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Individual Adaptation of Industry LCA Practice: Results from Two Case Studies in the Swedish Forest Products Industry

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Abstract

Goal, Scope and Background. The mere existence of life cycle assessment (LCA) methodology and general acceptance of the life cycle philosophy is not enough to make their use widespread in industry. To gain a better understanding of factors shaping LCA studies and life cycle related practice, field studies of the development of LCA practice in two companies were carried out.

Methods. In order to obtain a deeper understanding of LCA practice, the number of 'variables' was minimized and two similar companies were chosen for study: Stora Enso and SCA. Both companies are part of the Swedish forest products industry, are large multinational enterprises and have been working with LCA since the early 1990s. Both interviews and document studies were used to collect data regarding LCA work from its introduction until 2003.

Results and Discussion. We found fundamental differences in LCA practice between two similar companies in regard to LCA studies per se (the number of studies undertaken and methodological preferences) and also in regard to the organisation of and approach to LCA work. By testing various theoretical explanations of these divergent LCA practices, we identified the actions of individuals and their understanding of the situation as important factors shaping LCA practice.

Conclusions. Although sector-wide recommendations on LCA practice are common in the LCA community, this study indicates that companies use LCA differently despite similar structural conditions such as company size or sector affiliation.

Recommendations and Perspectives. Since the understanding and actions of individuals are important in shaping LCA practice, people working with LCA in industry probably have greater scope for action than they recognise and than sector recommendations may imply when it comes to organising and carrying out their work. Thus, those working with life cycle issues, even in different sectors, can learn much from each other about ways of organising and benefiting from LCA work.

Keywords: Field studies; LCA practice; LCA practitioners; organisation theory; Swedish forest products industry

Introduction

By now, some companies have been using life cycle assessment (LCA) for more than a decade and the tool has spread to many industries and countries worldwide. Concepts such as life cycle thinking (LCT) and life cycle management (LCM) reflect increased recognition and interest in the concept of the product life cycle in society, as demonstrated by the attempt at a European integrated product policy (IPP) (e.g. Commission of the European Communities 2003) and the inclusion of a life cycle perspective in corporate environmental policies (e.g. Nokia 2005, Skanska 2004). Yet continuous and expanding use of LCA in industry cannot be taken for granted. LCA is an ambitious tool. When companies use it, they have to address activities beyond their spheres of control and traditional responsibilities. Moreover, conducting LCA studies is both time-consuming and costly, and governments and the market impose few if any direct requirements for companies to carry them out, with the result that the driving forces for undertaking LCA are non-evident. A number of attempts have been made to make it easier for industry to undertake LCAs, including databases and simplifications. Yet LCA does not seem to easily find its role in industry. Although it is now more than ten years since the tool was introduced on a broad scale, many companies are still uncertain about it or, as Heiskanen (2002) puts it, they are 'dabbling' in LCA.

Research on LCA has traditionally focused on methodological issues. However, the existence of a methodology for life cycle assessment and general acceptance of the life cycle philosophy do not suffice to make it widespread in industry. To overcome this problem, we need to better understand what actually shapes LCA practice in industry. Why do some companies introduce and continue to use it, and how is it actually applied in the organisational setting? In order to achieve a better understanding of what shapes LCA practice in industry, we carried out field studies of two companies, analysing how their LCA practices had emerged over time.

1 Prior Research on LCA Practice

Prior research on LCA provides few clear answers on what shapes LCA practice in industry. LCA methodology has been the focus of most of the research done to date. Research on the application of the tool in industry is limited and provides divergent results.

Most research on LCA practice in industry covers only single areas of application and does not discuss the interaction of and relationship between various uses of LCA within a company. Product development is a field that was discussed early, and is also where the most research has been carried out (e.g. Bakker 1995, Ritzén 2000). Among the few studies of the application of LCA in other fields are Karlson (2002), who considered LCA in management and R&D, and Verschoor and Reijnders (1999), who discussed the issue of LCA in purchasing. Although highlighting the use of LCA in some applications, such studies do not provide us with an understanding of the role of the tool in a company as a whole.

A few surveys have sought to identify the reasons for companies introducing and using LCA. A divided picture of what shapes LCA practice has emerged. The explanations vary from external pressure from regulations to internal company motivation such as advantages in competition (see Berkhout & Howes 1997, Verschoor & Reijnders 1999).

Research has also been done on the distribution and nature of LCA in industry. These studies suggest that industry practice of LCA varies. This variation is evident in several surveys that mapped LCA work in various countries and sectors (e.g. Baumann 1996, Broberg & Christenssen 1999, Frankl & Rubik 2000). Different explanations are offered for this variation. Frankl and Rubik (2000) for example, studied LCA use in four different countries and found that the preferred application of LCA varied with the country in which the company operated. Berkhout and Howes (1997) compared LCA activity in six industrial sectors. They found 'sector-specific approaches to learning and adoption' and concluded that the nature of LCA is determined mainly by the life cycle position of the industry and the nature of competition in that industry.

Baumann (1998, 2000) adopted a somewhat different approach, following the introduction and practice of LCA in two companies over a period of time. Drawing on institutional theory (Tolbert & Zucker 1996), she found that the application of the LCA concept evolves gradually from 'learning to doing', and that the characteristics and actions of the LCA entrepreneur who promotes LCA activities at the company are a critical element in this process. Case studies with another 18 companies, reported by Frankl and Rubik (2000), showed similar results.

Taken together, the above studies indicate that LCA practices in industry differ, but tell us little about why and how they differ. Researchers with different approaches come to different conclusions. Some explain differences in LCA practice in terms of characteristics of the company itself, such as the country in which it operates, its size and its sector affiliation. Others highlight historical or personal characteristics such as the actors and timing as shaping LCA practice.

What most prior research has in common is that it focuses on LCA practice in companies that are 'as different as possible'. Typically, companies in different sectors are compared. So for the study presented in this paper we decided to focus on LCA practice in two companies in the same industry sector that are similar in terms of such structural characteristics as size, country and the length of time they have been using LCA. This approach is motivated by a desire to find out whether sector and other structural characteristics are as fundamental in shaping LCA practice as much of the previous research seems to assume.

2 Methods

Two large companies in the Swedish forest products industry were selected for study: Stora Enso and SCA. The forest products industry is a major industry in Sweden in terms of both its environmental and economic impact. The chosen companies are large enterprises with multinational markets and both are part of the LCA community that emerged in Sweden in the early 1990s. They are recognized for their LCA work and each has more than ten years of experience in working with LCA. In order to understand each company's LCA practice and how it was shaped, their actions related to LCA from the early 1990s until 2003 were mapped. We used an investigative strategy based on Glaser and Strauss (1967), who suggest empirically based theorizing. Accordingly the study was carried out in an exploratory way. LCA practice was studied broadly, as we identified LCA studies and their methodology, the actions and organisation of LCA work and the interaction between actors over time.

Data were collected in 2003–2004 and included internal company documents, external company reports, and interviews with former and current employees (four interviews at each company) as well as company visits and informal conversations at each company. The number and types of documents from each company are shown in **Table 1**.

Many people are involved in LCA-related work in a company. We divided these into 'core people' and 'LCA patrons', where core people where those belonging to operative LCA units and working daily with LCA, whereas LCA patrons were those in the organisational environment who influenced, managed, ordered or used LCA studies and related activity. For this study, we took the core people as the starting point and focus of our research. (the 'patrons' were studied in a follow-up study, see Rex & Baumann 2006)

The actions of the core people were decisive for the content and scope of the study. The study examined the core people's actions following on or relating to LCA studies and the organising of these studies. 'LCA practice' was taken as including all activities pertaining to any part of the LCA procedure (c.f. Baumann & Tillman 2004), including the development of tools and procedures, methodological discussions, and internal and external meetings and commu-

Table 1: Number and 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
Total	**78**	**134**

nications. This also means that we used 'LCA' as a collective term encompassing full LCA studies as well as studies with more limited scope (e.g. cradle-to-gate, life cycle inventory). Such an inclusive definition of LCA work allows for study of the extent to which companies do full or limited LCA studies, how the work is prepared and how experiences are built upon.

3 Outcome of the Field Work

The data collected from the two companies provided detailed accounting of both methodology and practice since the introduction of LCA in the early 1990s. The results from the study are presented and discussed below. A more detailed analysis of the LCA work in the two companies is presented in Rex and Baumann (2004).
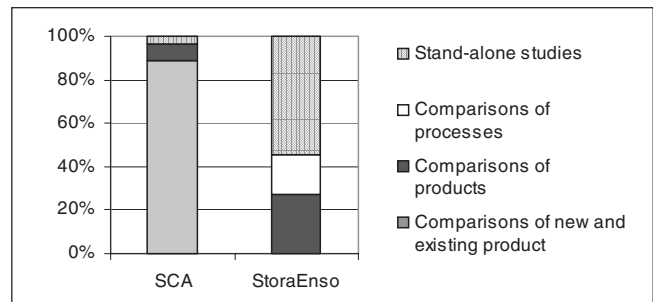
3.1 LCA studies

Both companies started to conduct LCA studies in the early 1990s. Between 1993 and 2003, Stora Enso conducted 13 LCA studies, while SCA conducted as many as 94. Of the studies conducted by Stora Enso, 40% were joint projects with other companies, while the other 60% were conducted either by employees or by students doing their master's project. At SCA, most of the studies were conducted by employees or by one of two consultants with a very good knowledge of the company (one had previously been an employee and LCA practitioner at SCA). Only 4% of the studies at SCA were collaborative, and 3% were done by students working on their master's degrees. There were thus large differences between the two companies in terms of the number of LCA studies and who conducted them (**Fig. 1**).

The studies at the two companies were also done in different contexts. At SCA, 83% of the LCA studies were conducted as part of the formal product development process. These 'routine LCAs' involved comparison of old and new versions of the same product. By contrast, the studies at Stora Enso ranged from stand-alone studies to comparisons of processes and of different products. The types of studies done at the companies are shown in **Fig. 2**.

Not only did the number and type of LCA studies differ, but we also found dissimilarities in the handling of methodological issues. One example concerns weighting, where Stora Enso made limited use of weighting while SCA used its own weighting system.
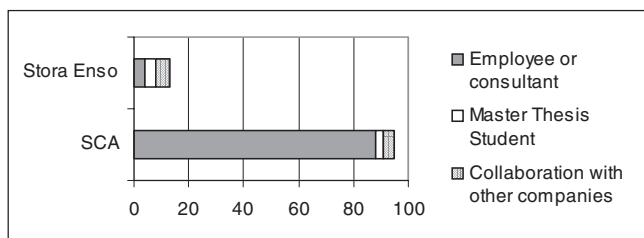
Fig. 1: The number of LCA studies and who conducted them at Stora Enso and SCA, 1993–2003


Fig. 2: Types of studies at SCA and Stora Enso 1993–2003

Finally, the LCA studies differed in terms of their focus and effort. At SCA, studies were done in order to assess products environmentally. Reports were standardized, short and focused on the results. At Stora Enso, the assessments had a methodological aim that paralleled the aim of assessing products and processes environmentally. The LCA reports were detailed and were specially designed to suit each study.

3.2 The organization of LCA work

In neither company had top management laid out a clear strategy on LCA use, and neither had a formally recognized LCA group. These organisational patterns remained relatively consistent throughout the studied period. At both Stora Enso and SCA, the group of LCA practitioners was small and informally organized (1–2 persons in the group at Stora Enso and 2–4 persons at SCA). However, the location of LCA work within the organization differed, as shown in **Fig. 3**. At SCA, most LCA work was done in the environmental department of one product group (hygiene products). At Stora Enso, LCA work was more widespread throughout the organization.

Products for assessment were selected more systematically at SCA than at Stora Enso. At SCA, some of the product development processes included a formal requirement for an LCA. The first product group selected for this type of continuous assessment was baby diapers. With time, the use of LCA spread to related products, first to other fluff products (i.e. incontinence products and sanitary towels) and later to tissue products (e.g. toilet paper and kitchen rolls). Stora Enso was less systematic in its assessment. The products chosen for assessment came from across the organisation and the LCAs were conducted at various mills.
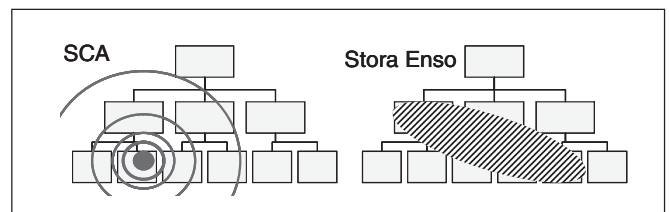
Fig. 3: Schematic illustration of the distribution of LCA activities in SCA and Stora Enso

4   Explaining Different Practices

Our comparison of LCA studies and other LCA-related activities revealed divergent practices in the two companies, including differences in the type and number of LCA studies and how LCA work was organised. Since we had chosen companies that were similar in sector affiliation, size, origin and years of experience with LCA, we were surprised at the extent of the variations. To understand these differences, we had to go beyond sector-based explanations and investigate the causes and consequences of the actions taken within each company.

4.1   The LCA studies: Methodological preferences

The two companies differ not only in the number of studies undertaken but also in the methodology used. Our study shows that this difference was not related to the types of studies. Rather, the choice of methodology was affected by the perceptions, actions and interests of the individuals in a particular organisational context.

This point can be illustrated using an example from Stora Enso. In 1996, the dominant LCA methodology shifted from 'cradle to grave' to 'cradle to gate' (**Fig. 4b**). We could not identify any methodological explanation for this shift, such as would have been provided by different types of goal definition (**Fig. 4a**). But when we examined the wider context of the company as a whole, the shift in methodological preference was shown to correspond to the time when a new LCA practitioner and a new environmental director joined the company, with new ideas about how to carry out LCA work. This finding indicates that the interests and perceptions of individuals are more important for methodological choices than standards or conventional methodology.
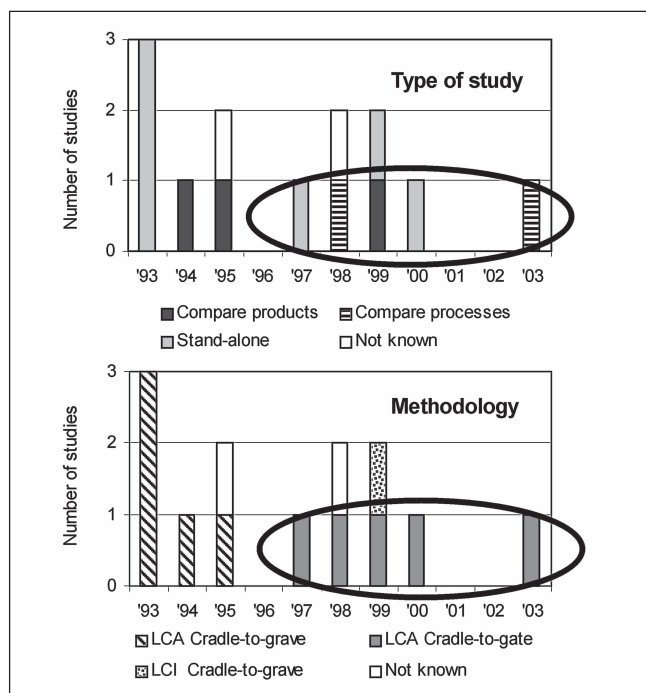

Fig. 4: LCA studies at Stora Enso 1993–2003. The various types of LCA studies were spread over the whole period (4 a, top) but the preferred LCA methodology changed in 1996 (4 b, bottom)

A related observation, highlighting the importance of how LCA practitioners perceive and handle various methodological choices, concerns the use of weighting methods. Weighting was an issue much discussed in the LCA community in the mid-1990s (although it was then called 'valuation'). Several weighting systems based on different values and worldviews were being put forward in the industry networks to which both Stora Enso and SCA belonged. Both companies were hesitant to adopt any of them as they did not think the methods being advocated were suitable for their businesses. For example, one concern was that the weighting systems resulted in unfair comparisons, especially concerning land use in forestry operations.

Although both companies faced the same problem, each handled the issue differently, resulting in different use of weighting methods. The LCA practitioners at Stora Enso discussed LCA issues in corporation-wide 'LCA-seminars' with invited external speakers. These discussions resulted in a restrictive stance towards the use of weighting in their own studies, but also in active support of further research on weighting methods. At SCA, methodological issues were decided within the small group of LCA practitioners. To solve the weighting problem, they designed a company-specific weighting method based on the priorities in the company's environmental policy.

4.2   The organisation of LCA work: Absence of strategies?

The companies had very different ways of organising their LCA work, but it was hard to see any system to their organisation. However, tracing related events shows that their LCA practice was shaped by personal strategies among the LCA core people wanting to encourage continuous use of LCA in each company.

The introduction of LCA was similar for both companies. In both, it was introduced by a person in an operating unit who had independently heard of and become interested in this tool in the late 1980s. Hence, the introduction of LCA was very much a 'bottom-up' initiative. The 'LCA entrepreneurs' (cf. Baumann 1998, 2000) in each company had to work hard to overcome internal barriers, mainly in terms of getting resources and acceptance for ongoing LCA work. The practitioners in the two companies adopted different approaches to overcoming these barriers, resulting in divergent LCA practices.

In both companies, the products to be assessed seem to have been chosen based on where the practical and economic barriers were lowest, not on where the environmental or business potential was greatest. The LCA entrepreneur at Stora Enso was for some years the only LCA practitioner in-house. He engaged in collaborative LCA work with external parties such as trade associations, customers and suppliers. Products were selected for study to fit these projects. An additional practitioner was hired in the mid-1990s and interest in internal LCA projects increased. Projects had to be ordered by the mills, and the practitioners' strategy became to spread information about LCAs and do studies for those mills where they succeeded in triggering an interest. Students working on master's projects were often asked to help conduct these studies, possibly to reduce the resources required. As a result, LCA activity became widespread in the organisation, but the number of in-house practitioners remained limited to one or two people.

At SCA, too, top managers were reluctant to allocate extensive general resources for LCA work. The LCA work started on a small scale, in part-time projects carried out by the same few people. The first product to be assessed was a baby diaper, the product with which the LCA entrepreneur was most familiar and to which she was organisationally connected. The LCA core people had to continually renew the part-time projects to sustain their LCA work. To enhance the importance of LCA internally and externally (and to facilitate data collection), the LCA entrepreneur initiated an LCA project within the trade association. An unexpected coincidence was also used to motivate continuous use of LCA. SCA had been reluctant to eco-label their products, partly for environmental reasons, and the LCA studies that had been undertaken happened to provide arguments in defence of this attitude. This incident helped the LCA core people to increase company acceptance of LCA and raised internal awareness of the benefits of the LCA work. In the mid-1990s, the status and volume of LCA work increased when the ordering of an LCA became a formal part of the product development process for fluff products. After establishing knowledge and routines for LCA work within this one product group, LCA activity slowly spread to related products.

These accounts indicate that the companies did not have any strategies for applying or implementing LCA when the tool was first introduced in the early 1990s. Rather, the organisation of the LCA work was a result of the gradually evolving strategies of LCA practitioners who wanted to encourage and continue with LCA within their companies. Their perception and response to various situations, their interests and reactions to both chance events and organisational changes, and the way they collected good reasons for LCA in order to motivate wider LCA work, all contributed to the patterns of LCA practice observed in their respective companies.

With time, company routines and positions on LCA have evolved from the work of the LCA practitioners. Within SCA, for example, LCA is a routine part of the product development process, and there is now a corporate-wide position paper on LCA (accepted in 2003).

4.3 Different 'logics' about LCA

Analysing the differences between the two companies reveals a more fundamental disparity than we could see by looking at each company in isolation. By studying actions taken over time, we found that the two companies acted according to different 'logics' about LCA, which we will call 'scientific' and 'pragmatic' approach.

Stora Enso exhibited a 'scientific' approach to LCAs. Their LCA work was permeated by a desire to use the correct methods of assessment, an ambition that is reflected in the methodological aims of their LCA studies and their contributions to LCA research. They were also reluctant to using methodology that could be considered subjective, such as weighting. The LCA core people at Stora Enso expressed a somewhat cautious attitude to LCA, characterized by discussions about the reliability of data and the 'scientificness' of the method.

SCA took a more 'pragmatic' approach to LCA. Their development of an in-house weighting system reflecting the values and priorities of the company is only one example of

the LCA-based tools developed at SCA to promote their internal work. Other examples of their pragmatic approach are the standardized and form-like reports and the routines developed for when to order an LCA.

To sum up, we found that individual actions and the organizational experience of LCA not only account for many variations but also have enduring effects on how LCA is handled and perceived throughout the organisation.

5 Two Approaches to Understanding LCA Practice

The field studies identified some similarities but also notable and considerable differences in the two companies' ways of conducting and organizing their LCA work. Differences in LCA practice have been observed in several studies prior to ours. Earlier explanations of why LCA practice differs refer mainly to what we call the 'structural' characteristics of the company, that is, those characteristics of the company that are externally observable, such as sector or size. For example, Berkhout and Howes (1997) used companies' sector affiliation to explain differences in LCA practice, and Frankl and Rubik (2000) suggested that country and company size determined LCA use in industry. In our study, however, we were not able to use this type of explanation as both the studied companies belong to the forest products industry and are large multinational enterprises. They also share other structural characteristics: they have the same county of origin, they produce both industrial and consumer goods, and they have been working with LCA for an equally long time. Yet their LCA practices differed, not only in terms of number and types of LCA studies made, but also in terms of their methodology, the organisation of their LCA work and their intellectual approaches to LCAs. Hence, we had to seek other explanations for our results.

Our analysis suggests that the shaping of LCA work was strongly influenced by particular individuals. Their experience, preferences and actions affected what was studied and how it was studied, as well as the 'logic' of the approach to LCA work. The weighting controversy, for example, clearly shows individuals reacting differently although exposed to very similar problems and external contexts. How these people reacted to upcoming situations and organised their work had long-lasting implications for LCA practice in the companies.

This emphasis on the role of the individual and organisational processes is fundamentally different from most previous attempts at explaining differences by referring to the characteristics of the company. The two approaches reflect different research designs, for example, a design calling for quantitative surveys versus one calling for qualitative field studies. They also represent two different ways of understanding how 'reality' is constituted. In the first approach, organisational actions are seen as determined by laws and regularities in the industrial system. In the other, people work together to 'construct' the social system. These different perspectives on reality are well-described in most general books on the theory of science (for textbooks relevant for management research, see e.g. Arbnor & Bjerke 1977, Easterby-Smith et al. 1991). The basic difference between the research approaches lies in whether explanations are based on causal regularities external to human intentions or in the sense-making and social construction of organisational processes. A further examination of what these

two perspectives on reality imply for the study of LCA use in industry is contained in Rex and Baumann (Forthcoming).

Researchers' approach to understanding LCA practice has an impact on their recommendations to actors aiming to advance the use of LCA in industry. If LCA practice is determined by causal regularities external to human intentions, the best way of working with LCA will be similar for all companies with similar external or structural circumstances such as sector or size. This is a common approach in the LCA community. The aim then becomes to design solutions for various types of companies. One consequence of such an understanding of LCA practices is the development of sector-wise recommendations regarding how to carry out LCA work. This has been a commonly used starting point in the LCA community, for example in standardisation (e.g. Weidema 1996) and when discussing measures to facilitate and encourage industry use of LCA (see e.g. Swiss LCA Forum 2004, UNEP 2004).

However, if LCA practice is shaped by individuals in social contexts and not determined by external conditions, a new set of recommendations will be relevant for those wanting to enhance LCA use in industry. This way of understanding LCA practice implies that it is not only possible but also necessary for people within companies to work consciously and actively using their own strategies for the application and implementation of LCA. Instead of adopting the recommended LCA practice as one 'ought to' do, LCA practitioners can be inspired by the ways of working with LCA that they find most applicable to their context. They can learn from each other about how to perform and benefit from LCA work despite being part of different sectors. Hence, organisations aiming to promote LCA use, including policymakers, should consider alternatives to sector-wise recommendations on how to carry out LCA work. One such alternative may be to present various uses and practices of LCA. Measures could also be taken to encourage and strengthen LCA practitioners in their work.

6 Conclusions

To further the understanding of what shapes LCA activity, we have followed LCA practice in two companies in the Swedish forest products industry. Contrary to expectations based on previous research, this field study points to considerable differences in both the scope and nature of LCA activities and in the companies' approaches to LCA. These differences exist despite the fact that the companies share similar characteristics: they belong to the same industry, are similar in size, in country of action and in the time they have been working with LCA. The differences found could not be explained by these kinds of 'structural' conditions. Instead, we had to turn to internal conditions where the actions and sense-making of individuals were identified as important for the shaping of the company's LCA work. The effect was seen both in methodological choices and in how LCA was organised and approached.

This way of explaining organisational action represents another way of understanding what shapes LCA practice than previously has been seen in the LCA literature. Instead of seeing companies as 'black boxes' responding to external conditions in accordance with their structural characteristics, there is a stronger emphasis on employees' interpretations and actions. Such a shift in understanding has implica-

tions for several stakeholders. It implies a greater role for LCA practitioners: they have more freedom than they may think in how they organise the LCA work, but they also have a responsibility to work consciously and actively with LCA. Another implication is that those working with life cycle issues in companies in different sectors can still learn from each other about how to perform and benefit from LCA work. Organisations aiming to advance LCA use in industry can help this process by monitoring various uses and motives for LCA work as well as by encouraging their LCA practitioners and their exchange of experience.

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