

# Expanding the green practice of LCA

The first decade of life cycle assessment activity in the Swedish forest products industry

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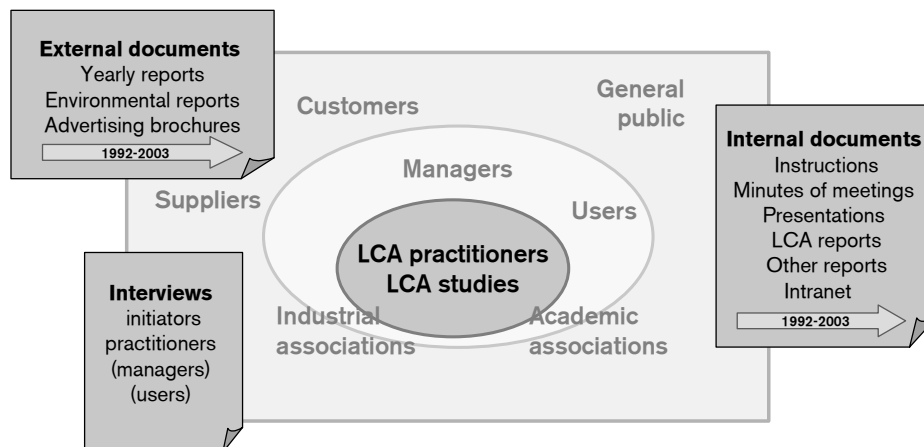
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## *Executive summary*

The Centre for Environmental Assessment of Product and Material Systems (CPM) has worked with Life Cycle Assessment (LCA) for a long time and, as in the academic research in this field, has focused mainly on methodological issues. In 2003, it was decided by CPM to evaluate what LCA work has been accomplished in industry. It was agreed to carry out a broad evaluation of LCA activity in the forest products industry, represented by Stora Enso and SCA (Svenska Cellulosa Aktiebolaget). This was done by explorative field studies on the distribution and nature of LCA approaches and practice at the two companies. Apart from this, a second goal of the study was to develop a methodology for such investigations, and to inspire similar studies at other companies.

### Methodology selected for the study

The evaluation of LCA work in industry started with a quick overview of the two companies chosen, as well as sources of further information. After the orientation, data were collected from internal documents, external documents, interviews and site visits. Practitioners and studies of LCA served as a starting point for the data collection. An analysis is based on the views of “core people”, i.e. those belonging to operative LCA units and working daily with this type of assessment. Methodological scope is shown in Figure 1.



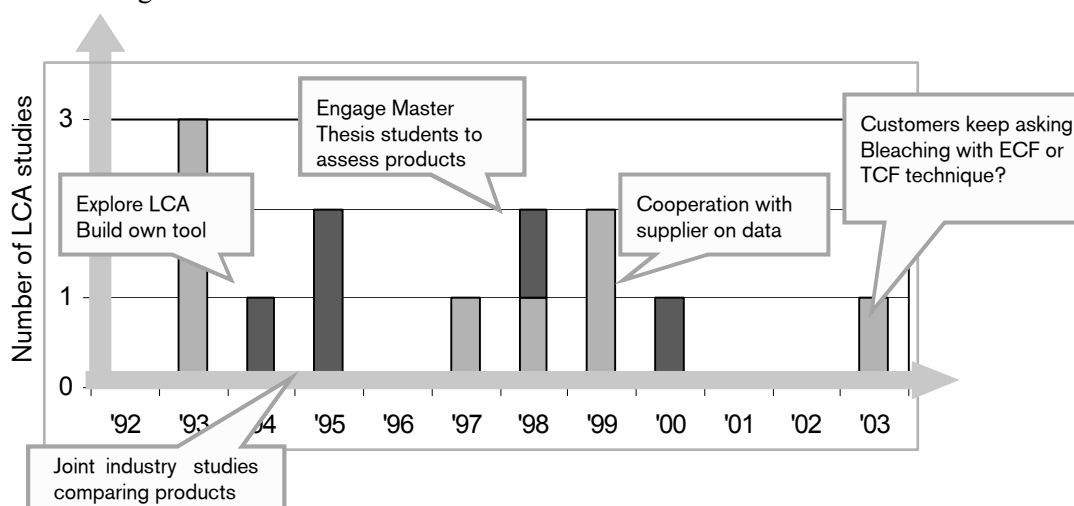
**Figure 1.** Methodological scope of the forest products industry study, with focus on the dark grey areas.

Data collected were archived and classified in seven categories. In parallel, the material was compiled in thematic descriptions and chronologies for each company. In the analysis, the two companies were compared with each other and with prior research on industry practice of LCA.

## Results: Stora Enso

Stora Enso were early in starting LCA activity, and built up their own Excel-based tool for LCA calculations in the first years of the 1990s. The LCA competence was used and developed in several joint projects involving nation-wide cooperation between industry and academia (e.g. the Product Ecology Project and the Nordic Project on Environmentally Sound Product Development) as well as partnerships in joint industrial efforts. Internally, LCA was also used to assess products at some mills, preferably with the aid of Master's Thesis students.

Since 1998, the concept of product life cycle has been central to Stora Enso's environmental and social responsibility policy. However, Stora Enso does not have any formal routines of LCA practice at a company level. The most recent LCA study was made in 2003, as additional input to the discourse on the environmental friendliness of two pulp-bleaching processes, elementary chlorine free (ECF) and totally chlorine free (TCF). In recent years, LCA methodology has also been used to calculate transport and CO<sub>2</sub> emissions. The LCA studies identified at Stora Enso are shown in Figure 2.



**Figure 2.** Life cycle assessment studies at Stora Enso 1992 – 2003; in-house studies (light grey) and studies in collaboration (dark grey). Elementary Chlorine Free (ECF); Totally Chlorine Free (TCF).

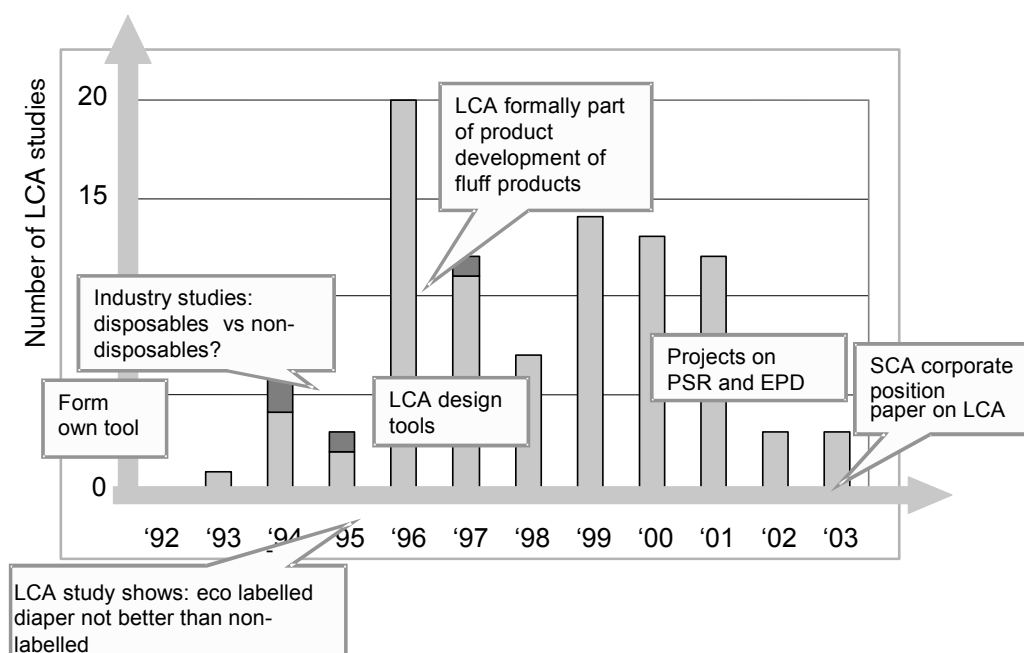
People working with LCA at Stora Enso have long been a small and informally organised group, although the issues were discussed at LCA seminars in larger groups in the company. However, since 2002, there has been a coordination team to pool knowledge on LCA within the organization. Stora Enso has used LCA mainly to learn about the methodology and their own products and production processes. Working with LCA has also helped Stora Enso to be an attractive business partner and to handle environmental discourses and issues, such as whether or not TCF or ECF is the best pulp-bleaching technology from an environmental point of view.

Altogether, Stora Enso has made 13 LCA studies, five of which are joint projects with other companies. These studies do not follow any internal routines. Most of these studies have dual aims, to study processes or products and to learn about LCA

methodology. The studies are either stand-alone investigations or comparisons of products or processes.

## Results: SCA

When the Environmental Department was started at Mölnlycke AB (later on incorporated into SCA), life cycle assessment was adopted to guide the way. In the 1990s, an ambitious database and program for LCA were built up to assess the products. At this time, disposable versus non-disposable diapers was a hot issue in Europe, and LCA was often used to shed light on this. Sometimes, Mölnlycke AB participated as a data supplier for the studies; they also called together companies in the European trade association European Disposables and Non-woven Association in a joint learning project on LCA. By the mid 1990s, knowledge on LCA was available but little used at SCA. To change this, LCA tools were designed to allow product developers themselves to carry out LCAs early in the process. In 1995, LCA also became useful in argument against the undesirable eco-labels, as a study showed that the non-labelled diapers were at least as environmentally good as the eco-labelled one. Soon thereafter, LCA was made a formal part of the development of all fluff products at SCA. With the new millennium, projects on product specific rules (PSR) and environmental product declarations (EPD) were started for several product groups. Life cycle assessment was also recognised at a corporate level by a position paper at SCA in 2003, see Figure 3.



**Figure 3.** Life cycle assessment studies at SCA 1992 – 2003; in-house studies (light grey) and studies in collaboration (dark grey). Product Specific Rules (PSR); Environmental Product Declarations (EPD).

At SCA, the people who work the most with LCA are found mainly at the environmental department of Hygiene Products. In product development, formal

routines ensure that an LCA study is made for each new product prior to its launch. Altogether, 94 studies have been identified, most of which are routine LCAs comparing a new version of a product with an existing one. Thus, LCA has been used to determine the environmental consequences of the design choices made. The mere fact that SCA is using this method has also been much emphasised in external communication as an important part of the environmental image of Hygiene Products.

## Analysis

When examining and linking the data collected, characteristics of the two companies were identified and analysed.

### **Both practitioner and application influence methodology choice**

An analysis of LCA studies shows that the type of LCA chosen is related to the purpose and context of the study: stand-alone studies and comparisons of one's own products or processes are made internally, while comparisons of competing products are handled as joint external matters. What is perhaps more interesting, however, is that methodological choices seem to relate not only to the aim and scope of the study, as often claimed, but also to the person involved.

### **Fulfilling similar needs of confidence and trust : Differing approaches**

The companies studied show two approaches to LCA, designated here as pragmatic and scientific. These approaches influence when and how LCA is carried out, as well as how its advocates express themselves. Just as the two companies have dissimilar approaches to LCA, they also act and benefit differently when they cooperate with industry and academia. Despite the divergent approaches and practices employed, LCA activity can serve the purpose of making practitioners and other employees feel secure that environment is taken into account. This work also provides evidence to diverse stakeholders (retailers, suppliers and customers) that the company is a serious partner regarding environmental issues. From a company perspective, LCA is valuable both in terms of reducing risks (e.g. knowing the possible environmental impacts of their products) and in terms of increasing trust (by more nuanced and provable support to environmental claims).

### **Benefits and reborn interest despite lack of strategy**

This evaluation has shown that at both companies studied, there was no clear strategy on LCA use from management. Early expectations from practitioners and other people were sometimes weakly formulated or too high. Nevertheless, LCA work was continued, and unexpected benefits evolved gradually. With time, LCA revealed its advantages in answering questions, participating in environmental discourses and in being an attractive partner. Still, both companies are uncertain about when it is useful to make LCA studies. Nevertheless, LCA has recently become more attractive to use for both marketing (EPD, market communication) and legislative purposes (integrated product policy, CO<sub>2</sub> emission trading). This implies

that it may have been fortunate that LCA was allowed to develop quite freely, and also that the lack of a strictly regulated strategy was an advantage rather than a disadvantage.

### **Widespread but little integrated**

Life cycle assessment influences, directly or indirectly, several departments of both companies studied, such as product and process development, sales and marketing, procurement (or purchasing) and top management. However, these departments do not seem to work actively with LCA, and its concepts seem to play a very little role in their everyday work. The main work of LCA is concentrated to a few key persons at environmental departments. It should be noted, however, that this study was based on these people and LCA studies. The role and use of LCA from the perspective of other departments and persons may be defined by future studies.

## **Concluding remarks**

At Stora Enso and SCA, life cycle assessment seems to have evolved through the enthusiasm of some key people, rather than as an expressed strategy of top management. The two companies use different approaches to LCA, which may partly be explained, as is suggested in the literature, by structural conditions such as position in the supply chain of the company or the part of the supply chain that contributes the most to the environmental impact. This evaluation indicates, however, that other factors also influence LCA practice, for example characteristics of the LCA practitioners and how LCA has previously been motivated and handled. This means that the companies themselves can influence the LCA practice. This finding also implies that companies can work more consciously and actively with implementation and integration of LCA; they can also learn from each other in forming their LCA practice. Finally, this investigation has found that LCA does not seem to be well integrated with company functions other than the environmental. If the companies want to incorporate life cycle thinking as a guiding principle for all company practice, they need to discuss how LCA can support and strengthen departments other than the environmental ones.

# *Preface*

This report is the outcome of a project, Evaluation of LCA activities, funded by the Centre for Environmental Assessment of Product and Material Systems (CPM). The project was carried out in preparation for an evaluation of CPM in 2004. It is also a preliminary study for further investigation of the role of life cycle approaches in business, within the research program, Furthering Life Cycle Considerations through Integrated Product Policy (FLIPP), funded by the Swedish Environmental Protection Agency. The investigation of how industries work with LCA requires access to companies that open their doors to inquisitive researchers. We wish to thank the people at Stora Enso and SCA for their openness and their patience.

Göteborg, July 2004

*Emma Rex*  
*Henrikke Baumann*



# *Table of Contents*

<b>1</b>	<b>INTRODUCTION .....</b>	<b>1</b>
1.1	Aim .....	1
1.2	Study outline.....	2
<b>2</b>	<b>LCA PRACTICE.....</b>	<b>3</b>
2.1	LCA activities.....	3
2.2	Integration of LCA .....	7
2.3	Implications for further research .....	9
<b>3</b>	<b>METHODOLOGY .....</b>	<b>11</b>
3.1	Organization of the project.....	11
3.2	Preparatory work .....	12
3.3	Data collection .....	13
3.4	Coding of data .....	14
3.5	Accounts and validation.....	15
3.6	Analysis and interpretation .....	15
<b>4</b>	<b>FOREST PRODUCTS INDUSTRY .....</b>	<b>16</b>
4.1	Stora Enso.....	16
4.2	SCA .....	17
<b>5</b>	<b>STORA ENSO.....</b>	<b>18</b>
5.1	The LCA history of Stora Enso .....	18
5.2	Organization of LCA work.....	26
5.3	LCA in corporate environmental work.....	29
5.4	Main areas of LCA work .....	31
5.5	LCA and external communication .....	32
5.6	LCA studies.....	33
<b>6</b>	<b>SCA .....</b>	<b>36</b>
6.1	The LCA history of SCA.....	36
6.2	Organization of LCA work.....	45
6.3	LCA in corporate environmental work.....	48
6.4	Main areas of LCA work .....	50
6.5	LCA and external communication .....	52
6.6	LCA studies .....	54
<b>7</b>	<b>LCA STUDIES.....</b>	<b>57</b>
7.1	LCA practitioners.....	57
7.2	Type and application .....	58
7.3	Factors governing methodological choices .....	59
7.4	LCA results and their dissemination .....	60

<b>8</b>	<b>DIFFERENCES IN LCA PRACTICE .....</b>	<b>61</b>
8.1	Two approaches to LCA.....	62
8.2	Cooperation with industry and academia .....	63
8.3	Explaining differences in LCA approach.....	65
<b>9</b>	<b>TEN YEARS OF LCA ACTIVITIES .....</b>	<b>68</b>
9.1	Gradually evolving benefits.....	68
9.2	The role of LCA from a company perspective.....	69
9.3	Integration of LCA.....	71
9.4	Ten years without strategy?.....	74
<b>10</b>	<b>CHALLENGES FOR THE FUTURE .....</b>	<b>76</b>
10.1	Levels of implementation .....	76
10.2	Broadening the scope.....	77
<b>11</b>	<b>CONCLUDING REMARKS .....</b>	<b>79</b>
<b>12</b>	<b>FURTHER STUDIES.....</b>	<b>80</b>
12.1	Research approach .....	80
12.2	Further research.....	81
<b>13</b>	<b>REFERENCES .....</b>	<b>83</b>
13.1	Literature.....	83
13.2	Field material: Stora Enso .....	85
13.3	Field material: SCA.....	86
<b>APPENDIX A</b>		
<b>APPENDIX B</b>		

## *List of abbreviations*

BAT	Best Available Technology
BASIL	Excel-based LCA software and database developed and used at SCA
CIT	Chalmers Industriteknik
CEPI	Confederation of European Paper Industries
CO <sub>2</sub>	Carbon dioxide
COST E9	EU project on LCA of forestry and forest products
COMPASS	Supplier auditing system at Stora Enso
CPM	The Centre for Environmental Assessment of Product and Material Systems
ECF	Elementary Chlorine Free
EDANA	European Disposables and Non-woven Association
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management Systems
EPCP	Environmental Policy Compliance Parameter
EPD	Environmental Product Declarations
EPS	Environmental Priority Strategies in Product Design
FLIPP	Furthering Life Cycle Considerations through Integrated Product Policy
IPP	Integrated Product Policy
ISO	International Organization for Standardization
ISO/TR	International Organization for Standardization/Technical Requirements
ISO/TS	International Organization for Standardization/Technical Specifications
KCL	Finnish Pulp and Paper Research Institute
LASCA	Short for LCA at SCA
LCA	Life Cycle Assessment
LCA-d	LCA design
LCA-k	LCA consequence
LCA-r	LCA research
LCI	Life Cycle Inventory
LCM	Life Cycle Management
LCT	Life Cycle Thinking
NEP	the Nordic Project on Environmentally Sound Product Development
PDP	Product Development Process
PEMS	Product Ecology Management Systems

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PFI	Norwegian institute working with LCA
PLP	Product Launch Process
PSR	Product Specific Rules
RMS	Resource Management System (at SCA)
SCA	Svenska Cellulosa Aktiebolaget
SETAC	Society of Environmental Toxicology and Chemistry
SEE	Stora Enso Environment
SPINE	Sustainable Product Information Network for the Environment
SSVL	Stiftelsen Skogsindustriernas Vatten- och Luftvårdsforskning
STFI	Swedish Pulp and Paper Research Institute
TCF	Totally Chlorine Free
UMBERTO	Database and software for LCA calculations developed within EDANA

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# *1 Introduction*

Over ten years have now passed since life cycle assessment (LCA) was introduced on a larger scale as a tool for environmental assessment of products and as decision support for product-related issues. During this time, the basic concept has evolved into varied approaches, from quantitative LCA to also include life cycle inventory (LCI), qualitative LCA, life cycle thinking and life cycle management. Moreover, fields of application have also expanded. From being thought of mostly as a tool for product development, it has come to be used in purchasing, market communication, and environmental business policy formulation. However, research in the field of LCA has dealt mainly with the methodological approach, with only a handful studying the application of LCA in industry.

Life cycle thinking is increasingly considered necessary to obtain a more sustainable production and consumption pattern. This calls for the concept of LCA to be applied in industry. That the concept exists is not enough, however. It has to be implemented in actual industry practice. To facilitate and ease this implementation, a deeper understanding of what shapes LCA activity is needed. This will allow companies to learn from each other and to better perceive their role and opportunities. Better understanding of the prerequisites for LCA work can also help policymakers to more efficiently promote and encourage life cycle concerns in industry. Such insights will also be interesting in research, to form a basis of further study of the practice and potential advantages of life cycle thinking in business.

The Centre for Environmental Assessment of Product and Material Systems (CPM), which was established in 1996, has since then coordinated many projects related to LCA. In 2003, it was decided to review what LCA work has been done by industry. For this, a project was initiated to evaluate life cycle activities. It was decided to make the evaluation according to a sector approach, to enable comparison of companies that have some surrounding conditions in common. The Swedish forest products industry was chosen for this study, as represented by the CPM member companies Stora Enso and SCA. Both of these companies have been working with LCA for more than ten years.

## *1.1 Aim*

The aim of the project is to describe and obtain an understanding of what shapes LCA activity in industry. This is done by describing and evaluating what has been done by two companies regarding LCA studies and resulting action since they started in the early 1990s. A secondary aim is to develop a methodology for conducting such evaluations.

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## 1.2 Study outline

Although not as intensely pursued as the methodological development, there is some previous research on the practice of LCA in industry. *Chapter 2* summaries prior studies in the field and concludes that there is a need to examine companies or sectors in a dynamic and long term perspective that includes actors and their actions in a broader scope than simply LCA studies. This approach is further developed in *Chapter 3*, which describes the methodology of this study. The study concerns forest products industries and includes some background data of both the industry and the two companies, given in *Chapter 4*. Data was collected, in the autumn of 2003, and compiled in company accounts, reported in *Chapters 5 and 6*. While working with the material, characteristics of each company were identified and further analysed. This analysis is presented in *Chapters 7 to 10*. Finally we draw some conclusions on the practice of LCA at the two companies and on the methodology chosen, followed by suggestions for further research, in *Chapters 11 and 12*.

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## 2 *LCA practice*

So far, LCA research has concentrated on the development of methodology. The first LCA conference was in 1990 (SETAC 1991). The first conference on life cycle management was not held until 2001 (Christiansen, Horup et al. 2001). This report deals with company practice of LCA. This chapter outlines previous research on LCA work as such at companies, as well as how LCA is integrated in company operations.

Why and how do companies practise LCA? These questions can be viewed from different perspectives. The LCA activities have been studied in terms of what companies and sectors engage in them and for what purposes they do so. Studies of LCA practice also describe how the work has developed and is organised at a company. In this project, we are also interested in how LCA is integrated with, and related to, other corporate activities. This is a relatively new area, which has thus been devoted more to definitions and potentials of various concepts related to a life cycle approach than to empirical studies of company practice.

### 2.1 LCA activities

In research on company practice, emphasis differs, for example in studies of *where* LCA is used, such as distribution in industries and countries. Such studies have showed that large companies conduct more LCA than small and medium-sized ones (Frankl and Rubik 2000). An example of the variation between sectors can be found in the environmental business barometer of 1995, which shows that the forest products industry was the sector with the widest practice of LCA in Sweden (72% of the companies were working with LCA) (Baumann 1996). In a study presented by Frankl and Rubik (2000), LCA use in four countries was compared. Companies in Switzerland, Sweden and Germany were more involved in LCA work than those in Italy, with Sweden having the largest share of LCA carried out internally in firms.

Research on the *purpose* of LCA studies deals with the applications of the LCA. This type of research has been linked to differing methodological considerations, as various types of LCA have been argued to suit a given application.

Another strand of research examines *why* companies practice LCA and identifies forces for its use. From the late 1990s, LCA has also been considered in terms of *how* it is organised, developed and implemented on a corporate level.

#### **LCA applications**

Although the usefulness of LCA has been argued for various applications in industry, the industry practice of it has not been examined to the same extent.

By now, LCA has been argued to play such roles in a company, as decision-making, communication and learning. This can be applied to various functions, such as product development, market communication, and procurement, see Table 2.1.

**Table 2.1** Role and application of LCA (Inspired by Baumann and Tillman 2004)

Role of LCA	Application
Decision-making, communication, and learning.	Product development Choices and optimisation of production processes Business policy formulation Supply-chain management Purchasing Market communication Environmental Product Declarations

Product development is an area of LCA application that was discussed early (Baumann and Tillman 2004). Industry practice and the role of LCA in product development have been explored relatively extensively by Bakker (1995), Karlson (2002), Ritzén (2000) and Kärnä (1999). Other areas of application are less well investigated, but some examples exist. Purchasing, for example, was mentioned in a survey by Verschoor and Reijnders<sup>1</sup> (1999). Hence, many LCA applications have not been studied specifically, nor has the interplay between various roles and applications at a company.

### Types of LCA

The types of LCA can be distinguished according to how detailed they are and how far in the procedure the study is carried out. Over the years, LCA has developed from a mere calculation tool towards the concept of life cycle thinking. Life cycle thinking is, according to the Commission of the European Communities (2003), the consideration of environmental impacts of a product from cradle to grave. Types of LCA include (Verschoor and Reijnders 1999; Baumann and Tillman 2004):

- Qualitative LCA and LCI,
- Full quantitative LCA,
- Screening LCA,
- LCA-based rules of thumb, and
- Life Cycle Thinking.

Quantitative LCA studies may in turn be categorised according to how the study is made (Baumann and Tillman 2004):

- Accounting LCA is comparative and retrospective studies,
- Change oriented LCA is comparative and prospective studies, and
- Stand-alone LCA is descriptive LCA.

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<sup>1</sup> They concluded that only two out of seven companies used results from LCAs in purchasing and, only in one case was the purchasing department involved in the development of the life cycle method used at the company.



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The application of LCA is where the researchers of practice and methodology meet. It has been argued that the applications addressed should influence the methodological choices in regard to the type of LCA (Baumann 1998; Tillman 2000).

### **Variations in LCA practice**

So far, this chapter has discussed what LCA can be used for, and how it is dealt with in some applications. There is also some research that maps LCA practice in industry. Such research has shown that industry practice and the use of LCA differ, between both countries and sectors. A survey in Frankl and Rubik (2000) shows that the identification of bottlenecks and information, or education, for external stakeholders were the most common applications of LCA in Swiss, Swedish and German industry, while the most common ones in Italy were in research, development and design.

Berkhout and Howes (1997) found, by studying LCA practice in six industrial sectors, that the patterns of LCA adoption differed. They argue that the differences depend mainly on the nature of competition in the industrial sectors concerned. They distinguish between upstream, commodity producing sectors, and downstream, assemblers of final products. The former, which usually gain competitive benefits at the sector level, engage in externally-oriented, large scale, collaborative life cycle inventory studies. Downstream assemblers of final products, which gain competitive benefits as individual firms, tend to take internally-oriented life cycle approaches that are confidential, small-scale, integrated into product development and less standardized; they also make life cycle studies that include the total life cycle. Similar results were found by Smith et al. (1998, in Frankl and Rubik 2000).

Berkhout and Howes (1997) also found that collaboration efforts on LCA work differed between sectors as well. According to them, collaboration reduces costs and risks associated with implementation, and they also found that *“...commodity producers tend to collaborate on data, while final goods producers tend to collaborate on methodology.”* (Berkhout and Howes 1997). Variations in approach to LCA could also be found between firms within the same sector and even between business units within the same firm. Such variations were assumed to be due to the newness of the technique, as well as the divergent interests and capabilities to adapt to the new method. Berkhout and Howes also suggest that interests and personalities of key people could influence the firm’s approach to LCA.

### **Motives for implementation of LCA activities**

Companies seem to have different reasons for using LCA. In principle, driving forces for environmental work in industry can basically be divided into two types of requirements: governmental and market. Since there are not yet any direct requirements made by government or the market, both are assumed to work indirectly, by gaining advantages in either legislation or competition.

Several surveys have been made to determine companies’ stated reasons for engaging in LCA. Conclusions vary as to whether market or government is the most important force for LCA use. In a study by Berkhout and Howes (1997),

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regulatory and market drivers were concluded to be equally common as the primary motive for adopting LCA. Frankl and Rubik (2000) found legislation to be a motive of “medium importance”<sup>2</sup>. None of the seven companies studied by Verschoor and Reijnders (1999) mentioned response to regulation as a reason for life cycle studies. Instead, these studies were developed to generate a data base creation and to answer questions from consumers. Baumann (1998) also concludes that LCA work in industry is carried out for internal company uses and only rarely to comply with authorities. Hence, it seems that there are either heterogeneous or unclear reasons why companies introduce and use LCA. It is possible that both governmental requirements and market demands play a role, and that the relative importance of the two differs between companies.

### **Implementation of LCA in certain companies**

Most of the studies referred to already aim to explain a specific LCA activity or phenomenon, such as LCA in purchasing or motives for using LCA). Baumann (2000) takes the company as a starting point, exploring LCA implementation in a longer perspective at the companies Akzo Nobel and Ericsson. She saw that LCA implementation progressed in phases, and found that the theory of institutionalisation was applicable to explain LCA introduction at the companies. Institutionalisation theory was used to explain the differences in LCA practice and also to analyse 20 case studies of LCA in European firms (including the two by Baumann 2000), as presented by Frankl and Rubik (2000).

According to the institutionalisation theory, a new phenomenon is adopted in an organization in four phases:

1. Innovation,
2. Habitualisation,
3. Objectification, and
4. Sedimentation

Each phase has its particular organizational characteristics and purpose. Studies show that the application of LCA changes at each institutionalisation stage: shifting from “learning to doing” (Frankl and Rubik 2000). Companies in early institutionalisation phases use LCA for simple products mostly for learning and confirmation of status quo, while companies in latter phases use LCA for more complex products, for internal and prospective use and transform LCA results into action. The organization of the LCA work also shifts from flexible to being more formal.

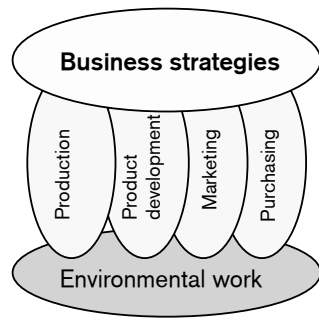
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<sup>2</sup> At Swedish companies, legislation was found to be “less important” for starting LCA.

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## 2.2 Integration of LCA

Since LCA describes the environmental impact of a product, LCA work should relate to the environmental work of a company. As shown above, LCA has possible applications in departments such as product development, purchasing and marketing. All of these applications call for an integration of LCA in operations of the company not restricted to those carried out by the environmental department.



Although little is known about the extent to which LCA is integrated in the various departments of a company, a lack of integration between LCA and corporate functions has been identified (Heiskanen 2002; Karlson 2002). This is illustrated in Figure 2.1. On a more general level, several authors call for better alignment between environmental goals and business goals (Baumann, Boons et al. 2002).

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**Figure 2.1.** Both LCA and environmental work in general are often only loosely linked to other functions of the company, including the business strategy.

It is argued that LCA is useful as a guiding principle in business strategies. Linking the principles of LCA with business strategies and actions is the basic idea underlying the concepts of life cycle thinking and life cycle management (Pedersen 2001; Saur 2001). A basic prerequisite of these concepts is the product orientation, which differs from more traditional ways of addressing environmental issues at a company. Research on life cycle thinking and life cycle management has dealt so far mainly with explaining the concepts; little empirical research has been done on how LCA is integrated in business strategies in practice.

### **Product orientation of environmental work**

The role of LCA in environmental work differs somewhat from that of site-specific command and control instruments or a voluntary certification program for environmental management systems. In contrast to traditional environmental work, LCA focuses on products instead of processes or sites. Hence LCA includes environmental impacts that are not restricted to a specific site or company, but also extend beyond the traditional control and responsibility of the firm. This implies that companies working with LCA voluntarily address a broader scope than their traditional sphere of responsibility. Introducing this approach leads to a rethinking of the environmental concerns of a firm, which has several implications for its interaction in the supply chain, for example.

Since the introduction of LCA, product oriented environmental work has gained increasing interest, and it is now at the core of integrated product policy, as stated in a green paper by the EU. There is growing belief that product

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orientation of environmental work includes using the principles of LCA (Berkhout and Howes 1997; Schmidt, Møller Christensen et al. 2001).

Like most traditional environmental work, environmental management systems such as EMAS and ISO 14 001 focus on a site or organization rather than a product. In recognition of the importance of a product perspective, an effort has been made to include this in environmental management systems (van Berkel, van Kampen et al. 1999; Ammenberg and Sundin 2004). Also, LCA is argued to be useful, e.g. in prioritising objectives (Finkbeiner, Wiedemann et al. 1998).

### **Life Cycle Thinking and Life Cycle Management**

The basic philosophy of LCA, to consider the environmental impact of a product from cradle to grave, is emphasised in the concept of life cycle thinking (LCT). The concept has attracted interest among policymakers, companies and the general public. Life cycle thinking is promoted by the Commission of the European Communities (2003), for example, as a way to reduce cumulative environmental impacts, as well as to prevent environmental sub-optimisations along the value chain. Heiskanen (2000; Heiskanen 2002) has studied institutionalisation of LCA in a broad sense and concludes that life cycle thinking is an “emerging institutional logic”. She finds that life cycle thinking is becoming considered the ‘right’ and ‘obvious’ way to deal with environmental issues and also states that a life cycle approach (although not necessarily LCA studies) is permeating company practices. Also in the general public, Heiskanen finds indications that life cycle thinking has gained “*some extent of intrinsic value*”. If life cycle thinking is emerging as the accepted way to deal with environmental issues, then new demand will be put on companies’ environmental work and their work in the supply chain.

Life cycle management (LCM) consists of the managerial practices and organizational arrangements that apply life cycle thinking (Baumann and Tillman 2004) and is thus a way to integrate the life cycle thinking into corporate strategies and practice. There is not yet a commonly accepted definition of life cycle management. Pedersen (2001) suggest: “*Life cycle management is business management based on environmental life cycle considerations.*” This would include: “*...any management activities that contribute to the minimization of the environmental impacts and resource consumptions throughout the full life cycle of a product or service.*” Accordingly, LCA is part of, but not the only LCM activity. Instead, LCM should be seen as a mix of LCA, traditional environmental management and business management. Pedersen also argues that LCM is more strategic than traditional environmental management, as it focuses product performance and tends to be driven by market benefits. Life cycle management is a new branch of study, however, with the first scientific conference held in 2001. Potentially, all aspects of LCA work covered in this chapter are topics of interest for the LCM field.

### **Integration of LCA in environmental work**

So far, we have discussed the usefulness of LCA itself for applications such as product development and purchasing, without placing its use in the context of other environmental efforts in industry. In principle, LCA could play a central role in corporate environmental management, however. Studies have suggested

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how LCA methodology can be used in environmental management systems (Zobel, Almroth et al. 2002), and also how it theoretically relates to other environmental tools and approaches of sustainability (Baumann and Cowell 1999; Robert, Schmidt-Bleek et al. 2002). Research on how LCA is integrated in corporate environmental work seems to concentrate on a normative or conceptual approach. How LCA relates to environmental work and approaches in practice is harder to determine.

### **LCA in management and business**

A few studies deal with LCA in relation to management and business. In a study by Karlson (2002), the role of LCA as a management tool is discussed. Based on perceptions and statements from academia and industry, Karlson comes to the conclusion that LCA seems to be a relevant and useful tool, as long as the user properly understands the limitations and assumptions associated with it. It should be noted, however, that users although having a very positive opinion about the applicability and usefulness of LCA, failed to show major benefits from the use of it. Karlson further concludes that LCA could serve as a management control and priority setting tool. To do this, the role of LCA has to be better more specifically defined from a management control perspective, and objectives and targets need to be set on a product level. At present, LCA is integrated at too low a level in normal operational procedures (Karlson 2002).

As shown above, it has been stated that LCA is useful in decision making. It is not clear, however, that this actually occurs and, if so, whether it applies to the strategically important decisions of a company. Some studies point out areas where LCA could be advantageous, but these have not yet been used by the companies. Verschoor and Reijnders (1999) saw little involvement in the purchasing department, which was considered to have a strategically important position. Frankl and Rubik (2000) showed that, in four countries studied, the two strategic applications requested, radical changes in product life cycle and a shift from product to service, were the least common applications at the companies studied.

Although LCA does not seem to be used for such radical changes in business, companies may still incorporate life cycle thinking or life cycle management into their business strategies. Two examples of this are given by Terrvik (2001), who explains how Swedish grocery retailers, ICA and KF, gradually changed their assortment and “generated” markets in favour of products that have less environmental impact in a life cycle perspective.

## **2.3 Implications for further research**

Methodological research on LCA has been intense since late 1980s. Nevertheless, research on industry application of this tool is modest and often takes a normative approach to its possible use and integration in corporate work. Researchers call for the benefits of life cycle management and for better correlation between business and environmental goals, but little has been done to explore the actual practice and integration of LCA in industry. Thus, there remains a need for further study of the applications of LCA (Frankl and Rubik

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2000; Heiskanen 2000; Baumann, Boons et al. 2002). This literature review has shown that there is also a need to study the integration of LCA in industry practice, for both specific applications (such as marketing and purchasing) and business strategies.

The literature review reveals an apparent consensus that product orientation of environmental work and life cycle thinking is a desirable development on a corporate level. Prior research also identifies several areas where LCA can be advantageous to use or could be linked to business strategies. However, LCA seems to be little integrated in practice. There are few empirical studies on the actual relationship between LCA and other company activities (including business strategies) or even on the prerequisites for such integration.

It was also found that research on industry practice of LCA addresses primarily specific aspects such as applications, driving forces, and relationship between LCA methodology and type of LCA. Less is done with the whole company as a starting point, mapping out various kinds of LCA activities and how they are related. This kind of study is required to understand what shapes LCA activities in industry and to analyse how LCA can support business activities.

It should be noted that LCA practice is not restricted to LCA studies. We have seen that LCA includes not only quantitative LCA studies, but also broader concepts of life cycle thinking and life cycle management. We have also demonstrated surrounding conditions (e.g. structural conditions such as company size and position in a value chain) can be critical in the practice of LCA. Application is for example one area that has been argued to be of importance for how companies work with LCA. Prior research on differences in LCA practice and motives for adopting it indicate that LCA activities may be influenced by interaction with other actors such as policymakers, customers, suppliers and competitors.

Based on the conclusions above, it seems relevant to make explorative field studies on a company level, to map not only LCA studies but also other kinds of LCA practice and conditions such as the application of LCA and the role of the actors involved. To understand of the interplay and dynamics of these factors and how they affect the work with LCA, a study need to cover a longer time period. A study covering several years also enables an understanding of how the work with LCA has developed over time, a factor that is argued to influence its practice. Taking the company as a starting point and mapping various LCA activities in this broad sense would facilitate discussions of how LCA is integrated, and motivated, at the company.

This project aims to understand the practice and outcomes of LCA in an industry perspective. Differences in company practice of LCA have sometimes been explained in prior research by structural conditions such as the nature of the sector the company belongs to. More detailed studies of single companies have shown that a more complex range of factors influences practice than the structural studies suggest. Making detailed studies on companies that belong to the same sector would facilitate a comparison of the LCA practices at different companies that share some similar conditions.

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## 3 *Methodology*

This project aims to describe and obtain an understanding of what shapes LCA activity in industry. To obtain such an understanding, actual LCA practice in industry is observed and evaluated. Based on the findings from the literature review, we chose to study an industrial sector, by making field studies at companies representing the sector for a decade of LCA work. These studies, which include LCA and other related work, have a broad scope including types of application, the role of LCA, actors and the organization of the work.

The Swedish forest products industry was chosen for its long engagement with LCA and for its importance in Sweden. Originally, forest products industries were to be represented by three companies operating, in different parts of the sector, and trade associations. Due to time constraints, two companies were studied: Stora Enso and SCA. Each of these companies have been working with LCA for approximately ten years. As no previous LCA evaluations have been found for such a long time span, the study also aims to develop a suitable methodology.

Since the study of LCA practice in industry is not an established branch of research with a dominant theoretical foundation, an explorative approach was chosen to collect empirically based findings (Glaser and Strauss 1967). In accordance with this theoretical approach, data was collected on a broad and open basis: it should speak for itself as far as possible. The risk of searching for evidence of assumed LCA activities, or of missing others not asked about, could thus be avoided. The eleven stages of the study are presented in Table 3.1. Methodology has been developed and refined continuously during the study, and some of the stages were simultaneous during the project.

### 3.1 Organization of the project

This project was agreed upon with the Centre for Environmental Assessment of Product and Material Systems (CPM) in the spring of 2003. A reference group was set up with representatives from CPM, the companies studied (both are members of CPM) and the authors.

- Henrikke Baumann, Ph.D., Environmental Systems Analysis, Chalmers, project leader,
- Ellen Riise, Area Manager Environmental Controlling and Assessment, SCA,
- Ola Svending, Environmental Engineer, Stora Enso Environment, Stora Enso,
- Peter Lysell, Director, CPM, and
- Emma Rex, Ph.D. student, Environmental Systems Analysis, Chalmers.

**Table 3.1.** Stages of the comparative study of two companies use of LCA

	Stage	Actions
1	Problem definition	Define aims and objectives of the project. Set up a reference group with representatives from companies studied
2	Methodological choices	Select field study design
3	Orientation	Hold introductory interviews with participating parties
4	Scope definition	Agree with members of companies on aim, scope and methodology chosen
5	Data collection	Collect internal and external documents Conduct open ended interviews Set up document archive Make site visits
6	Data coding	Transcribe interviews, read and classify documents Sort data chronologically and thematically
7	Linking data and writing accounts	Write chronology and observations
8	Validation	Have written and oral accounts approved by participating parties
9	Analysis and interpretations	Make comparative analysis of the two companies and relate it to prior research. Identify patterns in LCA-related activities
10	Report writing	Write report
11	Dissemination	Present results to industry and academia

## 3.2 Preparatory work

Prior to starting the field work, basic methodological decisions were taken. It was decided to divide actors into “core people” and “LCA patrons”. Core people are defined as those belonging to operative LCA units and working daily with LCA. The definition of LCA patrons is people in the organizational environment who influence, manage, order or use LCA studies and related activity. Core people served as the starting point for collection of data. Additional data sources, both people and documents, were identified by what is known as snowballing.

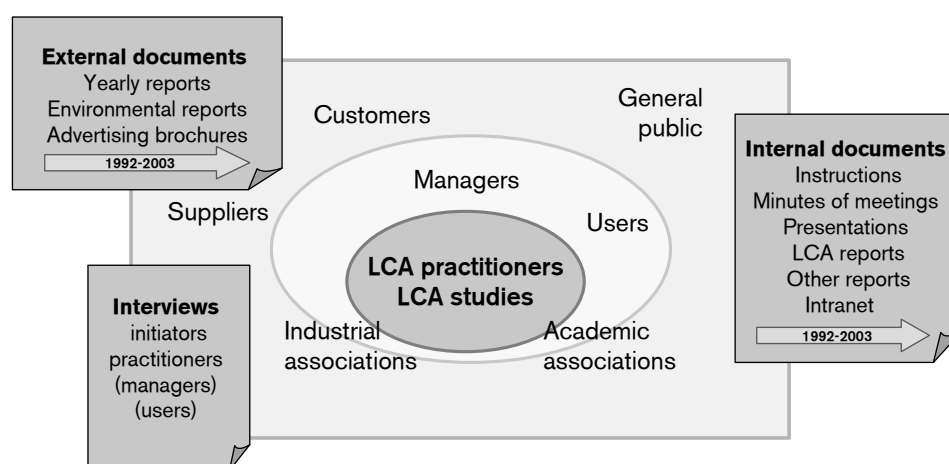
It was decided to include all kinds of LCA related work, i.e. not only traditional quantitative LCA-studies but also other types of LCA studies and work (e.g. routines, meetings, courses, advertising, cooperation, tools). The ambition was to chart LCA related work in the entire organization for the two companies studied and trade associations. As there was limited time for the study, the work was restricted to LCA practitioners in Sweden and to those parts of the organizations that were most closely connected with their work. The analysis should be read with this in mind. A more thorough survey including the LCA patrons would be necessary for a full evaluation of LCA work at the two companies.



The evaluation started with orientation interviews of representatives from the companies chosen (LCA practitioners at Stora Enso and SCA). The representatives interviewed at this stage of the project were both core people. The reason for choosing these persons was that they had good knowledge of LCA methodology and practice at their respective companies, they could help in identifying and accessing data sources for the study. The introductory interviews were intended for orientation to company LCA history and action undertaken at the companies. They also served as a basis for further field study design in terms of providing information on types, location and relevance of written data sources, as well as identification and access to additional core people for interviews. Prior to the extensive data collection, the reference group discussed and approved of the scope and methodological approach chosen. Possible outcomes and presentation of results were also reviewed.

### 3.3 Data collection

Three types of data sources were used for this study: written documents (internal and external), interviews and site visits. Information on LCA studies and related work was provided by the contact persons at each company. The companies were also visited to search for information in archives and on the intranet. Data collected included both LCA studies and environmental work in general. Documents collected also included minutes of meetings, presentations, yearly reports and brochures, see Figure 3.1.



**Figure 3.1** Methodological scope of the study. Practitioners of LCA and their interaction with stakeholders inside and outside the company are central. Information was collected from external documents, internal documents and interviews valid for the decade studied.

Open-ended interviews were held with LCA core people and, to minor extent, with managers and users of LCA studies. Three to four people who had initiated LCA activities or worked daily with them were interviewed at each company (including people no longer working there). Each interview lasted from 90 minutes to two hours. The person interviewed was asked to tell, quite freely, about how he or she had been working with LCA, preferably in a chronological order. Questions were asked mainly to encourage people to give more details or

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clarify their accounts. All interviews were tape-recorded. The interviews were transcribed, although not word for word.

Two site visits were made: one to Stora Enso, to be familiar with a pulp mill; the other to SCA, to observe for one day the work to an LCA calculation for product development.

To facilitate finding in the documents collected, an archive was formed in parallel with the data collection. All documents were marked with the date of collection, organization concerned (SCA, Stora Enso or trade association), type of document and document number. Data was collected from August to December 2003. Altogether 212 documents (including interview transcripts) were collected and studied. Documents were stored primarily by actor and secondarily by type. Number and types of documents are listed in table 3-2<sup>3</sup>. A more detailed list is given in Appendix A.

**Table 3.2.** Types of documents collected for the study

Type of document	Stora Enso	SCA
External reports and brochures	34	49
LCA studies	12	19
Minutes of meetings	9	19
Other internal documents (e.g. instructions and intranet sites)	16	40
Documents generated for this study (including interview transcripts)	7	7
<b>Total</b>	<b>78</b>	<b>134</b>

### 3.4 Coding of data

Documents were classified using a hierarchic system in two levels. From the literature review, it was concluded that the background conditions of LCA studies, such as role and application of LCA, related activities and interaction among actors should be taken into account. To establish classification categories in more detail, the documents were briefly reviewed parallel to collecting. After an iterative process of reading and testing systems for classification, seven main categories were determined. Each category was divided in subcategories (see Table 3.3), some of which were general, while others were designed for a specific type of document or actor. A more detailed list of codes used can be found in Appendix B.

Sections, or even phrases in the documents were colour encoded according to the seven categories. Subcategories were marked by keywords in the margin. The main objective of the classification was to organize the material when making the description and analysis.

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<sup>3</sup> Some documents that were written by external parties were classified with the company most concerned.

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## 3.5 Accounts and validation

Documents found at Stora Enso and SCA were sorted and activities were listed in chronological order. In addition, notes were made sorted according to the categories used for classification. These notes, together with the chronologies, served as a basis for linking data and writing accounts of how the companies had worked with LCA (see Chapters 5 and 6 of this report). The resulting accounts were validated by the company representatives, who commented on both written and oral presentations of the results.

**Table 3.3.** Categories for data classification

<b>Category</b>	<b>Subcategory</b>
1. Actors and activities	What kind of LCA activity? Who is the actor? When and in what context?
2. Application of LCA	What departments are involved? For what purpose is the action taken? What is the outcome? Is the action linked to a specific application or to promote LCA or environmental work in general?
3. LCA studies and methodology	Type and scope of study. Tools and databases used. Methodological considerations.
4. Conditions and resources	Resources needed, used or discussed, such as manpower, time and money.
5. Judgements about LCA	Statements on the value of about LCA methodology and LCA work.
6. Issues	Topics discussed, e.g. environment in general and holistic or life cycle views; specific issues such as ECF or TCF, disposables or non-disposables.
7. Other	Other notes of interest, not fitting in to the groups above such as general management statements and production process descriptions.

## 3.6 Analysis and interpretation

While working with the material prior to writing the account of LCA use, interesting themes emerged such as recurring connections within or between the classification categories. In parallel, characteristics of each company were identified and listed. This list served as a basis for mapping contrasts and similarities of the companies. Patterns and characteristics were subjected to deeper analysis, both as comparisons of the two companies and as comparisons of the empirical results found and the prior research.

Outcomes of the study are intended partly as input to an international evaluation of CPM in 2004. Hence, findings on cooperation between industry and academia are highlighted in Section 8.2. However, the data collection and analysis were open and explorative; they were not carried out with this input in mind. As stated above, the field studies were limited mainly to LCA core people at Stora Enso and SCA. Hence, a broader study of LCA activities at the companies as well as in the forest products industries in general was not possible in this study.

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## 4 *Forest products industry*

Forest products industry is an umbrella expression for industries based on forest products, including sawmills and pulp and paper companies (Nationalencyklopedin 2004b). Forest products industry make up 20% of the total export of Sweden (Skogsindustrierna 2003) and are an important industry in the Swedish economy. The “forest products industry cluster” includes suppliers and converters of forest based products and engages about 200 000 persons in Sweden (Nationalencyklopedin 2004b). The pulp and paper industry is a part of the forest products industry; there are companies producing pulp and paper products, which also often include those converting pulp and paper to other products such as packaging or hygiene products (Nationalencyklopedin 2004a).

By size alone, forest products industry has a considerable environmental impact. For example, forest products industries (here pulp, paper, graphics and wood industries) contributed more than 50 % of all oxygen demanding and degradable organic matter to the water in Sweden (1995), as well as more than 10% of the emissions of SO<sub>2</sub> in 1998, and of phosphorus in 1995 (Statistiska Centralbyrån 2000).

In this study, the forest products industry is represented by the companies Stora Enso and SCA. The two companies are both international and have a long tradition of LCA activities in Sweden. Their products differ somewhat, and address different consumer groups, Stora Enso mainly selling wholesale, while SCA also handles retail goods. Yet, the two companies are similar in terms of some product groups (e.g. packaging) and types of production sites (e.g. paper mills).

### 4.1 Stora Enso

Stora Enso is a world-wide paper and forest corporation, the main products of which are graphic and office papers, newsprint, packaging boards and wood products. Stora Enso’s mission is to “*promote communication and well-being of people by turning renewable fiber into paper, packaging and processed wood products*” (StoraEnso 2004). It has 42 000 employees and the total sales in 2003 were EUR 12 billion (StoraEnso 2004).

Stora Enso is organised in three product units; Stora Enso Paper, Stora Enso Packaging Boards and Stora Enso Forest Products (Stora Enso 2004). Stora Enso was formed in 1998, through the merger of Finnish Enso and Swedish STORA (StoraEnso 1999). This field study concentrates on the Swedish operations.

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## 4.2 SCA

As a world-wide corporation, SCA has 44 000 employees in 40 countries. They provide absorbent hygiene products, packaging solutions and publication papers. The SCA mission is to “*provide essential products that improve the quality of everyday life*”. Total sales 2003 were EUR 9 billion (SCA 2004).

During the decade studied, several organizational changes have taken place (Riise 2004). The hygiene part of the company, including both fluff products (i.e. incontinence, feminine and diaper products) and tissue products, was previously called Mölnlycke. Between 1995 and 1998, Mölnlycke was divided into SCA Mölnlycke and SCA Hygiene Paper, with separate environmental departments. In 1998, the two parts united again, as SCA Hygiene Products. When this report was written, SCA consisted of three divisions: SCA Hygiene Products, SCA Forest Products and SCA Packaging. This study deals mainly with the Hygiene Products.

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## 5 *Stora Enso*

Stora Enso started in the first years of the 1990s with joint LCA projects involving suppliers and customers. Although much emphasis has been laid on external engagements, in-house studies were also made. No routines have been implemented for LCA work, however, and the interest in this has somewhat weakened with time.

This section will further describe the development of LCA at Stora Enso, starting with the story of how LCA spread in the company, followed by thematic discussions.

### 5.1 The LCA history of Stora Enso

During the oil crisis in the 1970s, there was a growing interest in energy analyses. Several such studies that compared paper and plastic products, showed paper products to be associated with a much higher use of energy than similar ones made of plastic. According to Göran Swan, a customer services man at the time, and later on initiator of LCA activities at Stora Enso, the plastic product industry drew heavily upon these energy analyses in the 1970s, and they were very “aggressive in their marketing” (Swan 2004). The paper industry felt badly treated and Göran, working at Billerud (later on incorporated in Stora), conducted new energy analyses. In his studies, paper products turned out to be less disadvantageous than shown in the studies made by the plastic industry. The plastic industry had nothing to complain about in these studies, and they also modified their own studies (Swan 2004).

The public interest in product related environmental issues was growing in late 1980s, which was also the time life cycle assessment (LCA) started to be discussed. Again, paper and plastic products were compared, which showed plastic bags to be better than paper (Swan 2004). Göran, who had been working with the energy analyses in the 1970s, became interested in the new tool. He knew the Swedish LCA guru Gustav Sundström, with whom he discussed LCA issues. Göran also started out conducting LCA studies at the company: *“As no one knew anything, there were good reasons to specify and find data to see what was important and what was in need of being improved”*. As there were no software programs, Göran made the calculations in Excel. (Swan 2003)

#### **External projects**

As Göran was interested in LCA, he also became the Stora representative in external LCA projects. These were sometimes company decisions, and sometimes Göran’s own initiative. There were many of these starting in early 1990s (Swan 1994): participating in the Fraunhofer ILV LCA project starting in

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1991, supporting the Product Ecology Project starting in 1992 and attending the SETAC congress and workshops in 1993. Göran was also the Stora representative, and later on chairman, of a joint data base operation of the Swedish Pulp and Paper Research Institute (STFI) in Sweden, PFI in Oslo, KCL in Helsinki and Chalmers Industriteknik (CIT) in Sweden.

Life cycle assessment was discussed within the paper sack community, where Göran also was engaged. The Nordic Paper Sack Research Group sponsored a study on paper sacks for the craft paper producers in Scankraft. Data from this study was also fed into a joint study within the associations Eurosac and Eurokraft (European equivalents to Scankraft). Göran was asked to be the chairman of their LCA group, initiated in 1993. The aim of the study was to show the environmental advantages of paper sacks. The study was made as a comparison of paper and plastic sacks for distribution of mass industrial goods. A Danish company wrote the report.

Within the packaging branch, paper versus other kinds of materials was a hot issue, often subjected to LCA studies. Thomas Otto, working with packaging board at the Skoghall mill, had to learn about the new way of assessing materials. He also became engaged in the product ecology project together with Göran (Otto 2003).

### **Internal introduction**

At Stora Enso, Göran started an internal project that aimed to develop and introduce LCA. This resulted in a second version of the LCA Excel software program called “the STORA model”. The model was peer reviewed, on request from Göran, by Gustav Sundström in December 1993 (Swan 1993). The new version included weighting according to the EPS system, recently developed in the Product Ecology Project. Mainly to test the EPS system, a cradle to grave study of brick packages for milk was conducted. Another aim of the internal project was to map Stora’s products with LCA. This started with a study of fluff pulp at the mill Stora Cell in 1993.

To spread and discuss LCA within Stora, Göran arranged LCA seminars in 1993, 1994 and 1996. Between fifteen and twenty persons from different parts of the organization participated in these meetings. At the seminars, studies made and collaborations taking place were presented. Some external guests were also invited to the seminars, such as representatives from the Product Ecology Project presenting the EPS system. Methodological issues were highlighted and discussed at these gatherings. Land use was identified as an issue in need of further work as early as at the first seminar in 1993. Land use was determined by one single indicator in the weighting system used; this measure was too vague according to the many of the participants from Stora.

The environmental director at the time, Mats-Olof Hedblom, was personally enthusiastic about LCA; for example he was engaged in the development of the EPS system (Bresky 2003). He left the company in the mid 1990s, with no immediate successor.

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### **Acting as an active supplier**

Several customers of Stora began making LCA studies. As a supplier, Stora was asked to deliver data or to actively take part in this work. For example, in 1993, the manufacturer Unilever asked CIT to conduct a comparison between two board products, Koppargloss and Frövi Carrier. A pulp mill Stora Billerud Fors agreed to furnish data. To enable this, they first carried out a study of Koppargloss and Kopparwhite (both are parts of the board product Koppargloss). The final report to Unilever was written by CIT and presented in 1994.

Tetra Pak was another producer, interested early in LCA, that wanted to conduct a joint study with Stora and other suppliers. According to Thomas, Stora considered this an interesting learning project (Otto 2003). As a result, Stora, Tetra Pak and Borealis made a study together of a milk packaging system as one of seven case studies within the Nordic Project on Environmentally Sound Product Development (NEP), initiated in 1993. Thomas worked with Göran to get data for the study. Final editing was done by CIT and the report was published in 1995 (Swan 1996).

A third example of Stora's involvement, as a paper supplier, in LCA activities in cooperation with their customers, is a project initiated by the German Springer Verlag. Springer Verlag invited both their Canadian paper supplier, Canfor, and Stora to join this study. Stora was responsible for input to the study in every part of the life cycle from cradle to pulp and paper production. Göran spent a lot of time working with this study, for which had an interim report was finished in January 1996; it was officially published in 1998. The study included discussions on how to assess land use, an issue that had led to many discussions and also scepticism of LCA within the company, as it was expected to give rise to unfair comparisons.

### **Expanding the group of practitioners**

During some of his engagements in external projects, Göran met Jan Bresky, who was working with LCA at SCA. Jan was interested and experienced in LCA, and wanted to work in Värmland (a region in central Sweden). Besides, Göran was approaching the end of his working career and would retire in some years. In 1995, Jan started to work for Stora. Together with Göran, he revelled in LCA, both to learn more and to develop it internally. As there was no environmental director at the time, they explored LCA in accordance with their own preferences. Their studies became inflated, but there was tolerance and an economic climate allowing, or at least not refusing, this (Bresky 2003). However, Jan felt uncertain about whether their work was appreciated or not.

By engaging in LCA studies, the practitioners addressed processes outside Stora's own operations. The motive for doing this was to know that they "*did not introduce anything that they could be held responsible for later*". Accordingly, their studies concentrated on cradle to their own gate. Forest products industries had long been a target for environmental groups such as Greenpeace, and they now wanted to know about their products to prevent any unpleasant surprises (Bresky 2003). The LCA studies provided "expert knowledge" and made it easier to clear up myths and misunderstandings in communication with customers.



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Jan and Göran sometimes circulated in the organization to inform about LCA and their competence in this. Sometimes a mill became interested in using LCA to assess their products. It also happened that other departments wanted information as a basis for product communication. Jan perceived, however, that it was often enough for the sales people to tell the customers that an LCA had been made: the customer would be “*impressed*” by the environmental work (Bresky 2003).

### **Diverging views on weighting systems**

The first Stora environmental report was positive to LCA and stated that assessments of products’ environmental loads “...*should preferably be based on an LCA*”(Stora Enso 1996). The report also said that Stora takes part in the development of EPS. The EPS was never accepted within Stora, however. Jan was sceptical about this kind of aggregation of data, partly because of its one-dimensional measure of land use. As he considered weighting to require more research, he argued against using any such system, and favoured supporting research on this. Göran did much research, mainly concerning how to handle land use (for example in the COST project and projects in CPM, see below).

### **Pooling knowledge**

In 1997, an EU project on LCA of forestry and forest products, called COST E9, was started (Swan 2004). By his engagement in LCA issues at the Swedish Pulp and Paper Research Institute (STFI), Göran was appointed to lead one of three subgroups in this project, namely that regarding land use in forest products industries. The aim was to accelerate, by pooling knowledge, the development of assessments of land use. Once started, it turned out that there was not enough to pool; the methodology was still too undeveloped. Instead, they worked out a methodology for assessment of environmental impacts caused by land use. The project lasted for three years. During this time, Göran retired, and worked the rest of the time as a consultant for Stora (Swan 2004). The question of how to treat land use was not solved, however, and is still an LCA methodology that remains to be developed (Svending 2003).

In Sweden, when the Product Ecology Project and NEP were finished, there was still a need in industry to pool knowledge on LCA. A competence centre for environmental assessment of product and material systems (CPM) was founded in 1996. Stora was one of the companies participating from the start. Jan valued the centre as a way to “bounce ideas” and confront other companies with different methodological standpoints; some confrontations led to conflicts, but also to progress. It was important for him to use this opportunity to take part in the work and ideas of others, as there was little written material to study. Hence, CPM became a “*generator for knowledge*” (Bresky 2003).

### **Site-specific knowledge and refined studies**

When Per Broman took up the environmental directorship in 1997, he wanted to tighten the LCA work, and concentrate it more on Stora’s own processes. Also, Jan had concluded that it would be easier to keep track on their own processes and to let their suppliers do the same for theirs. Another ambition was to

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conduct narrower, but also more careful, studies. As a result, they focused on site-specific knowledge, and gate-to-gate studies. This represented a shift towards more refined work. They also made more investigative studies, for example to explore changes or to compare with the best available technology. A lot of this work was done with the aid of Master's Thesis students. All studies had to start with a request from a mill, as they were the ones to pay for the studies. Some mills had been interested in doing LCA studies after being informed by Jan and Göran, while others became interested after questions from customers (Bresky 2003).

One of the Master's Thesis students was Ola Svending, appointed to make an LCA study at Stora Norrsundet as part of Stora's environmental section's work program started in 1997. This program stated the need to survey the products with LCA. Norrsundet had heard about LCA and was interested in it, but had little experience (Svending 2003). A spin-off from the study was that it could give inputs to the EMAS system that they were about to implement. After finishing his thesis, Ola was employed at Stora a trainee on a corporate level.

### **Searching for higher quality data**

The more specific studies in the mid 1990s raised more concern about quality and reliability of data. The study by Norrsundet confirmed that Stora had problems with incomprehensible or insufficient data from their suppliers. Stora wanted to be able to deliver trustworthy information to their customers, and the lack of reliable data was perceived as a weakness. Data quality was an issue also discussed and worked with both at CPM and in forest products industry. At STFI, these discussions regarded mainly who should be responsible for the data collection and supply. A data-base with chemical supplier data existed at STFI, but was in need of being updated.

In 1997, a supplier auditing system, COMPASS, was introduced at Stora. It included a question on whether or not the supplier was willing to deliver LCI data. Stora did indeed get some data from the questionnaires asking for it, but often with very little transparency and information about how the data was collected (metadata). To get more reliable data, the core people of LCA at Stora wanted to make an LCA that emphasised LCI data, and they searched for suppliers interested in participating in such study.

Both Stora and Akzo Nobel were members of CPM at this time, and data format and data quality were hot issues. Stora and Akzo Nobel Eka Chemicals decided to make two studies together: one examining pulp process chemicals and the other paper process chemicals. This was done from 1997 to 1999. Jan coordinated Stora's parts of the studies. He engaged Ulrika Ågren from Stora Enso Environment, with some previous experience of LCA from wood products, for these studies. Ann-Charlotte Bergman from Stora Research also helped out in collecting data.

In parallel to this work, a project was started at CPM, which aimed to set up a database for pulp and paper in Sweden. Ola was appointed as the Stora representative in this project. The pulp and paper industry was sceptical about the usefulness of general and mean data, however, and the project was changed to deal with methodologies to handle data instead of a database (Svending 2003).

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## **The merger with Finland**

In 1998, Stora merged with Finnish Enso and formed Stora Enso. Enso was experienced in LCA and had worked with it in a somewhat different way; Enso performed LCA studies in accordance with instructions agreed on within the forest products industry in Finland, and they had concentrated on mills even more than Stora. Also, they used their own software (Bresky 2003). In addition, it was already understood in Finland that LCAs should be made on every mill and every key product (Svending 2003).

## **Organizing LCA issues**

Some years after Göran had retired in 1998, Jan shifted away from the work with LCA, leaving Ola and Ulrika as the only ones doing this. Ola had just finished a job implementing EMAS at Skoghall mill by that time. In parallel to the work with EMAS, Ola had also used the LCA software EcoLab to build models to calculate environmental data for the mill's products, since environmental product calculations were requested by some of their consumers, (e.g. Tetra Pak). Once back on a central level, Ola took over some work from Jan, for example as a representative in the Swedish Environmental Management Council's Technical Committee on Environmental Declarations Type III (i.e. on EPD).

Ola wanted to collect material for his own work and to spread information on LCA work in the organization. Hence, he started organizing informal meetings with Jan, Johan Holm and Per Broman. Later on Thomas Otto, Director of Environmental Affairs at packaging, was also included. They soon concluded that it was important to coordinate the LCA work with their Finnish colleagues, and invited them to attend the meetings. The resulting "LCA coordination team", had its first meeting in 2002. One of the first tasks for the team was to compile the work done in Sweden and Finland. A list of LCA practitioners and contact persons in each country was made. They also started to work on a list of LCA activities in each country. Environmental issues in general were dealt with by the existing Environmental Network of Stora Enso, where representatives from all of the mills gather a couple of times every year. These meetings are coordinated by Stora Enso Environment, and Ola has sometimes been asked to have presentations about LCA at them (Svending 2003).

Stora Enso has also participated in the ISO standardisation work, with Ola and Jan as representatives of ISO/TR 14025 on Environmental Declarations Type III (finished in 2000, revised in 2003 - 2004) and of ISO/TS 14 048 on Data Documentation Format (2000 - 2001) (Svending 2004).

## **Communicating environmental information**

The new millennium brought discussions among the paper producers on how to communicate environmental qualities of products. Stora Enso considered an eco-label, the Nordic Swan, as both expensive and restricted. By the early 2000s, major European paper producers agreed to write a joint guideline for environmental product declarations of the pulp and paper industry. The project was coordinated by the Finnish Forest products industry. Ola suggested that the declaration should be made as a standard EPD, partly because the procedure for this had been decided by a third party and, as such, it would be more trustworthy

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than a declaration system built up by the pulp and paper industry themselves. An EPD requires a complete LCA, however, and this was considered by the industry to be too extensive. After some consultation with the market departments, a system was chosen that should be better adjusted to what was perceived as important to the customers. The products addressed were the formerly eco-labelled products<sup>4</sup>, and the customer's information need was based heavily on the criteria for the Swan label, as some of them wanted to be sure they could keep the label on their own products. It was decided to design environmental information as "Paper Profiles", taking into account only the pulp and paper part of the product chain, gate to gate. The report on how to calculate and present a "Paper Profile" was finished in 2001. The manual was, however, somewhat flexible and allowed variations in how to calculate data. This was discussed by the LCA coordination team, and it was decided that Ola and his Finnish colleague, Märvi Niininen, should improve the manual to make sure that at least all Paper Profiles within Stora Enso would be made in the same way. Ulrika also helped out in this work. As a member of the Environmental Management Council's Technical Committee on EPD, Ola could use some of the experience of this association to improve the Paper Profile manual. Part of the work was also to make sure that the recommended method of calculation would be in line with procedures for EPD, if this were to be implemented in the future.

### **Elementary chlorine free or totally chlorine free pulp bleaching?**

The debate on elementary chlorine free (ECF) versus totally chlorine free (TCF) pulp has been an issue in the industry for many years. Customers have kept on asking questions or asking for certain qualities for many years, and the mills wanted to have arguments to use in discussions. Hence, the environmental coordinator at the Pulp Competence Centre, Eva Punta, recruited some mills from both Sweden and Finland and initiated an LCA project on TCF/ECF bleaching. A project group was formed, consisting of people from the Pulp Competence Centre, participating mills, and Ola from Stora Enso Environment. The study compared the best available technology (BAT) for ECF and TCF on equivalent pulps, which means that some processes that did not exist had to be modelled (Wäne, Svending et al. 2003). To reduce the workload, it was planned to take data from databases instead of from each supplier. Once the project was in progress, however, it turned out that there was indeed supplier data at the Finnish part of the organization, which was later used in the study. The study was finished in 2003, and the results were presented to the pulp environmental network at Stora Enso (Svending 2003). Results from the study were also to be communicated to the public in the environmental report of 2003. In addition, on request by the Department of Environmental Communications, the study was included in information used for sales and marketing.

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<sup>4</sup> Communication in the packaging field differs that from paper products, however. The customers in the former are fewer and in closer cooperation with the supplier. Hence, information delivered is adjusted to each customer and not provided in an established format (Otto 2003).

“All of a sudden economists and engineers meet, all of a sudden is there a joint interest, and all of a sudden there is a tool ready to use! If we hadn't developed LCA a long time ago, then we would have had to do a rush job, but now we didn't need to do that.” (Bresky 2003)

### **LCA methodology is used in emission trading and transports**

The LCA methodology proved to be useful when climate change and trading with CO<sub>2</sub> permits started to be discussed. To be prepared for the consequences of such a measure, Stora Enso decided to map 50 of the

most important products involved in their contribution to CO<sub>2</sub> emissions. For this, they used LCA methodology, although restricted to CO<sub>2</sub> emissions and including only primary suppliers, according to instructions stated by the EU (Svending 2003). The calculations were made in Excel. When making the studies, it became clear that good quality LCI data was hard to get, although promised by the supplier in the COMPASS system.

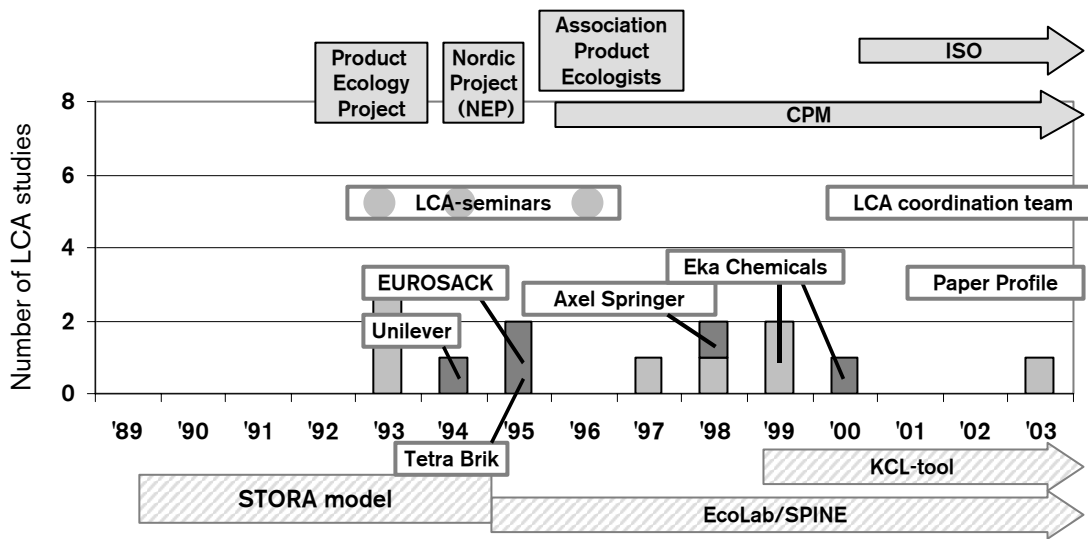
The mapping of CO<sub>2</sub> has not yet led to any changes within Stora Enso. Nevertheless, according to Jan, the assessments made have given people more awareness of areas and products with high contribution to CO<sub>2</sub>, which has led in turn to people starting to consider possible actions to reduce the CO<sub>2</sub> contribution, such as substitution of products (Bresky 2003). The LCA methodology is not very positively accepted at the company, however: *“If you use the expression LCA, people screw up their faces”* (Bresky 2003). To avoid negative associations, Jan uses the term “environmental accounting” instead of LCA for the methodology used. Jan also thinks it will be easier to implement the data format SPINE in this project. This is because emission trading is closely linked to money, which makes it easier to argue for a more careful and precise handling of data. Earlier, the SPINE format and associated requests for metadata were perceived as “too complicated”.

Another work related to LCA was done in the transport sector. In what are known as “Transport Chain Assessments”, transport chains from mill to customer are analysed from a product perspective. People working with transport optimisation are independent from LCA, although they sometimes help LCA practitioners with data.

### **No corporate guidelines on LCA use**

At Stora Enso the top management has emphasized, internally as well as externally, the importance of having a holistic view. However, there is no definition of whether, or how, this relates to the use of LCA. Hence, LCA practitioners sometimes lack guidance on what is desired, or not, when it comes to work associated to LCA (Svending 2003). In the Swedish forest products industry federation, there is a Code of Conduct when participating in LCA studies from 2000 (Stora Enso 2003?), and the European trade association CEPI, agreed on a Position on Life Cycle Thinking and Life Cycle Assessment in 2003. Stora Enso has participated in the formulation of these documents through Thomas. The formulations chosen were in line with the work already done, and the documents have not had any immediate effects on the work on LCA within Stora Enso.

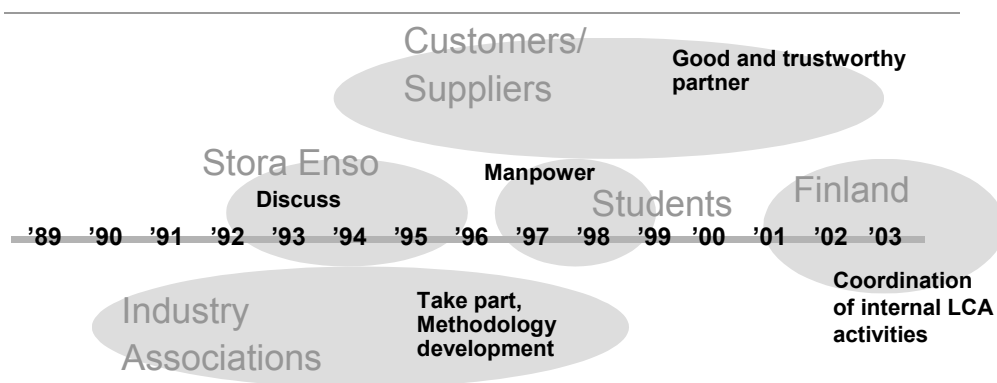
This section on the history of LCA at Stora Enso has shown that many parallel activities of various kinds make up LCA work. Figure 5.1 presents an overview of technical, organisational and communicative projects and activities through the years.



**Figure 5.1.** Overview of LCA studies and other LCA activities at Stora Enso. Studies in-house (light grey bars) and in collaboration (dark grey bars). The LCA tools used are shown under the diagram. Collaborative projects with industry and academia (e.g. NEP and CPM) are shown in the upper part, and some internal studies and matters (e.g. the EUROSAC study and the LCA-seminars) in the middle. Abbreviations are listed at page ix.

## 5.2 Organization of LCA work

The LCA work at Stora Enso is characterised by cooperation with external actors; most of the projects carried out by LCA core people have been established either in industrial or academic associations, or as partnerships in joint projects with suppliers and customers. This work was long driven by Göran Swan, who retired in 1998. The core LCA people at Stora Enso was first situated at the department “Teknik Säffle”, and later, through reorganizations on a corporate level, at the Department “Support Systems and Tools” at Stora Enso Environment. The organizational structure is quite informal, although meetings to discuss LCA with representatives from various parts of the organization from time to time have been arranged by LCA core people. The more formal group of LCA practitioners was created in 2002. The main clusters for interaction are found in Figure 5.2.



**Figure 5.2** Main clusters for interaction (shaded ellipses), groups taking part (grey letters) and motives for the interaction (black letters) at Stora Enso.

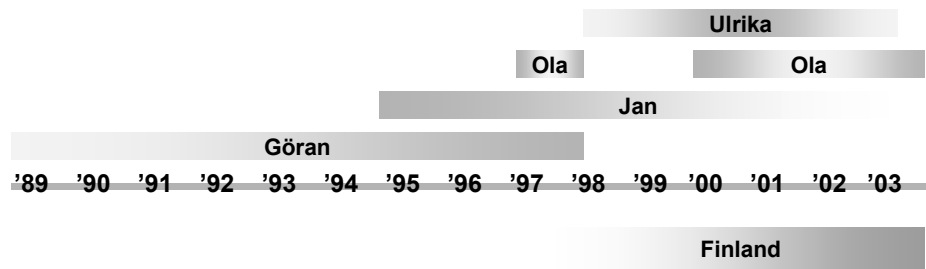
Until the mid 1990s, Göran Swan worked more or less alone as LCA practitioner at the company (department Teknik Säffle). He created a forum for LCA discussions within the corporation by organizing LCA seminars in 1993, 1994 and 1996 (as well as other discussions such as an environmental consequence analysis in 1993). Fifteen to twenty people from various parts of the organization attended these seminars, where a reference group was set up for the LCA work. The group was mentioned in 1996 (Swan 1996), but it is unclear how the group worked, when it was started, and for how long it existed. At any rate, the “group” of LCA core people still only consisted of Göran. Because he was known for his interest in the LCA area, he was requested to participate in several industry associations, regarding methodological developments and data supply. Once he was recognized in the field, he was given more LCA-related duties in new groups. As data supplier, Thomas Otto also became engaged in LCA work to provide data and later to make sure the data was handled correctly.

In order to assist Göran, and to secure continuation of the LCA work when he retired, Jan Bresky was hired at the request of Göran in 1995. As no environmental director existed, Göran and Jan found their own duties in the field, much in accordance with their own interests. Although not systematically, they sometimes informed the mills about their work. Once a mill showed an interest in a study they helped, often by providing Master’s Thesis students.

As Göran was soon to retire, Ola was hired in 1997, to maintain the informal and un-named LCA group, and to assist in joint studies with suppliers. Ola left the group in 1998 to work with EMS at a mill. About at the time he left, Ulrika Ågren was engaged to carry out LCA studies. She also continued with product related environmental work such as the Paper Profile. Ola came back to work with LCA in 2000, concentrating mainly on methodology and data quality in joint projects with the industry association and CPM (as part of a licentiate degree in industrial management of environmental data). Jan was appointed director of Group Level Support, and left the group of Support Systems and Tools in the new millennium. Ola wanted to consolidate the LCA work and set up an “LCA coordination team”, first informally, and later formalized and expanded with Finland in 2002.

Not counting the LCA people in Finland, the group of LCA core people has more or less consisted of one or two people since the very beginning (see Figure 5.3), sometimes mostly concentrated to a single person. This sole practitioner has sought support by creating forum for LCA discussions within the organi-

zation (e.g., LCA-seminars and LCA-discussion groups) and by engaging in joint projects with external actors. After Göran retired in 1998, the LCA work has continued, though without the responsibility for driving and developing LCA activities clearly dedicated to or taken on by anyone.



**Figure 5.3** LCA core people at Stora Enso

The LCA work at Stora Enso is to a large extent initiated externally, for example by customers and suppliers (e.g. Tetra Pak, Unilever), projects (e.g. NEP, COST), or issues in society (e.g. ECF or TCF, CO<sub>2</sub>). People working with LCA wait for a request or need, e.g. from mills or customers, in order to start an LCA activity.

A characteristic attitude to LCA work is that it should be correct and scientific. Methodology is often discussed, and data quality and data communication are given high priority.

### Tools and infrastructures for LCA work

As no software existed in the early 1990s, Göran started to build the STORA model in Excel. The EPS weighting system was early discussed (e.g. at LCA seminars) and a study aiming at testing the method was carried out as early as in 1993. The “I-tool” software was discussed in 1994, and tested in the NEP project (Swan 1994). In 1996, Stora had, as one of the early adopters, implemented the EcoLab software based on the SPINE data format. EcoLab has since been used at Stora, but when the ECF/TCF study was to be done with Finland in 2003, it was decided to try KCL Eco, the calculation tool and database used in Finland. Although Finland has routines for updating of supplier data, there are no such routines in Sweden.

Tools and infrastructure for LCA work have mainly been aimed at the LCA practitioners, and not for other functions at the company. There was an attempt in 1994 to provide “ready-made LCA studies on disc” to the business areas, allowing them to do “desk product development” (Swan 1994), but this ambition does not seem to have developed further.

### Cooperation between industry and academia

Cooperation with academia and industry has played a significant role for LCA work at Stora Enso (Sweden). Many of the LCA related projects have been linked to or stem from such networks. The joint study between Stora and Tetra Pak, presented in 1995, was initiated and coordinated in the NEP project, and Tetra Pak is still an important customer with whom Stora Enso works in close collaboration regarding product related environmental data. External networks

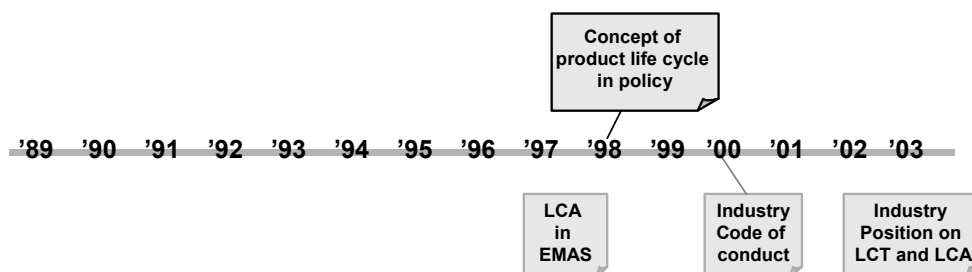


also inspired the development of internal procedures, such as the STORA model.

The joint industry and academia projects in the early 1990s considered one or a few studies. After years of such temporary organizations for LCA projects, CPM was founded in 1996, providing a forum for a wider range of people and projects working with LCA. Stora was part of the network from the start and found this forum important for sharing ideas and spurring each other on, among industries as well as academia. As LCA was a relatively new tool when CPM started and little was known about its methodology and use, CPM became a “generator for knowledge”. It also served as a catalyst in finding industrial partners for LCA projects (e.g. the Eka Chemicals studies) as well as becoming a breeding ground for deeper collaboration with academia (e.g. a licentiate degree in industrial management of environmental data) In addition to providing a basis for such initiatives, CPM also served as an appreciated “neutral forum” for this research.

### 5.3 LCA in corporate environmental work

The concept of “product life cycle” has been used in the environmental policy since 1998, but there are no formal routines at a corporate level on the use of LCA. There might be instructions for LCA practice at some mills (Svending 2003). Within trade associations, Stora Enso has participated in the formulation of a code of conduct in 2000, as well as a position paper on life cycle thinking and life cycle assessment (see Figure 5.4).



**Figure 5.4** Documents related to LCA at Stora Enso. Formal routines (black frame) and other documents (grey frames).

#### LCA as part of the environmental work

Stora had been working with environmental issues for a long time before LCA was introduced. Major investments to reduce pollution from the mills were, for example, made between 1960 and 1990. When environmental reports were introduced in 1995, LCA was recognized as a tool for corporate environmental work. The interest in LCA has however decreased over time. In the first two reports, about one page each was devoted to LCA, e.g. on its potential in terms of environmental product information. In the reports from 1997 to 1999, LCA received less attention, and in 2000 to 2002 the term Life Cycle Analysis is only found in the glossary. The preface to the 2001 environmental report states that,

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as a wood products company, SCA must consider the whole product chain from raw material to product handling. But LCA as such is not mentioned.

The LCA study carried out together with Axel Springer was highlighted as an example of cooperation with suppliers and customers in 1998. One lesson from the study presented is the “...insight into the relative contributions of the environmental loading from forestry (insignificant), pulp and paper production and printing. Such information is of great value for the continuation of improvement work.” It is also concluded that it is important to involve suppliers in the environmental improvement work as “...it is clear that suppliers of materials and services play a vital role in contributing to the environmental profile of the Group’s processes and products.” (StoraEnso 1999). In the 1999 environmental report, the complexity of environmental information is discussed: “The product life cycle approach gives a suitably holistic perspective to this exercise. This is where LCI (Life Cycle Inventory) and LCA (Life Cycle Assessment) can provide assistance, since these methods allow data from different sources to be compared. Stora Enso has been active in this field, ensuring that most of the company’s production units carry out such analyses, for instance.”(StoraEnso 2000)

### **Life cycle thinking in environmental policy**

The concept “product life cycle” was introduced in the environmental policy in 1998<sup>5</sup>. In previous policies the expression “low total environmental impact” had been used in relation to products.

“The concept of product life cycle guides our environmental activities and provides the framework for our efforts. We expect the same commitment from our suppliers and partners so that at every stage, from raw material to the end product, the impact on the environment will be minimized.”

Stora Enso Environmental and social responsibility policy, 1998-2002

### **LCA in environmental management systems**

LCA has been used in environmental management systems to identify and keep track of environmental aspects at the mill (Svending 2003), for example in 1997, when an LCA was finished just as EMAS was about to be introduced at Norrsundet mill. However, the main aim of the LCA study was not to support EMAS but to survey Stora Cell’s pulp production (Svending 1997). Another example of an attempt to use LCA in EMS is found in the joint study of Stora Enso Environment and Akzo Nobel in 2000, where ”Possibilities to use LCI/LCA-data as a foundation for important environmental aspects within EMAS.” are stated as a possible spin-off effect of the study (Ågren and Hallberg 2000), although these effects are not further discussed in the report.

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<sup>5</sup> It has not been possible to study objectives and follow-up of this policy.

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## Life cycle policies in forest products industries

The growing interest in life cycle thinking in public policymaking and legislation has made both Swedish and European forest trade associations consider LCA. A Code of Conduct for participating in a life cycle assessment was adopted in the Swedish Forest Industries Federation in 2000; listing items that should be agreed upon before participating in LCA studies. The Confederation of European Paper Industries (CEPI) recently formulated a position on life cycle thinking and life cycle assessment. Stora Enso took part in the writing of both these documents, but they have not directly influenced work within the organization (Svending 2003).

## 5.4 Main areas of LCA work

LCA work within Stora Enso seems to be mainly driven by two things: a desire to learn (about methodology and processes), and to be an attractive and trustworthy partner. In addition, LCA methodology is also useful when dealing with environmental issues such as ECF or TCF, CO<sub>2</sub> and transports.

"I would like to downplay the role of LCA. The ones making the decisions did not talk LCA. It was more a matter of getting data, creating credibility, and work in the product chain". (Bresky 2003)

### Learning about processes and methodology

Ola perceive learning about the environmental impact from products and processes to be the main applications for LCA studies (Svending 2003). Lessons learned should, for example, be used as one input when deciding on investments and when prioritising environmental aspects. (No direct example has yet been identified where LCA results have influenced decisions). In accordance with this learning ambition, most studies are also made with the aim of assessing the company's products. The studies often have a methodological aim as well, although the methodological part seem to have been more emphasised in earlier studies than in later ones.

### Being an attractive partner

Although it is not expressed in the goal and scope of any study, an underlying motive of many of them seem to be being an attractive and trustworthy business partner. Stora Enso participated early in joint studies, e.g. with customers wanting to carry out LCAs. In the late 1990s emphasis was put on data quality (e.g. in the CPM/SSVL project) in order to provide trustworthy data for customers and other stakeholders. Although it did not consider the whole life cycle, the refining of the Paper Profile instructions was also primarily to secure that uniform and "correct" data from the corporation was communicated to the customers. The work done by Thomas, to secure that data from Stora Enso Packaging is used correctly is also related to this field.

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## Handling environmental issues

LCA methodology has also been used when dealing with environmental issues in public discussion. As customers often asked about which chlorine bleaching was best, ECF or TCF, life cycle assessments were used to analyse environmental impacts of the different processes. Although without using the phrase LCA, LCA methodology has been used for calculations of CO<sub>2</sub>-contribution prior to emission trading. The transport sector also uses a methodology similar to LCA when allocating transport emissions to products.

## 5.5 LCA and external communication

External communication of LCA work is not a prioritised area at Stora Enso (Svending 2003), and LCA is not mentioned in external communication to any great extent. LCA has occasionally been given as an example of a tool for environmental work in environmental reports. There are also a few examples of when results of joint LCA studies have been communicated officially (such as the report of Axel Springer in 1998). Stora Enso has, together with many other companies in forest products industries, chosen to give environmental product information through a Paper Profile regarding only pulp and paper production, instead of a full EPD. Figure 5.5 shows areas where product oriented environmental information have been used in external communication.

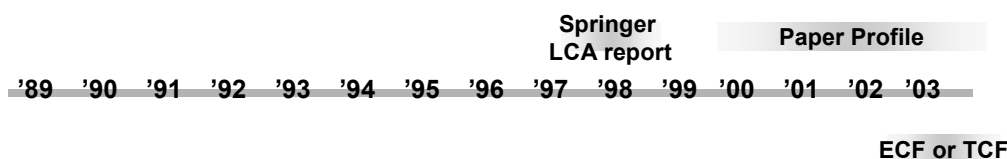


Figure 5.5 LCA related work used in external communication, Stora Enso.

### Communicating environmental work in general

Stora Enso has put a great deal of emphasis on having a “holistic view”, which is also disseminated in external communications. Common examples given of such an approach are forest certification, renewability, reuse, transport solutions, and “total environmental impact”. It is, however, hard to tell whether “total” refers to all environmental impacts associated with the product, or to the manufacturing site. The expression Life Cycle Assessment, or LCA, is only found in external communication in corporate environmental reports in 1995 - 1999<sup>6</sup>, where LCA is referred to as a useful tool for e.g. environmental product information, or as a source of knowledge for environmental load.

### Handling environmental discourses

Life cycle assessment has been used to provide more insight into extensively discussed environmental issues. Studies of ECF and TCF are referred to in the environmental reports of e.g. 1997 and 2002, though it is not stated whether or not these are LCA studies. Results from the latest study on the issue, an LCA

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<sup>6</sup> LCA is defined the glossary for 2000-2002.

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study made in 2003, are planned to be communicated in the 2003 environmental report as well as in a separate pamphlet ordered by the Environmental Communications department, intended for use by the sales and marketing department.

### **Eco-labels and paper profile**

The first environmental report from 1995 is optimistic about LCA: Stora considers buyers and sellers to have legitimate demands for impartial environmental information and states that such information should be based on Life Cycle Assessments. In the environmental report of 1996, Stora is critical about the environmental labels of type I offered, and supports development of LCA-based labelling. In the 1997 environmental report, too, LCA is commented on in relation to product information. Stora also states that they actively participate in the formulation of LCA-based product information. When major paper producers gathered to decide on how to communicate environmental information on their products however, they did not choose to consider a full life cycle perspective (e.g. an EPD), but only the pulp and paper production. This was because a full LCA was considered too extensive in relation to customer demands. The resulting Paper Profile was introduced in 2001.

### **LCA influences external communication**

Although Stora Enso are careful in communicating LCA results, they perceive that LCA studies have influenced external communication. Jan thinks that LCAs have contributed to a more holistic view, which has made it possible to communicate environmental issues in a different way (Bresky 2003). It has also been easier to answer to questions, and relate what are significant issues and what are not. This has in turn influenced the customers. Jan thinks that public perception of environmental problems in the forest products industry has become more linked to reality, with more concern about forest management and less about chemicals used (Bresky 2003).

## **5.6 LCA studies**

The first LCA study identified at Stora Enso is dated 1993, and is about Fluff Pulp at Stora Cell. Altogether, 13 LCAs have been identified at Stora Enso, performed alone or in cooperation with other organizations<sup>7</sup>. It should be noted that an LCA often covers several different products produced at a certain mill.

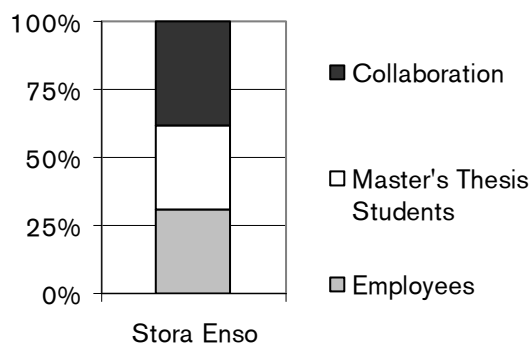
### **LCA practitioners**

Of the 13 LCA studies done, 5 were conducted in cooperation with other companies (where the reports were often edited by a consultant or an external institute). Studies made by persons employed at Stora Enso are concentrated to the first and last years (3 in 1993, 1 in 2003), while Masters Thesis Students were engaged to carry out the internal studies in 1997-1999 (4). Share of

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<sup>7</sup> This does not include LCA studies conducted by the Finnish Part of Stora Enso.

different types of LCA practitioners for the studies at Stora Enso are shown in Figure 5.6.



**Figure 5.6** LCA practitioners at Stora Enso

### Products studied

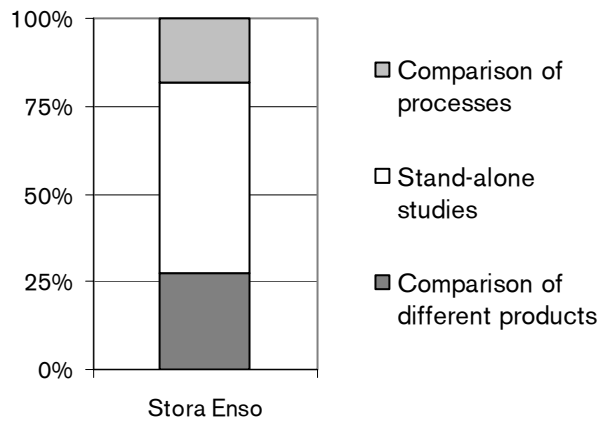
The products studied have not been chosen systematically by the LCA core people at Stora Enso, but determined by demands from external partners or requests from mills. Some mills that carried out LCAs have also been interested in participating in new ones (Svending 2003). Ten Swedish mills have been surveyed: 6 mills once, 2 mills participated in two studies each and 3 mills participated in three studies each.

### Aims of LCA studies

Studies are done with the aim of assessing the environmental load of the product concerned (for various reasons). Most studies also have a methodological aim, either a specific one or just to develop the methodology further: in the early 1990s, calculation models and weighting systems were tested. In the mid 1990s, methodological considerations shifted towards data handling.

### Types of LCA

Three types of LCA studies have been identified at Stora Enso: Stand-alone (6), studies comparing products (3) and studies comparing processes (2), as seen in Figure 5.7. Studies done at Stora Enso are mostly stand-alone (although they assess several pulps at the same mill) or comparing processes, while studies in cooperation are stand-alone or done to compare (competing) products.



**Figure 5.7** Types of LCA at Stora Enso

### Methodological considerations

Methodological choices in LCA shifted character in 1996. Before 1996, the studies were performed as cradle-to-grave, and were done as full LCAs, including weighting. Starting in 1997, studies were done as cradle-to-gate (with one exception) and assessed as LCI or LCA with characterization but no weighting.

### Reporting

Stora Enso’s LCA reports are unique in terms of scope and layout. Most of them are presented in detailed reports, about 50 pages long. The environmental loads of the products are always presented, and recommendations are sometimes given about how to improve the environmental qualities. The possible methodological aims of the study are not further discussed, however, there is no documentation on how the LCA results have been used.

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## 6 SCA

The Hygiene Product division of SCA was already working with LCA in the beginning of 1990, in house as well as in external associations. By the mid 1990s, making LCA studies became routine for some product groups, and since early 2003, there is a corporation wide position paper on LCA.

The account of LCA at SCA starts with how its practice spread at the company followed by four discussions on four themes.

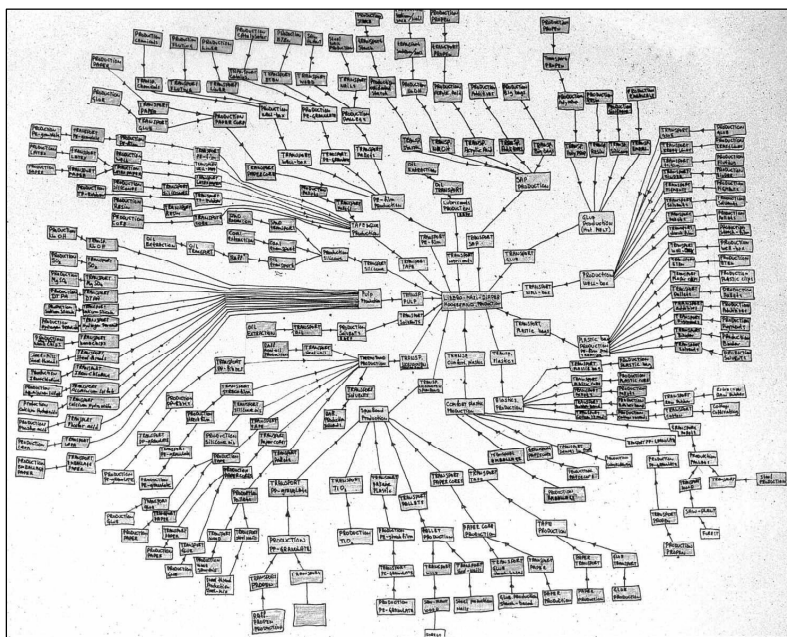
### 6.1 The LCA history of SCA

Elisabet Olofsson had heard about LCA by 1988, but it was at a conference in the US, in 1989, that she “got excited by LCA” (Olofsson 2003). She was a newly appointed environmental manager for Mölnlycke and became genuinely enthusiastic about the new methodology: *“This is exactly what we must do!”* Elisabet wanted to use LCA as a basis for organizing the environmental work, as she felt it could provide security to know both where the environmental load was the greatest, and how to work with it. On her own, as she was, at her one-person environmental department, she searched the organization for helpers who were both pragmatic and had an interest in environmental issues.

To spread the word about LCA at the company, the Swedish “LCA guru”, Gustav Sundström, was invited to give a seminar at the company. A wide range of people attended the meeting. *“You cannot even spell environment”*, exclaimed Gustav Sundström to the people at SCA, who at least until then had thought they were quite good at environmental issues (Brohammer 2003). Many people got irritated, but Göran Brohammer, a process developer working with non-woven material, became fascinated by the new method of systems analysis. Several persons in the organization thought it sounded like a powerful tool, which the company should at least investigate further.

It was decided to do a pilot project. Göran, from the Non-woven materials Department and Elisabet, with prior experience in pulp, formed a team together with a third person from the Packaging Department (who also was appointed as the project leader). Together, they represented the main aspects of diaper manufacture. They met in a conference room and started to draw a flow-chart: “Baby diaper LCA” became the starting point for their first LCA (see Figure 6.1).





**Figure 6.1.** The flow chart of the first LCA at SCA. This reproduction illustrates the complexity of their first project.

Gustav Sundström attended some of the meetings to help the project group in the beginning. Experts on different kinds of materials were also invited to assist in drawing the process tree. Many persons, including the project leader at that time, thought the LCA project was much too fuzzy and could not see its value. Göran, however, was *"fired with enthusiasm"* and thought this to be great fun. Mostly because of his curiosity, and that LCA, according to his point of view, was *"the answer to everything"*, Göran was appointed to take over the diaper project. He started to build a life cycle inventory database in Excel, which was named BASIL.

Elisabet was pleased to have someone else to do the calculations, since she preferred to do the talking and to make things happen. She pressed the managers and succeeded in getting resources to let Göran work quite undisturbed with LCA, building and refining BASIL in part time projects for 2 to 3 years, without more demand than that they should learn. Göran was a bit surprised but pleased with the new projects: *"I don't understand how I was allowed to do this"* (Brohammer 2003).

### The Diaper War

In late 1980s, the environmental movement was strong in Sweden, and there were numerous questions from customers about the environmental impact from diapers. In contrast to other countries, especially England, Sweden had a large market share of disposable diapers. With the growing environmental concern, the debate of environmental impacts from disposable versus non-disposable diapers became widespread. Mölnlycke did not want to make LCA comparisons of disposable and non-disposable diapers on their own, as they did not think this would be perceived as trustworthy. Instead, they participated in a study conducted by the Swedish Pulp and Paper Research Institute (STFI). The report was finished in 1991. Several other studies were made on this issue: in Norway 1993; Denmark 1994; and Canada 1994, (EDANA 1998). Most of the studies concluded that the most environmentally friendly choice of diaper differed

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regarding different environmental aspects and stages in the life cycle. Mölnlycke contributed data to many of these studies, as did their competitors. There was a common interest in the disposable diaper industry to support such studies: *"We were so much criticized as an industry that we had to hurry"* (Olofsson 2003). The studies did indeed lead to a more balanced picture, and quieted some unfounded allegations from the non-disposable side (Olofsson 2003). Elisabet realized that it was a problem that there were such diverse ways of doing LCAs: this caused a lack of confidence in the communication with consumers. She decided to work for a more standardized way of doing LCA.

### **Hygiene Paper (Tissue) starts to work with LCA**

The questions about disposable versus non-disposable products extended also to the Tissue part of SCA (at this point of time SCA Hygiene Paper). Here, Berit Gullbransson was the environmental manager, and she decided to let the interim project leader, Jan Bresky, start making LCAs. The purpose was to use LCA to compare disposable and non-disposable tissue products (Gullbransson 2003). Since Jan did not have any experience with LCA, he visited Gustav Sundström a couple of times to learn more before he could start making his own studies.

Tork Offset was a new SCA product for industrial cleaning, intended to replace cotton rags, and everyone at the company wanted arguments for it (Gullbransson 2003). Tissue decided to do a comparative LCA study between Tork Offset and cotton rags. In 1992, a German report had shown that the need for solvents during use was lower for Tork Offset than for cotton rags. To get more information on the textile products, the Tissue unit ordered a study on textile cleaning rags from the German Ökoinstitut in early 1993 (Pfeifer 1994; Gullbransson 2003). The study was finished in 1994, and it was used as input to the LCA study comparing SCA's Tork Offset with cotton rags. Tork Offset was compared with rags made of cotton from Israel, representing the most efficient cotton-growing country, instead of the more probably source Turkey. The weight of cloth needed to clean a printing press after 10 000 print units was used as functional unit and the smaller amount of solvent needed made Tork Offset better in the use phase of the study. Results were assessed using two weighting methods: EPS (Environmental Priority Strategies in Product Design) and Ecotoxicity. The weighting showed that Tork Offset was better in 4 out of 5 phases of the life cycle. The LCA study was presented in a public pamphlet in 1995/6 (Mölnlycke 1995 ?). The pamphlet stated that, due to the experiences gained when making the study, they had stopped using one type of rayon in the process because it was found to consume a great deal of energy during production. The pamphlet was handed over to sales people, who were happy to have more arguments for the new product. However, the data they used most from the pamphlet was not the LCA result, but that Tork Offset needed less solvent than cotton rags (shown already in the German report in 1992).

After the Tork Offset study, Berit considered it difficult to use LCA studies for external communication, mainly because it was hard to get good enough data on external products. Moreover, Jan was recruited to Stora Enso in mid 1990s. The interest in LCA in the tissue area weakened, and when they merged with the German PWA in 1995, interest shifted towards environmental management systems (EMS) (Gullbransson 2003).

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### **LCA interest grows in academia and industry**

Interest in LCA did not grow only within SCA. In early 1992, a few years after LCA was introduced at Mölnlycke, the Swedish Federation of Industries started the Product Ecology Project, which aimed to develop working models for assessments of environmental impacts throughout a product's life cycle, while also being suitable and comprehensible for company use. Mölnlycke was a member of the federation and Elisabet sent Göran to attend the meetings. Göran became a bit frustrated with the association: *"I was very naïve in my love for this tool ... but everyone wasn't as passionate as I"* (Brohammer 2003).

When the Product Ecology Project ended in about 1993, many of the members moved on to the Nordic Project on Environmentally Sound Product Development (NEP). This project also included members from the other Nordic countries. As a joint effort of the Product Ecology Project and NEP, a data format, SPINE, was developed and introduced (see Carlson and Pålsson 1998).

At this time in the early 1990s, two software programs were being developed in Sweden: LCA-iT at CIT (Chalmers Industriteknik) and EcoLab at Nordic Port. The LCA core people at Mölnlycke realized that their way of handling data in Excel was not the most appropriate. However, their own LCA software and database, BASIL, was found to be more advanced, and it was decided to continue with this system until the external software became had been developed further.

### **Involving suppliers leads to industry cooperation**

Many LCA studies at SCA Mölnlycke showed that the largest environmental load from their products was caused by the production of the raw materials (pulp and polymers). The suppliers were reluctant to deliver data, however, as they were afraid it might reveal an environmental "catastrophe". To influence the suppliers, strengthen the position of the disposable diapers, and be able to answer customers questions, Elisabet initiated a project within the industry association, European Disposables and Non-woven Association (EDANA) in 1992. This resulted in a "learning project on LCA", starting in 1993 (EDANA 1997). As part of the project, an LCA study was made on a disposable diaper, which involved 66 member companies to contribute data and co-finance the budget. The aim of the project was for industry, both producers and suppliers, to gain experience in LCA and its application. The learning project also included developing a database and software for LCA calculations, UMBERTO. Compared to other companies, SCA had come far with their LCA tool BASIL, and several of the sub models in BASIL were included in UMBERTO.

To make the EDANA project trustworthy, it was subjected to a peer review for confirmation that the LCA methodology used was up to date. The EDANA project was completed in December 1995, and presented at conferences in 1996 and 1999. An official report describing the project was printed in 1997, but actual figures were never published.

### **Adjustment of LCA-tools**

Göran continued his work, expanding the internal LCA tool BASIL with more sub models and life cycle inventory data. In the winter of 1993/94, he invited

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Gustav Sundström to overview the database; it was found to be satisfactory. In 1994, Göran published an LCA report internally, in which common results from internal LCA studies were pointed out (Brohammer 1994). At this time, Elisabet had succeeded in getting acceptance that all products should be environmentally evaluated, although routines for this were not yet formalized.

Sometime in 1993/94, managers started to ask the LCA core people for results of the LCA work (Brohammer 2003). To explain what had been accomplished, Göran made a survey of the LCAs done. He found that most of the studies were put away in a binder, and no action had been taken. One reason was that an LCA study was not made until all materials, design and suppliers had already been decided. To promote any improvements, environmental information had to be offered earlier in the product development process. The product developers also said that they wanted just one figure, not a lot of parameters. Göran realized he had to omit the details, hence he made a short version, of the now very extensive BASIL, which was called LCA-design (LCA-d). This new tool was based on the mean values of several materials and suppliers. To reduce the information to just one parameter, he constructed a weighting system, based on the environmental policy of SCA, designated the Environmental Policy Compliance Parameter (EPCP) (Brohammer 2003). He thought that a company adapted weighting system would prevent discussions of alternative weighting systems and their applicability for different needs (which was a hot issue in LCA methodology at the time). To make the product developers more aware of the environmental consequences of different design options, a recommendation was added to the LCA order form, that the product developer should suggest alternative ways of satisfying customer needs, and take into account consider the environmental impact of those alternatives.

The LCA-d software allowed the designers to put in the amount, in grams, of materials chosen and to get an indicator of the resulting environmental impact in comparison with the existing product. Hence, the tool allowed the product developer to test the outcome of different solutions at an early stage and to have an immediate indicator. The design tools were criticized by the product developers for not being realistic, as they were based on mean values of materials and did not allow any choice of supplier. Göran argued that this method was at least better than nothing (Brohammer 2003). He also designed a checklist for very early research, LCA-r (LCA research), which was something like a qualitative LCA. Hence, the demand to motivate the LCA work led to an adaptation of LCA tools within the company.

### **Unwanted eco-label gives unexpected help**

Eco-labelling of diapers attracted interest in early 1990s. Mölnlycke was a member of the Nordic Swan Committee, but not entirely pleased with the criteria chosen by the committee's panel of experts and stakeholders. The criteria included, for example, restrictions on the proportions of renewable and non-renewable material (e.g. paper and plastic). The environmental group at Mölnlycke found these criteria misleading, and that they did not encourage an environmentally friendly development of the products. This was because more fluff pulp in the diaper would mean a heavier product, yet environmentally better, according to the criteria, as it would have a larger share of pulp in relation to plastic material. The product developers also opposed being guided by these criteria. In addition to the design constraints, the label also made it hard

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to change the supplier on short notice. As a consequence, SCA decided not to label their diapers.

However, one of the private labels<sup>8</sup> supplied by SCA, wanted an environmental label of their diaper. The diaper was also manufactured in accordance to this. When the LCA was done for the diaper in 1995, it turned out that the labelled diaper (known as the Lappträsk diaper) was not environmentally superior to the unlabelled ones. This provided well-needed arguments to why SCA chose no label. Moreover, it was also a hands-on example within SCA on the usefulness of doing LCAs. Instead of a Swan or other third part label, SCA decided to put an own “LCA label” on their diaper packages.

### **Keeping industry network alive**

When the Nordic Project on Environmentally Sound Product Development (NEP) ended in 1995, participating industries wanted to continue exchanging LCA experience. They saw two ways of doing this: to form a network with companies interested or to start a competence centre to continue the work. The network Association of Product Ecologists was founded in 1995, and Göran became the chairman. About half a year after the network had started, money was allocated to start the competence centre discussed. The Centre for Environmental Assessment of Product and Material Systems (CPM) was founded in 1996.

Göran worked to keep up the Association of Product Ecologists and also to lead a project in standardizing data questionnaires among the participating companies. More and more firms did not have resources for two networks however, and ended their engagement in the organization. The Association of Product Ecologists ended in late 1997.

### **Coordinating LCA within SCA**

Within SCA, Göran felt a need to coordinate the LCA work. Although the LCA work was performed mainly by SCA Mölnlycke, other parts of the company had started to become involved with it. On request from the SCA Environmental Council, an LCA group at SCA, later called LASCA (short for Lca At SCA), was formed. The LASCA group had their first meeting in 1996 (Brohammer 1996). Other parts of the company were invited, although some divisions had a harder time finding representatives for the meetings.

The LASCA group focused mainly on two things: the work within CPM and the routines of doing LCAs within SCA. Elisabet, who wanted cooperative method of doing LCA in industry, welcomed CPM and was happy to see a forum developing shared values for different industries. For Göran, it was too academic. The cooperation with CPM was not entirely satisfactory. Yet, it was a working network, and the discussions of the LASCA group always ended with the decision to continue supporting CPM. For the routines of LCA, Göran had worked on a management system called Product Ecology Management System (PEMS). This system was presented and discussed within the LASCA group. The LASCA group also worked on a “factor book” intended to ensure that

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<sup>8</sup> Private label products are those manufactured by one actor, to be sold under the brand of another actor, e.g. when a grocery retailer wants products with their own brand.

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different divisions worked in a similar way regarding what data to use in certain applications, and how to make environmental calculations (Riise 1997).

### **1996 was a busy year**

In addition to starting the LASCA group, 1996 was a busy year in SCA regarding LCA. Hygiene Paper became a member of the Swedish standardisation body, SIS. At the environmental department, Ellen Riise was hired in February, mainly to relieve the pressure on Göran in making LCAs (Riise 2003). There was certainly a need for one more person. Although today nobody can tell how, it was then<sup>9</sup> written into the formalized product development processes that an LCA should be ordered for every product to be launched. In 1996, nineteen so called Product Ecology Comparisons and Product Ecology Analyses were made.

The LCA-d tools continued to be made for more product groups. Yet, the environmental department felt that something was still needed to get product developers to think environmentally. Elisabet went about in the organization, talking with people and pressing groups to order courses in LCA. These were held, both when a new LCA-d tool was introduced and in other circumstances.

There had long been a conviction among the LCA core people that their way of handling data in BASIL was not appropriate. In the mid 1990s, the externally developed data format SPINE “*came with its revelation*”, telling them what to do (Riise 2003). The interaction with CPM also revealed thoughts from other industries, which made it easy to decide to use SPINE for the SCA data handling. The software based on SPINE, EcoLab, was however seen as a bit clumsy. It was hard to work with the meta data, for example. Although licenses for EcoLab had already been bought by 1995 (SCA 1996), it was decided to wait for new versions of EcoLab before making the shift from BASIL to SPINE. Another reason for not changing to SPINE at that time is that they were so many LCA studies to do that there was no time to transfer all the data to a new system.

### **Competence in handling data**

Environmental management systems (EMS) began to be implemented in the mid 1990s, and dominated environmental work at some divisions of SCA (e.g. in the Tissue area). With this, a need developed for keeping track of more environmental data. From the LCA work, a lot of data was already collected, and the environmental group of SCA Mölnlycke was also experienced in handling such information. Hence, it was no major challenge to also take care of the data needed for the EMS. The environmental data was collected in what was called a “resource management system” (RMS).

### **Reorganizing divisions and LCA practitioners**

In 1998, an organizational change was implemented at SCA. The Tissue area, which had merged with the German company PWA in 1995, came back. Susan Iliefski, employed at the environmental department of Tissue, was about to recommence the LCA work (which had been put on ice since the merger with PWA) when a competitor eco-labelled a tissue product. All efforts then turned

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<sup>9</sup> Somewhere between 1996-1998

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to labelling. As Susan went on parental leave after the labelling project, the LCA work at Tissue was taken care of within the now common environmental group of Hygiene Products (directed by Berit Gullbransson). An LCA tool was also designed for tissue products.

In 1998 it was finally time to change to EcoLab, an LCA software based on the data format SPINE. A student made the first LCA study in EcoLab as her Master's Thesis, and she was later hired to transfer all the data from BASIL to SPINE. Having developed the LCA databases and design tools, Göran decided to leave the company in October 1997. Göran soon returned, however, as a consultant making LCA studies. When Göran was no longer consultant, Malin Bogeskär replaced him in 1999. She happened to know EcoLab from her Master's Thesis at Akzo Nobel.

A new practitioner, Björn Spak, was hired in late 1998, allowing Ellen to stop making LCAs and to concentrate more on methodological development, strategic LCA work and education. When Björn left the company for studies, Erik Lövgren was hired to make LCAs in 1999, and continued doing this until Björn returned in 2002. Malin was engaged as a consultant to work sporadically with LCA until 2002. In 2002, Ingela Keskitalo was also occasionally hired to make LCAs. In 2003, the group of practitioners expanded again, this time with Doris Berens-Bredahl making LCAs in Germany.

Berit made sure that environmental courses became a part of the introduction of new managers. As Tissue was a newcomer, they were prioritised for LCA information, e.g. with courses on LCAs from the research and development team. In order to encourage Tissue to start ordering LCAs, some studies were made free of charge.

The LASCA network continued to work with data quality, partly as a joint project within CPM and SSVL (Stiftelsen Skogsindustriernas Vatten- och Luftvårdsforskning, part of the Swedish pulp and paper research organisation). When the corporate-wide Environmental Management Network was introduced in 2001, they took over the issues previously dealt with by the LASCA group.

In standardisation, too, SCA engaged in LCA work, e.g. in the technical committee of LCA and environmental labelling. Together with CPM, they were also active in e.g. data documentation formats (ISO 14 048) and requirements of data quality in environmental data handling (Riise 2004).

### **Back to external communication**

Not only SCA started to implement environmental management systems, so did many of their customers, (e.g. elderly care institutions). These customers wanted to buy eco-labelled products to prove their environmental concern. In the absence of an eco-label, salespeople at SCA wanted another way to communicate environmental information. As a result, a project on EPDs (Environmental Product Declarations) for incontinence products was started in 2000, with Susan as project leader. After discussions among the core people at Hygiene Products, as well as with the sales manager and environmental coordinator concerned, it was decided to recommend EPD for all sizes and versions of a product (Riise 2003). This could be done because of the well-

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developed routines of doing LCAs. The ability to offer such refined information was also considered a possible competitive advantage.

Parallel to the EPD work on incontinence products, Elisabet initiated a new project in EDANA, with the aim of defining Product Specific Rules (PSR) for diapers (as a basis for EPD). Berit did the same for tissue products at the Nordic Tissue Association. The reason was not mainly to introduce EPD, but to secure that PSRs were not defined without letting SCA be part of it. However, the project in EDANA revealed that the industry was not too fond of using EPDs and this was a lesson transferred to the EPD project at incontinence products. The decision of whether or not to oppose the industry and introduce EPDs on their own became a task for the Incontinence Category at SCA.

### **Knowing enough to do fewer studies**

Although it is still formalized that an LCA should be ordered prior to every launch, not all of them result in a study. Experienced practitioners can often predict the outcome, and discussions are held among the LCA core people about making fewer full studies. Since 2001, some LCAs ordered have been rejected with the motivation: “*no LCA was performed due to very small changes in the product*” (Riise 2002). Instead of a full LCA, an “environmental evaluation” is made, qualitatively summarizing expected outcomes. One challenge for the future perceived by the LCA core people is to find routines for deciding on when it is of interest to do a full LCA, and when it is enough to do an environmental evaluation.

### **Consolidation of LCA work at SCA**

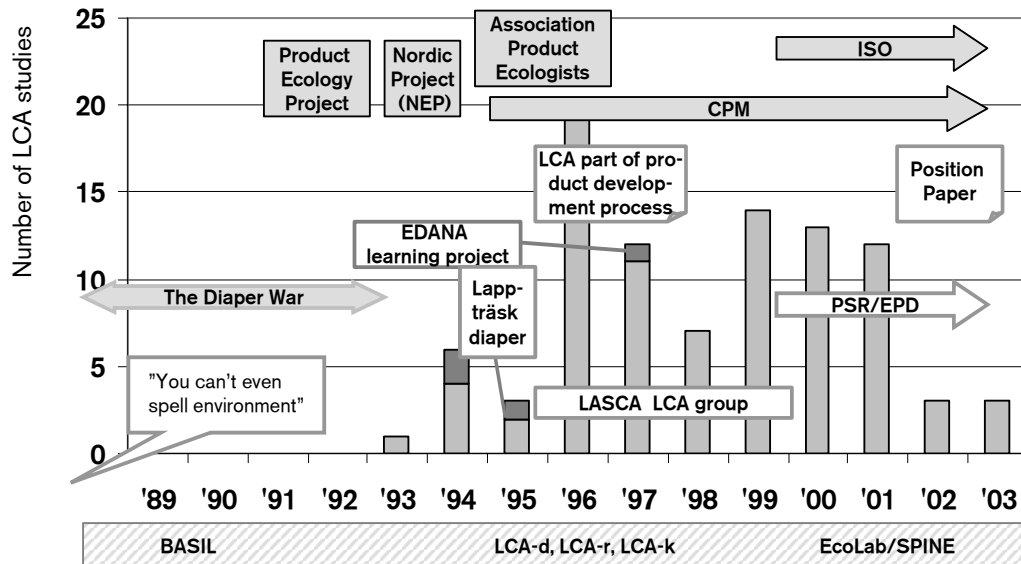
With the new millennium, ordering an LCA was written into the product development processes for tissue products on request by a project leader at the product development department who wanted instructions on when and how to consider environmental aspects. Even externally, LCA core people at SCA engaged in LCA practice. In 2002, Ellen was appointed to be the Swedish chair of the working group on standardisation of type III declarations (EPD), as well as the Swedish expert at international meetings (Riise 2004). More, when the ISO standard for LCA (ISO 14 040) recently should be revised, Ellen was appointed as Swedish expert in this work.

Discussions about life cycle thinking as related to public policy, starting in the late 1990s, (such as the EU directive on integrated product policy), made top managers at SCA more interested in LCA work. Berit took advantage of this and started a process to obtain a position paper on LCA at SCA. In August 2002, Berit invited Ellen to hold a presentation on LCA at the Environmental Council. She presented LCA as “environmental bookkeeping” and compared it to economic bookkeeping. She also explained classification and characterization. She successfully reduced many of the doubts of managers about LCA: “*All of a sudden it was not ‘magic’ anymore*”(Riise 2003). A proposal for a position paper on LCA, describing the company’s standpoint about how to work with the tool strategically and operationally was prepared by the environmental management network, and adopted by the Environmental Council in 2003 (Riise 2003). Hygiene Products was appointed as the leading



division for this work. The position paper was a welcome confirmation of the LCA work done for more than 10 years.

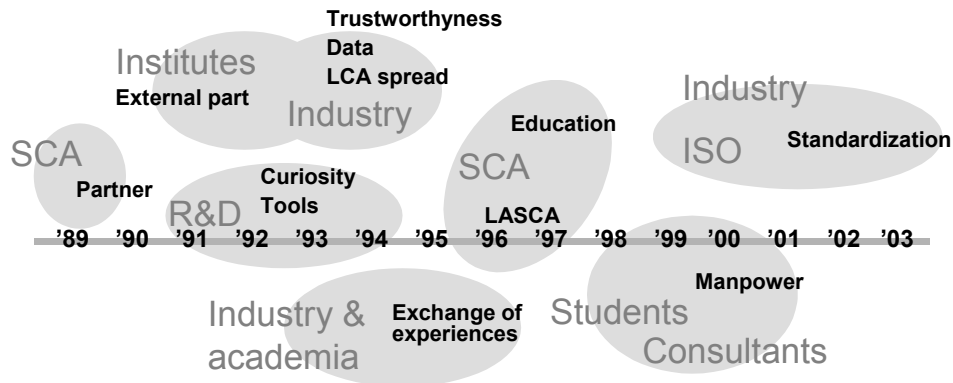
This section on the history of LCA at SCA has shown that many parallel activities of various kinds make up LCA work. Figure 6.2 presents an overview of technical, organisational and communicative projects and activities through the years.



**Figure 6.2.** Overview of LCA studies and other LCA activities at SCA. Studies in-house (light grey bars) and in collaboration (dark grey bars). The LCA tools used are shown under the diagram. Collaborative projects with industry and academia (e.g. NEP and CPM) are shown in the upper part, and some internal matters (e.g. the Lappträsk diaper and the LASCA group) in the middle. Abbreviations are listed at page ix.

## 6.2 Organization of LCA work

The LCA work at SCA has been organized through LCA core people, taking part in more or less formalized groups, with other actors when necessary, to fulfil certain needs (see Figure 6.3). These groups are not formalized organizational structures. Rather, the people in them use existing structures as their field of play. Occasionally, ad hoc groups are organized for specific purposes, such as project groups for tool development or joint studies with external parties. Discussions regarding LCA methodology and work are held informally within the group of LCA core people, or in the existing environmental network. Only lately, after 12 years of work, has a position paper been published which formally acknowledges the standing of LCA at the company.



**Figure 6.3** Main clusters of interaction (shaded ellipses), groups taking part (grey letters) and motivation for the interaction (black letters) at SCA.

The organization of LCA work started as a one-person group Elisabet. After searching the company, the group expanded to Göran, who worked part time with the issue. No "LCA group" was formally set up, but Göran remained organizationally employed as a process engineer until in mid 1990s, when he was no longer allowed to work with LCA from his former position, and moved to the Environmental Department. The LCA group had no other name than "Elisabet and Göran". Elisabet and Göran defined their own tasks, with Göran working internally with tools and databases, and Elisabet communicating inside and outside of the company. Elisabet triggered acceptance and demand for the LCA work through informal talk. As Environmental Manager, she was part of the SCA Environmental Network and used this to spread the word about LCA. Also externally, she used existing networks and organizations (for example EDANA and the Product Ecology Project).

To ease Göran's work, Ellen was employed as LCA practitioner in 1996. The demand for LCA studies grew in the late 1990s, and so did the group of people working daily with LCA at SCA, using consultants, students, and temporary employees (see Figure 6.4).



**Figure 6.4** LCA core people at SCA

The LCA core people at SCA chose their assignments on their own, either by personally initiating projects or from a demand for their work, e.g. by talking around, educating others or developing tools. Methodological issues and other LCA related discussions have continuously been held in informal meetings among the practitioners (Riise 2003). Little of the LCA work seems to be

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actively formalized in the organization. The formal routines that exist, such as the LCA study requirement in the product development processes or the position paper, were not initiated by LCA core people, but by others influenced or affected by their work. Another example of this is that the official LCA committee, the LASCA group, was not developed until in 1996, at the request of the Environmental Steering Council.

### **Designing tools and infrastructure for LCA work**

The LCA core people have worked pragmatically with tools and infrastructure for LCA, to fulfil needs perceived in the company (both those of the Environmental Department and others). For instance, the database BASIL, with associated models and calculation tools was developed by Göran primarily to be used by LCA core people, but it was later offered in versions adapted for the needs of developers.

After learning about the products, Göran soon addressed the product developers with studies comparing a new version of a product with an existing one. These studies had little potential to influence the design of the new product, however, as they could not be done before materials, suppliers etc., were already decided on. Hence, the design tools LCA-d and LCA-r (specially constructed to be used by product developers and researchers respectively<sup>10</sup>) were developed in late 1990s, one for each product group. These tools included the EPCP (Environmental Priority Compliance Parameter) weighting system that helped fulfil the demand for one single measure, while at the same time linking the product development with the environmental goals of the corporation. The tools were not used for long, however. One reason for this is said to be that it was not possible to choose a supplier, hence making it less “realistic”, another was that they were difficult to update (Riise 2003).

The core people were convinced that they needed more correct data handling than that offered in BASIL, as well as a system used by other actors than SCA. Accordingly, they decided to change LCA software from BASIL to EcoLab, using the data format SPINE. The new software was introduced slowly, when it could be done without slowing down or downgrading the work already done. Data was collected through questionnaires and updated when new studies were made, which turned out to be quite regularly as the products are continuously updated and an LCA study is done at every launch. The practice of performing calculations in EcoLab, linked to a SPINE database which is continually updating through studies made, is still used.

### **Cooperation between industry and academia**

The LCA core people at SCA use collaborative LCA work in order to give substance to arguments and gain credibility for their own issues, externally as well as internally, (e.g. they use other studies to argue against non-disposables, or use EDANA to spread LCA and EDP in industry). LCA organisations with representatives from industry and academia (e.g. NEP and CPM) have also been used, less to do LCA studies than as to gain credibility, support findings and gain confidence and confirmation of SCA’s ways of working with LCA. One

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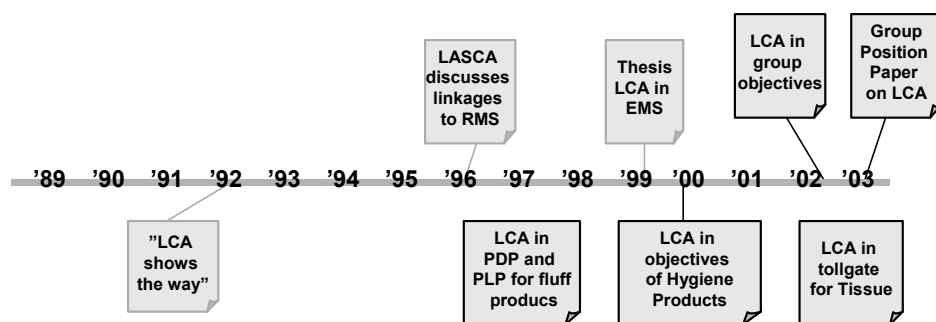
<sup>10</sup> The full LCA done by the environmental department at product launch was called LCA-k, k=consequence.

example is software for LCA studies. Membership of CPM provided both projects on data handling (in which SCA was engaged) and insights in how other companies were thinking, which gave support and security in the decision to switch from BASIL to EcoLab. Such quick and direct sharing of experiences and ideas with other companies are highly valued among the LCA practitioners at SCA. Apart from this, the work within CPM has also led to closer cooperation with academia. Chalmers is now considered a natural and active partner in LCA related work at SCA.

Another kind of collaborative effort is the standardisation of LCA and related matters, in which SCA has been engaged since the mid 1990s. After building up their own competence, they were actively involved from 1999, with representatives as Swedish expert in the international standardisation work of environmental declarations Type III and the revision of the LCA standard, for example (Riise 2004). Participation in the standardisation work is perceived by the company as important, both to provide internal security and external credibility for their LCA work.

### 6.3 LCA in corporate environmental work

Life cycle assessment is one of several tools used to help companies consider environmental issues. It was introduced early for fluff and tissue products, and ever since, LCA activities and competence at SCA have been found, mainly at the environmental competence centre of Hygiene Products. Gradually, a policy on LCA has also become an issue for the whole corporation. There is now a Position Paper on LCA that recognises the use of LCA at SCA (see Figure 6.5).



**Figure 6.5** Documents related to LCA in policy and other environmental work at SCA. Formal routines (black frame) and other documents (shaded frame).

#### LCA in corporate divisions

The Hygiene Products division of SCA is the most active in LCA, and is also pointed out in the Position Paper on LCA as the leading division in this field. In other parts of the company, LCA work has been less prominent, restricted to participating in their respective trade associations' LCA groups, covering studies done in their field of action and occasionally performing own studies. Other kinds of environmental work, such as EMS, seem to have gained more

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importance than LCA. On a corporate level, the LASCA group, and later the Environmental Network, have been the forum for LCA discussions.

At Hygiene Products, the philosophy of LCA was very early part of the environmental work. Mölnlycke more or less started their Environmental Department on the basis of the concept of LCA. As early as in 1992 the environmental policy of Mölnlycke is describes as follows: *“Life Cycle Analysis shows the way”*. Life cycle assessment is also mentioned as part of the environmental work of SCA Mölnlycke in the 1993 annual report of SCA. Since then, it has gradually become more firmly rooted as a way of handling environmental issues: formal routines for ordering an LCA in the product development process (PDP) and product launch process (PLP) were introduced some time between 1996 and 1998 (and in 2003 for tissue products), and use of LCA was expressed in the objectives of Hygiene Products in the late 1990s. With this, LCA has been used to secure and circulate the environmental work to other parts of the company.

The introduction of LCA has not been driven from the top down. Nevertheless, it has sometimes been recognized at corporate level as a tool for environmental work. The first corporate statement about LCA work is in the 1994 annual report: *“Life-cycle assessments (LCA) are used by the business groups in product and process development....”*(SCA 1995) In the first environmental report (regarding 1998), LCA is more closely connected to the business group itself: *“A major demonstration of the SCA Group’s environmental commitment is the assessment of product life cycle. Life cycle assessment (LCA) is part of the total quality chain through which SCA takes comprehensive responsibility for its products.”* (SCA 1999).

The interest in LCA in the environmental reports has varied over time. In the reports of 1998 and 1999, LCA takes up about two pages, but in 2000 and 2001, it is mentioned but not discussed. In 2002, however, the Executive Vice President and Deputy CEO Jan Åström referred to LCA in his introductory interview.

### **Life cycle thinking in environmental policy**

LCA studies have been gradually incorporated in the environmental policy and objectives, slowly spreading from Hygiene Products to corporate level. Until 2000, LCA was not directly linked to environmental policy, but only used by Hygiene Products when translating the policy to objectives and follow up (see Table 6.1).

**Table 6.1.** Environmental policy, objectives and follow up for products at Hygiene Products 2000 (SCA 2000?).

Environmental policy	Objectives	Follow-up
“When choosing raw materials, product design, packaging and distribution systems, we consider the environmental impact as well as economic and functional aspects.”	“Implement and use LCA – Life Cycle Assessment – as a decision-making tool for product design and supplier evaluation, focusing on source reduction including energy.”	“Number of LCA (LCA-k, LCA-d) LCA result compared to previous products Total number and outcome of supplier audits.”

In 2001, the corporate environmental policy was reviewed to include formulations closer to the life cycle thinking:

“SCA assesses the environmental impact of its products during the various stages of their lifespan, and includes suppliers and subcontractors in this process”.

SCA Environmental Policy 2001-2002

It has not been possible to determine whether this reformulation affected the objectives decided on in the different divisions of the company.

### LCA in environmental management systems

Hygiene Products has occasionally discussed the possibility of synchronizing LCA work with environmental management systems (EMS). When more and more sites were EMAS certified, the need for handling environmental information increased. Synchronization of the LCA work and the Resource Management System (RMS) became an issue for the LASCA group, and they also finally got a representative from RMS in the group. Yet, the question seems to have remained unanswered. In the 1998 environmental report, it is stated that there are clear opportunities for LCA to be used to highlight improvements in the EMS systems EMAS and ISO 14 001. In 1999, a Master’s Thesis student was hired to investigate how LCA could be used in EMS at a tissue mill. No report on the progress of this ambition has been located.

## 6.4 Main areas of LCA work

The main types of LCA work at SCA are product development, communication and competence building. The LCA work began mainly to build environmental competence and to some extent to communicate environmental qualities. It soon found its application in product development processes, which now has the largest share of studies made. During recent years, LCA has turned out to have possible advantages in communication through product declarations, in parallel to the competence gained for lobbying.

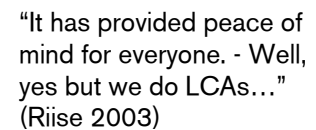
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## LCA in product development

The most common application of LCA studies at SCA is in product development, with almost all internal studies made since 1996 devoted to this field. The development of internal LCA tools has had this application in mind, and a lot of effort has been put into adapting the LCA routines to suit the product developers (adjusting tools, understandable results and reports etc.). Since 1996, all products launched for the product groups Baby, Feminine, Light Incontinence and Heavy Incontinence have been assessed, along with some studies on Away From Home and Consumer Tissue (SCA 2000?). LCA studies are said to have influenced decisions (Brohammer 2003). LCA core people claim that product developers have reported on LCA being helpful concerning choice of materials. However, concrete examples of this remain to be found. As LCAs are done relatively late in the process, they have little chance to change design decisions already made. The Environmental Departments still think it is valuable to carry out the studies however, as the product developers can learn for future projects.

## Knowledge for peace of mind and lobbying

The first LCA studies were primarily used for learning about the products studied. The knowledge provided peace of mind for the Environmental Department as it raised confidence that they were working with the right things and certainty that no unpleasant surprises were waiting. The mere fact that the company was performing LCAs also provided security in the whole organization, in that people knew that environment was being “handled”. The competence gained in handling data, building calculation models and performing LCAs was in a way a by-product, obtained “for free”. With time, this competence turned out to be useful in various applications: being able to argue against external claims (e.g. to prevent eco-labelling or defend the company against non-disposable diapers and rags), perform lobbying (e.g. being able to make sure standardization work and PSR will not counteract the work done at SCA), and being able to discuss and feel confident in IPP attempts. Gaining knowledge for security and lobbying has not been the explicit aim of many LCA studies, but a result of experience in the field.



“It has provided peace of mind for everyone. - Well, yes but we do LCAs...”  
(Riise 2003)

## External communication

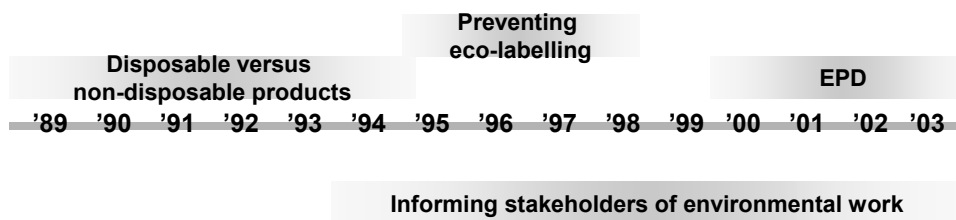
Another area where LCA has found application, although not the primary aim of the studies, is in external communication. Life cycle assessments have been used to answer consumers’ questions, as well as to gaining credibility for the environmental work. External communication is further discussed in the next section.

## 6.5 LCA and external communication

External communication of LCA at SCA includes both information to consumers and other stakeholders, and lobbying of policymakers, opinion and industrial organizations. Findings from LCA studies were used to argue against non-disposables and eco-labels, and the LCA concept as such has been used to show ambitious and systematic environmental work. Data from studies are also used as a basis for Environmental Product Declarations (EPD), Figure 6.6.

“If you want to communicate ‘product,’ there is no other tool.”  
(Gullbransson 2003)

LCA



**Figure 6.6** LCA and related topics in external communication

### Disposable versus non-disposable

In the early 1990s, Mölnlycke used LCA studies by external institutions in order to argue against non-disposable diapers or to prove that there were contradicting findings from previous studies (Mölnlycke 1993). When referring to LCA studies they were very careful to tell that the studies were made, or results confirmed, by an independent actor ((Mölnlycke 1993; SCA Hygiene Paper 1996 ?). Brochures written at this time, in the early 1990s, are positive but somewhat restrictive about the tool: LCAs are said to provide the “best accessible scientific information” (Mölnlycke 1993) and to be important for product development (Mölnlycke 1993), yet without providing any general answers and in need of further development. In the tissue area, external communication (more specifically information for promoting disposable tissue products), is said to be one of the main reasons to start building up SCA’s LCA competence and to perform LCA studies (Gullbransson 2003)<sup>11</sup>.

### Information about environmental work done

The LCA concept was often mentioned in external communication when describing the environmental work, especially regarding diaper products. During the second half of the 1990s, LCA was commonly stated as being the basis of the environmental work at Hygiene Products (Mölnlycke 1993; Mölnlycke 1994?; SCA Mölnlycke 1997). Although the judgements about LCA were a bit more cautious in the early 1990s, it is predominantly positive

<sup>11</sup> The study on “Tork Offset” actually provided marketing arguments for the products, though not because of the environmental qualities but because it showed that Tork Offset used less solvent than cotton rags.



statements about the tool from the mid 1990s; “Life cycle assessment (LCA) – the best route to environmentally adapted products” was one of the headlines in the brochure “Blöjor är inte ett hot mot miljön?!” (Diapers are not an environmental threat?!) (Mölnlycke 1994?). Although LCA in external communication was most common for diapers, and to some extent also tissue products, LCA as a basis for environmental work has also occasionally been mentioned in information regarding the business group of SCA (SCA?).

“When it comes to resistance to eco-labeling, LCA provided great security for some years” (Riise 2003)

### Preventing eco-labels

Life cycle assessment has been used to argue against eco-labels. One indicator of this can be found in the 1994 annual report: “An important tool is life cycle assessment (LCA) as a basis for environmental efforts. ... The method provides the best basis for prioritising measures in terms of the environment. Certain conclusions reached through LCA may be contrary to public opinion or environmental labelling criteria, but Mölnlycke has decided to work consistently with the method since it provides the optimal conditions for effective and long-term environmental efforts.” (SCA 1995).

After the Lapträsk diaper study in 1995, showing that this eco-labelled diaper was not environmentally better than SCA’s non-labelled ones, the wording became more straightforward. In *Libero Journalen* (an end consumer magazine about baby diapers) in 1997, SCA Mölnlycke tells that they have chosen not to label their products, but to use LCA instead (SCA Mölnlycke 1997). Similar argument for LCA instead of eco-labelling have also been found for incontinence products (SCA Mölnlycke 1997?). In the mid- or late 1990s, SCA introduced their own “LCA-label” symbolising the different steps of a life cycle for a diaper on the diaper package to explain the environmental efforts, see Figure 6.7.



Figure 6.7 “LCA-label”, used on diaper packages at SCA (SCA Mölnlycke 1997?)

### Environmental Product Declarations

Although LCA is communicated as part of the environmental work, salespeople at SCA sometimes perceive disadvantages in their products not being eco-labelled. To be able to communicate the environmental qualities of the products, the company is considering providing environmental product declarations (EPD) for some product groups. During the last few years, projects preparing for EPD have started for incontinence, diaper and tissue products. It has not yet been decided whether or not EPD will be implemented.

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### **Problems in communicating environmental issues**

The intention of the Tissue division in the early 1990s to use LCA to prove that their products were better than those by their competitors was soon abandoned. This was because it was difficult to obtain as good data for external products as for internal ones. They also felt it was hard to communicate environmental information to the consumers (Gullbransson 2003). Moreover, the rest of Hygiene Products found it hard to communicate the results of LCA studies, as their LCA studies compared new and existing products, or were done to secure the quality of the environmental work. Instead of communicating studies made, interest shifted to communicating that studies had been made.

## **6.6 LCA studies**

Since the first LCA study documented at SCA in 1993<sup>12</sup>, 94 such studies have been identified. The majority were carried out within the company (90), and only a few were made in cooperation with other industries or associations (4). The dominant part of these are “routine LCAs”, conducted as part of the product development process. These were all conducted by people employed by SCA (as employees or consultants): they compare a new version of a product with an existing one, and have the aim of assessing the environmental consequences of the upgrade. A few concern comparisons with similar product, e.g. when the product to be launched is new. Some of the studies also concern changes in packaging material or site location. The routine ones were conducted as cradle-to-grave LCAs, including characterization and sometimes also weighting. Out of 90 studies within the company, 78 (83%) are classified as routine studies<sup>13</sup>. In addition to these, 5 planned LCA studies (4 in 2001, and 1 in 2003) were not made as full LCAs, but replaced with “environmental evaluations”.

### **LCA practitioners**

Individuals employed at SCA made most of the LCAs (87 = 93%). Some studies were conducted in collaboration (4) with an external actor writing the report. A few studies (3) have been made with the aid of Master’s Thesis students, see Figure 6.8.

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<sup>12</sup> This is not the first study, however, as it is an updated version of a prior one. No earlier studies were found in the documentation, however.

<sup>13</sup> Studies called routine LCAs, i.e. product ecology analysis or product ecology discussions, are assumed to follow this pattern. However, not all studies were available.

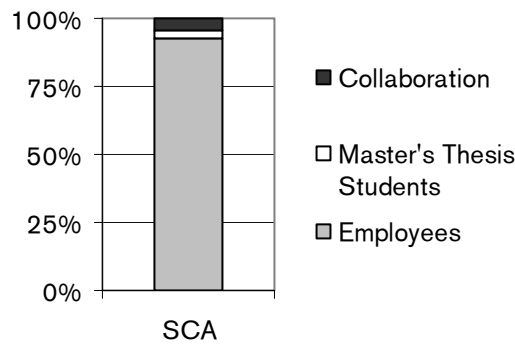


Figure 6.8. LCA practitioners at SCA

### Products studied

Products studied began with diapers, and since 1996 incontinence products and feminine products have also been subject to LCA studies. Tissue products were assessed in about 1995, and thereafter again starting in 1998. Products to be studied for internal use were first chosen by the LCA core people, but later based on requests from product developers. Some product developers were keener on ordering LCA than others, until it became compulsory according to the product development processes (Riise 2003).

### Aims of LCA studies

Most studies are made as part of the product development process, to assess the environmental consequences of the new design. Three studies have methodological aims in addition to the environmental assessment. One of these studies was the learning project in EDANA, initiated in 1993, and the other two were Master's Thesis projects (evaluating the EcoLab tool and the role of LCA in EMS).

### Types of LCA

Three types of LCA have been identified at SCA: studies comparing new and existing version of a product (78 studies), studies comparing competing products (7 studies), and stand-alone studies (3 studies), see Figure 6.9. Six studies were not possible to characterize (not in the figure).

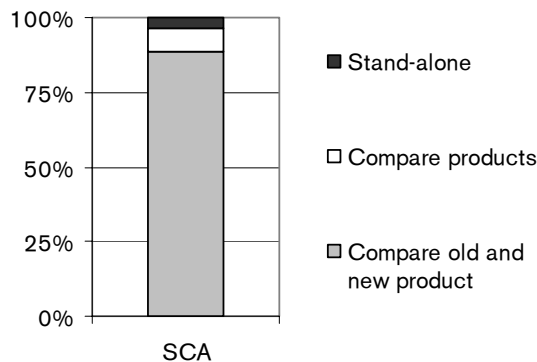


Figure 6.9 Types of LCA at SCA

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Studies comparing new and existing products are the routine LCAs. Of the seven studies comparing competing products three were made in collaboration with industry (all comparisons of disposable and non-disposable diapers), and three were carried out at SCA (these studies were otherwise conducted as routine LCAs). One stand-alone study was the EDANA learning project. The last two stand-alone studies were Master's Thesis studies, both on tissue mills.

### **Methodological considerations**

All LCA studies were made as a cradle-to-grave analysis, apart from one Master's Thesis regarding EMS in LCA that was carried out as cradle-to-gate (of a tissue mill). All studies were also made as full LCAs, including characterisation, although weighting was not always included.

### **Reporting**

Reports from routine LCAs consist of a brief summary of the assessment (5-10 pages). Since the late 1990s, explanations of procedures and methods, as well as environmental parameters used, have been lifted out from the reports and are given in separate guidelines, valid for all the studies. The report of a typical routine LCA ends with a comparison of the new and existing (reference) product as regards parameters, e.g. renewability, and impact categories (assessed as a positive or negative change in relation to the reference product). Weighting is sometimes used according to the EPCP value. Master's Thesis reports from cooperative projects have their own unique layout and are normally more extensive.

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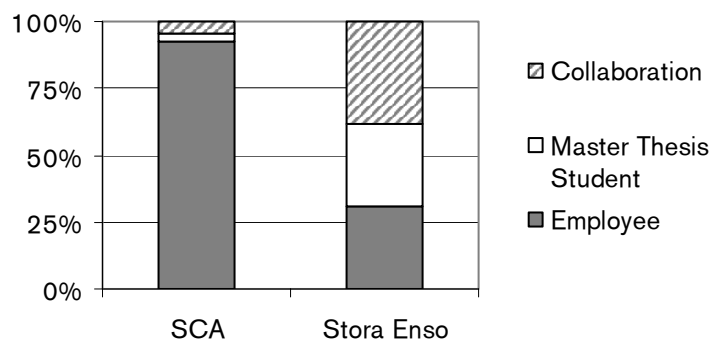
## 7 *LCA studies*

We have compared the material from Stora Enso and SCA both between the two companies and with findings from the field studies and in the literature. The following chapters (7 to 10) are dedicated to this analysis. We begin with a closer look at the LCA studies, including how practitioners, types of LCA, and methodological considerations are distributed in time and between the companies. The two companies, although they belong to the same sector, differ in types of LCA used. Also, the locations of their most dominant environmental impacts differ (inside or outside their own sites). The analysis show that the type of LCA chosen seems to relate to its intended use, but also to who is conducting or influencing the study.

### 7.1 LCA practitioners

The practitioners of LCA differ in time and between Stora Enso and SCA. At SCA, studies are normally made in house by employees, or with the aid of one of two consultants (both with very good knowledge of the routines of the company). Occasionally, external partners or Master's Thesis students have conducted the studies. Such studies are spread over time, and have taken place about every second year.

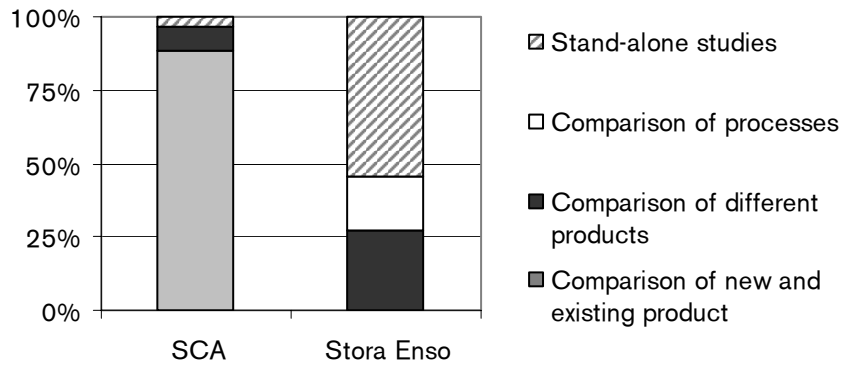
At Stora Enso, LCA practitioners have varied over time. Employees made the studies in 1993 and 2003. All other studies have been carried out in collaboration with other parties or by Master's Thesis students; most collaborative studies were made in the mid 1990s, and studies with the aid of Master's Thesis students were made in the late 1990s. Consultants have sometimes been used for collaborative studies, but not for studies in house. Figure 7.1 shows LCA practitioners at the two companies.



**Figure 7.1** Shares of different LCA practitioners at SCA and Stora Enso 1993 – 2003.

## 7.2 Type and application

We found four different types of LCA studies at Stora Enso and SCA: stand-alone, comparison of different (competing) products, comparison of different processes and comparison of new and existing version of the same product (see Figure 7.2).



**Figure 7.2** Types of LCA at SCA and Stora Enso 1993 – 2003.

A comparison of type of study and in what situations they were made shows that different types of studies were undertaken in different situations, as summarized in Table 7.1.

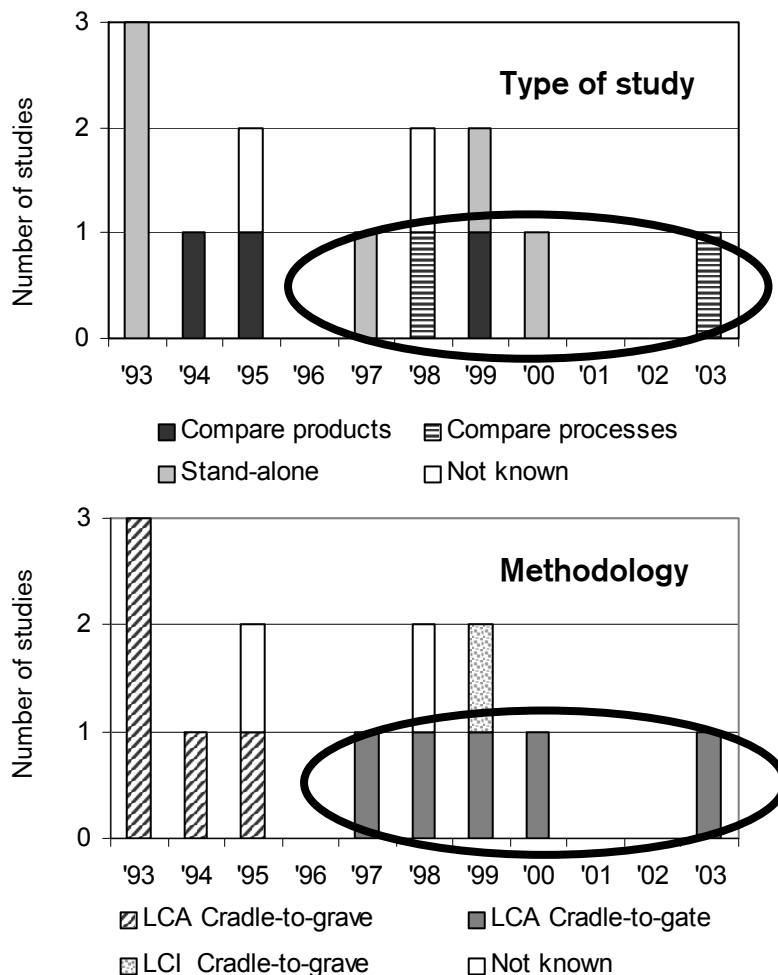
**Table 7.1** Type and use of LCA.

Type of LCA	Use
Compare different products	Used by both companies but almost always as <i>collaborative studies</i> with other companies
Compare new and existing product	The most common LCA at SCA, used for <i>internal studies</i> in product development
Compare processes	Occasionally used at Stora Enso in <i>internal studies</i>
Stand-alone	Used by both companies for <i>internal studies</i> or <i>learning projects</i>

As seen in the table, studies that compare new and existing products or processes are used internally, while comparisons of different *competing* products are used in collaborative studies. These include other companies and are authored by an external party.

### 7.3 Factors governing methodological choices

It has been argued in previous research that methodological choices regarding types of LCA depend on the aim of the study (e.g. Tillman 2000). No such relation was obvious in this project. Studies carried out at Stora Enso indicate that methodological choices depend on who is performing the study. This is more difficult to analyse at SCA, as the majority of studies are made in the very same way. With a few exceptions, SCA conduct cradle-to-gate LCAs while Stora Enso started out making full cradle-to-grave LCAs but changed to cradle-to-gate LCIs, or LCAs with weighing excluded in the mid 1990s. This shift at Stora Enso corresponds to the time at which new people began influence the LCA practice (new LCA practitioner and new environmental manager). Although the methodology chosen was changed, type of study still varied, see Figure 7.3.



**Figure 7.3** LCA studies at Stora Enso 1993 – 2003. The various types of LCA studies were spread over the whole period but preferred LCA methodology changed in 1996.

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## 7.4 LCA results and their dissemination

At SCA, results of LCA studies are reported as a positive or negative change from the existing to the new version of the product. Changes are assessed in different impact categories, and possibly in EPCP value. Reasons for the result are often mentioned, for example material selection or changes in product weight. The reports do not state which processes or materials are the main contributors to the environmental load. However, a general conclusion drawn early by LCA practitioners (based on studies of diapers and feminine towels) was that the main environmental load did not occur at SCA's own sites, but at the sites for production of the raw material.

At Stora Enso, internal LCAs assessing the environmental impacts of certain products often include a dominance analysis of the results. One common result is that the mill contributes most to the environmental impact (Svending 1997; Bäckström 1998; Oldberg 1999). Steam production gives high contributions to emissions to air while wastewater at the pulp production plant contributes the most to emissions to water. It is interesting to note that forestry is often considered to have only a modest impact compared to 'pulp production (Svending 1997; Ågren and Hallberg 2000). Forestry is an area much emphasised when communicating environmental work externally and Stora Enso has engaged in several projects on how to evaluate land use in LCA (Swan 1998; Swan 1999).

During recent years, SCA have started to generate lists of all LCAs they have carried out (from 1999), their outcomes (positive or negative) and reasons for the results. These lists seem, however, to be for internal use only by the Environmental Department. Apart from this, very little has been found on evaluation, follow up or lessons learned from LCA studies in the two companies.

Practitioners at both companies have learned about the environmental impacts and contributions from different steps in the life cycle by carrying out LCA studies, but this knowledge is not always spread in the organisation. At SCA, the practitioners nowadays often know the result before conducting the study. The LCA results for the product considered are presented in a way as to be easily understandable and relevant to the product developer in that project. It does not seem, however, that the built up competence from all studies is collected and transferred outside the Environmental Department. At Stora Enso, LCA results are, at least in recent years, discussed in the Environmental Management Network. Life cycle assessment is said to be one of the inputs when deciding on investments and at the mills, although it is not clear how and to what extent this influences decisions.



## 8 Differences in LCA practice

When working with the material collected, characteristics of the LCA practice at each company were identified and listed. Some of these characteristics are shown in Table 8.1. It soon became clear that the companies not only varied in terms of LCA studies, but also in other areas linked to the LCA practice. These differences are further explained and discussed in this Chapter.

**Table 8.1** Examples of identified characteristics of LCA practice at SCA and Stora Enso

	<b>SCA</b>	<b>Stora Enso</b>
<b>Choice of product to study</b>	Systematically by product group Formalised routines for some products before every launch	Not systematised By request from (more or less active) mills
<b>Data</b>	Own database updated continuously (in parallel to studies done)	Own database No continuous update on supplier data
<b>LCA software</b>	BASIL (Excel) Own design tools for certain product groups EcoLab	STORA-model (Excel) EcoLab, KCL (Finland) and Excel
<b>External communication</b>	LCA often highlighted as part of the environmental work (at Hygiene Products)	Emphasis on holistic view but not specifically LCA
<b>Own versus collaborative studies</b>	High share of own studies	Many studies in collaboration
<b>Environmental work</b>	LCA was a basic concept when the Environmental Department at Mölnlycke started their work	Yet another way of working with environmental issues
<b>Top management interaction</b>	Not driven by top management, but they sometimes use LCA as an example of environmental work	Not driven by top management, but holistic view is much emphasised
<b>Placement of LCA units in the organization</b>	At the different divisions, mainly Environmental Department at Hygiene Products	At the corporate support function Stora Enso Environment
<b>Weighting</b>	Started with no weighting, constructed own system later	Started with EPS, later preferred not using weighting methods
<b>Cooperation with industry and academia</b>	Legitimacy to knowledge gained Credibility to data and claims Active in influencing standards	Carry out and support further research Find methodological consensus Being trustworthy and an attractive partner

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## 8.1 Two approaches to LCA

Stora Enso and SCA both belong to the forest products industry, they were both early in adopting LCA and started out at about the same time using it as a tool for environmental assessment. Yet, the way in which they work and talk about LCA varies. Looking beyond the details, these ways of working with LCA seem connected to the two companies having different approaches to the concept.

### **Scientific approach at Stora Enso**

The work with LCA at Stora Enso is characterised by a scientific approach. Life cycle assessment is mainly seen as a *calculation tool* that should be as correct and objective as possible. As a result, weighting is not used, as it is perceived as not yet scientifically defined and objective. There are no routine ways of making an LCA. Moreover, studies made not only have a practical aim but also aim at developing the LCA methodology. Stora Enso also supports and contributes to further academic research on LCA, e.g. by supporting an industrial doctoral student.

Methodological discussions are held in broad groups within the company (e.g. at “LCA seminars”) as well as in cooperation with other parties. When the applicability of different weighting methods was questioned, Stora Enso engaged in further methodological development at the same time as they stopped using weighting in their own studies. When communicating internally, present and previous practitioners are restrictive about LCA, often highlighting the limitations of the tool.

Although restrictive about LCA as a calculation tool, Stora Enso works so to speak in the life cycle: meaning, Stora Enso works actively pursuing environmental issues with suppliers and consumers. Examples of activities they engage in are joint LCA projects and exchange of LCI data. Stora Enso often refers to such collaborative efforts with external parties as part of their own LCA work. The practitioners are restrictive about communicating data but think that the extended knowledge gained from LCA work has contributed to mediating a more balanced picture of the environmental impacts from their products.

### **Pragmatic approach at SCA**

At SCA, life cycle assessment is treated in a pragmatic way. Tools were developed early, using estimated values when data was not available. The models were refined step by step, and methodological choices were decided on by small groups of LCA practitioners. Several internal LCA tools were also developed, specifically designed for certain purposes and users outside the Environmental Department. More, methodology was adjusted to fit other processes or strategies in the company. When the applicability of different weighting methods was questioned, SCA created their own weighting system; the EPCP value based on the corporate environmental policy.

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Practitioners at SCA preferred to engage in practical efforts in industrial or academic associations, e.g. on data handling and data formats. Over the years, LCA became formalized into the routines of other groups at the company (product developers) apart from the Environmental Department.

The LCA core people are devoted to the concept, and “mission” the word of LCA throughout the organization. They are positive to LCA and have presentations and courses about it, mainly internally but also externally. The core people initiate activities and run campaigns in house, as well as working actively to promote LCA in the industry. The work with LCA is concentrated to a limited part of the company (mainly at SCA Hygiene Products). Focus is on working with product development, not directly on influencing the supply chain.

### **Antagonisms**

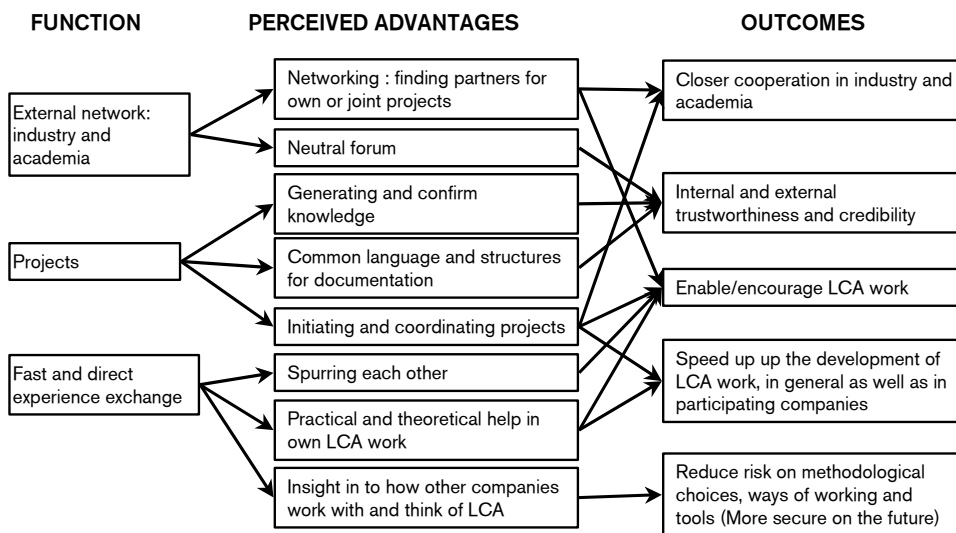
Given the two approaches to LCA work, the areas of “conflict” regarding LCA activities at Stora Enso and SCA also differ. At Stora Enso the friction is *between the tool of LCA and the philosophy of life cycle thinking*. Top management emphasise a holistic view (in external communication). The term LCA, however, upsets feelings in house. This could possibly stem from unfulfilled expectations about LCA being objective and scientific, and perceptions (and fear) of uneven treatments regarding e.g. simplifications of land use, competing materials and LCA being used to lobby for legislation. Nevertheless, LCA methodology was useful, e.g. in assessments of transports and CO<sub>2</sub>. These calculations gained acceptance, though they were used under other names than LCA (i.e. transport chain assessment and environmental calculations).

At SCA, the friction lies *between the people who are devoted to LCA and those who are not*. The already devoted LCA core people (mainly at SCA Hygiene) discuss methodology as well as pros and cons in different applications. Outside this group, they act as eager advocates of the concept and work actively to spread the word about LCA internally and externally. Internally, courses are held, specifically designed for certain target groups such as product developers and newly appointed managers. Externally, LCA work is initiated and encouraged in trade associations, e.g. EDANA. This leads to LCA receiving more attention and importance, both in industry and at SCA. Life cycle assessment core people also seek confirmation of their work by promoting and assisting the formulation of a corporate position paper on LCA.

## **8.2 Cooperation with industry and academia**

Collaboration has proven to be important for the LCA work at both Stora Enso and SCA, although the characteristics of such cooperation differ between the companies. Stora Enso expresses an active way of taking part in collaborative projects, and also internalise such projects in their own LCA work; SCA views themselves more as a data supplier and support in joint studies.

Cooperation with industry and academia take place in different groupings: within a specific trade association such as CEPI or EDANA, or in projects engaging industries and academia such as the Product Ecology Project and NEP. Work within industrial associations and projects between industry and academia in the 1990s are referred to as single studies or projects. The ongoing CPM however, is regarded as an independent, neutral actor, providing a broader and more long-term forum for LCA related work. The forum for discussions, exchange of experience and support that it provides is highly valued by the companies. Functions, perceived advantages and positive outcomes of CPM expressed by the companies are summarized in Figure 8.1.



**Figure 8.1** The role of CPM expressed by Stora Enso and SCA.

### Different approaches but similar outcomes

Just as Stora Enso and SCA vary in their approaches to LCA, they also work and benefit from collaboration in different ways. Stora Enso takes part in collaborative studies in industry or in joint projects with suppliers and customers. These studies often aim at a consensus on methodology or to collaborate on data handling and collection. Communities of LCA practitioners are also used as a breeding ground for finding partners, projects and knowledge. People at SCA initiate and drive collaboration in industry, as they perceive that this makes them more trustworthy externally than if they acted alone. They also want to spread the LCA method in industry and make sure methodological agreements will be made in line with their own work. They use the wider LCA community to confirm their own work and to reduce the risks by knowing (and influencing) that other companies work in the same way. Table 8.2 summarises the main focus and advantages of engaging in joint forums of industry and academia for the two companies.

**Table 8.2** Main focus and perceived advantages of engaging in joint forum of industry and academia for Stora Enso and SCA

<b>Stora Enso: Breeding ground for cooperation, own LCA work and knowledge</b>
<ul style="list-style-type: none"> <li>▪ Participate and coordinate studies</li> <li>▪ Methodology development</li> <li>▪ Finding partners</li> <li>▪ Neutral forum for research</li> <li>▪ Generator for knowledge</li> <li>▪ Encourage and spur LCA practitioners</li> </ul>
<b>SCA: Gain trustworthiness, confirmation and reduce risks</b>
<ul style="list-style-type: none"> <li>▪ Security about what is the right way to do things</li> <li>▪ Support and confirm LCA practitioners in their work</li> <li>▪ Legitimise conclusions and statements</li> <li>▪ Security in knowing how other companies think</li> <li>▪ Academia as a natural partner</li> <li>▪ Being credible</li> </ul>

Although they have different approaches, in a broad sense both companies benefit from cooperation in terms of increased trustworthiness and credibility. Addressed stakeholders are slightly different, however. Stora Enso becomes a credible partner through joint projects with suppliers and customers, while at SCA, the mere legitimacy of studies carried out by a “third party” is used to support and to gain credibility for their claims, and to build consumer trust.

### 8.3 Explaining differences in LCA approach

Several researchers of LCA practice have observed that companies work differently with LCA. There are several explanations for this, often based on structural factors such as:

- 1 Position of the company studied in the supply chain (Berkhout and Howes 1997),
- 2 Country in which the company acts (Frankl and Rubik 2000), and
- 3 Size of the company (Frankl and Rubik 2000).

Smith et al. (1998, in Frankl and Rubik 2000) and well as Berkhout and Howes (1997) argues that the nature of LCA practice in industry is to a large extent determined by the companies’ position in the supply chain. Basically, they distinguish between upstream commodity producing sectors with competitive benefits at sector level, and downstream assemblers of final products having individual competitive benefits. There are dissimilarities in the products offered, as well as customers addressed. Stora Enso has mainly worked with LCA on pulp and cardboard products sold business to business while SCA has done most of their LCA work on Hygiene Products aimed at a consumer market. Yet, both companies belong to the forest products industry, have some product areas in common (e.g. packaging) and are assumed to face competitive benefits on both the sectoral and the individual level. The two firms have also engaged in both types of approaches suggested by Berkhout and Howes; externally oriented,

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large-scale and collaborative LCI studies, and more internally oriented studies on a smaller scale considering the total life cycle.

Our study is a dynamic one and is as such, as Frankl and Rubik point out, difficult to use to verify Berkhout and Howes' conclusions, which are based on a static research approach. Looking more closely at the studies done at Stora Enso and SCA however, it seems possible that the different approaches are linked to the question of how *the study* aims to be used: at a sectoral or individual level. It therefore seems as if the nature of the competition may influence the set up of single projects rather than determine the overall approach to LCA on a company level.

The other two factors: country in which the company acts and size, are not relevant to explaining the differences between Stora Enso and SCA, as they do not differ significantly in these senses, given the set up of this study.

### **Other factors determining a company's approach**

A structural condition less discussed in theory than the life cycle position of the company is the *life cycle position of the main environmental load*. The two companies themselves stress this as a possible explanation for why their approaches to LCA differ. Life cycle assessment studies have shown that the environmental load is highest in Stora Enso's own operations. At SCA, this varies with product groups: for diapers, the raw materials contribute the most to the environmental impact while the environmental impact from tissue products are more similar to those of Stora Enso. Both diapers and tissue products belong to the Hygiene Product division of SCA however, which, by now, work similarly with LCA. This observation indicates that the position of the main environmental load does not determine the practice or approach to LCA, although it may influence the environmental measures taken, e.g. if they are site-specific or product oriented. This, in turn, may influence how easily LCA is introduced and motivated in the environmental work.

Apart from the structural conditions discussed above, the field studies also point out more dynamic or occasional factors that can influence LCA practice. In Chapter 7, we concluded that methodological choices depended both on the aim of the study and on the people. In a similar way, the general approach to LCA seems to vary with the core people. Their point of view may be influenced by structural conditions such as types of products or customers, and by personal characteristics. The different approaches to methodological choices mentioned and the handling of the weighting controversy (see 7.1.) may be a result of different personal interests among the practitioners. Another example from the field studies is the location of the LCA "entrepreneur". The people that became interested in LCA at SCA worked in the Hygiene division, which is also where LCA is most used today. At Stora Enso, LCA is organized on corporate support level and at certain mills, which is also in line with where the people interested in LCA worked.

Stora Enso and SCA have had somewhat different experiences with LCA. In both companies their respective products were compared with competing alternative products in early LCA studies, e.g. disposable and non-disposable diapers or plastic versus paper. Stora Enso has experience of representing the "bad" alternative, feeling unfairly treated in terms of the methodological

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choices. SCA, on the other hand, gained, mainly by chance, very concrete benefits from LCA when they could use it to argue against eco-labeling, which was also an important issue for the marketing and purchasing departments. Such differences in experience are assumed to have influenced perceptions of LCA as positive or negative at the companies, and also to have an impact on the approach to the concept. However, perceptions of LCA are not distinguished from the characteristics of the entrepreneurs. They could work more or less actively to use and promote LCA as a way of gaining advantages at a corporate level. SCA used the various results presented in external studies of disposables versus non-disposables to communicate externally that disposable and non-disposable diapers differ in a number of senses and that SCA was serious and systematic in their environmental ambitions through working with LCA.

The analysis above shows that common structural explanations of variations in LCA practice do not suffice to fully explain why the two companies behave differently regarding LCA practices. Instead, it seems that a number of components influence each companies approach, including the characteristics of the LCA entrepreneur and historical experience. These aspects are of importance to how companies introduce the new concept. Prior research has shown that companies act differently, e.g. regarding how they apply LCA studies, depending on how far they have come towards the institutionalisation of LCA (Frankl and Rubik 2000). Frankl and Rubik found that in early phases of institutionalisation, the focus is on learning, with a later shift from learning to doing, e.g. when LCA results are transferred into action. Institutionalisation theory might be useful in explaining how well implemented the LCA concept is at a company, or how it has developed over time, and could be valuable in working more actively to incorporate the concept in company practice. This is discussed further in Chapter 9.

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## 9 *Ten years of LCA activities*

None of the two companies studied have shown an explicit strategy for their LCA work from top management. Yet, LCA has survived more than ten years at each company. How is this possible? And what has come of the LCA work?

### 9.1 Gradually evolving benefits

At both Stora Enso and SCA, LCA work seems to have emerged bottom-up, driven by the curiosity, conviction and intermediate goals of a few enthusiastic people (often LCA practitioners) rather than by a clear and conscious strategy from top management. Baumann (1998) also found such individuals in her study, and called them the “LCA entrepreneurs”.

Although strategies from top management were weak, the LCA entrepreneurs have had some direction in their work. At SCA, there were core people aiming at a uniform and widely spread method, and at both companies they were curious and eager to build up (internal) competence in this new field. Early expectations from practitioners and other people were, however, sometimes weakly formulated, and sometimes too high. Competence was built up, but without any clear, hands-on application in mind, LCA did not turn out to be an objective tool and early intentions (e.g. market claims in the tissue area) did not turn out to be possible. Instead, Stora Enso and SCA seem to have experienced most of the direct and obvious benefits *after* studies had been carried out, e.g. unintentional (but nonetheless valuable) spin-off effects such as “defence” against eco-labelling of diapers and competence in handling environmental data at SCA, or as a way of answering questions about ECF/TCF at Stora Enso. These areas of “application” have provided support to motivate a continued engagement in LCA activities.

Heiskanen (2002) recognizes that many companies lack a systematic use of LCA for a clearly defined purpose, and states that “it seems that many companies are ‘dabbling’ with LCA”. This was also true for Stora Enso and SCA in the early years of implementation. Over the years, LCA found applications in product development at SCA, and to some extent in more general environmental assessments at Stora Enso.

Although the benefits of formal strategic planning has been emphasised (e.g. Kotler and Armstrong 1994), it may have been fortune that there were no clear purposes of LCA introduction expressed at Stora Enso and SCA, as many of the benefits came gradually. There is a risk associated with having too high expectations of a tool. Frankl and Rubik (2000) found that in companies where marketing was the main driver for LCA, when there were problems in this field, the company reacted by either shifting to other uses of LCA (mostly internal) or phasing out LCA activities. This is also what happened to the Tissue division at



SCA. They had early expectations of LCA in marketing, and when they couldn't use it that way they put LCA use on ice. Later, after merging with the Fluff division, they started to use LCA again for internal purposes.

Gradually, people working with LCA start to find more strategic applications for the competence gained by doing LCA studies. SCA works actively to influence standards related to LCA to fit their needs and routines and hence to be better off than companies with less competence in LCA. Stora Enso uses LCA methodology to calculate CO<sub>2</sub> prior to emission trading. Recently, people other than LCA practitioners have started to ask for LCA, such as the market communication department at Stora Enso.

Table 9.1 shows examples found in this evaluation of positive outcomes of the companies' work with LCA activities, directly or indirectly expressed by LCA core people. The list shows that many of the outcomes concern the interaction with external stakeholders, both in terms of being secure and confident and in terms of communication.

**Table 9.1** Positive outcomes of LCA activities apart from deeper knowledge of the environmental impact

SCA	Stora Enso
Good night's sleep	Being a good and trustworthy partner
Answer to non-disposables	Providing credible data
Arguments not to eco-label	Answering questions (e.g. ECF/TCF)
Assure that environmental issues are handled within the company	Competence and tool for CO <sub>2</sub> calculations
Assure that environmental issues are handled systematically	Supporting EMS
Knowledge for lobbying	More nuances in information (in external communication)
Prepared for future (e.g. EPD and IPP)	
Competence in data handling	

## 9.2 The role of LCA from a company perspective

Above, we have mainly dealt with the LCA core people and examples of benefits from their work. In this section we widen the scope and discuss rationales for LCA work from a company perspective.

### Rationales for LCA work

Engagement in environmental activities at corporate level may have different explanations. A traditional rationale for engaging in environmental work is risk reduction (Kolk 2000), for example by identifying environmental hazards and taking measures to decrease their negative impacts. Companies may also engage environmentally to gain legitimacy. The stakeholders need to trust the company to support its operations. Grolin (1998) argues that businesses increasingly need to seek legitimacy directly from the public.

Stora Enso and SCA have motivated their work with LCA from a company perspective in both of these ways, although with somewhat different focus. At Stora Enso, LCA is seen as a way of knowing about the products and feeling safe about that, if necessary, they can deliver credible and consistent data. This is part of the strategy of being a trustworthy partner, and seems to have been the main way in which LCA work (including methodological contributions) has been motivated from a company perspective. To some extent, LCA was also used in the early years to make sure no environmental hazards were included in their processes (reducing risks).

At SCA, life cycle assessment was early used risk reduction. Life cycle assessments were carried out to assure that environmental issues were handled and no environmental surprises were waiting. The war between disposable and non-disposable diapers also emphasised end of life treatment. LCA studies, from cradle to grave, helped out to provide both peace of mind and answers to the companies promoting non-disposable products. Life cycle assessment was used in external communication, mainly to mediate to end consumers that environmental precautions (in general) are taken. This was an advantageous spin-off effect that was much used in the mid 1990s. The way in which LCA is motivated from a company perspective, however, seems to be more associated with getting “a good night’s sleep”. Risk is also reduced by actively promoting LCA in the trade associations, and working actively to influence standardization work. By such actions, they make sure their way of handling LCA remains the “right” way.

A general conclusion from the above, (apart from that both rationales can be used in LCA work and that the two companies use both so, with different focus), is that the type of LCA activity relates differently to the different rationales (see Figure 9.1).

RISK	TRUST
LCA studies	Communication

**Figure 9.1** Type of LCA activity relates differently to the rationales of risk and trust.

LCA studies contribute to risk reduction (and the scope of the study may relate to how far the company perceives that the risks affect them). Communication of LCA, in turn, is used to increase trust, as communication about both environmental care in general and data provision gives increased legitimacy and credibility.

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## 9.3 Integration of LCA

Life cycle assessment is one of several ways of structuring environmental work at a company. It is often considered a tool for environmental assessment of products, but the philosophy of life cycle thinking can also be used in a broader sense – both approaches are product oriented. Life cycle assessment, it has been argued, is useful in a number of applications such as product and process development, purchasing, business policy etc. Studies addressing these areas are, however, not the same as actually making LCA an integral part of and support to these functions. In this section we examine how LCA relates to the environmental work in general and to other functions of the companies studied.

### **LCA as part of environmental work**

Before going into detail on how LCA is spread in the organisations, we begin by examining how it relates to the environmental work of the companies. Today, LCA is a recognized, formalised and ongoing part of the environmental work at SCA Hygiene Products, with less systematic activities in other parts of the organisation. At Stora Enso, LCA is used occasionally at different mills. It is more often highlighted in external communication as part of the environmental work at SCA than at Stora Enso.

Although recognized in both companies, it seems that LCA has not yet found its position in the environmental work. At Stora Enso, an LCA is a separate investigation that may be added on top of other environmental work. The environmental department of SCA Hygiene Products works more systematically with LCA, with formal routines in product development. Yet, this does not necessarily mean it influences decisions, and it says nothing about how it is related to other environmental efforts.

History is one factor possibly influencing the differences in LCA work at the two companies. When LCA was introduced at Stora Enso, they already had a long tradition of environmental work, focusing on sites rather than products. SCA Hygiene Products (former Mölnlycke), on the other hand, started to build up their environmental department in 1980s, with LCA and its product orientation being one of the main concepts from which the environmental work was organized.

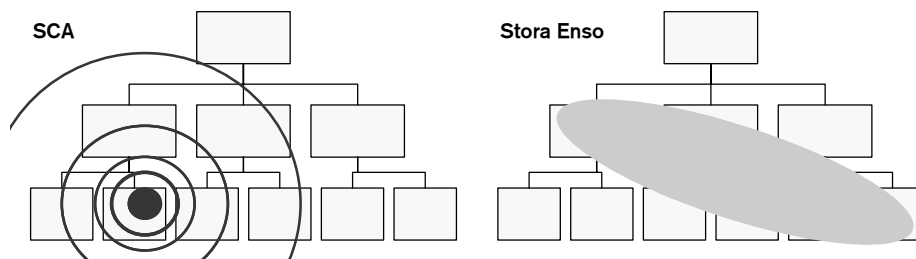
Another interesting issue is the role or function of LCA in environmental work. It has been argued by the companies that LCA is used for examples in decision making or in identifying environmental aspects in EMS. Yet hands-on examples of such use were hard to find. One reason for this may be that lessons learned in one study are used in forthcoming considerations. At SCA, knowledge from LCA studies done for one product is said not to change the decisions already made on that product, but to provide insight to be used in future development projects. At Stora Enso, LCA results could be part of, but not the single reason for, decisions on future measures and investments. Prior research on the use of LCA results has shown that there is generally high acceptance for the integration of LCA results with long-term planning. In the short term, LCAs are

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translated into action only if they indicate win-win situations (Frankl and Rubik 2000). This seems to apply to both companies, although rather in terms of long term *learning* than long term planning (which however may lead to implications on the latter). The magnitude and importance of this is not clear from the field studies. How LCA results are actually used is an interesting area for further study. Such studies need to address actual and potential users of LCA results.

### LCA integration in other parts of the company

LCA activities are distributed differently in the two companies: intensely and in concentrated form at SCA and more broadly but also less intensely at Stora Enso, see Figure 9.3.



**Figure 9.3** Schematic illustration of the distribution of LCA activities in SCA and Stora Enso

The distribution of LCA activities seems to be related to where the early entrepreneurs and core people of LCA worked. At Stora Enso, they worked centrally, in a support division in the organization (first as part of a technological, then a environmental support division). At SCA, the LCA entrepreneurs were associated with the environmental competence centre at Hygiene Products.

At SCA, LCA as a concept is spread to an increasing number of people at the company and recognized through educational efforts and internal lobbying. At Stora Enso, LCA work is less intense, but also more widely spread in the organization, including the Stora Enso Environment Department, Pulp Competence Centre and specific mills and business areas.

In this study LCA related work has been found in activities at several departments of both companies, listed in Tables 9.2 and 9.3.

**Table 9.2** Departments involved and activities done related to LCA at Stora Enso

<b>Department</b>	<b>Activities</b>
<b>Corporate Environmental Department</b>	Develop tools in-house (e.g. the STORA model, data handling at Skoghall) Buy tool (EcoLab) Contribute to methodological development (e.g. land use, data handling) Make LCA (Own studies, in collaboration, M. Th. Students) Monitor Stora Enso's interest in Industry associations Participate in industrial and academic associations Participate in standardization work Calculations on CO <sub>2</sub>
<b>Mills</b>	Order LCA Participate in, or provide data to, joint LCA studies Consider LCA before prioritisation of work <ul style="list-style-type: none"> <li>▪ Change minor details</li> <li>▪ Before major investments</li> <li>▪ Environmental aspects, EMAS</li> </ul> Provide data and information to customers
<b>Sales and marketing</b>	Mediate questions and information demand from customers to the Environmental Department Answer questions and give information to customers
<b>Pulp Competence Centre</b>	Mediate questions and information demand from researchers or mills to the Environmental Department Order LCA
<b>Divisions</b>	Monitor Stora Enso's interest for certain products/materials (e.g. packaging)
<b>Environmental communications</b>	Ask for and create information based on LCA results to hand over to sales and marketing
<b>Purchasing</b>	Administrate supplier evaluation, including question about willingness to provide LCI data
<b>Management</b>	Decide on Environmental/Sustainability Policy Comment in external public communication (e.g. environmental reports) Decide on resources for LCA work

**Table 9.3** Departments involved and activities done related to LCA at SCA

Department	Activities
<b>Environmental Competence Centre (Hygiene Products)</b>	Develop tools in house (BASIL, LCA-d, k, r) Buy tool (EcoLab) Update database Make LCA (Own studies, in collaboration, by aid of Master's Thesis Students) Monitor SCA's interest related to LCA Promote LCA internally and externally Participate in industrial and academic associations Participate in standardization work
<b>Product development</b>	(Use LCA-d) Order LCA Consider alternative ways when developing products Consider and present LCA results in product development processes Be educated on LCA
<b>All employees at Hygiene</b>	Be educated on environmental work, inclusive of LCA
<b>Category</b>	Decide on product strategies form labels and EPD
<b>Sales and marketing</b>	Mediate questions and information demand from customers to Environmental Department Find and explore competitive advantages with existing competence in LCA
<b>Sourcing</b>	Help in data collection
<b>Management</b>	Decide on Environmental or Sustainability Policy Comment in external public communication (e.g. environmental reports) Decide on resources to LCA work Decide on business strategies related to LCA (position paper)

Purchasing (or sourcing) departments are sometimes used as help in data collection. Willingness to supply LCI data is part of Stora Enso's supplier evaluation, for example. In both companies, sales, marketing and environmental communication mediate requests and answers to environmental issues including LCA-related topics. Managers decide on product strategies and resources that have implications for the work with LCA. Product or process developers order LCA studies. Hence, the LCA concept exists at many departments. Yet, this existence seems to be more associated with fulfilling the needs of the Environmental Department, than as a conviction that the LCA concept could support their own work.

## 9.4 Ten years without strategy?

Life Cycle Assessment seems to have survived at the companies without any explicit strategy on its use and implementation from top management. Instead, LCA work has developed ad-hoc, driven by some people devoted to the concept, motivating their activities and using unexpected spin-off effects of their LCA work. In order to make LCA survive in a longer term and used for more strategic benefits, its use need to be identified from a company perspective. This chapter has identified two such rationales for LCA work: increasing trust and

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reducing risks. It is, however, not enough to identify such areas, they must also be promoted and understood, as well as giving benefits to the organisation.

### **Integration or isolation?**

So far, LCA has mainly been a tool used and advocated by the environmental departments, although they sometimes involve other departments in their LCA attempts. In the last few years, however, other functions have started to be interested in using it to support their needs, such as the Environmental Communications Department at Stora Enso and Sales and Marketing at SCA. This motivation from the other functions is probably necessary if the company wants to integrate LCA into their organization. Such integration is in turn needed if the company wants a life cycle approach to be a guiding principle at corporate level.

As seen in the chapter on LCA studies, LCA practitioners gain the most knowledge from the LCA studies. This knowledge needs to be transferred to people in other functions at the company in order for them to be able to decide when and how the concept of LCA can be advantageous in their work. It is not necessarily so that the life cycle approach has to be operationalised through quantitative LCA studies. As seen from the literature review, the LCA concept also includes, for instance, life cycle rules of thumb and life cycle thinking. Stora Enso does not work with systematic LCA studies. Nevertheless “the concept of product life cycle” is central to their environmental and social responsibility policy. The practice of this statement would be an interesting area to study further.

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# 10 Challenges for the future

Life cycle assessment was introduced more than ten years ago at both Stora Enso and SCA. This report concerns how the use of the concept has emerged and developed over time at these companies. Their implementation of LCA is still an ongoing process. This last part of the analysis discusses and comments on the future uses of LCA.

## 10.1 Levels of implementation

Institutionalisation theory explains how a new idea is implemented in an organisation, and it has been used in prior research to explain how LCA is introduced and spread in a company (Baumann 2000; Frankl and Rubik 2000). Recalling that institutionalisation develops through four stages: innovation, habitualisation, objectification, and sedimentation, where do our companies stand and what implications does this have for the future?

*Innovation* is when a new idea has been identified, in this case the concept of LCA. In the *habitualisation stage*, there is a perceived need for LCA in the company. Organised ways of working with LCA start to develop, although initially often in short-lived structures. In the *objectification* stage, a shared understanding and a consensus in the company on the general utility of LCA develops. This can be achieved in two ways:

- Monitoring – Identifying and “imitating” the use of LCA in other companies
- LCA entrepreneurs – Identifying a generic organisational problem that can be solved by using LCA, and justify LCA as the solution to this problem, e.g. by collecting good examples.

The *sedimentation* stage is reached when LCA is integrated into business activities and will survive irrespective of shifts in personnel. In this phase LCA is demanded in certain situations and perceived as a natural part of company work.

### **How far have the studied companies got?**

Neither Stora Enso nor SCA is considered to have reached the sedimentation phase. Although both companies have been working with LCA for more than a decade, the work still seems to depend on the dedication of some core people. At SCA, there are routines for ordering LCA and a position paper that recognizes the use of LCA within the company. Yet there is no general consensus in the company as to when and why LCA is desirable, or how it should be used.



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We have seen that LCA has been used and motivated differently at the two companies. Yet at both companies LCA has “turned out” to be useful in answering environmental questions, as an unexpected spin-off effect of LCA work. This is in line with the findings of Heiskanen (2002) that strategies for LCA implementation were both unexpressed and “dabbling”. Nevertheless, using LCA for environmental discourses helped promote a continued commitment to LCA. Such collection and argumentation through good examples are typical of the objectification stage. However, so far these examples have seemed to be achieved more by chance than through intentional actions of the LCA advocates. If the companies want to continue use and promote LCA, it could be fruitful for them to work more consciously with its implementation. One such action is to search actively for issues of importance for the company and show how LCA could support to answer to ongoing discussions. Such a strategy would reinforce the institutionalisation process and strengthen the position of LCA.

A consensus on the usefulness of LCA is not sufficient to secure that it is used, however. In order to make LCA a natural part of environmental work at the companies, they need to be clear *when* to do an LCA, and make sure it is requested in certain situations. This is a challenge both Stora Enso and SCA face today. At SCA, formal routines secure LCA demands in parts of the organisation, but the motivation for these studies is weakening, because many of the studies do not provide new insights for the practitioners. Stora Enso does not have any corporate-wide systematisation of their LCA requests.

## 10.2 Broadening the scope

It is possible that LCA can continue, as has been the case to date, to be used mainly as a tool for Environmental Departments. As seen from the literature review, however, there is increased interest in broadening the scope of the LCA concept to include the concepts of life cycle thinking and life cycle management, addressing broader areas in the company. If the companies want to explore the potential benefits of such an approach, they have to consider how LCA relates to, and can support, other corporate functions.

Recently, SCA has adopted a position paper recognizing the LCA work done by the environmental groups. Such a position paper is important to confirm the work and methods used. Yet it does not determine how the whole corporation may use and gain advantages from the concept of LCA. This would require discussions between different departments at the company on what LCA can and should be used for. This project has identified some areas and activities of LCA. In order to understand both the actual practice and potential advantages (and disadvantages) of such attempts, further research is needed to investigate how LCA and related concepts apply to various departments as well as to the overall business strategies.

There are several indications on why companies should consider widening the scope for their LCA attempts, (apart from environmental improvements, which seem to be taken for granted). Life cycle assessment is increasingly recognised

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in top management thinking, with a position paper on LCA at SCA, and a more broadly holistic view at Stora Enso. The EU integrated product policy has contributed to further increasing the interest in and necessity of life cycle thinking. The LCA methodology is also applicable to CO<sub>2</sub> emissions trading, which affects both Stora Enso and SCA.

Beyond the regulative area, LCA has also gained increased attention. SCA has started to investigate possible advantages of their built up competence of LCA in marketing (e.g. EPD). At Stora Enso, the Environmental Communications Department requests LCA results as a basis for their communications. In a broader perspective, corporate legitimacy is predicted to gain importance. Legitimacy is an area where LCA has already provided perceived benefits at the two companies studied. Hence the LCA concept will be increasingly important in the future, with a growing interest in strategic issues such as marketing and trust.

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## *11 Concluding remarks*

In this report we have seen indications from both the literature review and the companies that the LCA concept will gain importance in company work. Until now, LCA has been spread in the companies studied through the enthusiasm of some core people rather than as an explicit strategy from top management. Over time, benefits of the LCA work have gradually evolved. Work with LCA has mainly been done at the Environmental Departments, but recently other departments have also started to consider how they could benefit from the built up LCA competence.

We have seen that although both companies studied belong to the same industrial sector and have some similar product groups, they have different approaches to LCA. There are several possible reasons for this. Structural conditions such as position of the company in the supply chain or the main environmental load may affect which LCA practices are easiest (or most urgent) to put into practice. However, other factors such as characteristics of the practitioners and how LCA has previously been handled and motivated also influence LCA practice. The insight that variations in LCA approach are not determined only by institutional or structural conditions, but also by the behaviour and actions of individuals, allows the companies to work both more consciously and actively with LCA - and to learn from each other.

Perhaps more important than to understand why the companies have different approaches to LCA is to understand if and in what way the companies can benefit from such work. This report has identified two rationales for using LCA from a company perspective: increasing trust and reducing risks related to environmental issues. Moreover, life cycle assessment and life cycle thinking is often said to potentially provide business benefits, for example in marketing. If the companies want to fully use their competence in LCA, and work actively to gain more strategic advantages, we recommend that they consider how LCA can support and strengthen departments other than the Environmental Department.

This report suggests that advocates of LCA can work actively to strengthen the implementation of the LCA concept, e.g. by finding corporate discourses within which the use of LCA could be promoted as the solution. Depending on to whom these discourses are important, this will also affect how integrated LCA will be with other departments of the company. Such integration is needed if the company wants to incorporate life cycle thinking as a principle guiding overall company practice.

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## 12 *Further studies*

This report aimed to assess LCA activities in the two companies since the start more than ten years ago, as well as to develop a methodology for performing such studies. We consider the methodology chosen in this study to have worked well. Yet there are areas in which the research approach has been associated with some difficulties. In order to learn for future studies, such concerns are discussed here. During the projects, some questions have not been able to be answered, and new interests have arisen. This report concludes with a discussion of issues that remain for future research.

### 12.1 Research approach

Methodological choices were discussed in Chapter 3, and overall the methodology chosen has served the purpose of this study. Problems have mainly concerned how to compile and sort such a broad range of data and how to deal with a time period of more than ten years. Material collected was classified in order to ease the linking and analysing of data. The classification system enabled thematic descriptions, and data was linked by taking notes parallel to encoding.

As noted above, there were some difficulties associated with evaluating a long time span. These difficulties are discussed below, together with some practical tips for possible future evaluations.

#### **Difficulties in evaluating more than a decade**

On a general level, there are several problems connected with evaluation of a time span as long as ten years. Problems that arose and how they have been handled include:

- It was difficult to find documents from the early years of the evaluation. Many of these are not part of existing document handling systems. Using various channels for data collection such as intranet, archives etc., partly solved this. Secondary data was also used in some cases.
- A lot of work is never written down in text. Interviews have been very valuable, although unfortunately they are often the only source of information for such data.
- People do not remember everything and may unintentionally reconstruct the stories. It was useful to let people tell their stories in a chronological order, making the process of telling the story help them recall what and when things happened. Written documents such as minutes of meetings, etc., have been very useful in triangulating data from interviews.

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- Far from all documents are dated. This was a particular problem regarding external brochures at SCA. Another problem is auto-date functions for electronic documents, which change the date every time a document I accessed. Documents or events referred to in the text were used to help dating documents, as well as questions to company representatives.
  - Extra care was taken about events described in documents that had not yet happened when the document was written. As far as possible, we double-checked that the event actually took place.

### **Some practical tips**

The data channels chosen prior to this study, i.e. internal and external company documents and interviews all proved to be of importance for the evaluation. It was very helpful to have an archive system for easy finding of references used.

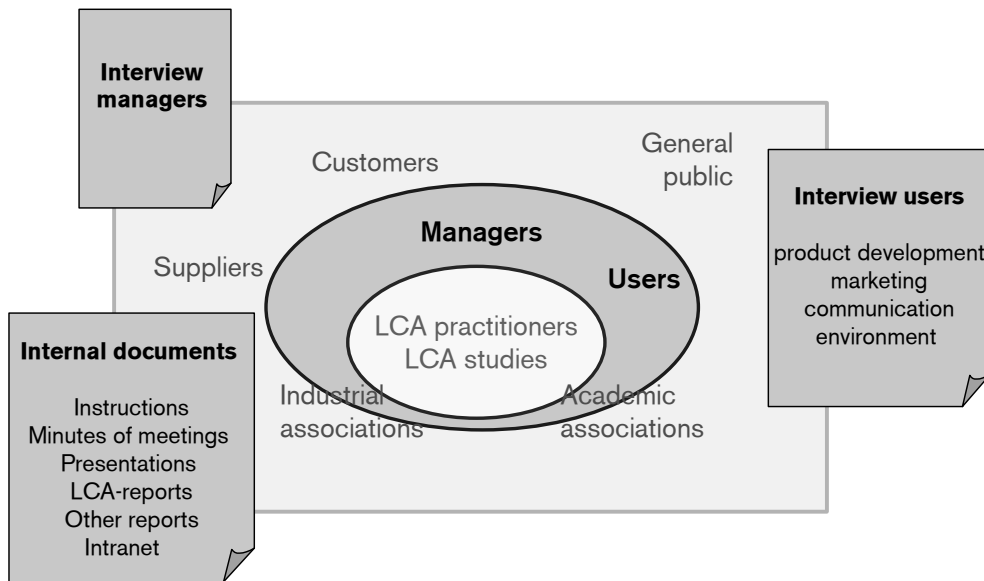
Searching for “LCA” in internal document handling systems as well as the intranet served as a good starting point to find out where and when LCA had been discussed (and documented). Quick and informative overviews of LCA activities through the years were obtained by combining this list with external documents and then sorting the files in chronological order for each company. This list was also useful in relating oral information to the material collected, and extended with information from interviews, it served as a basis for writing the accounts of the two companies.

## **12.2 Further research**

This evaluation has been based on the views of the LCA core people in each company. During the analysis several areas of interest for further research were identified, including:

- How LCA results and knowledge are used in the organisation, e.g. for decision-making.
- How statements about environmental policies such as product life cycle concerns and holistic view are operationalised in the companies.
- How LCA relates to, and can support, different corporate functions, including overall business strategies.

All these areas call for another scope, and for seeing LCA from the point of view of other functions in the company, including managers and (both existing and potential) users of LCA results. Figure 12.1 suggests the focus for such a study.



**Figure 12.1** Suggested methodological scope for a further study, (dark grey area).

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# *Appendix A*

## Categorisation of documents

MR	Miljörapport (Environmental report)
ÅR	Årsrapport (Annual report)
ÖEI	Övrig extern information (Other external information)
ÖII	Övrig intern information (Other internal information)
IMPr	Interna mötesprotokoll (Internal minutes of meetings)
INet	Intranet
IIInf	Intern information eller instruktion (Internal Information or instructions)
P/U	Presentation eller utbildning (Presentation or education)
DA	Data
LCA	LCA rapport (LCA report)
IU	Intervjuutskrift (Interview transcript)
IA	Intervjuanteckningar (Interview notes)
OB	Observation

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# *Appendix B*

## Data categories

### **1. Actors and activities**

Individuals, SCA or Stora Enso  
Department, organization (Environmental Department, Marketing, R&D, purchasing...)  
Consumer, customers, general public, finance, owner, industrial organizations, competitors, other organizations  
Collaborations or joint activities  
Chronology

### **2. Application of LCA**

Research, product or process development, purchasing  
Learn about product or process, learn about LCA and LCA methodology  
Consumer information, external communication  
Environment in general, LCA in general  
Education  
Decision-making, policies  
Spin-off effects

### **3. LCA studies and methodology**

Cradle-to-grave, Cradle-to-gate  
LCA, LCI, Screening LCA  
Type of study (Stand-alone, Compare new vs. old product or process, Compare competing products or processes)  
Tools, databases, data quality  
Methodological development

### **4. Conditions and resources**

Manpower, money, time

### **5. Judgements on LCA**

Optimistic, pessimistic, neutral  
Promoting or restrictive, questioning, descriptive

### **6. Issues**

Environment in general, life cycle thinking, holistic view, transports, ECF or TCF, disposables or non-disposables, virgin versus recycled fibres, paper versus plastic, energy use, forestry, CO<sub>2</sub>, waste handling, EMS, chemicals...

### **7. Other**

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