Managing Environmental Aspects in Product Development - The ABB Experience

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Abstract

This paper describes how environmental aspects are implemented in product development projects within ABB. Both organisational considerations and results from the work are discussed. ABB's environmental management program and environmental organization are discussed first, since these found an essential basis and "infra-structure" for all environmental activities. Then, the specific process related to implementation of environmental aspects in product development is discussed, followed by concrete examples from two of ABB business areas. Finally, a short outlook to the future is made and some suggestions for developments in this area are discussed.

1. Introduction

Society's increasing demand for a sustainable development during the last few decades has expanded the scope of corporate responsibility to include sustainability issues at all levels of operation. Industrial organizations have, as one example, responded to this demand by taking several kinds of environmental management actions within their organizations (Welford, 1998). A number of different environmental management tools and procedures have been implemented in companies to support this process, like environmental management systems, life cycle assessment and design for environment tools and procedures (cf e.g. Schaltegger et al, 2000, Gray et al, 1993 and Dewulf et al, 2001).

The aim of this paper is to describe how environmental considerations are implemented in product development projects within ABB and to discuss some results and experiences from this work. Organizational considerations are also discussed.

2. Environmental (sustainability) management in ABB

ABB is a global leader in power and automation technologies that enable utility and industry to improve their performance while lowering environmental impact. ABB has approximately 152,000 employees in more than 100 countries. ABB serves customers in the utilities, industries and oil, gas and petrochemicals sectors as well as providing financial services.

Sustainable development is integral to all aspects of ABB's business. It involves working in three dimensions: environmental, economic and social. The corporate main priorities are:

- To integrate sustainability into all management systems.
- To raise awareness and engage the commitment of every employee.
- To extend the environmental management system to non-manufacturing activities
- To implement the ABB social policy.
- To align the core areas of power and automation technologies with common efforts to help reduce poverty throughout the world, the "Access to Electricity" program.

After signing the International Chamber of Commerce' Business Charter for Sustainable Development in 1991, ABB launched its formal environmental management program. The first phase, completed in 1994, included establishing an environmental organization and a general environmental strategy, as well as completing an initial review of ABB's overall environmental performance through environmental audits of ABB manufacturing processes in about 500 facilities in 35 countries. ABB also started to develop LCA, (Life Cycle Assessment) into an operational tool in cooperation with leading scientific organizations and other industries. Product development was then identified as a key application for the LCA tool. Another activity was to develop a handbook containing e.g. concrete design advice and material selection guidelines to be used for environmentally conscious design in ABB's product development departments.

The second phase, beginning in 1994, was the full-scale, group wide implementation of site-specific, formal environmental management systems at ABB's manufacturing and service sites. Additionally, a LCA software tool and the handbook for environmentally conscious design were introduced in ABB's product development departments on a global basis along with education and training programs. More than 100 LCA studies have been conducted since then and some 1000 persons have participated in LCA related

education programs within ABB. At the end of 1999, ABB came close to implementing Environmental Management System at 96% of all its sites, worldwide, corresponding to more than 500 units.

The third phase, started in 1998 and still ongoing, puts focus even more on the environmental performance of the product over its life cycle. The environmental organization was broadened by the appointment of 23 Business Area Sustainability Controllers. These controllers are responsible for sustainability issues in relation to product management. This includes: identifying market requirements, setting up product specifications, goals and programs, and developing environmental product declarations, EPD, according to the international standard ISO/TR 14025 (MSR 1999:1, Swedish Environmental Management Council). Today, more than 50 environmental product declarations have been made for ABB's core products, and more will come. Country sustainability controllers are responsible for establishing, communicating and follow up ABB's social and environmental policies and programs within their countries. This includes promoting eco-efficient technologies and developing education and training programs. In addition to these activities, ABB extended the environmental program to include all aspects of sustainability during year 2000. To investigate the social impact of ABB's operations in society, case studies were conducted in seven countries at sites where ABB is active. The environmental organization was adapted to correspond to the sustainability activities and the first "triple bottom line" sustainability report, taking account of the Global Reporting Initiatives Guidelines, GRI, was produced in 2001 (GRI, 2000). Today, ABB's Sustainability Affairs organization comprises a network of some 600 people located in more than 50 countries, not all of them working full time. Also, within the Corporate Research organization, there is now a development program established, aimed at supporting ABB's organization with e.g. IT based sustainability tools and methodologies to support both strategic and operational decisions. During this phase, ABB also started to explore the connection between environmental management and management control systems in general with the aim to enhance the integration of environmental management into normal management procedures (Karlson, 2002).

3. Implementation of environmental aspects in product development

As already discussed in the previous section, product development was early identified as a key activity in the environmental management program and different types of environmental design tools were developed. At that time, ABB was well aware of the many uncertainties and challenges in achieving a truly objective measure of the "cradle-to-grave" impact of a product or a system. But it was important to make the attempt, since what cannot be measured cannot be acted upon and controlled. ABB's strategy was to actively take part in developing the LCA technique into a useful environmental management tool. ABB, together with other companies, supported the establishment of a center (CPM) for environmental assessment of products and systems at Chalmers University of Technology in Gothenburg, Sweden. Since its establishment in 1996, this center has become a major international actor in this area and thus a key partner of ABB. A decision was also taken at an early stage that environmental assessment, e.g. through conducting LCAs should be a part of all major ABB R&D projects.

Another important external activity for ABB is to participate in the International Organization for Standardization where ABB is a member of Technical Committee 207, environmental management. ABB have been actively involved in the development of the technical report ISO/TR 14062, Integrating environmental aspects into product design and development. This technical report outlines the procedure for how to include environmental considerations in the product development process.

During year 2000, ABB launched a web based Design For Environment Information Site (the DFE Site) on ABB's Intranet. Product-related environmental management tools and environmental knowledge developed in ABB were then made accessible to all ABB employees for use in various decision-making situations, like in product management, product development and marketing. ABB Corporate Research in Sweden has been responsible for coordinating the development of the DFE site and other types of tools within ABB. This site is now undergoing a major revision and a second version of the DFE site will be released in December 2002. Some examples of the contents of the DFE site are:

- Concrete design advice and guidelines for environmentally sound decisions in product management and development.

- ABB's list of restricted substances, i.e. hazardous materials to be phased out or replaced as well as more detailed information about materials and chemicals and potential substitutes.
- Environmental assessment tools, e.g. LCA screening tools.
- Methodology descriptions and practical guidelines for how to conduct e.g. DFE, LCA and EPD.
- ABB experience, including references to the practitioner.
- Educational material covering general environmental issues and product related issues.

A core activity related to product development is the implementation of environmental considerations in ABB's GATE model. The GATE model, today implemented in all ABB's business areas, is an approach aimed at ensuring that product development projects are driven by business objectives and executed with full management commitment and in a professional way. During year 2001, ABB implemented environmental considerations in the GATE model. This was a very big step forward, since within the whole of ABB, there is now one common approach in place that fully integrates environmental considerations in product development projects. The new DFE site, to be released during the second half of 2002, will fully support all parts of this process with tools and knowledge. It is important; however, to emphasize that environmental aspects must also be considered in strategic activities related to product development, like product planning. In this respect, management and, as discussed earlier, the business area sustainability controller, have a key task in taking strategic decisions based on an analysis of the market conditions and the actual product portfolio.

The environmental considerations in the GATE model includes the following concrete actions:

1. Identify environmental aspects and requirements.
2. Set environmental goals and establish an environmental plan.
3. Communicate the environmental plan and execute actions in the project according to the environmental plan. Prepare material to be used in e.g. marketing and manufacturing of the product.
4. Follow up whether the environmental plan was met and document experiences for coming projects.

The environmental plan is the "main thread" since all items of relevance should be compiled in this document.

4. Examples

Activities to continuously improve the environmental performance of its products are ongoing in all of ABB's more than 20 business areas. Examples from two of these have been selected to illustrate concrete action taken on business area level. These two examples have been chosen since not only do they illustrate activities in two different business areas but also point out that together, the improvements in these business areas in parallel enhances the eco-efficiency dramatically for the whole system. It is therefore most critical to expand the perspective to encompass the entire product systems to also utilise the reposing potential for more radical improvements of the eco-efficiency of complete product systems.

4.1. The Machines division of ABB Motors

The Machines division develops and manufactures rotating electric machines e.g. for use in cranes and lifts, in process industries for paper machines, extruders, mixers and winders. The targets set in the division's ISO 14001 certified environmental management system has lead to considerable improvements of the environmental performance at manufacturing site level between 1996 and 2000:

- Reduction of electric energy used per produced product unit by 70%, e.g. through more efficient control of ventilation fans and the production process.
- Reduction of emissions to air with 70%.
- Reduction of emissions to water with 50-100%.
- Reduction of waste for deposit with 90%.
- Reduction of used district heating with 55%.

It is even more important; however, to focus on the use of the electric machines, since hundreds of times more environmental impact originates from this phase compared to the manufacturing phase. Consideration of environmental aspects in product development is thus critical since the decisions taken during the design stage influence the environmental performance of the product over its full life cycle. The Machines division recognised these conditions at an early stage and has for several years had procedures in place to integrate environmental aspects into all product development projects, e.g. by actively improving the efficiency of the electrical machines and replacing hazardous materials. As an illustration the following activities were conducted when the DC (direct current) motor named DMI was developed:

- In an early stage of the product development project, the business area environmental controller participated as environmental specialist e.g. by specifying environmental requirements and aspects for the product.
- An FMEA (Failure Mode Effect Analysis) was performed which included an analysis of the environmental aspects. A result from this analysis was that emissions to air had to be especially considered. This created a need to introduce monomer free resins for impregnation. This reduces the total emissions of VOC by 80-90% during the production of the DMI.
- Development of a slimmed rotor with small diameter. This will minimize the need of energy when the motor is accelerating. The energy losses are reduced by 2-10% depending on the operating cycle, and less CO_2 is released into the atmosphere because less electricity needs to be produced during the many years when the product is used.
- Development of an optimizing system to be used in the customer dialogue, DC-size, making it possible to deliver an exact-size motor according to specific customer demands. This improves the efficiency by 1.2% on an average.
- Utilizing the complete width of the strips of electro steel sheet for punching stator laminates. The consumption of this specific material is reduced by 3%.
- Enhanced speed range of the motor making it possible to select a smaller motor when the required speed range is large. This saves material by 5-40% depending on the type.
- No PVC, halogenated flame-retardants or use of 6-valid chromium in the processes or in material purchased from suppliers.

Other types of conventional electric machines are also continuously improved and a new generation 180 kW motor reduces the emission of carbon dioxide by 12%, which equals 230 tons, during its life cycle compared to previous product generation. This corresponds to a saving of 25 000 USD for the customer during the life cycle of the product.

Another interesting development beside the DMI machine is the new concept Motorformer ^{TM} with high voltage cables insulated with cross linked polyethylene in the stator instead of impregnated core steel. This concept eliminates the need for transformers, medium voltage switchgears and other ancillary components normally used with large electric motors. This reduces system losses - often by as much as 25 percent.

This business area example illustrates that a wide range of actions during product development is necessary to improve a product's environmental performance, thus resulting in an eco-efficient product. A number of other actions than listed here are also taken, as example development of scrapping and recycling instructions for the products. It is critical in all these actions to have a thorough understanding of ecological, economic as well as technical characteristics of the product and their interrelation.

4.2. Business Area Drives & Power electronics

An AC (alternate current) drive system is an AC motor controlled by a frequency converter, which is a power electronics device that can change the motor supply, often step-less from zero up to the line supply frequency. Varying motor speeds to match process requirements raise system efficiency. The systems produced by this business area are used to facilitate more efficient use of motors in industry. Households use about half the electricity generated in the world and industry uses the other half. In industry, electric motors account for about 65% of the electricity consumption. Most motors that drive pumps, fans and conveyors are fixed-speed devices. They are designed for maximum capacity requirements and always run at full speed - although requirements are usually lower. Mechanical throttling may control the output of

the pump or fan. This is like controlling the speed of a car only by braking. The efficiency of such a system is poor. This also illustrates that it is not enough to improve a product itself, like the motor, but also to improve the total system as well, including the control system. Such system effects must therefore also be addressed in product development and the work in this business area is a good example of this.

The work in this business area is in many parts very similar to the work described in the previous section. Additionally, an important goal is to improve the efficiency of the complete system, i.e. the power electronic system and the motor. By variable speed control of pumps and fans by power electronics, the energy efficiency of a pumping system can be improved by 30-70% compared to the conventional throttling method. Using efficient technology at the customer site can increase efficiency from 30-60%. In other words, a variable speed drive can save about five times more energy than it actually needs.

AC drives are among the most eco-efficient products on the market. It is estimated that ABB AC drives reduce annual energy consumption by 46 000 GWh, corresponding to 38 million tons of carbon dioxide.

5. Conclusions

- Inclusion of environmental considerations in strategic processes, like e.g. product management and product planning, is critical since fundamental parts of the product specification are often settled at this early stage.
- The perspective should be extended to encompassing the complete system. It is essential to consider and improve the eco -efficiency of the complete system where the product will belong and not only the eco-efficiency of the product itself.
- Environmental goals and plans at product level should be established early in the development project; else there is nothing to measure, control and communicate.
- It is important not to underestimate the time perspective of the implementation process. It is therefore essential to develop a long-term strategy for this process and take a step-by-step approach at operational level, including competence build up. The relation between the environment and a product over its life cycle is very complex, and to many of those involved in product management and development, ecology is a new competence area to deal with.
- Environmental considerations must be fully integrated into normal management procedures and management control systems as well as daily operational procedures.
- In practice there is mostly no conflict between economy and ecology. In general, energy and resource efficiency as well as waste minimization is also economic issues. Taking pro-active environmental considerations early in the product development cycle will offer more competitive and sustainable products to the market.
- Access to easy to use and cost-efficient tools and procedures to be used in various decision situations related to product management and product development is critical. There are a lot of different tools available on the market but much more could be done to improve them. One area to focus on is to combine these tools in an efficient way and make them accessible through common IT platforms. Other factors to consider are to enhance communication of data and results between these tools and other management tools and procedures.

6. Outlook to the future

Even if many positive results can be identified from implementing environmental aspects in the product development process, there is a lot more to do. A major challenge is to accomplish the integration of environmental considerations into ABB's strategic planning process and management control systems. An important part of this work is to improve the dialogue with the customers to explore different viewpoints and identify market requirements. Business area controllers and product managers will have a vital role in this process. The goal is to meet customer needs in new ways to deliver better performance while using less resources and creating less waste. Equally important is continuous improvement to raise the environmental performance of existing products. The products must also offer high economic performance over their complete life cycles to replace traditional, less eco-efficient products. To further develop tools and methodologies that will support the organization in this process will be necessary.

The development of tools and methodologies should be based on a careful analysis of the real demand for environmental information to measure, control and communicate over the whole product development cycle.

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