Eco-efficient products and services through LCA in R&D/design

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Abstract *Increasing demand for sustainable development during the last decades has expanded the scope of corporate responsibility to include environmental issues in all levels of operations. A number of different environmental management tools have been developed and implemented in companies. One important question is whether the resources spent in environmental management tools are used in an optimal way. Another question is if these resources give more eco-efficient products as well as increased competitiveness. The aim of this paper is to analyse whether, and to what extent, the environmental management tool LCA is perceived as efficient within ABB. The conclusions to be drawn from this study are somewhat contradictory. On the one hand the technical, economic and environmental benefits from current use of the LCA tool seem to be very modest and LCA activities seem not to be integrated in normal operational activities, nor have they been used frequently in product development projects. On the other hand, there is a very positive opinion about the applicability and future use of the LCA tool. In fact a majority of the respondents believe that the LCA tool will stay and can be useful in the future.*

1. Introduction

1.1 Corporate environmental management

Increasing demand for sustainable development during recent decades has expanded the scope of corporate responsibility to include environmental issues in all levels of operations. A major change in corporate strategy to include environmental issues has been observed (Welford, 1998). In connection with this, there is a fast progress in development and standardisation of environmental management tools, for example in the International Organisation for Standardisation or ISO[1]. Environmental management systems, environmental audits and life cycle assessment (LCA) are examples of commonly used environmental management tools. Other examples are material flow analysis (Burström *et al.*, 1997), material intensity per service unit (Schmidt-Bleek, 1993) and environmental impact assessment.

The fast expansion in environmental management recently can be illustrated in several ways. Half of all literature on "environmental management" available in Swedish research libraries and all texts on "corporate environmental management" have been published in 1993 or later[2]. The increasing numbers of issued ISO 14001 certificates during the last five years is another illustration of the increased interest, as seen in Figure 1.

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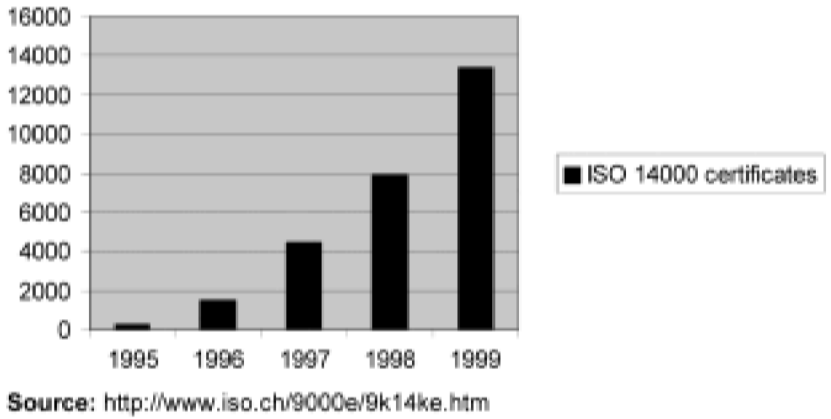

Figure 1.
Numbers of issued ISO 14000 certificates between 1995 and 1999

Large economic and personal resources are spent in companies on method development, knowledge build up, implementation and maintenance of environmental management tools. One important question is whether these resources are used in an optimal way. Another question is if this investment in environmental management tools gives more eco-efficient products and processes as well as increased competitiveness. For these tools to remain within the corporate environment in the long run, i.e. to become sustainable in themselves, they must be efficient and enforce a transformation towards sustainability as well as contribute to development of eco-efficient products and competitiveness. The tools must furthermore be integrated in a smooth way, both in day-to-day activities and in strategy and business development.

Viewed from a business perspective, environmental pressures influence the competitiveness of companies. Porter and van der Linde (1995) discuss the changes in competitiveness on industrial organisations driven by environmental regulations. Innovative solutions from the regulatory pressure not only decreased the environmental problem addressed but also resulted in more eco-efficient products and better competitiveness. They also stress that the legislation must be based on a long-term governmental policy so that companies can adapt the requirements within the corporate strategy in an ordered way. Also those environmental strategies proactively adopted among companies must, and presumably may, be developed to live up not only to sustainability and ecoefficiency but to competitiveness as well.

Our general research problem is to analyse the efficiency (and sustainability) of the rapid growth in environmental management work in companies. The aim of this particular paper, which is a part of that larger project, is more limited however. It is to analyse whether, and to what extent, the environmental management tool LCA is perceived as efficient within ABB. This has been done by a study of the implementation of LCA in ABB and how this influences the eco-efficiency of products and services and the competitiveness of the company as well as business strategy and plans.

2.2. Life cycle assessment

LCA is a tool for analysing the potential environmental impact of a product or system spanning its whole life cycle. According to ISO 14040 the LCA methodology is divided into four iterative phases[3]:

(1) goal and scope definition;

(2) inventory analysis;

(3) impact assessment;

(4) interpretation.

LCA has been used in many different situations (Christiansen *et al.*, 1995):

- strategic development of companies;
- product development and improvement of product systems;
- marketing;
- development of governmental policy and regulations.

A "code of practice" for LCA was published by the Society of Environmental Toxicology and Chemistry or SETAC (Consoli, 1993). Several LCA guidelines have been published, exemplified by Lindfors *et al.* (1995), Hejungs *et al.* (1992), Hansen *et al.* (1995) and Arbor (1993). In 1993 the ISO started a project for environmental standardisation, and four LCA standards, ISO 14040 to 14043, were published between 1997 and 2000. A number of joint projects were conducted during the first half of the 1990s with participants from industrial and governmental as well as scientific organisations. The common goal was to develop a LCA methodology and to make it useful as a tool in product and process development, policy development and communication. The following projects illustrate this:

- The Swedish Product ecology project (Ryding, 1995).
- The Nordic project for sustainable product development (Hansen *et al.*, 1995).
- Centre for environmental assessment of Product and Material systems, CPM[4].
- The Dutch Eco-indicator project[5].
- The Danish UMIP project (Wenzel *et al.*, 1996).

The development of the LCA methodology is also documented in a number of doctoral theses.

Baumann (1998) studies the practice of LCA with the purpose of developing a practice-based LCA methodology. She identifies two principally different types of LCA, Life Cycle Accounting and Life Cycle Assessment. Life Cycle Accounting is described as "full and complete" and Life Cycle Assessment as "relevance guided". She also concludes that the LCA methodology would benefit from a greater separation between the LCA procedure and the LCA model.

Frischknecht (1998) discusses inconsistencies related to setting up of LCA system models and value choices of actors involved in product systems. He

introduces a disutility function to be used for the default choice of technologies or technology mixes within the product system, and for joint product allocation. Further he discusses the need for different time horizons in LCA based decisions, which to a large degree controls the requirements for life cycle inventory data. He also concludes that LCA complements economic information, capable of representing changes with the economic system.

Finnveden (1998) discusses limitations of the LCA methodology in relation to the decisions taken based on LCA results. He points out the problem of selecting the most environmentally preferable alternative based on a LCA study. The conclusion is that it can be necessary to take decisions based on a less rigid basis.

2.3. Environmental management within ABB

ABB's environmental management programme in its present form was established in 1992 and initially focused on improvements of manufacturing processes and implementation of environmental management systems. Gradually the focus for the environmental management programme shifted towards a more holistic view considering the total impact from products and systems over their life cycle. Even if LCA had been used since the beginning of the 1990s within ABB it was during the latest years that LCA was first more formally integrated into ABB's environmental management programme[6].

2.4. Methodology

The implementation of the LCA tool in ABB was evaluated with help of a questionnaire sent to 84 persons with different types of key roles in relation to LCA, R&D, strategy and business development. The questionnaire was sent out to the following three personal categories:

(1) Environmental co-ordinators in ABB's business areas (22 persons, 18 replied). Their role is to implement environmental management into business area strategies, plans and operations.

(2) Customers of LCA studies during the last five years (26 persons, 18 replied). These persons are managers (nine), engineers (six) in R&D and design and others (three).

(3) Licence holders of the LCA software tool EcoLab, the common LCA tool in ABB (36 persons, 29 replied). More than half of this group consists of engineers, and a majority of the others are mainly working with quality, production, management or as environmental controllers.

In total 65 out of 84 questionnaires were filled in and sent back (77 percent).

3. Results

3.1. Working time with environmental issues and LCA

Working time with environmental issues and LCA are here related to position[7]. A total of 35 persons are engineers or managers and 28 persons are

environmental controllers or environmental engineers. Figure 2 illustrates the position of work time with environmental issues.

There are today very few "full time professional" LCA persons in operational activities in ABB since only five people worked more than three months with it during 1999 (Figure 3).

The estimated work time with LCA during year 2000 can be found in Figure 4. The trend is an increase in the LCA use. A total of 33 people have worked more with LCA and only 13 people have worked less with LCA during the year 2000.

A more detailed analysis shows that 22 people declared product development as their main responsibility and seven as their second responsibility. Furthermore the 18 business area controllers are responsible for implementation of environmental management into business area strategies, plans and operations. This means that at least 72 percent of the answers should be very relevant for the subject of this paper (R&D, strategy and business development).

Furthermore the detailed analysis shows that there is mostly no significant difference between answers from the different groups. One conclusion is that the selected group of persons seems to be homogeneous in relation to the goal of this paper. The results are therefore presented for the whole population and if there are significant deviations this is pointed out in the text.

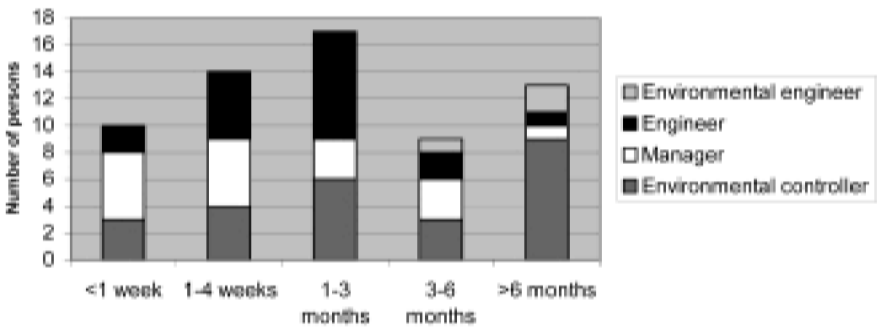

Figure 2.
Work time with environmental issues related to position during 1999

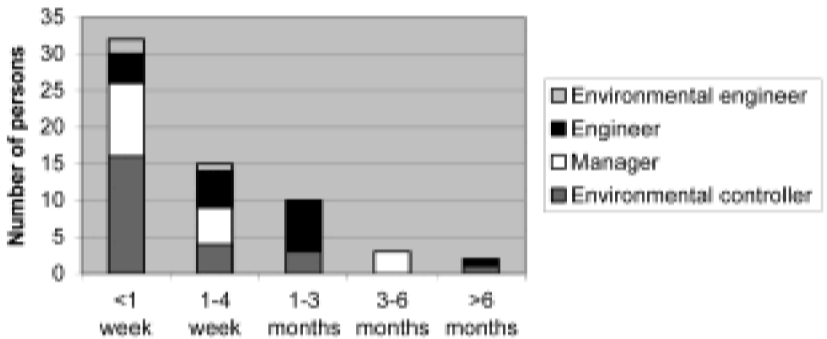

Figure 3.
Work time with LCA related to position during 1999

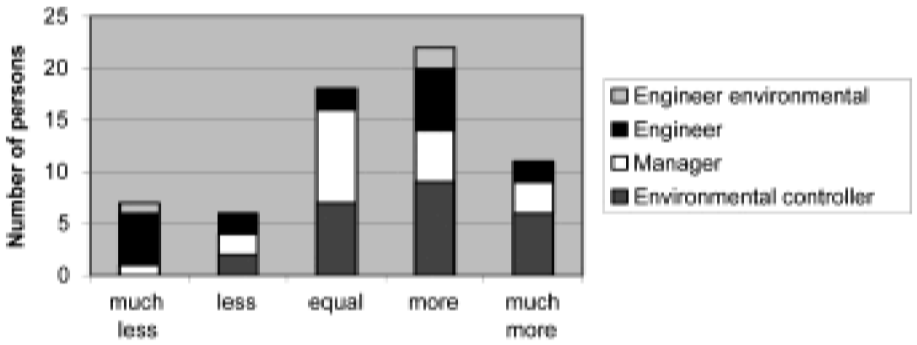

Figure 4.
Estimated work time with LCA related to position during 2000

3.2. Results from the LCA tool use

We have also examined the technical, economical and environmental results from the use of the LCA tool. Three questions with alternative yes/no were answered:

(1) Has LCA led to technical product improvement/s for at least one product or system during the last three years?

(2) Has LCA led to cost reduction for at least one product or system during the last three years?

(3) Has LCA led to environmental improvement/s for at least one product or system during the last three years?

The technical, economical and environmental benefits from the LCA tool use do not seem to be very obvious today (see Figure 5). A total of 76 percent did not identify technical improvements, 83 percent did not identify cost reductions and 64 percent did not identify environmental improvements from the LCA tool use. However a detailed analysis shows that persons working most with LCA identified the improvements more often.

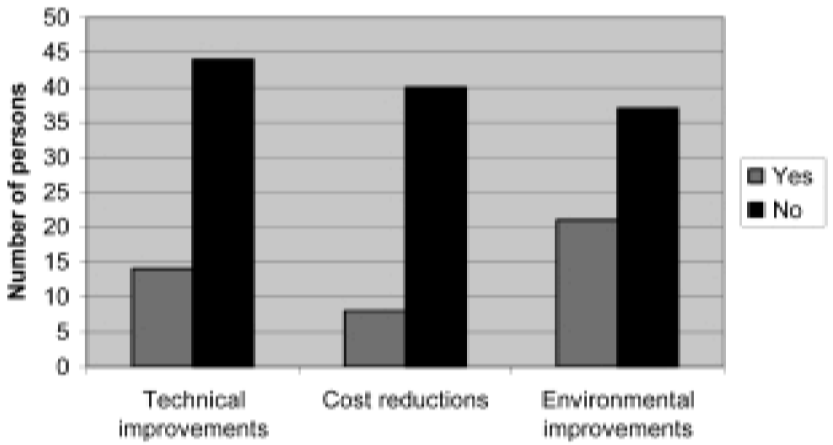

Figure 5.
The technical, economical and environmental results from the use of the LCA tool

3.3. Judgements about LCA

These 20 statements were judged on a scale between 1 and 5; 1 stands for absolute disagreement and 5 for absolute agreement. 1 and 2 is presented as disagree, 3 as neutral, 4 and 5 as agree (see Figure 6).

Statements:

(1) LCA is a natural tool in the environmental management toolbox.

(2) Current LCA software tool/s fulfils our demands.

(3) LCA is a useful tool for identification of environmental improvement possibilities.

(4) LCA is a useful tool for development of the corporate environmental strategy.

(5) Customers demand environmental related data.

(6) Customers demand LCA or LCA related data, as for example EPDs.

(7) The LCA tool is too time consuming.

(8) LCA has been used in product development project/s.

(9) LCA has been used in marketing/sales and/or customer communication.

(10) LCA is a useful tool for identification of cost reduction possibilities.

(11) LCA is a useful tool for identification of cost reduction possibilities for ABB's customers.

(12) The LCA tool is too blunt a tool to be useful.

(13) The LCA tool is too resource consuming.

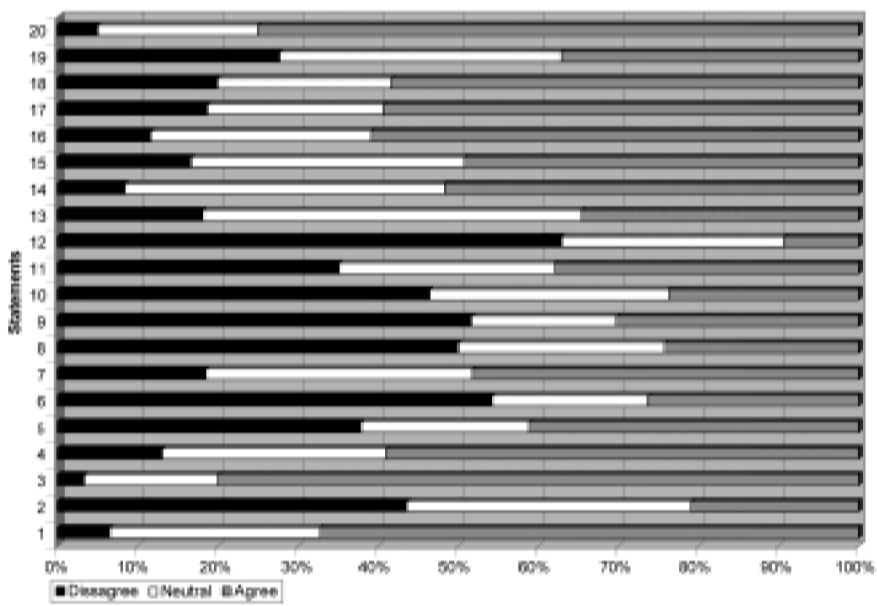

Figure 6.
Statements about LCA to judge in the questionnaire

(14) LCA results are reliable enough to serve as a decision basis in product development.

(15) LCA results are reliable enough to serve as a decision basis in strategic decisions.

(16) LCA results are reliable enough to serve as a basis for customer communication.

(17) LCA results are reliable enough to serve as a basis for communication with authorities.

(18) LCA gives ABB a competitive advantage on the market.

(19) Current LCA tools are too complex to be useful in normal operational and development activities.

(20) The LCA tool will remain in the environmental management toolbox viewed from a three-year perspective.

Despite the relatively low level of current benefits from LCA tool use, the opinion about the applicability and future use of the LCA tool seems positive (1 and 20 in Figure 6). Sixty-seven percent judge LCA as a natural tool in the environmental management toolbox contra 6 percent for the opposite. A total of 75 percent claims that LCA will remain in the environmental management toolbox viewed from a three-year perspective contra 5 percent for the opposite opinion. Furthermore LCA is judged as a useful tool for development of the corporate environmental strategy (4 in Figure 6) by 59 percent contra 13 percent for the opposite opinion, as well as for identification of environmental improvement possibilities (3 in Figure 6) by 80 percent contra 3 percent for the opposite opinion. LCA is not very frequently used in product development projects (8 in Figure 6); 25 percent claim that LCA has been used in product development projects contra 51 percent for the opposite opinion. The opinion about currently used software tools seems to be negative. A majority claims that current software tools are too time consuming and do not fulfil current demands (2 in Figure 6). A detailed analysis however shows that these problems can be divided into a number of different types of problems, many of them not software oriented. The problems are connected to the following problem areas: the software tool as such, access to inventory data, standardisation of weighting methods, acceptance among customers, management commitment and organisational integration aspects. In this "software tool issue" there is thus a mix of many different problems that are both tool specific, but also LCA methodology specific, and more general environmental management questions.

The customers do not ask for LCA or LCA related data to a large extent today (6 in Figure 6); 27 percent judge that there is no demand for LCA data contra 54 percent for the opposite opinion.

3.4 Is LCA integrated in the normal activities

LCA do not seem to be integrated in the normal (operational) activities today, see Figure 7. Only 6 percent claim that LCA is integrated, but on the other hand 44 percent claim that LCA is partly integrated.

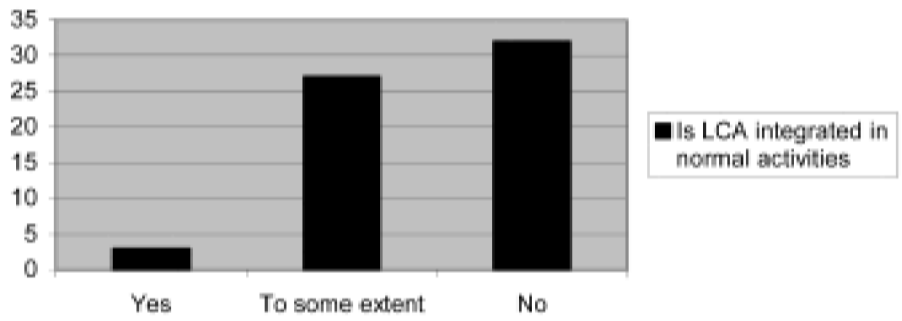

Figure 7.
Integration of LCA in normal activities

4. Conclusion

The conclusions possible to draw from this first and limited analysis of how life cycle assessments are carried out and perceived within industry, as illustrated by the ABB case, are somewhat contradictory.

As regards the representativeness of the answers, we have reasons to believe that they are not severely biased. Although our questionnaire was sent to people who in one way or another have had contact with LCA the answers indicate that they – with some possible exceptions – do not constitute a full time professional group with its own interests. Only five persons had worked more than three months with LCA but most of the respondents had worked less than one month with LCA. A majority claim that LCA activities will expand during 2000.

The contradictory answers given may be summarized in this way:

> On the one hand the technical, economic and environmental benefit from current use of the LCA tool seems to be very modest and LCA activities seem not to be integrated in normal operational activities. Neither has the LCA analysis have been frequently used in product development projects.

But on the other hand there is a very positive opinion about the applicability and future use of the LCA tool. In fact a majority of the respondents believe that the LCA tool will stay and can be useful in the future.

LCA is a relatively new tool under establishment and has not found its exact role in environmental management yet. It is still not asked for by customers. Its potentials, benefits and problems are still not known by management in industry. Further it is not clear what the alternatives to LCA could be and what paths of development that are open for this new tool. This may be reflected in the somewhat contradictory answers which however may be interpreted that there is a lot of work to do to create a integrated and useful tool for environmental management.

The opinion about currently used software tools seems to be negative. A majority claim that current software tools are too time consuming and do not fulfil current demands. A detailed analysis shows that these software tool problems can be divided into a number of different types of problems that are

not only software tool specific, but also LCA methodology specific and more general environmental management questions.

Notes

1. ISO/TC 207 *Environmental Management Standardisation*, International Organisation for Standardisation, Geneva. Can be accessed at http://www.tc207.org/home/index/html
2. www.libris.kb.se 2000-04-28.
3. ISO 14040 *Life Cycle Assessment – Principles and Guidelines*, International Organisation for Standardisation, Geneva.
4. CPM http://www.cpm.chalmers.se
5. Eco-indicator project, PRé Consultancy, 1993.
6. ABBs Environmental Management Report 1999, http://www.abb.com/
7. The summary of each individual presentation in section 3 is not always 65 since all persons did not answer all questions. All calculations of the answer frequency in percent are related to the total number of persons answering each question, and not to the total number of persons sending back the questionnaire.

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