, Life Cycle thinking and tools have a variety of applications in other existing concepts and programs such as:

- Sustainable Consumption

- Cleaner production;
- Environmental performance indicators;
- Integrated product policy;
- Extended producer responsibility;
- Product Stewardship,
- Industrial ecology;
- Corporate social responsibility;
- Resource productivity, dematerialization, factor 4-10;

1.4 Definitions on Life Cycle Management

Existing definitions for LCM show a great variety in expectations and experiences. The following definitions show the variety and breath:

LCM is a flexible integrated framework of concepts, techniques and procedures to address environmental, economic, technological and social aspects of products and organizations to achieve continuous environmental improvement from a Life Cycle perspective. LCM, as any other management pattern, is applied on a voluntary basis and can be adapted to the specific needs and characteristics of individual organizations

SETAC Working Group LCM, 2003 (Hunkeler et al. 2003)

LCM assures that the processes used across projects are consistent and that there is effective sharing and coordination of resources, information and technologies. This Life Cycle spans the conception of ideas through to the retirement of a system. It provides the processes for acquiring and supplying system products and services that are configured from one or more of the following types of system component: hardware, software and humans. In addition, this framework provides for the assessment and improvement of the Life Cycle.

ISO/IEC 15288 CD 2, 2000

LCM is business management based on environmental Life Cycle considerations.

Petersen, 2001

LCM is the extension of the technical approach towards cleaner products and production though amending stakeholder views, by communication and regulatory tracking.

Remmen, 2001

LCM is a concept of innovation management towards sustainable products, by supporting strategic decision making and product development.

Saur, 2003

2. What is Life Cycle Management?

2.1 Why Life Cycle Management?

Increasing globalization, revolutions in information technology, rapid process and product innovations and chaotic marketplace demands are changing and shaping the business climate of the 21st Century. Our understanding of the complexity of the social, political, economic, technical and environmental connections that underlie systems increases with each new discovery in science and technology.

The emerging business climate will demand improvements in current ways of working, but also, more significantly, shifts in how organizations deliver products and services to customers. Firms in many sectors are already using management systems and Life Cycle Thinking to understand and improve their operations, products and services. However, a more comprehensive and holistic approach to decision making is needed if we are to significantly reduce pressures on natural systems and improve our abilities to navigate the complex realities of the emerging business climate.

There are many potential benefits of moving toward more sustainable practices and integrating these efforts into core operations. For firms with a strategy aimed at complying with existing regulations, a system that identifies and tracks releases offers the benefit of reduced liabilities and fines. Other firms may identify opportunities for cost savings and greater efficiencies in the use of resources. For companies with sustainable business practices in place, the emergence of environmentally conscious consumers and public sector purchasing departments can generate increased revenues, enhance their reputation and brand value and, increasingly, earn them a more favorable position with market analysts. Some firms will identify product or service adjustments that improve customer satisfaction, while others that integrate full system considerations into their core operations will define new technologies and innovative change. Overall, integrating efforts into core operations and decisions will allow a more transparent cost structure and will avoid false starts and inefficient investments.

To realize these benefits, many organizations have started to address the environmental aspects of their operations and products by implementing environmental management systems and conducting Life Cycle studies. While these tools can achieve improvements and bring about some change, their scope is limited and they fall short of enabling organizations to realize sustained benefits from their efforts. Interactions with the environment do not occur in isolation and must therefore be considered in the decisions of all levels of an organization.

There is no single program or technique that provides a completely satisfactory answer with respect to improving the overall environmental performance of operations, products and services. However, for an organization to respond to the decision making challenges of the emerging business climate in an economically and environmentally sustainable manner, it must go beyond the current capabilities of existing environmental management systems and the Life Cycle information gathered on existing products. An approach that identifies economically viable and environmentally compatible solutions is needed.

A Life Cycle Management approach can address these needs and form the basis of an effective business strategy by providing a framework for improving the performance of an organization and its respective products and services. Decisions taken at all levels of an organization have an influence on the overall impact a product or service has throughout its Life Cycle. The framework therefore needs to be integrated into the decision-making processes of all levels of the organization—i.e., in marketing, purchasing, research and development, product design, strategic planning, corporate reporting and management.

Life Cycle management as a concept has been discussed and defined by many organizations in both the private and public sectors and in academia. While definitions may differ slightly, they share a number of elements, which help highlight what distinguishes Life Cycle Management from other concepts.

2.2 Drivers for Life Cycle Management

It is understood, that using Life Cycle approaches contributes to environmental protection and sustainable development, helping to overcome global challenges. Those challenges include:

- Concentrations of the greenhouse gases like carbon dioxide and methane continue to grow.
- Toxic substances (including heavy metals and persistent organic pollutants (POPs)) continue to accumulate in polar and other sensitive ecosystems.
- The Millennium Development Goals state as targets for 2015 to halve the proportion of people living on less than one dollar a day, and to reduce by half the proportion of people without access to safe drinking water.

- The improvement in efficiency per unit of production has been offset by an increase in the volume of goods and services consumed and discarded.
- At current patterns of consumption and population growth, by 2100, we will need the resources of four planets to sustain us at decent living conditions.

In 2002, at the World Summit on Sustainable Development (WSSD), Governments called for decisive action to reverse these critical social and environmental trends. Doing so will require addressing underlying unsustainable patterns of consumption and production, as recognized in the third chapter of the WSSD plan of implementation. Thus governments were asked to promote:

- "Fundamental changes in the way societies produce and consume (…); indispensable for achieving global sustainable development",
- "The development of a 10-year framework of programs in support of regional and national initiatives to accelerate the shift towards sustainable consumption and production patterns that will promote social and economic development within the carrying capacity of ecosystems."

The LCM program is supposed to support UNEPs and broader efforts in achieving the above.

More specifically for LCM the following challenges will be center for the work program:

- How to link environmental and social improvements with business benefits?
- How to design policy programs and corporate efforts successfully?
- What are the most appropriate tools and approaches for different questions?
- What are capabilities needed?
- How to avoid false starts?
- Which incentives are required?
- What are the "right" leveraging points in the individual systems?
- Etc.

Many factors can influence an organization to consider environmental improvement and to develop clear policies, implement tools and structure programs that integrate LCM into their core operations.

Externally, these include legislation, as well as public pressure for many industry sectors. A public demanding accountability drives firms to improve stakeholder relations and their reputation with non-governmental organizations. Beyond their physical boundaries, firms are driven from one end of the

product chain by customers who demand environmentally superior products and from the other end by suppliers who may also impose environmental requirements.

Internally, a business striving for increased operational and resource efficiency may see in sustainability a business strategy for realizing these goals. Leading companies may undertake initiatives to increase market share and enhance their potential for innovation. More conservatively, internal drivers may include reduced fines and decreased liabilities, as mentioned previously.

Market: The market will also help drive the implementation of a Life Cycle Management framework. In terms of opportunity, the market offers significant advantages to firms that are the first to move on these issues. Increasingly, leading companies are linking Life Cycle Management initiatives to increased market share and innovation.

Public procurement policies can be very specific about systems for environmental management, materials content of certain products, as well as the sourcing and disposal practices of the firms they buy from. Product information, including consumer information tools and environmental labels, act as a driver for improved sustainability in certain product groups and service sectors.

Companies are increasingly driven to improve their environmental performance from both ends of their value chain; by customers at one end who are looking for environmentally superior products and, from the other, by suppliers who may also impose environmental requirements. As companies integrate environmental considerations into their product development processes, they must begin to involve actors up (and down) the product chain. Companies that supply components and systems and those that deal with the use and disposal of products find their environmental work driven by other actors in the system. To avoid playing 'catch-up' with a response-driven approach, firms are best to use an integrated, comprehensive, Life Cycle approach to manage their environmental impacts together with more traditional cost-driven supply chain management efforts.

Management: Institutional factors can play at least as important a role as technical factors in reducing the content of hazardous substances in products. In the case of product design and development processes, for example, design decisions take place within the broader corporate management structure, and a formal environmental management system with a policy, goals, performance measures and strategic plan that support environmental improvements will be a driver for successful integration of environmental performance concerns. LCM offers a framework that allows management to organize and align the various tools in such a way to exploit the synergies and interrelations between them.

Financial Sector: Increasingly, investors, insurance companies, banks and ranking institutions are driving firms toward sustainability and product Life Cycle optimization. Traditionally, investors look for funds with calculated risks and some level of predictability. As the characteristics of the business climate change, firms that do not have a comprehensive approach to understanding and managing their environmental and social impacts on the system in which they operate will be viewed as a bad-risk investment. This tend can be seen in the emergence of sustainability indexes such as the Dow Jones Group Sustainability Indexes and the FTSE4Good, which use social, economic and environmental criteria to assess and rank the sustainability of listed companies. While such ratings do not yet include a full Life Cycle perspective, there is a clear indication that this is a development to come.

Using the same logic, insurance companies are beginning to charge higher rates to companies who, for one reason or another, appear to be a greater risk in terms of their environmental or social performance, both of their operations, and their whole value chain and products.

Legislation: Today, there are existing regulations that target substances of concern, pending regulations targeting specific products and increasing policy emphasis on the sustainability of services and product service systems. Perhaps most well known are the EU directives on end-of-life vehicles and on waste electronics along with similar policy initiatives at the national level. While the ELV and WEEE directive stem from a waste prevention background, they use a product perspective, though only focus on the end-of-life phase rather than on the complete life cycle. Public procurement efforts, such as the Environmental Preferable Purchasing program in the US or other Green Procurement initiatives clearly are using a Life Cycle perspective, some specifically mention LCA and LCC.

The focus is on producers because they have the greatest knowledge and ability to adapt product design to proactively improve their environmental performance and meet legislated requirements. The existing regulatory framework also acts as a strong driver for firms to consider the environmental impacts of their operations, products and services. Liability for exceeding local air quality emissions limits, for example, can result in fines and, even licensing restrictions and costs. The threat of retrospective liability makes a clear case for a proactive Life Cycle management approach to understand all aspects of the organization and ensure Life Cycle information is available for decision making at all levels.

2.3 LCM Framework

LCM is being positioned as a framework that builds on existing structures, systems, tools and information. LCM is not meant to replace existing concepts, tools and programs, but rather offer a novel approach for improving the application of different systems, processes and tools. Figure 1 depicts the LCM framework.

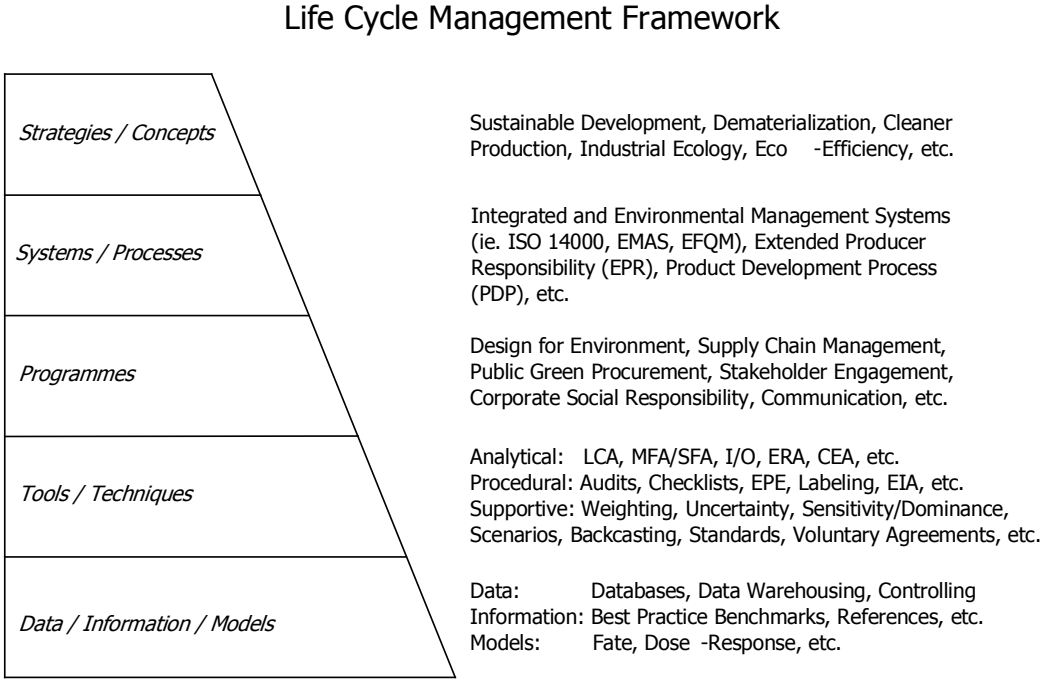

Figure 1: LCM Framework

To integrate environmental considerations into their everyday decision-making processes companies use various approaches and techniques. Environmental approaches and techniques can be described as operating at a management system level, a program level, or a technical level.

Companies can deploy each of these systems, programs, and tools in different ways. What follows is a description of some of the more common management systems, programs, and tools that are used to support environmental decision-making.

The toolbox for LCM needs to include both analytical and procedural tools. In this context, interfaces and recommended practice must be defined, when tools are used in conjunction with LCA (parallel or

sequential). This must build on an assessment of scientific background and the use of those other tools, including:

Procedural concepts, systems, programs and tools:

- Environmental management systems (EMS);
- Specific audits, certification, standards;
- Environmental accounting;
- Design for environment;
- Environmental labeling;
- Environmental impact assessment (EIA);
- Environmental reporting;
- Product stewardship;
- Extended producer responsibility.

Social and economic analytical concepts, programs and tools:

- Life Cycle costing (LCC);
- Total cost of ownership (TCO);
- Input-output analysis (IOA);
- Cost-benefit analysis (CBA);
- Stakeholder expectation analysis;
- Corporate social responsibility (CSR);
- Social accounting.

Environmental Analytical concepts, programs and tools:

- Life Cycle assessment (LCA);
- Input / output analysis (IOA);
- Simulation / modeling techniques;
- Environmental risk assessment (ERA);
- Substance flow analysis (SFA);
- Material flow analysis (MFA);
- Cumulated energy demand (CED);

- Environmental monitoring;
- Full cost accounting.

Communication programs and tools:

- ISO Type III labels (environmental product declarations);
- ISO Type II labels (environmental claims);
- ISO Type I environmental labels;
- Environmental reporting;
- Environmental certifications.

2.4 User needs

Based on the general aims of the LCM Program as laid out in the terms of reference of the LCM Definition Study, a user needs assessment was conducted. The existence of many different possible definitions for LCM mirrors the widespread expectations of what LCM should be. Definitions range from a pure industry implementation approach to integrated supply chain management with a major focus on product and service. Beyond those definitions, the governmental dimension, including integrated product policies and extended producer responsibility, needs to be included in the overall architecture.

Based on the user needs survey and ongoing additional consultations with stakeholders, LCM should build on existing environmental and socio-economic tools as described above.

The user needs survey confirmed the existence of strong drivers towards product orientation and the need for a paradigm shift from an end-of-pipe, single media, single substance and single site oriented environmental protection approach to a proactive innovation and preventive approach focusing on product, services, both in policy formulation and corporate strategies.

Life Cycle Management is at an early stage of development, at least as far a formal definition and harmonization of methodological approaches are concerned. Life Cycle management is increasingly being applied in business and policy making circles, although different names are used to describe what the LCM framework covers. It may very well be that LCM will remain an umbrella concept and that different tools, procedures and management systems will emerge under this umbrella. Based on results of the user needs survey and the experience of the draft author team and other stakeholders in the Life Cycle Initiative, a number of conclusions can be made:

- There is a need to link LC-related tools with procedural approaches, such as management systems, the product development processes, etc. The management of products and services along their whole Life Cycle has been identified as a key need.
- Consequently it is critical to understand and manage the interests of all stakeholders along the Life Cycle.
- There is a desire to link corporate and governmental strategies with communications tools, such as reporting, labeling, third party certified best practice (e.g., Forest Stewardship Council and Marine Stewardship Council).
- The key leverage point towards better products and services clearly is the product development process, that needs to be focused on the whole product Life Cycle.
- There is a need to develop performance-based approaches to stakeholder communications, and to better understand and manage stakeholder expectations.
- There is a need to develop and make available training materials and case studies. One major deliverable should be a reference publication, describing notable practice and successful implementations of Life Cycle Management.

The user needs survey and interactions with the user community suggested also a practical approach for implementing the LCM framework:

The field should be defined more precisely and address the questions: *Who are key players in LCM?* And *What are key enablers for LCM?* Understanding which actors have influence and control will allow possible areas for interaction and implementation to be identified.

- A suggested process for implementation is to use existing best practice case studies on specific sectors/products.
- Social and economic considerations are key in the overall sustainability discussion. In the beginning, the major focus of the LCM program will, however, be the environmental dimension. Economic aspects and social considerations will be added over time as knowledge becomes accessible.

3. LCM Programme Topics

Based on the results of the user needs study and discussions at two international workshops on Life Cycle Management, a program of actions has been identified for LCM over the coming years.

Task forces will be established for specific deliverables, such as: the organization of a workshop; the writing of a report; or, the development of an information system. This implies that task forces will be installed for a limited period of time, in line with the deliverable in question. Here the expertise in the given field specifically counts, and it will also be necessary to ensure an acceptable regional and stakeholder balance. The number of members will have to be adapted to the task at hand.

It is envisioned that theme champions and supporting teams will be essential to ensure consistency and derive the general results and findings. Since workshops may be the primary delivery route, a strong set of rules and procedures will be important in order to guarantee broad participation, participation of the theme leaders, and overhead financing of cross-functional efforts. These rules of procedure and participation will be established and agreed by the ILCP.

Context wise the following aspects serve as key guiding principles for the LCM program:

- Definition of LCM: not too critical today to have a final definition, this is work in progress; the practical implementation is a key objective.
- Important aspects are the systems/Life Cycle perspective, the triple bottom line approach sustainable development), keeping things at a practical level and supporting better decision making in government and industry.
- Overall guiding principles include scientific credibility, demonstrated applicability and successes, relevance, and accessibility.

While LCM can have strategic relevance, particularly in corporate strategy formulation and policy development, it is felt that, for the time being, the majority of applications and the major needs lie in implementing a systems perspective.

Priority Themes

Based on the level of stakeholder interest, resulting from the user needs survey, the workshops and communication with interested parties, five priority themes have been identified for immediate work. These are described below.

- Topic Area 1—**Life Cycle based product development:** Innovation of products and services: the role of Life Cycle thinking in product development, innovation, including approaches such as Design for Environment (DfE), product to service, product service systems, etc.;
- Topic Area 2—**Communication of Life Cycle information**: labeling, product declarations, reporting, certifications;
- Topic Area 3—**Management along the Life Cycle:** Product-oriented environmental management systems (POEMS), supply chain management, material data sheets and restrictions, procurement;
- Topic Area 4 —**Stakeholder responsibility along the Life Cycle:** stakeholder analysis, product stewardship, extended producer responsibility programs;
- Topic Area 5—**Capacity building** for developing countries and small to medium sized enterprises.

Two additional themes were identified as being of key importance in the near future:

- Integration of economic aspects, tools and interfaces with LCM
- Integration of social aspects in LCM

Annex B describes these priority areas of interest in greater detail. The description of the theme includes typical drivers and challenges, provides insights into promising approaches and gives an overview on needs for related stakeholders.

4. Work Plan

The LCM Definition Study identified the need for six Task Forces under the LCM Program. All task forces support the overall objectives of the LC Initiative and have particular relevance for the aims set forth for the LCM Program in particular. The six suggested Task Forces are:

- LCM TF 1: LCM Handbook
- LCM TF 2: Life cycle based product development
- LCM TF 3: Communication of life cycle information
- LCM TF 4: Management along the life cycle
- LCM TF 5: Stakeholder engagement along the life cycle
- LCM TF 6: Development of Training materials on LCM

The general and specific needs for Life Cycle Thinking and Life Cycle Management will be a core element of the LCM Handbook, where motivations, success factors and drivers will be discussed in greater detail. Specific needs for a life cycle perspective will also arise in the task forces on product development and managerial approaches along the life cycle. In the same way, the handbook will discuss and position possible applications of LCM with the larger toolbox, as laid out in the LCM definition study. Finally the handbook will provide important input into developing training material and contribute to capacity building.

Task forces 2, 3 and 4 will, opposite to task force 1, 5 and 6, be more focused on developing analytical input into the development of the LCM framework. Task force 5 is more of educational and dissemination nature. Task force 6 will focus on the development and dissemination of training materials it is related to LCM.

All task forces are closely linked. Information exchange and mutual input is critical. Task Force 1 requires input from task forces 2, 3, 4 and 5 in order to achieve the objectives. In the same way, task force 6 requires input from all other task forces, be if on a conceptual level, case studies of references. Since training will build on the other LCM task forces, all aims play a decisive role in assembling deliverables. The task forces are not stand alone efforts, but require a high degree of coordination and planning. The overarching elements for all task forces is the LCM framework. All efforts centre around the framework and position tools and approaches within.

It is therefore suggested to assemble a steering committee for the LCM program, consisting of the task force leadership and the LCM program leadership. An external advisory board may complement and guide these efforts.

4.1 LCM Task Force 1: Life Cycle Management Handbook

LCM is a rather new concept, but product oriented policies and corporate strategies have already successfully been used to meet emerging challenges and explore opportunities towards more sustainable patterns of production and consumption. LCM offers a promising platform for linking existing strategies, concepts, programs and tools to meet broader stakeholder, market and societal needs. The handbook will describe the links within the different tools and discuss how they can become mutually reinforcing. The handbook will also discuss success factors and provide insights in paths forward to implement life cycle thinking within organizations, both private and public.

The task force will become effective in 2003, and will conclude with the presentation of the final draft handbook, ready for publication.

By beginning of 2004, a draft outline of the handbook will be presented to the program and initiative leadership. Herein included are contributions for other task forces, that supply state-of-the art descriptions of their respective fields. The draft handbook will be completed by June 2004.

4.2 LCM Task Force 2: Life cycle based product development

The integration of environmental and life cycle related information in the product development process is being viewed as one of the most promising approaches to change products and service systems towards improved environmental performance. The predominant emphasis is on the continuous improvement mode, opposite to step-change improvements through system change. This theme is dealt with separately under the UNEP Eco-Design manual effort. It is however important to provide explore linkages between both activities.

The task force will become effective in 2003. The term of the task force is foreseen to be active for two years. Depending on user needs, the term may be extended.

The task force will become effective December 2003, at least in an inaugural state. Addition members will be added over time. The first major work package is the development of a respective input into the LCM Handbook.

- By October December 2003 provide a first draft chapter in the LCM Handbook covering the following issues:
    - Drivers: Why, for whom?
    - Actors: Champions, content shepherds, roll-out
    - Definitions, existing standards and references
    - Role of different market actors and stakeholders; what is difference between actors and market actors; put them together
    - Critical success factors: incentives, organizational challenges, knowledge barriers, Capabilities required
    - Concepts and tools used; e.g.: level of improvement
    - Clarification of different approaches: DfE, Ecodesign, Step-change improvements vs. continuous improvement.
    - Positioning in an organization, organizational issues Data and information needs
    - Benefits, business case
    - Illustrative examples
- By April 2004 provide content support, organizational support and a report from the tentative DfE workshop with ABB on DfE to be held in Sweden 4th quarter 2003 or 1st quarter 2004
- By the 3rd or 4th quarter 2004 organize, support and document a further workshop

Foreseen deliverables beyond 2004:

- Report on recommended practice on the integration of environmental aspects into product development
- Monitoring possible international standardization efforts in the field
- Organize further workshops for information collection and outreach in different regions

4.3 LCM Task Force 3: Communication of life cycle information

The task force will position the existing tools and identify the best options to initiate changes of consumption and production patterns. In particular the task force will examine the mutual reinforcement amongst the tools and within the larger LCM framework, specifically within management systems, with other tools.

Communication of life cycle information is one of the key approaches discussed in industry and in the public sector to promote sustainable patterns of production and consumption. Communicating to the different stakeholders, including the value chain actors, regulators, opinion leaders, consumers, NGOs, is a critical success factor to stimulate the supply and demand for innovative products and services. Different approaches have been developed and introduced successfully, including environmental labels (ISO type I labels), environmental claims (ISO type II labels), product declarations (ISO type III labels such as EPDs) and environmental certifications (such as FSC, MSC).

The task force will become effective in September 2003. The term of the task force is foreseen to be active for two years. Depending on user needs, the term may be extended.

The task force will concentrate its activities around two major themes of interest:

- Role and abilities of communication tools?
- Target audiences and respective needs
- Links of communication with other processes
- Role of tools

Deliverables

- By October December 2003 provide a first draft chapter in the LCM Handbook covering the following issues:
  - Drivers: Why, for whom?
  - Definitions, existing standards and references
  - Positioning of the different tools
  - Role of different market actors and stakeholders; I think it is important to may a clear distinction between business-to-business information; information to retailers; and information to consumers;
  - Critical success factors: incentives, organizational challenges, knowledge barriers, capabilities required;
  - Concepts, Tools used, description of the toolbox
  - Positioning in organizations and in public policy
  - Benefits, business case

    - Illustrative examples
- By October 2003 provide content support and a report from the Type III workshop in Sweden
- By the 3rd quarter 2004 organize, support and document a further workshop

Foreseen deliverables beyond 2004:

- Report on recommended practice on the communication of life cycle information
- Monitoring possible international standardization efforts in the field
- Organize further workshops for information collection and outreach in different regions
- Reach out to public and private sector initiatives

4.4 LCM Task Force 4: Management along the life cycle

Management along the life cycle is to approach and apply Life Cycle Thinking from the management system point of view i.e. using 14001 and 14004 but also other standards if appropriate e.g. ISO 14031 on indicators together with GRI indicators (for environmental reporting!) which are presently being discussed in conjunction with Global Compact, can be seen as check lists of potential environmental and other sustainability aspects to be included in a life cycle oriented management system (sometimes referred as Product-Oriented Environmental Management System); and from the life cycle perspective especially EMAS II with the unique (in many ways) list of indirect aspects should also be included. Another approach for the TF 3 will be the integrated management systems approach combining quality, environment, OHS, social accountability and other issues in the same management system and also integrated with the business and strategy circles of the organization.

In particular for the private sector, management systems and business processes are key elements to achieve business goals, objectives and targets. Integrating environmental aspects together with elements of quality or more recently social issues has successfully been guided by implementation of international or national standards for environmental and quality management systems, such as ISO 14000 and ISO 9001, in many industries. In Europe, similarly EMAS is playing a key role and especially by adding indisputable legal compliance, employee involvement and public outreach by the verified environmental statement.

Presently, the number of industries using certified environmental management is below 1% and the application of the standards (e.g. ISO 14001 and EMAS) do not exceed 5% of the industries. Using a life cycle approach and integrating product-oriented management might turn out to be a framework to

related and motivate more companies and other organizations in product and value chains to embrace environmental and other sustainability aspects.

The task force will become effective in October December 2003. The term of the task force is foreseen to be active for two years. Depending on user needs, the term may be extended.

The task force will become effective December 2003, at least in an inaugural state. Addition members will be added over time. The first major work package is the development of a respective input into the LCM Handbook. Further on the task force will look into the following:

- Organization and moderation support for a workshop to be held in the second or third quarter 2004.
- Planning of a further workshop needs
- Development of a report on the state of the art

The task force will close link its activities with the leadership of the LCM program and align its activities with the other task forces. The leadership of the task force will represent the theme in a LCM program steering committee.

Deliverables

- By December 2003 provide a chapter in the LCM Handbook on the management system options and barriers to Life Cycle Management; preliminary list of content elements:
  - Drivers: Why? Places to intervene with the systems?
  - Actors: Champions, content shepherds, roll-out
  - Definitions, existing standards and references
  - Critical success factors: incentives, organizational challenges, knowledge barriers, capabilities required
  - Discussion of existing approaches
  - Positioning in an organization, organizational issues
  - Benefits and barriers for business and society
  - Illustrative and practical examples
- By July 2004 provide content support, organizational support and a report for a tentative theme workshop

Foreseen deliverables beyond 2004:

- Organization and documentation of a second thematic workshop
- Report on recommended practice
- Monitoring possible international standardization efforts in the field
- Organize further workshops for information collection and outreach in different regions

- Reach out to public and private sector initiatives

4.5 LCM Task Force 5: Stakeholder engagement along the life cycle

Three elements relating to stakeholder responsibility along the life cycle of products therefore need to be explored – the roles and expectations of different stakeholders; their information requirements and the processes and tools by which this information is gathered and transmitted or communicated.

Life cycle thinking in practice requires the involvement of multiple market actors and related stakeholders. One of the most important challenges has been the management of product life cycle impact along the value chain. Consistency and alignment of information flows, overall environmental objectives and a fair distribution of collectively achieved economic advantages characterize one of the fundamental challenges for applying Life Cycle Management. On top of this, seeking and finding alignment with other market actors, including particular consumers; e.g. retailers, but also regulators is critical to achieve business benefits and remove barriers. In order to optimize our present systems of production and consumption, the management of product life cycle impact is critical.

The task force will become effective in September 2003. The term of the task force is foreseen to be active for two years. Depending on user needs, the term may be extended. The task force will work closely with Task Forces 2 and 3 where appropriate.

Work program and work process:

The overall nature of this task force is the provision of illustrative cases and success factors. The task force will primarily look into opportunities for gathering success stories and develop adequate meeting and information gathering. Workshops, study missions, and interviews may become preferred routes.

Expected 03 / 04 deliverables:

- In September 2003 support and help organize a workshop on LCM in association with the INLCM Conference in Seattle;
- Organize and document a study mission by End 2003 to assemble practical solutions and identify fruitful approaches to demonstrate stakeholder responsibility along the life cycle;
- By October 2003 provide a draft in the LCM Handbook/Guidance covering the following issues mentioned above;
- By the 3rd or 4th quarter 2004 organize, support and document a further workshop.

Foreseen deliverables beyond 2004:

- Report on recommended practice
- Communicating to relevant public sector bodies
- Reach out to public and private sector initiatives

4.6 LCM Task Force 6: Life cycle training material

LCM and life cycle thinking seem to be very adequate approaches to support the promotion of more sustainable patterns of production and consumption. A critical capacity need is the overall understanding of the life cycle perspective and the development of a respective capacity on a global basis. Capacity building refers to large and small and medium sized companies in all parts of the world. It also refers to capacity building in academia, governments and non-governmental organizations.

The task force will start as soon as funding becomes available and the other task forces have provided sufficient input, so that a work program can be developed.

As of today, no detailed work plan exists. Activities have to be planned including the following considerations:

- To whom to communicate?
- In which form?
- Capacity building efforts include:
    - Workshops
    - Case studies
    - Reference materials
    - Train-the trainers events

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Glossary

Activity based costing (ABC)—A cost accounting methodology that breaks down the activities (ie functions) that go into producing an organization's output and then allocates the costs that are not directly variable with output volume according to the activities.

Corporate social responsibility (CSR)—Corporate social responsibility is the commitment of business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve their quality of life (WBCSD).

Cost-benefit analysis (CBA)—Cost-benefit analysis is a macro-economic tool for determining whether or not the benefits of an investment or a policy outweigh its costs. The tool has a very broad scope and aims at expressing all positive and negative effects of an activity in a common unit, namely money, from a social, as opposed to a firm's point of view. Usually whole production and consumption systems are examined. Thus, in a world of perfect markets, costs and benefits would indicate to any decision maker every relevant information for economic welfare. Economic and environmental elements are likewise expressed in monetary values – as far as possible and depending on the level of detail. In terms of methodological steps CBA involves first of all a determination which costs and benefits are examined, then tries to identify these costs and benefits and finally weighs them against each other. Latest developments point out that CBA is more and more used as appraisal methodology for overall public regulation.

Cumulated energy demand —see CERA

Cumulative energy requirements analysis (CERA)—Cumulative energy requirements analysis (CERA) states the entire demand valued as primary energy which arises in connection with the production, use and disposal of an economic good (product or service) or which may be attributed respectively to it in a causal relation. This energy demand represents the sum of the *Cumulative Energy Requirements* for the production CERA), for the use (CERA) and for the disposal (CERA) of the economic good.

Disability adjusted life years (DALYS)—The summation of healthy life years lost due to disability and mortality. Life years lost due to disability are computed by adjusting age-specific life expectancy for loss of healthy life due to disability. The value of a year of life at each age is weighted, as are decrements to health from disability from specific diseases and injuries and future life years are discounted (Gold, etal, 1996).

Design for environment (DfE)—In DfE, all environmental considerations in the whole Life Cycle of the product are taken into account. Design for the environment can be defined as: *systematic consideration of design performance with respect to environmental, health, and safety objectives over the full product and process Life Cycle* (Fiksel, 1996). Sustainable product design (SPD) is sometimes referred to as

going one step beyond DfE. While DfE focuses on the redesign of existing products SPD also investigates the possibilities of function and system innovation.

Duales System Deutschland (DSD)—Also known as the German "Green Dot" system, this is an extended producer responsibility program that makes producers and distributors of packaging responsible for establishing and maintaining a system to take back wastes associated with their products.

Eco-efficiency—The term eco-efficiency was introduced by the Business Council for Sustainable Development (BCSD, 1993), now World Business Council for Sustainable Development (WBCSD). It is defined as follows: "Eco-efficiency is the delivery of competitively-priced goods and services, that satisfy human needs and bring quality of life, whilst progressively reducing ecological impacts and resource intensity throughout the lifecycle, to a level in line with the Earth's estimated carrying capacity". Eco-efficiency has become a synonym for management philosophy towards sustainability, in short eco-efficiency means producing more from less. Eco-efficiency as a concept can be applied as a practical approach, and quantified performance indicators for production and consumption processes can be calculated according to the general formula: *Eco-efficiency = Environmental impact/Costs*.

Environmental audit—In the 1980s, the first environmental auditing programmes began on a voluntary basis, adapted from the well-established auditing procedures in quality audits. Environmental audit has become part of the ISO 14.000 series and can be seen as a checking of the environmental management systems (EMS). ISO 14010 sets out the principles and rules for an internal or external auditing of an EMS, including qualification criteria for the auditors.

Environmental accounting—(1) National accounting: physical and monetary accounts of environmental assets and the costs of their depletion and degradation. (2) Systematic, documented verification process of objectively obtaining and evaluation audit evidence to determine whether specified environmental activities, events, conditions, management systems, or information about these matters conform with audit criteria, and communicating the results of this process to the client [ISO 14001].

Environmental impact assessment (EIA)—A technique used for identifying the environmental effects of development projects. An EIA requires a scoping study to be undertaken in order to focus the assessment. This can be carried out in the field or as a desk study depending on the nature/scale of the project.

Environmental labeling—The environmental labeling tool, provides guidelines for the use of environmental labels and declaration. These provide communication of information on environmental aspects of products and services, to encourage the demand and supply of those products and services that cause less stress on the environment and is especially relevant for the needs of consumers. ISO provides standards for three different types of labels: Type II environmental claims (ISO 14021) and the Type I and Type III environmental labeling scheme. Type I labels are based on a multiple criteria-based

third-party environmental labeling programme aiming at yes/no decisions whether products will get a label or not; Type III labeling aims at more detailed information on a number of criteria attached to a product, without a yes/no decision regarding the provision of a label.

Eco-Management and Audit Scheme (EMAS) - The EU Eco-Management and Audit Scheme (EMAS) is a management tool for companies and other organizations to evaluate, report and improve their environmental performance. The scheme has been available for participation by companies since 1995 (Council Regulation (EEC) No 1836/93 of 29 June 1993) and was originally restricted to companies in industrial sectors. Since 2001 EMAS has been open to all economic sectors including public and private services (Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001). In addition, EMAS was strengthened by the integration of EN/ISO 14001 as the environmental management system required by EMAS; by adopting an attractive EMAS logo to signal EMAS registration to the outside world; and by considering more strongly indirect effects such as those related to financial services or administrative and planning decisions.

Participation is voluntary and extends to public or private organizations operating in the European Union and the European Economic Area (EEA) — Iceland, Liechtenstein, and Norway. An increasing number of candidate countries are also implementing the scheme in preparation for their accession to the EU.

Environmental management system (EMS)—An environmental management system specifies how an organisation can formulate an environmental policy and objectives taking legislative requirements and information about significant environmental impacts into account. The overall objective is a continual environmental improvement of the organisation. The EMS according to ISO 14001 makes a distinction between 5 different decision steps: environmental policy, planning, implementation and operation, checking and corrective action and management review

Environmental performance indicators—A specific expression that provides information about an organization's environmental performance (definition from ISO 14031).

Environmental product declaration (EPD)—A declaration of a product's environmental impact during its Life Cycle, gives prospective customers information that allows them to compare the performance of competing products. (See environmental labeling, Type III labels).

Environmental risk assessment (ERA)—Environmental risk assessment is the examination of risk resulting from technology that threaten ecosystems, animals and people. An approach to estimate the risks related to substances, processes and technology is either quantitative or qualitative. Risk assessments vary widely in scope and application. In broad terms risk assessments are carried out to examine the effects on humans (health risk assessment) and ecosystems (ecological risk assessment). The focus on the present description concerns risk assessments of substances in ecosystems.

Extended producer responsibility (EPR)—The Organization for Economic Cooperation and Development (OECD) defines extended producer responsibility as "an environmental policy approach in

which a producer's responsibility for a product is extended to the post-consumer stage of a product's Life Cycle. There are two related aspects of EPR policy: 1) the shifting of responsibility (physically and / or economically; fully or partially) upstream toward the producer and away from municipalities; and, (2) to provide incentives to producers to incorporate environmental considerations in the design of their products. While other policy instruments tend to target a single point in the chain, EPR seeks to integrate signals related to the environmental characteristics of products and production processes throughout the product chain. (OECD 2001).

Environmental supply chain management (ESCM)—Environmental supply chain management is the organization of activities to address the environmental performance of materials, components, goods and services that an organization buys and uses.

Full cost accounting—A tool to identify, quantify and allocate the direct and indirect environmental costs of ongoing company operations. Full cost accounting helps identify and qualify the following four types of costs for an organisation, process or project: direct costs, hidden costs, contingent liability costs, and less tangible costs.

Green procurement—Green procurement means buying products or services with a reduced environmental impact. This can be achieved in a number of ways and may mean looking at product characteristics such as energy efficiency, durability, packaging and/or the environmental impacts in a Life Cycle perspective. A number of third party organisations have developed standards and guidelines for green products and services. One form of guidelines is set up by Environment Canada (1996). It provides a checklist focusing on the four Rs: Reduce, Reuse, Recycle and Recover in each phase of the materiel Life Cycle. This approach differs from the EU eco-labelling scheme, which issues environmental labels to products.

Input / output analysis— Input-output analysis (IOA) was founded by Wassily Leontief in the 1930s, focusing on how industries trade with each other, and how such inter-industry trading influenced the overall demand for labour and capital within an economy. The basic distinction that is made in input-output analysis is between the output of goods and services sold to 'final demand' (households, governments, exports, investment), and the 'total output' of the various sectors, comprising final demand, plus the output that is used as inputs into other sectors (intermediate demand).

Industrial ecology (IE)—Industrial ecology is the multidisciplinary study of industrial systems and economic activities, and their link to fundamental natural systems (Allenby, 1999). It is concerned with the evolution of technology and economic systems such that human activities mimic mature biological systems as regards being self-contained in their material and resource use (Allenby, 1994). Thus it emphasises the need to search for greater synergism between industrial processes, emphasising the potential for reduction in environmental impacts by linking different manufacturing processes via their waste streams and encouraging cyclic flows of materials (Graedel *et al.*, 1993).

Integrated product policy (IPP)—Integrated product policy is public policy that seeks to *reduce the Life Cycle environmental impacts of products* from the mining of raw materials to production, distribution, use, and waste management. It is not, as its name might suggest, a single policy instrument, but rather a framework for integrating a number of product-focused concepts, tools and policy instruments (e.g., eco-labelling, extended producer responsibility, green procurement, etc). It is seen as a means by which governments and authorities can encourage, facilitate and coordinate the actions of stakeholders along the product Life Cycle to improve the environmental performance of products, whether this involves greening their design and development, production, distribution, use, recycling or disposal.

Life Cycle - Consecutive and interlinked stages of a product system, from raw material acquisition, through manufacturing, use and final disposal.

Life Cycle Assessment (LCA) - Compilation and evaluation of the inputs and outputs and the potential environmental impacts of a product or process system throughout its Life Cycle.

Life Cycle costing (LCC) - Life Cycle Costing is an "assessment of all costs associated with the life cycle of a product that are directly covered by the any one or more of the actors in the product life cycle (supplier, producer, user/consumer, end-of-life-actor), with complimentary inclusion of externalities that are anticipated to be internalized in the decision-relevant future." (Rebitzer and Hunkeler 2003)

Life Cycle thinking—Life Cycle thinking considers the cradle-to-grave implications of any action. It reflects the acceptance that key societal actors cannot strictly limit their responsibilities to those phases of the Life Cycle of a product, process or activity in which they are directly involved. It expands the scope of their responsibility to include environmental implications along the entire Life Cycle of the product, process or activity.

Material flow accounting—Material flow accounting aims at specifying the pathways of materials in, out and through the economy of a nation, a region, a community, a business sector, a company or a household. Two main complementary approaches exist: 1) the flows of bulk materials, e.g., steel, wood, total mass, are analysed to study the industrial metabolism *(b-MFA = bulk material flow analysis)*; the results can be used to set priorities for policy measures towards increased resource efficiency and sustainable supply and waste management systems; and, 2) the flows of a single substance or a group of substances are studied which are associated with specific environmental effects *(SFA = substance flow analysis)*; this allows for an effective cause-effect modelling, linking the actual industrial metabolism to specific environmental issues in a quantitative manner.

Material flow analysis (MFA)— A mapping of the total use, recycling and disposal of a specific material in a defined region. The mapping reveals for which purposes the material is used. The mapping quantifies use, recycling and disposal of the material for the different purposes.

Product stewardship— Product Stewardship is a principle that directs all actors in the Life Cycle of a product to minimize the impacts of that product on the environment, as well as on health and safety aspects (Rebitzer and Buxmann 2003). What is unique about product stewardship is its emphasis on the entire product system in achieving sustainable development. Product stewardship emphasizes making the entire product system sustainable. All participants in the product Life Cycle - designers, suppliers, manufacturers, distributors, retailers, consumers, recyclers and disposers - share responsibility for the environmental effects of products.

Product-oriented environmental management system (POEMS)— Product Oriented Environmental Management (POEMS) is environmental management that does not only focus on plants or production sites of a firm but takes the Life Cycle of the products and intermediates into account that pass through the company's operations.

Responsible Care - Responsible Care is a program created in 1988 by the Chemical Manufacturers Association (CMA), now called International Council of Chemicals Association (ICCA). It is a program adopted by ICCA's members to foster environmentally responsible management of chemicals. Guiding principles and codes of management practices have been established.

Simplified Life Cycle assessments (SLCA)— (synonymous: Streamlined LCA): An LCA obtained through a procedure that reduces the complexity of an LCA and therefore cost, time and effort involved in the study. "This may involve exclusion of certain life cycle stages, system inputs or outputs, or impact categories, or may involve the use of generic data modules rather than specific data for the system under study". (Christiansen 1997)

Social accounting—Social accounting is a way of demonstrating the extent to which an organization is meeting its stated social or ethical goals. Whilst independently verified, the organization itself owns the process of data collection and analysis and the process is driven by indicators the organization sets in consultation with stakeholders, as opposed to being based on standards or criteria determined externally.

Stakeholder—An individual or organization with an interest in a product, system or organization.

Substance flow accounting (SFA) - A mapping of the total use, recycling and disposal of a specific substance in a defined region. The mapping reveals which materials the substance is a part of. The mapping quantifies use, recycling and disposal of the substance for the different purposes. Part of Material Flow Analysis.

Substance flow analysis (SFA)—See material flow accounting.

Total cost accounting (TCA)— Total cost accounting describes the long-term, comprehensive analysis of the full range of internal costs and savings resulting from pollution prevention projects and other environmental projects undertaken by a firm. As such, TCA encompasses conventional companies and less tangible, hidden, indirect company costs, and is a subset of Life Cycle costs. It is a dynamic subset,

however, subject to change and redefinition as the boundary between internal and external costs shifts with changing regulations and company policies.

Voluntary agreements—Voluntary agreements (VAs) are commitments undertaken by firms or by industrial organisations to deal with environmental problems. The agreements are made with public authorities or recognised by the authorities. They may comprise individual firms and/or groups of firms within an industry. VAs have been in existence in European Union states for some years already. The site of the concerted action CAVA (1998) provides bibliographical references on VA.

UNEP/SETAC Life Cycle Initiative
Draft Final Report of the LCM Definition Study

Version 3.5, October 24, 2003

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Appendix A. User Needs Assessment

While the field of Life Cycle assessment (LCA) is very well developed, not least through the work of SETAC and ISO, but also increasingly by through industrial practice, Life Cycle management (LCM) is still a relatively undeveloped field. It is important to note that the term Life Cycle management is relatively new, whereas Life Cycle thinking and systems analysis are well understood and in common practice. Like the other programs of the UNEP/SETAC Life Cycle Initiative, this LCM Program Definition Study began with a focused user needs assessment.

Before proceeding with a discussion of the results of the user needs survey, it is important to note that the survey questionnaire was not developed by professional surveyors, making inconsistencies possible. The quality of the results should, however, be good enough to uncover major challenges and needs. As was the case with the other user need surveys the views, needs and concerns expressed by stakeholders can vary geographically, between sectors and between large versus small companies.

119 surveys were received in all, of which 78 were submitted by individuals, 23 by organizations and interest groups, and 17 by a variety of organizations, where it was unclear whether the views expressed the opinion of the individuals responding or their respective organizations.

The survey responses contained three types of information:

- Categorical (generally identifying attributes of the respondent from a list);
- Scores rating the importance of different issues;
- Free text comments.

A.1 User Profiles

Surveys were received from 33 different countries, the breakdown of which is shown in Figure A1. Responses from Europe predominated, accounting for 53 of the 119 responses, followed by North America and Asia/Pacific with 21 and 24 of responses, respectively. Latin America accounted for 16 responses, while Africa accounted for 5.

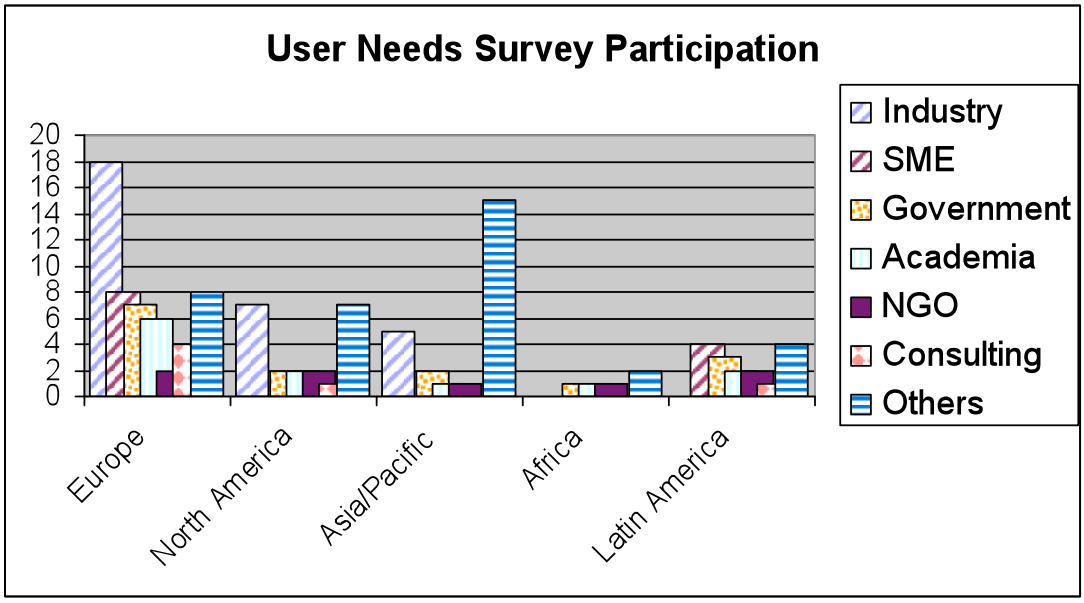

Figure A1: Breakdown of Participation in the LCM User Needs Survey

The breakdown according to affiliation is also remarkable. Business, including industry, small and medium sized companies and industry associations (the latter representing 29 of the 36 in the "Others" category) clearly dominate. Governments and particularly were not as well represented as they were in other surveys conducted as part of the Life Cycle Initiative. Consultants and NGOs would appear to be rather underrepresented.

A number of general observations can be made:

- A major interest in LCM comes from business.
- Since LCM is a relatively new field, it is not surprising that governments and researchers are not as dominant.
- Participation by Asian and Latin American industry in the survey was largely through industry associations.
- The only SMEs to participate in the survey were from Europe and Latin America participated.
- Participants from developing countries were particularly interested in support and training.

While the low response rate to the survey (119 out of 1500 questionnaires) does not permit any definitive conclusions to be drawn, it is interesting to note the high representation by industry among the feedback received. Generally, it is innovative, leading organizations that are interested in being involved. Followers and laggards can be expected to follow suite later.

A.2 Use of LCM

Figure A2 below shows the breakdown of what repondents consider the primary uses for LCM:

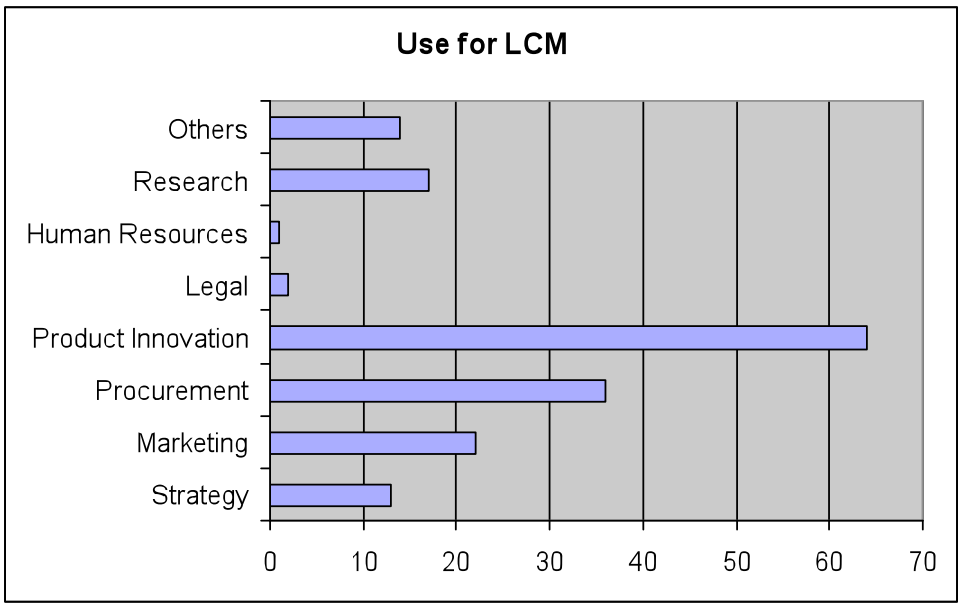

Figure A2: Use Patterns for LCM

A very clear majority of responsesviews product development as a key application for Life Cycle thinking and LCM. Procurement and marketing also are viewed as important uses. The responses show that:

- LCM is viewed as a framework;
- LCM has broad application;
- Product development and innovation management are important uses.

The survey also asked respondents to identify what they felt was the key factor for promoting Life Cycle thinking and what they felt was the best way to introduce the use of Life Cycle management. Figure A3 shows the breakdown of responses regarding key benefits/drivers:

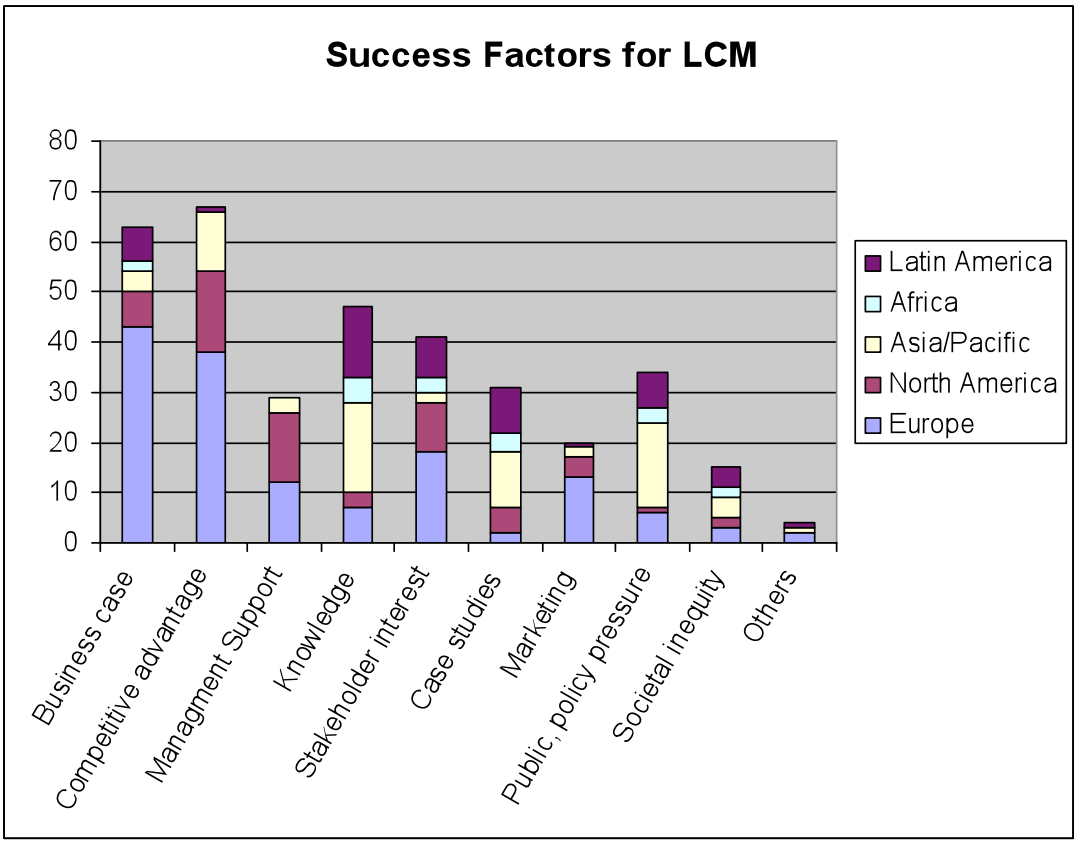

Figure A3: Success Factors for LCM

Overall competitive advantage and the "business case" for implementing LCM are the predominant reasons for using LCM. This response is not surprising, since it reemphasizes the typical needs of industry, who dominated the responses to this survey. Stakeholder interest and societal pressures, including those from governments, interest groups, were also identified as important reasons for using LCM. This reflects an increase in the use of interdiscilinary thinking and integrated implementation of social, environmental and business drivers. Linking LCM to economic success therefore is critical according to the survey results.

Respondents from developing countries and SMEs highlighted a need for training and cacity building.

Finally, we asked how LCM and Life Cycle thinking can best be introduced to an organization. Figure A4 summarizes the survey responses:

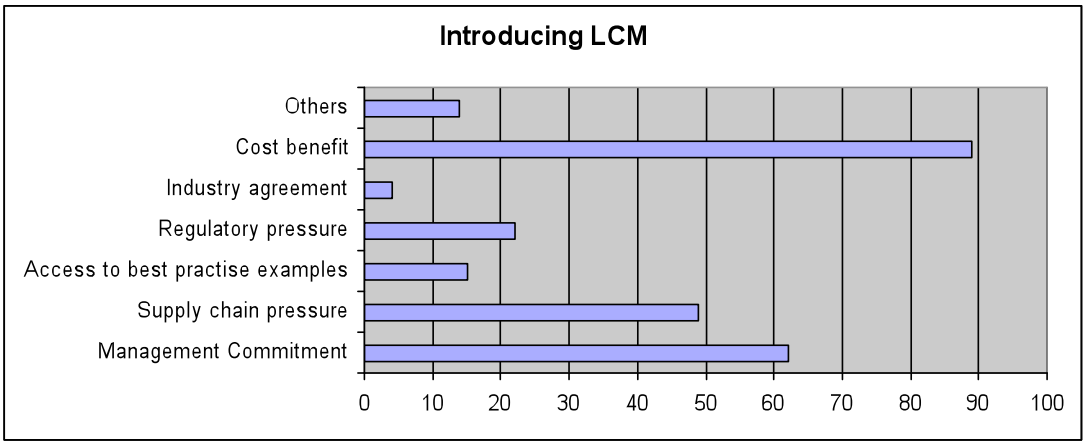

Figure A4: How to Best to Introduce LCM?

Respondents identified the ability to demonstrate the economic benefits and obtaining management support as the most important success factors for introducing LCM and Life Cycle thinking into an organization. Both of these factors are linked. Pressure along the supply chain was also identified as important, as more and more major companies begin to introduce Life Cycle thinking into their supply chain.

A.3 Major User Needs

The second major element in the survey concerned the identification of major user needs for LCM, including expectations for using LCM and LC Thinking.

The responses reveal two areas of interest. Most respondents identified the need to link Life Cycle thinking with (environmental) management systems and Life Cycle costing (LCC) and the need to provide training materials and build capacity. In addition the following observations can be made:

- The environmental toolbox and LCA are not seen as essential for promoting Life Cycle thinking;
- Life Cycle costing and total cost of ownership are likely still not very well understood, since respondents were equally divided between those who think these are critical and those who rank their importance low. This has been mainly discovered through interviews;

- LCM and Life Cycle thinking are seen at a programmatic level and at a strategy level.
- Communications with stakeholders is a field of emerging interest.

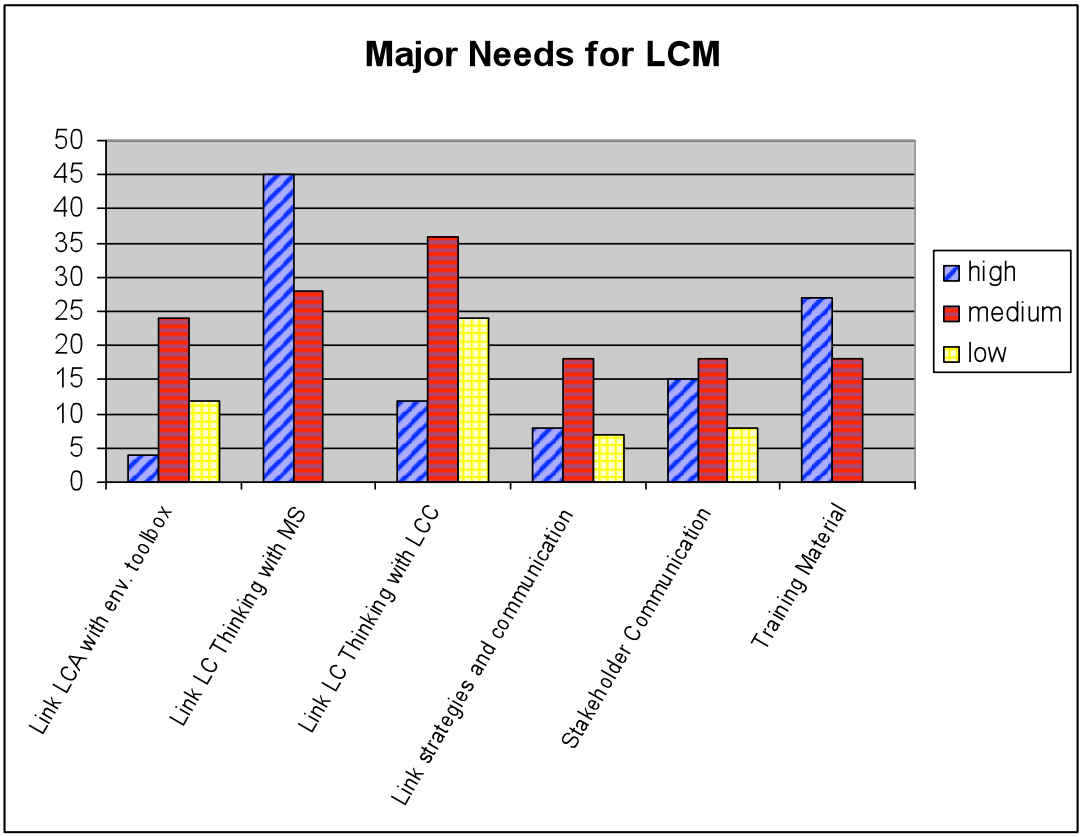

Figure A5: Major Needs for LCM

The survey respondents made it clear that the LCM framework should be linked to ongoing efforts in the policy arena and this may represent a business response to the challenges of sustainable development, integrated product policy (IPP), extended producer responsibility (EPR) and others.

A.4 Specific Needs and Importance Rankings

The third section of the survey identified a set of candidate needs, requested numerical scoring of their importance, and invited free text reactions to the needs as well.

The first question queried respondents on the major methodologies (i.e., tools and approaches) that support the application and use of LCM. Figure A6, shows the need for key links within the LCM to:

- (Environmental) management systems;
- Design for environment, product innovation;
- Communication and labeling;

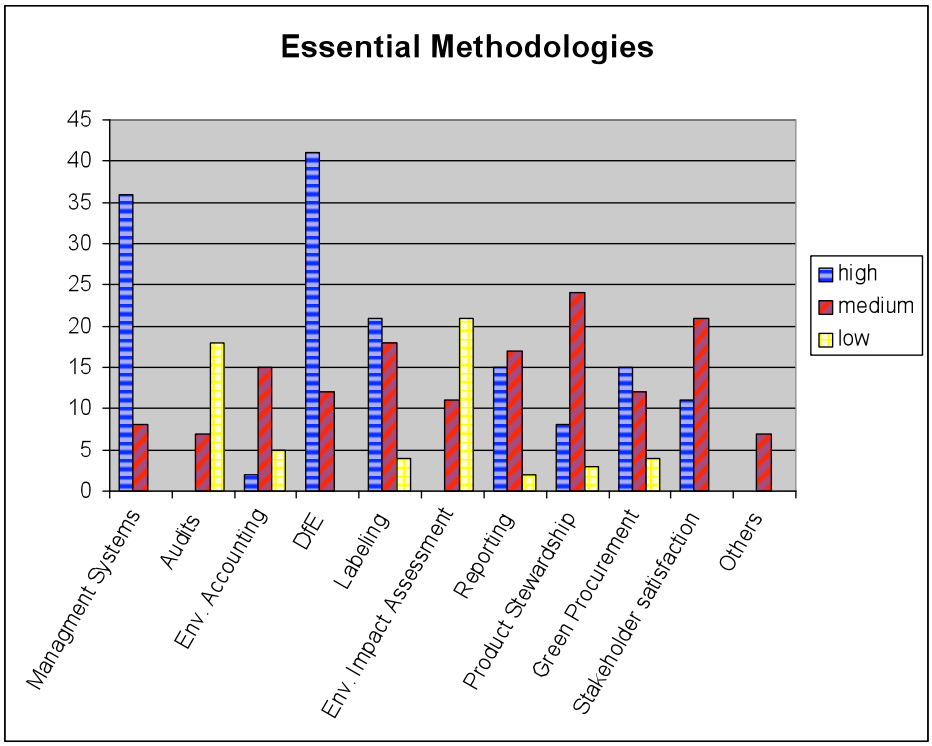

Figure A6: Important Supporting Methodologies for LCM

Themes with emerging importance that should also be given attention include:

- Product stewardship programs;
- Procurement and buying;
- Stakeholder expectations analysis.

Methodologies that were not identified as having an important role in the LCM framework include (environmental) audits—which may become part of a supply chain program for external assurance or a management program for internal quality assurance—environmental accounting and environmental impact assessment.

More specifically, in terms of environmental tools for LCM, the user needs survey identified LCA as having a key role in supporting LCM and Life Cycle thinking, as shown in Figure A7. At the same time, however, respondents noted that a formal Life Cycle assessment may not always be required to implement LCM.

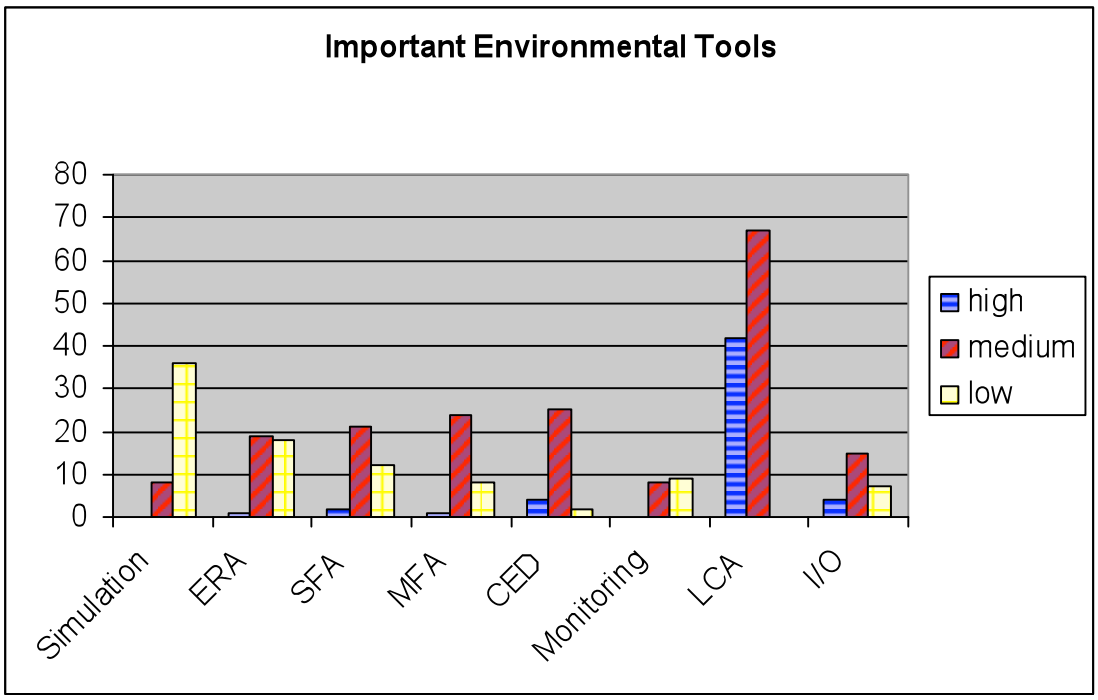

Figure A7: Importance of Environmental Tools for LCM

Complementary tools including environmental risk analysis, substance flow analysis and environmental risk assessment were identified as only having medium importance. It is still unclear how those tools can complement each other. More research and case studies may be needed to not only explore opportunities for using these tools, but also provide a basic foundation to better understanding the opportunities the different tools present.

Figure A8 shows the results for the assessment of socio-economic tools in conjunction with LCM. From the responses and comments received, it is clear that not all the tools listed were fully understood. This clearly points to a lack of experience with applying these tools and a lack of understanding of the insights these tools offer.

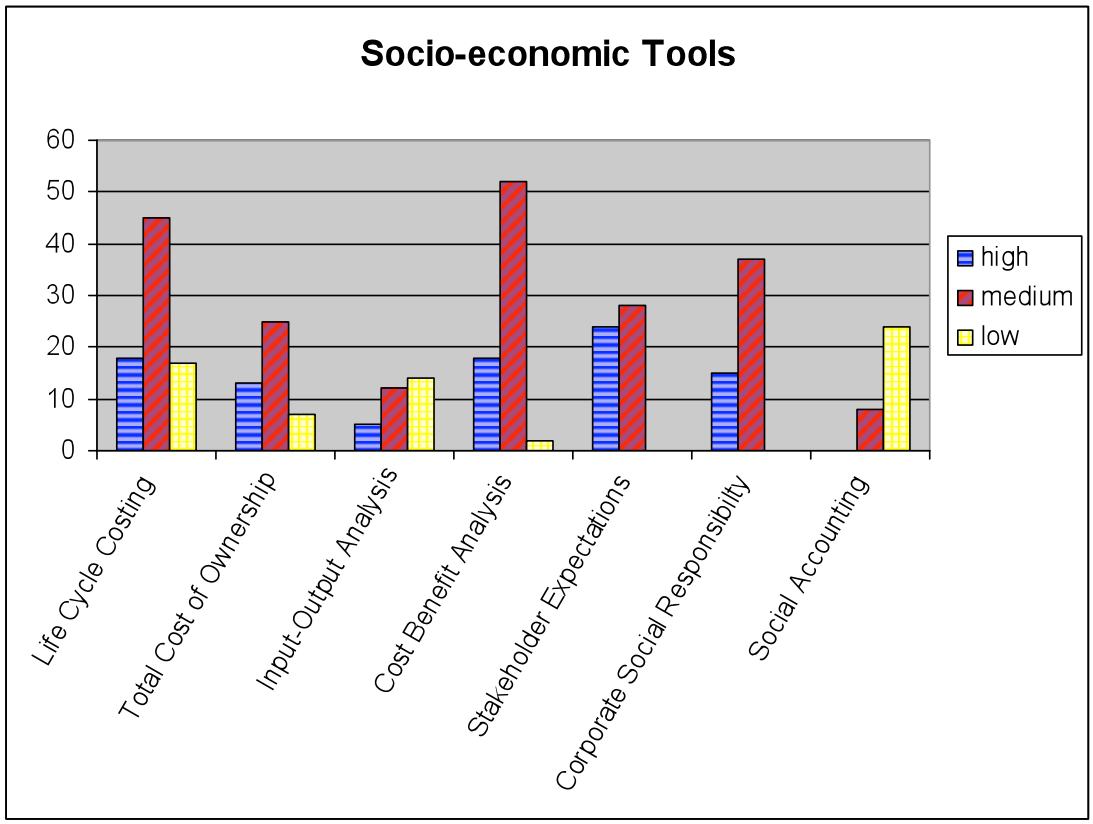

Figure A8: Importance of Socio-Economic Tools for LCM

As discussed earlier, cost benefit analysis and LCC / TCO are priority areas where background information and case studies are needed. The low importance of input / output analysis may reflect a lack of familiarity or understanding of the tool.

The role of identifying stakeholder expectations, as well as the positioning of LCM as a framework concept such as corporate social responsibility or industrial ecology are given priority. This feedback points to a general understanding of, and interest in, the interrelationship between the different tools and the linkages between the three dimensions of sustainability among users.. These linkages and relationships however remain underdeveloped.

Figure A9 shows the results from the survey regarding communication tools for LCM. It can be seen that labeling in general is considered to be important. While ISO Type I and Type II labels are already well introduced in the market and users see a value in better linking those labels with management and marketing, ISO Type III labels (product declarations) have not yet been fully introduced and uncertainties still exist with respect to how they can be utilized most appropriately. Some users feel that product declarations are extremely important, while others decline their usefulness almost completely. More work is needed on the inclusion of communication tools into the LCM framework. The exploration of possible parallel uses of complementary tools and their mutual reinforcement, up to a common underlying data structure, was identified in additional comments.

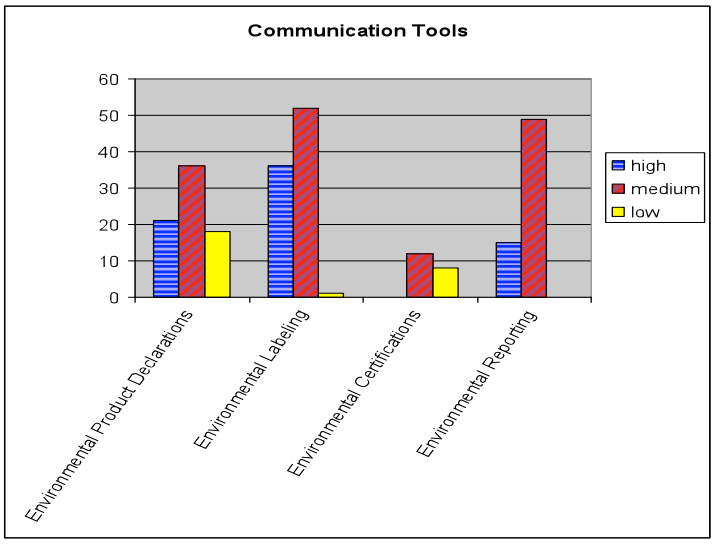

Figure A9: Importance of Communication Tools for LCM

Environmental reporting is a well established practice and users see a need to strengthen the product dimension within it. The desire to go beyond site-specific information and single case studies was expressed by all stakeholder groups.

Environmental certifications scored low in the survey, likely because only few applications exist and a systems perspective has yet to be introduced. Even so, respondents expressed a rather strong desire to develop certifications of a type that better uses a Life Cycle perspective.

Finally, as shown in Figure A10, the survey produced a clear picture of the environmental indicators that users consider to be most suitable to inform and support broader policy or management decisions.

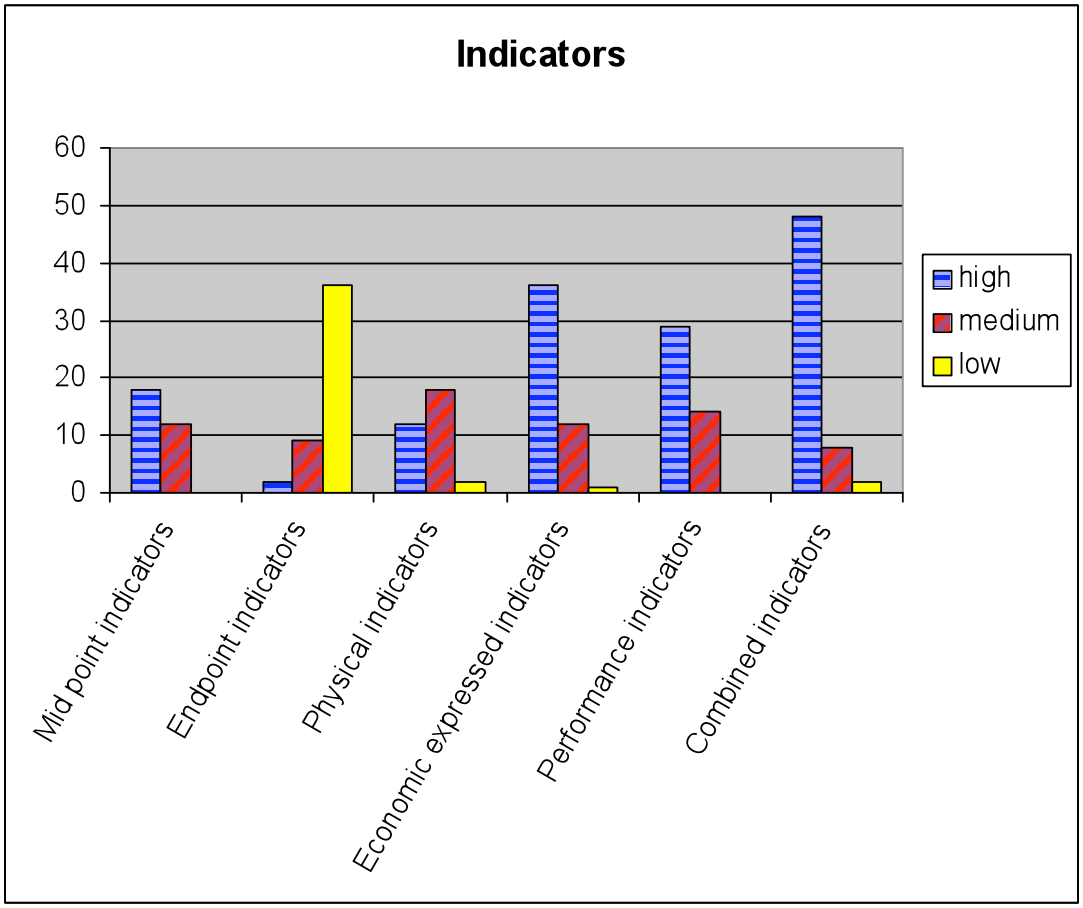

Figure A10: Required Sophistication for Indicators to Manage Product Life Cycles

Of the three typical LCA indicators, physical (such as MJ / unit), mid-point (such as GHG-equivalents), and end-point (such as DALYs), users favor the Life Cycle inventory-based physical indicators for their clarity, as well as the mid-point indicators, due to their acceptable level of uncertainties and the level of comfort decision makers have in using them. The results show clearly that LCA-indicators need to be translated into more meaningful (and, therefore more complex) indicators, or into combined indicators that express the environmental performance in conjunction with other aspects such as economic performance. Performance indicators such as MJ / person and kilometer traveled are viewed as more meaningful. Even more important is the link to economic performance, such as waste disposal cost per unit of service.

All in all, users felt that LCM indicators should not only express performance, but should also clearly link the environmental dimension with other dimensions such as economic performance.

Appendix B. Description of topic areas

B.1 Life Cycle based product development

All products including services exert impacts on the environment, which may occur at any or all stages of their Life Cycle—raw material acquisition, manufacture, distribution, use and disposal. The goal of integrating environmental and sustainability aspects into product development processes is an overall reduction in the adverse environmental impacts of products throughout their entire Life Cycles. Linking technologies of companies involved in the product chain (i.e., upstream suppliers, manufacturers and downstream customers) can lead to improved communication, increased efficiencies and productivity, improved environmental performance and lower overall costs. (ISO/TR 14062).

The interest of customers, manufacturers, and other stakeholders in the environmental aspects and impacts of products is on the increase. This interest can be seen in the level of discussions taking place between businesses, governments and non-governmental organizations on a variety of subjects such as sustainable development and eco-efficiency and in the growing number of international agreements, trade measures, national legislation, and sector-based voluntary initiatives that address some aspect of product environmental performance .

This interest is being driven by the economics of various market segments that are beginning to recognize the competitive advantage these new approaches to product design offer. These business benefits include resource and process efficiencies, potential product differentiation, costs savings and reductions in regulatory burden and potential liability. In addition, globalization of markets, shifts in sourcing, manufacturing, and distribution all influence the supply chain, and therefore have an impact on the environment.

The process of integrating environmental aspects into product design and development can enhance creativity and innovation and identify opportunities for environmental improvement. It is important, however, to note that a product's environmental aspects must be balanced against other factors, such as the its intended function, performance, health and safety aspects, cost, marketability, quality, and legal and regulatory requirements. (ISO/TR 14062)

Many organizations are beginning to realize that there are substantial benefits to be had in integrating environmental aspects into product design and development. These potential benefits include the following (ISO/TR 14062):

- lower costs by optimizing the use of materials and energy, more efficient processes, reduced waste disposal;
- stimulation of innovation and creativity;
- meeting or surpassing customer expectations;
- enhancement of organization image and/or brand;
- improvement in customer loyalty;
- attraction of financing and investment, particularly from environmentally conscious investors;
- increase in knowledge about the product;
- reduction in liability through reduced environmental impacts;
- improved relations with regulators;
- improved internal and external communications.

Obstacles:

There are a number of common obstacles that organizations encounter as they implement eco-design. They include: 1) the level of awareness of the environmental issues at different levels within the organization, 2) levels of environmental knowledge and competence, 3) organizational structure and internal routines, and 4) and availability of, or familiarity with, tools for handling environmental issues within the whole value chain.

Requirement for the involvement of multiple disciplines and business functions:

The success of integrating environmental aspects into product design and development is improved by involving a variety of relevant disciplines and organizational functions such as design, engineering, marketing, environment, quality, purchasing, service, delivery, etc. The key tasks and business functions (shown below in brackets) involved in the process include: (ISO/TR 14062)

- Analyzing environmental aspects to arrive at solutions (environmental personnel);

- Finding and implementing design ideas (product planners, developers and designers);
- Providing information to the supply chain about environmental requirements (purchasing managers);
- Checking the technical feasibility of the production processes or the end of life treatment of suppliers (management, engineering);
- Increasing internal environmental awareness through training and education (environmental and training personnel);
- Tracking new developments in legislation, environmental regulations, competitors' practices and customers' needs, and providing strategic information on the direction of product development and pricing at the end of live of the product (marketing managers).

There is consensus that current patterns of production and consumption are not sustainable in the long run. Individual companies responding to market signals will not create the system level changes needed to move to more sustainable practices. Advocates of sustainability are calling for inter- firm and inter-sector collaboration to create these new systems. Business is challenged to become more proactive, but at the same time remains constrained by existing organizational structures. Management has limited ability to control or influence the system level innovations needed. New product development (NPD) teams continue to make routine decisions that lock in current, non-sustainable patterns. This apparent contradiction suggests an important starting point for implementing an LCM approach.

LCM forces an expansion of traditional boundaries of decisions to consider the entire systems. For example, companies have traditionally developed procedures to incorporate the voice of the customer into NPD processes. LCM challenges the company to extend beyond customers to include the views of other interested parties, such as the stakeholders of its customers. For example, members of an NPD team normally optimize product development based on the boundaries of their technical function. LCM challenges product designers to look to the next higher level of the system to identify unanticipated impacts of their design decisions. This is the essence of an LCM implementation strategy. A decision can be described as comparing the current state to the desired state and then defining the corrective action needed to reach the desired state (see Figure 3). Efforts to develop formal, standardized methods and tools should focus on describing the current state and estimating the effect of proposed corrective actions. This is because the desired state is not an area amenable to technical standardization; defining the desired state is a social process that will depend on organizational and

cultural norms, which is set by corporate strategic planning (for business objectives) or by political processes (for social objectives). On the other hand, describing the current state is an objective, technical process. There is nevertheless great value in having standardized processes to help establish consensus on the current position and to evaluate whether the alternative desired states proposed by corporate marketing efforts, political campaigns, or governmental regulations are achievable.

NPD decisions shape the future of the enterprise one decision at a time, making this a critical point for integrating LCM into the business. Building internal capability for systems thinking is a necessary (but not sufficient) condition for enabling inter-firm or system-level innovations as they move toward sustainability. These capabilities must be in place before companies can implement broader sustainable development initiatives. One of the barriers to sustainable development is that there is no clear consensus on how to define or measure sustainability. There is significant uncertainty in quantifying actual Life Cycle damage caused by industrial activities and products, and by extension, disagreement about what companies should do, other than always pollute less. Thus, a critical success factor is for companies to set clear goals and objectives to guide their internal business processes toward the desired state. These goals and objectives help isolate the NPD team from uncertainties and help integrate decisions with the corporate strategy.

Setting measurable goals and objectives helps an organization put its vision into action. Goals are stated in terms of stakeholder needs, which facilitates external communication. Goals and objectives also define the company's scope of influence and control. Formally setting goals also provides a firewall that ensures internal business decisions are safely separated from external communications; in other words, it allows a company some measure of control over its external communications. It allows rapid and open sharing of information internally without fear of compromising intellectual property, while providing a meaningful response to stakeholder requests on the environmental impact of company actions.

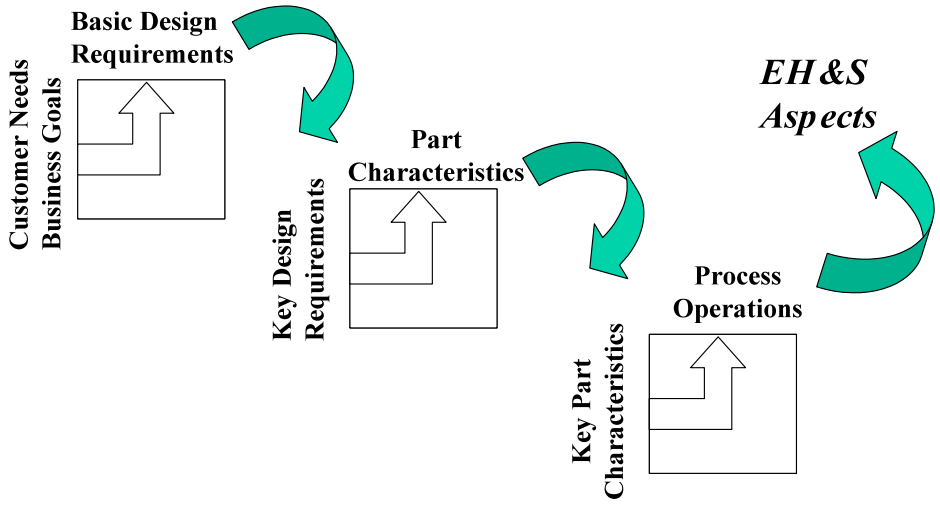

Figure B.1: New Product Development Process

A second critical success factor for LCM is the existence of a robust NPD process. The challenge is to link downstream impacts with specific decisions taken in the NPD process. The process is shown schematically in Figure B.2. Based on customer needs and preferences, the company defines a set of basic design requirements that describe the product offering. These key design requirements, in turn, determine the specification of key parts. The characteristics of key parts drive the selection of manufacturing processes, and finally, the specific processes determine the environmental, health and safety aspects of company operations. The combination of design choices and end user consumption patterns determines the ultimate impact resulting from the consumption of the product offering. These impacts are well removed in both time and place from the original decisions. Designers do not receive timely and meaningful feedback to guide their decisions. Regulations tend to work backwards from impacts, while market forces continue to push out new product innovations with ever-shorter cycle times. Best in class corporate programs attack this problem with disciplined procedures to develop quantified design requirements, assure complete and effective integration into routine practices, and measure and report performance.

An important tool in these programs is the use of simplified Life Cycle assessments (SLCA) early in the design process before any detailed definition of the design. SLCAs are typically based on qualitative or other simplified criteria which enable their early use without imposing the burdensome data collection requirements of full LCAs. SLCAs are often used for identifying priority areas of concern to be addressed during design and development. Once SLCA has identified priority areas of concern,

quantitative metrics can be developed to monitor and improve performance. (However, it should be noted that SLCAs are usually not a substitute for full LCAs, because they can be incomplete and can therefore miss important factors). Specific guidelines can be identified and/or developed to assist in the product design and development processes. Quantified metrics impose a level of rigor on the product development process and allow product designs to be benchmarked against earlier versions. The metrics also provide criteria that can be used to assess if the design project is ready to proceed to the next stage. Design guidelines establish standard work procedures that make performance outcomes more predictable. Effective integration is also dependent upon the development metrics for product EH&S attributes and processes for formally including these in the design specifications of products. However, design teams should be permitted to choose and develop their own tools and methodologies. Finally, successful programs will focus not just on the environmental benefits of eco-design but also on the added business value that this approach makes possible.

A third critical factor for success is to ensure that product environmental information from the NPD process is effectively linked to business and technology planning processes. This assures that the required substitute technologies are ready in time to support the NPD program, and that the company can capture competitive advantage from its improvement initiatives.

A fourth critical success factor concerns communications and training. Because there is no consensus on the definition of sustainability, there is no general agreement on what constitutes responsible corporate behavior. This can mean that the best efforts of a corporate green initiative may be ignored or interpreted as green-washing. Companies must develop transparent and objective communications platforms to build awareness of company initiatives and assure that the initiatives are aligned with the interests and expectations of their stakeholders.

Finally, success depends in many ways on collaborating with external organizations. The most obvious type of collaboration is with supply chain partners. These initiatives can achieve savings greater than either of the partners can achieve alone, delivering direct business value and environmental benefits to both parties. Longer-term initiatives may involve partnering with academic and non- governmental organizations to address the needs of stakeholders currently excluded from the market system.

It has been stated that efficiencies must increase in the next generation by a factor of 4 to 10 in order to compensate for the expected growth in population and ensure a healthy increase in wealth per capita. The LCM Program should contribute to this goal.

A closer look at the Factor 4/10 hypothesis reveals that it will require more than incremental innovations in how we deliver products and services. To understand the types of change needed to achieve Factor 4/10, it is useful to consider the following types of innovation: (see Figure 4):

- **System Optimization (or Incremental Change)**: These leave the existing product concept intact and focus on improving performance; for example, by making a car more fuel-efficient. Typically, this kind of change can achieve improvements of around 50% to a factor 2. The advantage is that such improvements can be implemented in relatively short time frames and usually do not require extensive co-operation along the value chain.
- **System Re-Design**: This involves re-organizing a part of the production chain, but leaving the product concept by and large unchanged (e.g., changing the end-of life structure of a production-consumption chain and adapting design accordingly). This often requires a form of co-operation between companies along the value chain, but the structure of the chain remains largely unchanged.
- **Functional innovation**: This type of innovation begins with the product function, and tries to develop innovative ways of delivering the same function. It necessarily involves radical changes, such as a for example, switching energy supplies from coal to oil/gas or from oil/gas to renewables. It also necessitates a completely different set of actors to deliver the new 'product' that fulfils the function. An example of such a radical change is the switch from sea to air for intercontinental travel (the function). It is in functional innovation that real prospects for reaching a factor 4 or 10 can be found.

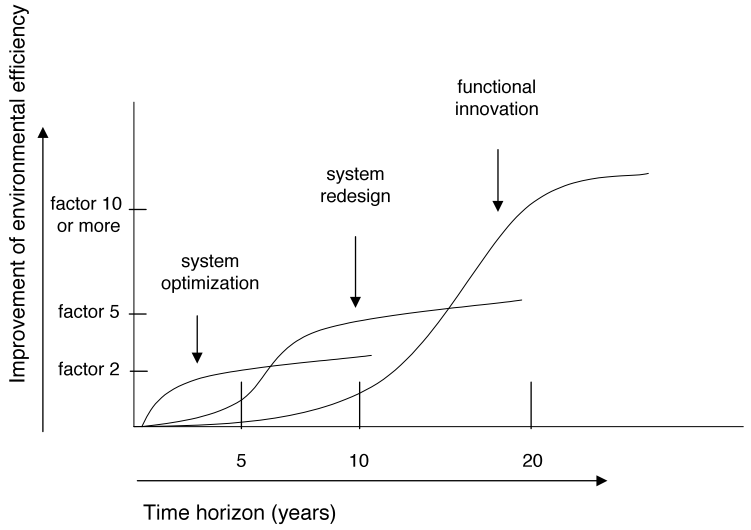

Figure B.2: Step-change function in product innovation

B.2 Communication of Life Cycle Information

Companies have three types of environmental labeling schemes to choose from—ISO Type I, ISO Type II and ISO Type III labels—depending on their intended use for the labels and the needs of their stakeholders. In principle, a company that has well-developed LCA capabilities will want to move toward an ISO Type III labeling (environmental product declaration) scheme. The use of this kind of labeling, suitable for sharing environmental information on products and services along the supply chain, enables faster and more accurate LCA analyses, more effective DfE practices and "greener" purchasing mechanisms. The sharing of Life Cycle data along the supply chain means that companies have access to reliable data with which to perform more accurate LCA analyses, without having to resort to time-consuming data collection themselves. As well, because the information is provided directly by suppliers, it is more accurate and application-specific than information available from generic, publicly available database, which in turn makes for better environmental product design. Finally, the provision of Life Cycle data along the supply chain facilitates environmentally preferable purchasing. In their current state of development, Type III labels have immediate application in business-to-business relationships and in interactions between businesses and public authorities. Further work is needed to design labels that can be easily understood and used by the public at large to drive improvements in the overall environmental performance of the products and services they purchase. The information gathered in ISO Type III labeling programs can be used to easily develop Type I labels (public-oriented labels) to identify those products that are best in class. For some product classes it is possible to to develop Type I labels, without having Type III labeling programs in place. However, unlike ISO Type III labels, Type I labels are not a mechanism for driving continuous improvement in a company's environmental performance. The ability of Type III labels to propel continuous improvement reinforces the value of a structured LCM approach.

Type III labeling opens the door to stakeholder participation in LCM, to help define what aspects and impacts should be controlled and how environmental performance priorities should be set, given the realities of the product's market. As well, stakeholder participation can help expand LCM beyond environmental considerations, by helping define the social aspects of products that should be managed for improvement.

In the past decade, environmental policymakers around the world have showed a growing interest in finding ways to improve the environmental performance of products across their Life Cycle. In February 2001, the European Commission published its thinking on these issues in its *Green Paper on Integrated Product Policy (IPP)*. One of the overarching goals of IPP is to stimulate demand for greener products through easily accessible, understandable and credible information. A possible tool for achieving this is the use of environmental labeling of which environmental product declarations (EPDs) are an integral part.

Within the context of LCM, it is important to understand the roles that environmental communication can play. Environmental management systems, of which ISO 14001 and EMAS are the best known, allow companies to manage all of their activities, products and services that can have a significant impact on the environment. In the context of EPDs, such systems can be used in a variety of ways, such as managing and verifying product information, or a combination of both. Management systems can potentially be used to manage and verify EPDs, increase time and cost efficiencies and lower the threshold for companies wanting to publish environmental product declarations. However, this requires the integration of information management into the environmental management system.

Type I and II labels are the other forms of environmental information covered by the ISO labeling standards. Whereas Type I labeling identifies products as being less harmful to the environment compared to other, similar products fulfilling the same function, Type II labels are self-declared environmental claims which allow statements about the environmental performance of a product by the manufacturer itself. Unlike EPDs, which are primarily a business-to-business communications tool, Type I and Type II labels inform final consumers. The underlying information should come from the same sources, in order to avoid duplication of work. A careful design of labeling programs (with and without government participation) is therefore advised.

There are clear synergies between the processes used and the data required to develop product-specific requirements and EPDs, Type I labeling criteria and Type II environmental claims, including the use of a common LCA data background and a common verification procedure. Exploiting these synergies should help reduce costs and offer greater opportunities to companies and governments to communicate product impact and Life Cycle data to a variety of different audiences.

The Global Reporting Initiative (GRI) is developing universally applicable reporting guidelines for organizations wishing to report on the economic, environmental, and social performance of their activities, products, and services. The GRI is following an iterative, multi-stakeholder process that

incorporates the active participation of representatives from business, accounting firms, investors, environmental, human rights groups, and research and labor organizations from around the world. The demand for a standard framework for reporting has increased in recent years, as more and more investors, fund managers, consumers, NGOs and other groups seek social and environmental information absent from conventional corporate financial reports. GRI is becoming an important player in efforts to standardize the communication of non-financial performance information and its guidelines are an important tool in the larger LCM toolbox.

As sustainability reporting gathers momentum, the need for a common reporting framework has become acute. With a common framework, such as the generally accepted principles that guide financial reporting, organizations can focus on what they're reporting, not on deciding which are the right indicators to address. Report users can focus on assessing and comparing information, not whether the report itself is based on a credible framework.

Sustainability reporting is part of a broader landscape of initiatives linked to higher standards of accountability. These include charters, principles, codes of conduct, management systems, and performance standards. The GRI Guidelines complement these mechanisms by providing an integrated disclosure framework that enables organizations and their stakeholders to assess economic, environmental, and social performance. The United Nation's 2002 *Report of the World Summit on Sustainable Development* formally recognizes the GRI Guidelines as an important tool that will help encourage industry to improve its corporate accountability and responsibility. In support of the guidelines, the United Nations Environment Program (UNEP) has designated GRI as an official collaborating centre.

To meet the reporting needs of specific kinds of companies, GRI is partnering with sector-based initiatives to develop sector-specific performance indicators. The core guidelines have already been through two pilot tests involving a total of 45 companies. Sector supplements will follow a similar pattern of development and testing.

Recent years have seen the emergence of certification schemes, such as the Forest Stewardship Council (FSC) and the Marine Stewardship Council (MSC), which provide assurance to stakeholders and consumers that certain performance standards were met in the production of raw materials. Because these standards were developed with the participation of a broad group of stakeholders, companies can be confident that there certified products comply with the expectations of these interest groups. These schemes fulfill a need for performance standards, something that certification to environmental management systems does not provide. It has become established practice for retailers

to use these schemes to determine product placement on their shelves. Investors and others in the financial sector are using these certification schemes to determine compliance with leading practice.

B.3 Management along the Life Cycle

LCM can be understood as an approach for ensuring that the processes used across the Life Cycle of projects are consistent and that there is effective sharing and coordination of resources, information and technologies. This Life Cycle spans the conception of ideas through to the retirement of a system. It provides the processes for acquiring and supplying system products and services that are configured from one or more of the following types of system component: hardware, software and human resources. In addition, this framework allows the Life Cycle performance of products and services to be assessed and improved upon. The approach should also attempt to integrate environmental, economic and social considerations in order to allow organizations to move forward on the path to more sustainable production.

Stretching the systems perspective a little bit, it is correct to say that organizations currently implementing a quality standard have also already begun implementing an LCM approach. Extending their quality management system to include environmental and social performance factors as well is simply a question of organizational responsibility. Because an organization's legal status defines the economic Life Cycle in a quality management system, the development of an environmental (and social) policy should result in the formulation of sustainability goals (i.e., the addition of social and environmental goals to existing economic ones) within the same management system. Today, this is mainly a trust building mechanism (opposite to buyers and the boarder public, but also to correspond to product safety and producer responsibility obligations). Still there is a remaining gap in LCM, namely the inclusion of the broader sustainability concept.

The first step towards implementing LCM within a company should consist of defining the roles and responsibilities of individuals; in other words, it should define the organizational structure. Depending on the size of the company, its business and its cultural background, these roles could be assumed by the quality department or in an ad-hoc department such as sustainability affairs. We don't believe it is possible to provide a single, universally applicable recipe for the perfect organizational structure; its form in most cases will be defined by decisions taken at high levels within the organization. In general, however, it is possible to envisage three levels within the structure of large organizations. At the top, the head of sustainability affairs should be in charge of strategic decision and of drafting and updating corporate policies. Policies are, in essence, a declaration of intent and should be finalized in

consultation with the company's significant stakeholders to ensure they meet external expectations. At mid levels within the organization, a pool of people should have a tactical role, where they are responsible for developing and coordinating the hardware, software and human resources needed to translate words (policy) into practice (tools and procedures). At the bottom of this structure lies the company's operations. At this level, several branches of the company (procurement, production planning, sales, production and controlling) need to be involved, with each in charge specific elementary tasks. Of course, in small to medium sized enterprises (SMEs), these levels may not exist, and one individual may fulfill the role of all three levels. The successful development and implementation of this kind of management system in SMEs will therefore depend on a high degree of penetration of information technology tools within these companies.

The second step in implementing LCM approach should involve establishing an environmental management system (EMS) or a social responsibility management system (SR). Unless companies see a strategic advantage in pioneering a social responsibility management system, we recommend starting with an EMS for the simple reason that EMSs have been around for a long time, and the necessary skilled human resources, guidance documents and tools for measuring performance are readily available. A Plan-Do-Check-Act-based (PDCA) management system must lead to measurable and demonstrable improvements that align with the expectations of stakeholders. Demonstrating meaningful improvements at all levels of performance to all stakeholders is often the most difficult milestone to achieve, and yet is extremely important if companies are to reap the business benefits of their efforts. Without supporting performance measures, certification of EMS is often viewed by stakeholders as no more than an expression of the company's commitment.

In order to add relevance to performance measures in an EMS, environmental accounting or Life Cycle assessment (LCA) need to be introduced. The choice of which tools to use should be based on the levers that the company wants to activate in order to reach its stakeholders. A step-by-step approach might be to start with environmental accounting (processes/site accounting approach), followed by Life Cycle assessment (product/service accounting approach). On the other hand, since business must usually respond to customer needs, which tend to focus on the performance of products as opposed tooperations, the reverse process is also valid. Environmental accounting ensures better monitoring and reporting of EMS performance. While there is no universally accepted standard for non-financial reporting, the work of the Global Reporting Initiative has led to a certain degree of standardization through the development of its *Sustainability Reporting Guidelines*. Users of environmental reports are usually high-level interlocutors such financial partners or NGOs. This level of communication is fairly

easy to achieve and could already be thought to be made effective just in a first phase of a Life Cycle Management program implementation for an organization

Switching from a site-or facility-focused approach to a product-oriented approach should be the third step toward implementing a LCM approach. This step is necessary in order to enable: supply chain management, design for environment practices, LCA and environmental labeling. These are the key activities that must be coordinated if the environmental performance of products is to be continuously improved. Life Cycle assessment is a methodology that can play a central role here by linking environmental considerations to procurement decisions, product development processes and design choices. Theoretically, the introduction of LCA should allow companies to outline critical hotspots along the entire product value chain and thereby identify and prioritize areas for improvement. Each branch of the value chain should be investigated for opportunities, both those under the direct control of the organization and those outside. LCA should first be used for understanding where the research and development (R&D) department needs to concentrate its efforts in order to develop more environmentally sound products. This is played out in practice, where R&D departments are often the point of introduction of LCA into a company. Companies may use internal or external resources, depending on the organization's mission and strategy and the availability of internal skills and their degree of confidence in conducting LCAs. However, because LCAs are expensive and the data they generate are often commercially sensitive, most companies use internal resources to conduct LCAs. Because they are expensive and there are no guaranteed returns on investment, LCAs are usually carried out only on core business products. It also makes strategic sense to do so, since these products usually represent a good portion of a company's sales volume, and, therefore, environmental impact.

Once the entire line of products has been assessed using LCA, data can be aggregated for a full environmental accounting of the company's performance along its value chain. One of the first outputs of an LCA study should be a design for environment guide for use by the R&D department. How the results of LCAs are used to modify existing production processes depends on the organizational structure of the company and the position of the company in the value chain. In general, if the main impacts of the product under investigation occur during production and if the company largely out-sources production, then priority should be given to managing performance of suppliers. On the other hand, if the higher impacts occur during the product's use phase or at its end of life (e.g., dismantling), then priority should be given to environmental labeling. Currently, the main tools used in supply chain management are questionnaires and, sometimes, audits (depending on contractual obligations and the awareness of the supplier). In the near future, improvements in information technology can be expected to improve supply chain management and procurement practices. Information technology can be

expected to give rise to new tools that will facilitate the collection of data needed for Life Cycle inventories while protecting commercially sensitive data. The procurement department assisted with specific tools is expected to include more and more stringent environmental requirements in supplier selection.

Both ISO 14001 and EMAS II (European Eco-Management and Audit Scheme) address the environmental performance of products to some degree. EMAS II clearly requires products to be considered within the boundaries of an EMS when they are deemed to have an environmental impact. EMAS II also allows companies to make validated environmental claims regarding their products and services and to use the new EMAS logo in this context. Because the product dimension of EMAS was only recently added, it is still to early to judge its effectiveness at driving improvements along the Life Cycle of products and services. There continues to be debate over the extent to which ISO 14001 covers products and services, based on the standard's text which refers to "an organization's activities, products or services". ISO 14001 certifiers/auditors still tend to focus on sites rather than product chains, in part because the product dimension is beyond their current technical capabilities.

The main drivers influencing companies to implement product-oriented management systems (POEMS) include:

- competitive advantage, particularly among larger firms;
- a desire to better understand and manage product supply chains, both upstream and downstream;
- an awareness of the increasing strategic importance of environmental issues;
- an awareness that management commitment and an organized process or management structure is essential, which embraces all functions in the company— marketing, product design, production, environmental affairs, etc.;
- the existence of a product-focused quality management system (e.g., ISO 9001).

B.4 Stakeholder involvement in the Life Cycle

Systems theory refers to leverage points as those places within a complex system (such as a corporation, economy, living organism, city or ecosystem) where small intervention produces big changes in the rest of the system. The product or Life Cycle system has many such leverage points, which can be identified in order to understand how to best intervene with the system to achieve the

desired change. Since one small change can lead to changes, both desired and undesired, that are multiple orders of magnitude larger, understanding the dynamics of the product system is critical. This is key challenge of implementing Life Cycle management.

Typical leverage points for intervention include the expectations from different stakeholders, the various functions within the organization, and individual incentives or motivations. More concretely for LCM, places to intervene in the system include:

- the product Life Cycle: from Life Cycle stages to individual process changes;
- the public sector: from producer responsibility regulations to green procurement programs;
- the various business functions of the company: procurement, product development, marketing;
- stakeholders expectations: financial sector, consumers, special interest groups.

There is natural tendency to try to identify leverage points that are universally applicable, such as a piece of legislation targeting a product's most significant environmental impact. However, leverage points vary from product to product, sector to sector and region to region, making it impossible to arrive at a one-size-fits-all approach. This is illustrated in Figure 2 which shows how the key leverage points of different types of products occur at different Life Cycle stages.

It should also be noted that one of the major benefits of Life Cycle thinking and LCA are their ability to consider multiple measures of environmental performance over the entire product Life Cycle, making it possible to identify potential trade-offs and avoid shifting the environmental burden from one Life Cycle stage to another. The goal of LCM is to improve the net performance of the entire system.

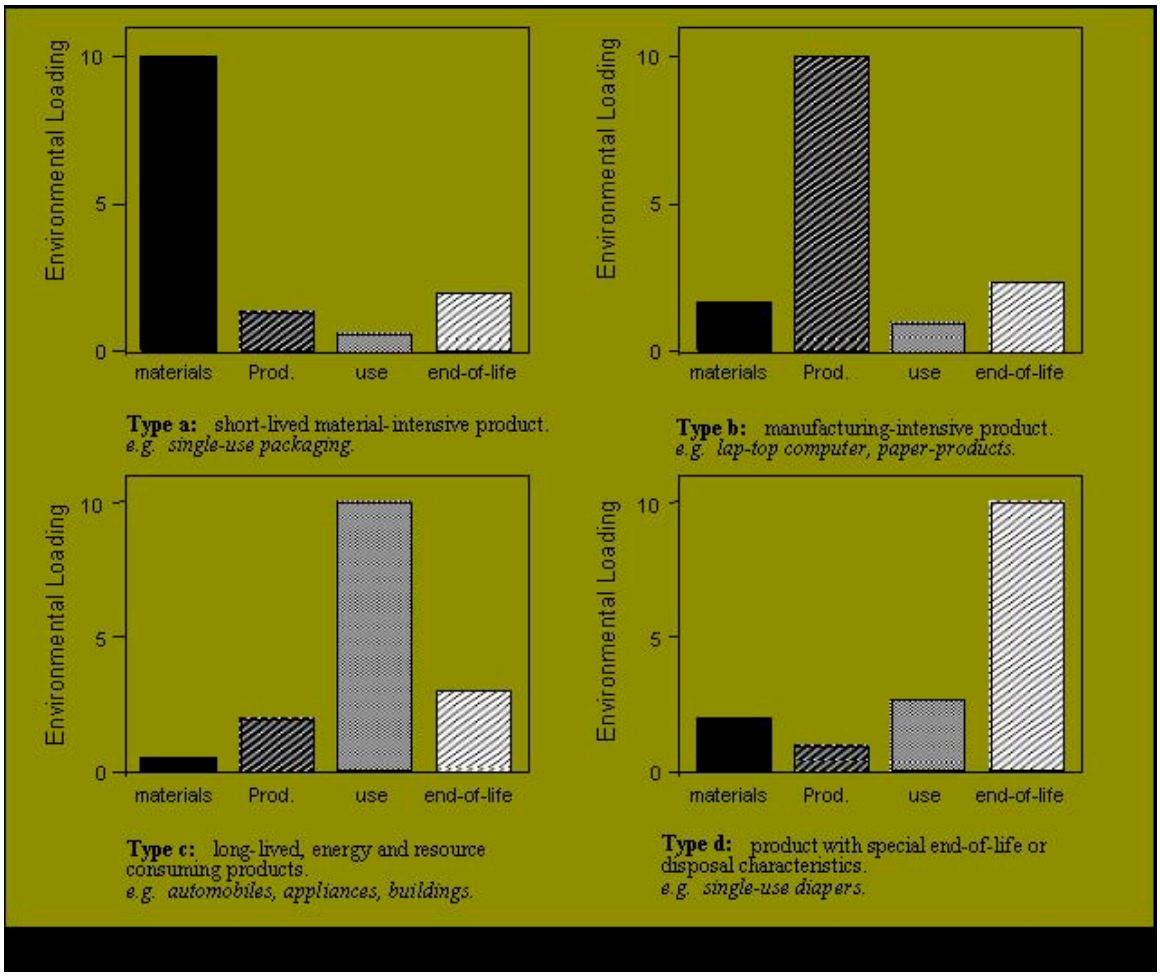

Figure B.3: Relevance of Life Cycle Stages for Different Product Categories

Life Cycle management requires guiding concepts, programs and specific tools. While the overall goal is to integrate the approach into all functions and levels within the organization, implementation will likely start slowly from one or more points in the firm. These are referred to as the “entry gates” for Life Cycle management:

Upper levels of management are potential entry gates for Life Cycle management in an organization. Upper management has the ability to examine and re-chart the course of the existing strategy, redefine environmental commitment beyond compliance and make it a part of business strategy. Commitment from management is also indispensable to direct the necessary changes in vision and policy and shareholder and employee. Ensuring that the core competencies in the company are developed depends on securing management support.

A second entry gate for Life Cycle management is at the level of *marketing*. In one common anecdote, a firm's marketing division widely communicated the company's initiatives for improving environmental performance. While the company had committed to these initiatives on paper, in practice, they were not being implemented. This generated external pressures to develop and implement the programs and tools to carry forward the company's written commitments. *Procurement* is an important potential entry gate. A firm that is unsure of how or where to begin can use an effective procurement policy to learn and benefit from the efforts of other firms in the chain. Alternatively, companies that are environmental leaders can help up- and down-stream suppliers by communicating their programs, tools and efforts. This comprehensive approach might serve to align the improvement progress of the chain, and ensure the exchange of usefully formatted information.

The *product design* division, manufacturing and *research and development* functions are two entry gates for Life Cycle management. Interested individuals may be looking to alter existing operations to include better information and a more comprehensive perspective. In turn, employees may use their experience and expertise to modify environmental tools to better satisfy their daily functional needs.

Life Cycle management as an approach is associated with brand enhancement and possibly a leadership position. In this regard, *Corporate reporting* can serve as an important entry gate.

In most cases, some level of environmental awareness and improvement initiative will already be present at several of these 'gates'. While the maturity will differ in each, a Life Cycle management approach should foster this awareness and efforts, and encourage their development and integration with key functions and decisions at each 'gate'.

The place to intervene in a system may, not however always be the one with the most significant impact, but the point where the most promising influence can be made. In the same way, influences and indirect impacts on the whole system must be considered when making changes in order to avoid unexpected problems and shifting environmental burdens. This all requires an understanding of

underlying influences and importance, in order to make sound decisions, as policy maker, as consumer, or as industry.

B.5 Challenges for Developing Countries

Life Cycle management is emerging as one of the most powerful environmental tools in developed countries. The use of LCM is particularly evident in industries and private business. In most of the developing countries, including Egypt and probably many other developing countries, LCM stand a different posture. On the one hand, LCM is perceived to be a vague concept in this countries which creates uncertainty over its proper placement and role within the hierarchy of available environmental tools. This view is also shared to some extent in developed countries where LCM still lacks a clear definition. On the other hand, unlike developed countries where clients and end users are the strongest drivers for LCM, in developing countries such driving forces do not exist. As well, many of the requisite components for LCM, such as green procurement, environmental databases, eco labeling schemes and other related tools are barely known or non-existent in the vast majority of developing countries. Furthermore, one of the most important obstacles to implementing LCM in developing countries is the complexity and difficulty of the many of the methods in the LCM toolbox, which tend to require special training and experience.

Developing countries, in general, and African countries, specifically, are still lag behind in developing methods and implementing LCM approaches. For example, in Egypt, the emphasis of environmental policies and practices is on environmental management processes such as pollution prevention, waste elimination and / or reduction and so forth. LCM-related methods and tools including product-based methods are still many years away from being applied. One of the main reasons for the absence of these tools is the lack of pressure groups and environmental awareness among the public that could orient industry to adopt these measures.

It is a subject of debate whether there is a need for LCM in developing countries. Many believe that the complexity of, and extensive experience needed to, implement LCM is a barrier to its successful implementation in developing countries. Nevertheless, most agree that Life Cycle thinking, a major component of LCM, should be considered in the development of environmental policies in developing countries, even if the full spectrum of LCM and its related tools are not implemented. There is no doubt that most of the chronic problems facing the majority of developing countries, such as solid waste, sustainable development of cities and pollution could be dealt with more effectively if policies and regulations were developed using a Life Cycle approach. Given that LCM will become increasingly

important to business success, it seems certain that developing countries will consider implementing some of the tools of LCM. A pressing issue in this respect is the demand for eco-labeled goods in European countries and how this demand could become a driving force for the adoption of LCM among developing countries that have commercial ties with EC member countries. Recent reports of the European Community indicate that the number of goods bearing the eco-label is on the rise. According to plans, the number of these product categories can be expected to increase to about 35 by 2004. Plans are also underway to increase awareness of, and demand for, eco-labeled products among European consumers. In Egypt, some textile producers, especially those that export to Nordic countries and Germany, have already taken the necessary steps to ensure their products qualify for eco-label status. Demand in developing countries for the tools that help secure eco-labels for a variety of different products sold on the European market is expected to increase over the coming years.

While private sector demand for LCM tools increases, their use in the design and delivery of public policy and services continues to lag. In Egypt, for example, municipal solid waste is one of the most serious environmental problems faced by cities big and small alike. Efforts to combat the problem have never been successful despite the large investments made, largely because Life Cycle thinking played no part in the solutions developed. Power generation policies and sustainable consumption are areas where a Life Cycle thinking approach could make a significant contribution to solving pressing environmental problems.

Training Needs

Developing countries are in dire need of training in Life Cycle approaches and tools. Two aspects of training need to be considered carefully: whom to train (target group) and what to train (training materials).It will also be very important to consider how training programs should be financed.

1. Target Group

Training should be directed at select target groups, which should include industries, with an emphasis on small to medium-sized enterprises (SMEs), who represent as the most resilient sector of industry most able to accommodate new concepts and practices. Unlike large industrial facilities, which tend to resist change for the bureaucracy involved, SMEs, with their simple infrastructures are more responsive to market needs and new trends. Other groups that should be

targeted include the staff of regulatory bodies, municipalities, environmental officers and academics.

2. Training Materials

Because LCM is still at an early stage of development in most developing countries, training materials should be carefully tailored to match practical needs and avoid an overemphasis on its theoretical and academic underpinnings. Capacity building should focus of topics of direct relevance and impact on developing countries or developing economies. LCM, as a business-focused environmental toolbox ,should be highlighted because of the bearing of this paradigm on the success of developing economies.

Topics should be chosen for their ability to introduce the state of the art and stages of the Life Cycle. Topics could include:

- How Life Cycle thinking can help change sustainable production and consumption patterns.
- Life Cycle assessment, theory and practice.
- Life Cycle management as an practice-oriented program.
- Analytical tools that underpin LCM, such as environmental risk assessment, substance flow analysis, types of environmental labeling, etc.
- Integrated product policy (IPP), which is probably of special importance to developing countries as an important framework for promoting sustainability. It may also help shape production and consumption patterns in order to secure resources for future generations.

In conclusion, is should also emphasize that what has been described for developing countries applies equally to small and medium-sized companies in developed countries. They experience the same challenges related to knowledge, lack of data, lack of experience and, in particular, lack of recommended practice and practical guidance. It may also be stated that large industry, both in the developed and developing worlds, can benefit from these efforts. Training and disseminating materials will help build internal capacities, partnership and cooperation with suppliers and stakeholders, and, last but not least, to further any existing Life Cycle efforts. There is still a huge number of large industrial players that are newcomers to LCA and Life Cycle thinking, that are in need of capacity building and can benefit from guidance on recommended practice.

B.6 Integrating Economic Aspects into LCM

While the inclusion of economic aspects in LCM has been identified as a major area of interest, research in this area is still at an early stage. The topic itself was not included in the 2003 work plan of the Life Cycle Initiative, but has been identified for work at a later stage. Until now a SETAC Working Group on Life Cycle Costing is spearheading the work on this topic.

Life Cycle costing (LCC) is one of the most useful, if not most important, concepts for linking environmental Life Cycle approaches to management decisions. It should therefore be seen as a priority area of LCM.

While there are several definitions of LCC, for many different applications, the definition by Blanchard and Fabrycky (1998) is consistent with SETAC's definition of LCM (see Hunkeler et al. 2003) and therefore can serve as a useful starting point: "Life Cycle costs refer to all costs associated with the system as applied to the defined Life Cycle." Based on this, a more LCM-specific definition has been developed, which states that Life Cycle Costing is an "assessment of all costs associated with the life cycle of a product that are directly covered by the any one or more of the actors in the product life cycle (supplier, producer, user/consumer, end-of-life-actor), with complimentary inclusion of externalities that are anticipated to be internalized in the decision-relevant future." (Rebitzer and Hunkeler 2003)

LCM is a business-driven approach to management that addresses environmental, social, and economic aspects. Conventional cost management is limited in its ability to assess costs and revenues over the Life Cycle of products. Methods are therefore needed that integrate existing business-relevant financial data, information, and metrics into Life Cycle approaches. Such an approach is offered by Life Cycle costing (LCC). At present, there is neither complete scientific nor procedural agreement among stakeholders regarding LCC terminology, methodology, data formats, reporting, etc. With the exception of some very sector-specific frameworks (see, for example, ASTM 1999), clear guidelines have not been developed. There is therefore an opportunity for the UNEP/SETAC Life Cycle Initiative to play a crucial role in the development of the needed methodological background and application procedures of LCC, by bringing together the knowledge and expertise of SETAC and the Society of Industrial Ecology and other, more economics- and business management-oriented research groups. Furthermore, LCA and LCC, when carried out in an integrated manner and from a systems perspective, offer tremendous potentials for moving industrial practice towards sustainable development.

The SETAC Working Group Life Cycle Costing has the following objectives, which are consistent with the objectives of the UNEP/SETAC Life Cycle Initiative (Rebitzer and Seuring 2003):

a) Define the state of the art in LCC methodology (survey of existing approaches, definitions, and applications).

   This involves contacts and cooperation with communities and experts (research, consultancy, and industry) in total cost accounting (TCA), supply chain costing (SCC), total cost of ownership (TCO), activity based costing (ABC), value chain analysis (VCA), etc.

b) Collect and analyze LCC case studies.

   For this, representation from corporate partners in the working group is critical, as it was for the previous SETAC Life Cycle Management working group.

c) Analyze methodological challenges in the integration of LCC and LCA (e.g., system boundaries, allocation, data definitions and formats, interaction with Life Cycle inventory and Life Cycle impact assessment).

d) Develop an LCC data concept for Life Cycle management (LCM).

e) Develop an LCC Code of Practice/guidelines in the form of a SETAC or UNEP/SETAC publication (overall deliverable of the working group).

The following groups are currently being targeted by the SETAC LCC WG:

a) LCM and LCI/LCA researchers and practitioners from all parts of the world, including industry (small to medium-sized enterprises, multinationals) and other stakeholders from the developed as well as emerging regions.

b) Industry and researchers in total cost accounting (TCA), supply chain management (SCM) and supply chain costing, total cost of ownership, activity based accounting (ABC), value chain analysis (VCA), etc., from all parts of the world. This could lead to the establishment of links and networks among these groups to further the development of LCM.

c) Stakeholders related to LCM in all parts of the world.

Intermediate reports and other working papers that are cleared for publication (such as, case studies, methodology papers) can be regularly published. Guidelines and other background material could also be published within the framework of the UNEP/SETAC Life Cycle Initiative.

The following areas and activities have already been identified by the SETAC working group. Work in all of these areas has already begun:

- Life Cycle costing methodology;
- Life Cycle costing in business;
- Life Cycle costing and its link to Life Cycle inventory;
- Life Cycle costing and its link to sustainability and externalities.

Figure 5 shows a scheme for categorizing approaches to environmental accounting which provides a useful framework for understanding the goals of LCC in relation to other types of accounting (Bartolomeo et al., 2000). LCC expands traditional organizational boundaries to include suppliers and customers and extends the time horizon into the future. LCC fits in the top two quadrants. Life Cycle management (LCM), which promotes a holistic view of the product system that encompasses both material and energy flows and interactions with natural systems, fits primarily in the left half of the figure. External stakeholders view the company through voluntary and mandated reporting, i.e., the right half of the figure. It can be assumed that the interest in LCC stems from a general dissatisfaction with business decisions based on conventional cost management information.

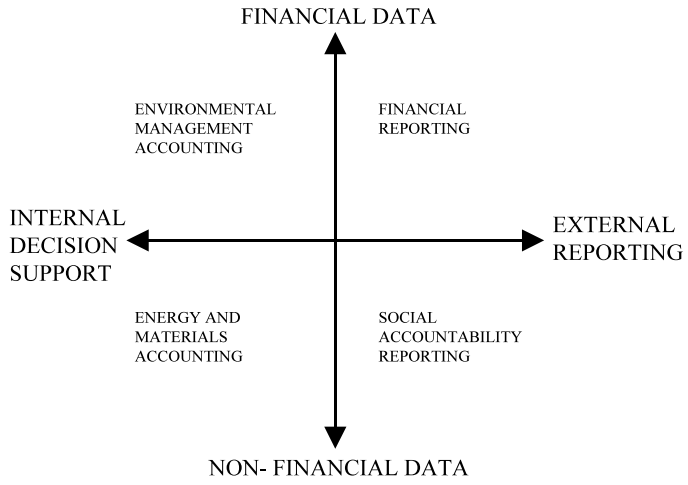

Figure B.4: Objectives of Life Cycle Costing

Environmental managers have been interested in LCC because there is a general consensus that existing cost management practices do not fully capture the downstream costs of many business decisions. This has been aggravated by the common practice of lumping many environmental management activities into overhead accounts that are then allocated to various cost centers.

Significant work has been carried out to estimate true cost by identifying indirect or partially hidden costs, contingent costs and less tangible costs such as image and relationships (US Environmental Protection Agency, 1998). While these studies have highlighted the potential to distort decisions by burying costs in overhead accounts, the administrative outlay required to identify and allocate these costs can be prohibitive. This is not a problem unique to environmental management. Activity based costing (ABC) has been used to minimize allocation by tracing activities and their associated costs back to specific cost objects. Managers can then tackle key cost drivers in their improvement efforts.

ABC is an area being addressed by established initiatives in the business management community. The SETAC LCC WG should build on these initiatives and provide additional guidance only when needed to address issues unique to life cycle management. A question that needs to be addressed is, “how does a manager know hidden costs are significant until after spending the significant time and resources needed to uncover them?”

Another challenge is to determine exactly what constitutes an “environmental cost.” In the past, the focus was on capturing the hidden costs of mitigating and controlling the environmental impacts locked in by past decisions, e.g., by installing scrubbers on existing, environmentally inefficient stacks, providing hazard communication training to employees working with hazardous processes or equipment, et. These practices are unlikely to promote eco-efficiency since, in effect, they reinforce the idea of environment as a cost adder. And while more complete and accurate allocation of costs to existing product lines may encourage pollution prevention and waste minimization projects, benefits are often in the form of avoided costs. Eliminating a hazardous waste from one process or product line will not necessarily result in a reduction of the hidden overhead charges. Financial managers recognize these improvements only when redundant employees are terminated or excess real estate is sold, producing gains that show on company financial statements. More progressive accounting approaches attempt to capture process inefficiencies and wasted materials as environmental costs. In such cases, improvements translate directly into reduced operating costs, but the approach is not without problems. For example, what portion of the costs (and benefits) of a new process technology that provides multiple benefits—e.g., higher throughputs, better quality, and reduced scrap—should be allocated to environment. While these accounting approaches should help promote eco-efficiency, it is not clear

whether they are more effective than simply promoting lean manufacturing concepts, given the extra work involved in reclassifying costs. Should LCC be used as a means to advocate increased awareness of environmental issues or to rigorously integrate the life cycle approach into business routines?

Another argument that has been used to advocate for better tracking and disclosure of environmental costs focuses on the need to help investors and customers avoid potential liabilities, such as the current asbestos claims. This may be a misguided use of LCC. In the case of asbestos claims, it is unlikely that more accounting would have helped uncover unanticipated problems or predict future problems. In these cases, better risk assessment practices to manage the introduction of new materials might have helped. LCC is better used to assess the broader value chain, since environmental impacts of a company often fall outside its legal accounting boundaries. In this regard, guidance on where to draw the boundaries in LCC analyses would be useful.

LCC's greatest value is in assessing future actions (e.g., for estimating the life cycle costs of future products in product development), enabling companies to gradually make the shift to more sustainable patterns of production and to provide more sustainable products. This raises a number of interesting questions. Accrual accounting seeks to match costs and revenue in the appropriate time period in order to provide a more accurate and consistent picture of company profitability. Because many environmental effects are delayed, this can be difficult. Another point of discussion is discounting and how this contributes to the difficulty of applying accrual accounting to life cycle management (Schmidt 2003). Treating costs as an expense or capital investment leads to yet another set of questions. There may be value in providing rules of thumb for forecasting reasonable future expenses for various aspects, and to provide guidance on what costs can be capitalized.

The foregoing discussion is concerned with those costs that have been captured by the market economy. This leads to an obvious difficulty, which is that monetary costs do not truly capture the social costs of resource consumption and environmental degradation. A robust LCM framework should link LCA studies to LCC, given insights into two of the three pillars of sustainable development (Rebitzer and Hunkeler 2003). Unless these dollar-driven decisions can also be assessed in terms of the physical limits of natural systems, it will be difficult to assess progress toward sustainability.

The LCC framework should provide guidance on estimating potential business risks.. Being able to aggregate cost data by commodity group may be one way to leverage the procurement data to support simplified Life Cycle costing across extended enterprises. Sharing data that have been aggregated by a standard industrial classification (SIC) code, or other comparable schema, may alleviate some of the confidentiality issues with an acceptable loss of quality of the data. If the data could be aligned with

environmental assessments, then the cost data could be used to compare economic activity with imposed environmental impacts and to assess eco-efficiency.

B.7 Integrating Social Aspects Into LCM

The globalization of the economy, pressing ecological issues such as climate change, and recent events such as the collapse of WorldCom and Enron, or the market failures with the "dot com" crisis are shaping and changing how we view the role of corporations in society. Traditionally, the role of the corporation has been understood primarily in economic terms. Companies provide products and services and, in doing so, they create jobs and wealth. Increasingly, stakeholders (shareholders, investors, communities, regulators, employees, customers and non-governmental organizations) are taking a broader perspective of corporate responsibility that incorporates not only economic performance, but also social, governance and environmental performance factors. This new role of business was recently emphasized at the World Summit on Sustainable Development (WSSD) in Johannesburg, in August 2002, where the private sector was been recognized as a key player in promoting sustainable development.

These four performance areas (economic, social, environmental and governance) are the key areas stakeholders are evaluating to determine whether a company is moving toward more sustainable business practices and whether a company is conducting its business in an ethical and socially responsible manner.

Evidence of this broader perspective on corporate performance can be found in a variety of guidelines and standards (e.g., the Global Reporting Initiative's sustainability reporting guidelines and SA8000, a social performance standard based on International Labour Organization (ILO) conventions, the Universal Declaration of Human Rights and the United Nations' Convention on the Rights of the Child) and in emerging financial sector rating schemes which try to identify best-in-class performers (e.g., the sustainability rating schemes developed by companies such as Innovest and the Dow Jones Sustainability Index). The recent financial collapse of a number of major corporations, and the associated massive loss of shareholder value, has focused stakeholder attention on ethical and transparent governance policies and procedures. A number of organizations are currently developing guidance to improve corporate accountability in these areas (e.g., the OECD's recent initiative to review, and provide recommendations on strengthening corporate governance procedures).

In response to, and in some cases in advance of, the current situation, a growing number of private and public sector organizations are adopting the term corporate social responsibility (CSR) to describe an organization's overall commitment to meeting stakeholder expectations on economic, environmental, social and governance performance. CSR, emerging from socially responsible investing, has become a preferred implementation approach for corporate sustainability. Examples of organizations using or investigating elements of CSR include:

- The World Business Council on Sustainable Development's (WBCSD) in its report entitled *Corporate Social Responsibility: Making Good Business Sense*;
- The *OECD Guidelines for Multi-National Enterprises* which include a discussion of CSR;
- The Commission for the European Communities' Green Paper entitled *Promoting a European Framework for Corporate Social Responsibility*;
- Canadian Business for Social Responsibility (CBSR) and its *Good Company Guidelines for Corporate Social Performance* and its research on CSR practices;

In addition, many private sector organizations use the term CSR to describe their activities in a range of areas such as environmental performance, employee programs, community investment, stakeholder engagement, supply chain management and others. Many of the world's biggest companies (e.g., Microsoft, Shell, HP, General Motors, Coca-Cola, IBM, ABB, Alcoa, Alcan and many others) are members of organizations that promote the adoption of CSR practices, such as Business for Social Responsibility (BSR), CBSR and CSR Europe

The number of proponents advocating CSR has led to a range of definitions or interpretations of CSR. Some recent definitions include:

> *Corporate social responsibility is the commitment of business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve their quality of life.*
>
> World Business Council for Sustainable Development (WBCSD)

> *CSR is defined as operating a business in a manner that meets or exceeds the ethical, legal, commercial and public expectations that society has of business.*
>
> Business for Social Responsibility

Corporate Social Responsibility is the overall relationship of the corporation with all of its stakeholders. These include customers, employees, communities, owners/investors, government, suppliers and competitors. Elements of social responsibility include investment in community outreach, employee relations, creation and maintenance of employment, environmental stewardship and financial performance.

The Conference Board of Canada

Corporate social responsibility is essentially a concept whereby companies decide voluntarily to contribute to a better society and a cleaner environment.

European Green Paper

As varied as the definitions of CSR are, they possess the following common elements:

- **Commitment of business**—This refers to responsibility or obligation of companies to operate in a manner that adds value (beyond traditional economic value) to society.
- **Benefits to society/stakeholders**—The can be fairly broad, although some of definitions have been specific in listing families, communities and employees as the parts of society that should benefit from a company's operations.
- **Ethical behavior**—Three of the definitions speak of "ethics". This ties in with an obligation of business to operate in an ethical manner. However, the ethics in these definitions appear to move beyond traditional business expectations (i.e., fair, non-corrupt business practice), to include society's expectation of what is "acceptable" business practice.
- **Environmental performance**—Although CSR is a broad concept, environmental management/performance is often highlighted perhaps to remind us that CSR is not just about social performance

Other key issues covered by CSR are human rights, employee rights, community involvement and supplier relations. It also advocates an open information policy, including issues on disclosure, transparency, consumer education and anticorruption measures. Depending on the emphasis placed on supplier and consumer relations, CSR comes close to the definition of ethical trade, which can also extend throughout the value chain.

How far Does CSR Extend in the Value Chain?

To answer this question, it is useful to look at the parallel question in Life Cycle Assessment (LCA): "What processes should be included in the product system?" Since it is,in principle, not possible to find any sharp boundaries between environmental and social responsibilities, it is reasonable to conclude that the system boundaries for LCA can also be applied to CSR issues. Thus, the methodology of ISO standard 14041 (on Life Cycle Inventory) can provide an objective means for delimitating system boundaries in CSR/ethical trade, as well.

Continuous Improvement and Site Certification

Linking CSR to LCM will drive a commitment to continuous improvement, as expressed, for instance, in the ISO 14001 and 14040 standards on environmental management. It also implies that any attempt to quantify CSR should focus on marginal improvements rather than on average performance. When seeking to quantify social influences in the value chain, a fundamental problem occurs: It is very difficult to find any consistent differences between different technologies or production routes involved in the production of any given product, simply because the social impacts are so site-specific that the variation between sites exceed the variation between technologies or production routes. In LCA, a parallel problem has been described for emissions of toxic substances. However, this has not led to the conclusion that toxic releases should not be included in LCA, but rather that it may be necessary to ensure site certification with respect to this issue. Similarly, we may conclude that the quantification of social influences may in general require site-specific certification of suppliers.

The Need for Harmonization

There are already a number of initiatives that seek to improve reporting and certification of social responsibility issues. The Ethical Trade Initiative (www.ethicaltrade.org), Rugmark (www.rugmark.org) and SA8000 (www.cepaa.org), among others, focus on human rights issues for employees (notably forced labor, child labor, rights to organize in unions), in some cases also cover wage issues. Indigenous people's rights are included in the standards of the Forest Stewardship Council (www.fscoax.org), while Business in the Community touches upon the issue of income distribution (www.bitc.org.uk/communities.html). Initiatives that cover a wider range of issues include fair trade associations (www.ifat.org) and the Global Reporting Initiative (www.globalreporting.org). However, these broader initiatives typically do not seek to quantify or certify the issues involved.