Integrating environmental aspects in DeLaval Development Model DCS 015

BRITTA-STINA KARLSSON
SOFIA SVENSSON

Master of Science Thesis
Stockholm, Sweden 2010
Integrating environmental aspects in DeLaval Development Model DCS 015

Britta-Stina Karlsson
Sofia Svensson

Master of Science Thesis MMK 2010:03 MCE 217
KTH Industrial Engineering and Management
Machine Design
SE-100 44 STOCKHOLM
Abstract

DeLaval is a global group producing milking systems and equipment for facilitating the daily work of dairy farmers. The 1st of January 2009 a new development model, DeLaval Corporate Standard 015 (DCS 015), for developing new products and solutions was introduced. The purpose of this master thesis was to investigate how environmental aspects could be implemented in DCS 015 and provide a measurable environmental tool to obtain information regarding what environmental impacts the development process contributes to.

The master thesis was initialized with a theoretical study of the field of sustainable development and corporate environmental work, which resulted in the frame of reference in the report. Then, internal interviews were conducted at DeLaval to investigate the previous and present corporate environmental work. Simultaneously, external interviews at large, international companies with an environmental profile were conducted to investigate what DeLaval could learn from other companies. The knowledge gained from the theoretical study and the conducted interviews worked as a foundation when introducing proposals on how DeLaval could implement environmental considerations in DCS 015.

The result of the master thesis is that corporate environmental work needs to be a combination of environmental tools and environmental management to be truly successful. Several ideas on how to implement environmental tools in DCS 015 and environmental management at DeLaval were presented and three major ideas were developed into more detailed proposals.
Sammanfattning


Examensarbetet inleddes med en teoristudie av området hållbar utveckling och företags miljöarbete vilket resulterade i den teoretiska referensramen i rapporten. Sedan utfördes interna intervjuer på DeLaval för att utreda hur tidigare och nuvarande miljöarbete har utförts och vilka delar av detta arbete som kunde vara värdefulla att bevara i DCS 015. Samtidigt utfördes intervjuer på stora, internationella företag med en uttalad miljöprofilering för att utreda vad DeLaval kunde ta till sig från andra företags miljöarbete. Informationen som inhämtats från teoristudien och de utförda intervjuerna användes sedan för att presentera förslag på hur DeLaval kunde implementera miljöaspekter i DCS 015.

Examensarbetet resulterade i insikten att för att ett företags miljöarbete ska vara framgångsrikt behöver det bestå av en kombination av miljöverktyg och miljömanagement. Ett antal idéer på hur miljöaspekter kunde integreras i DCS 015 och hur DeLaval kunde ta till sig tankar om miljömanagement togs fram och tre större idéer utvecklades till mer detaljerade förslag och rekommendationer.
Acknowledgements

We would like to thank the following people for their help and contribution to this master thesis.

- Jan Agri and Mikael Gisslegård, our supervisors at DeLaval International AB
- Conrad Luttropp, our supervisor at KTH
- Anna Hedlund Åström for help with defining system boundaries in the MET-matrix
- Jannicke Bjurselius and Heléne Ernow for valuable opposition on the report and presentation
- All corporate representatives who we had the privilege of interviewing for their commitment and valuable comments on environmental work
- Johan Bäckvall, Pauline Christensen, Therése Dahlström, Theresa Engborg, Camilla Runnquist and Leif Söderlund for valuable proof-reading of the report
# Table of contents

1. Introduction ................................................................................................................ 1
   1.1 Background............................................................................................................. 1
   1.2 Purpose ................................................................................................................... 1
   1.3 Limitations .............................................................................................................. 2

2. Research approach ..................................................................................................... 3
   2.1 Literature study....................................................................................................... 3
   2.2 Interviews ............................................................................................................... 3
   2.3 Proposals ................................................................................................................. 4

3. Sustainable development ............................................................................................ 5
   3.1 Background............................................................................................................. 5
   3.2 Sustainable development ........................................................................................ 6
   3.3 Society’s environmental strategies ....................................................................... 10
   3.4 Companies’ environmental strategies ................................................................... 12

4. Environmental methods and tools .......................................................................... 17
   4.1 Environmental audit ............................................................................................. 17
   4.2 Environmental Management System .................................................................... 18
   4.3 Resource efficiency ............................................................................................... 19
   4.4 Life Cycle Assessment .......................................................................................... 20
   4.5 MET-matrix .......................................................................................................... 22
   4.6 The Ten Golden Rules ......................................................................................... 22
   4.7 Eco Design Strategy Wheel .................................................................................. 23
   4.8 Chemical lists ....................................................................................................... 24
   4.9 Environmental Effect Analysis ............................................................................ 25
   4.10 Environmental labeling type I and II .................................................................. 26
   4.11 Environmental labeling type III – Environmental Product Declaration .......... 26

5. Presentation of DCS 015 .......................................................................................... 27
   5.1 Structure ................................................................................................................ 27
   5.2 Logical routing ...................................................................................................... 28

6. Findings from the interviews within DeLaval ........................................................ 31
   6.1 DCS 015 ............................................................................................................... 31
   6.2 Environmental methods and tools ........................................................................ 31
   6.3 Environmental priorities ....................................................................................... 32
1. Introduction

This is the final report of a master thesis performed in cooperation with DeLaval International AB and KTH in the fall of 2009. The master thesis equals 30 hp and has been performed during 20 weeks.

1.1 Background

DeLaval International AB, which henceforth will be called DeLaval, is a global company with 4400 employees and headquarters in Tumba, Sweden. DeLaval produces milking systems and equipment for facilitating the daily work of dairy farmers. When developing new products and solutions, the development projects at DeLaval was controlled by a development model called DeLaval Corporate Standard 015 (DCS 015). The 1st of January 2009, the previous development model at DeLaval, DCS 010 was updated to the new version DCS 015.

At the moment, no defined environmental considerations exist within the development model DCS 015 but during the fall of 2008, an initiative called Sustainable Dairy Farming (SDF) was initialized. SDF concerns the environmental work of the farmers and at the farm and have only an indirect relationship to the environmental work within DCS 015.

1.2 Purpose

The purpose of this master thesis was to present a proposal as to how DeLaval can implement tools to consider environmental aspects in the development model DCS 015. The proposal was based on how environmental aspects have been taken into consideration in the previous development model DCS 010 at DeLaval, literature studies and a mapping of how other companies integrated environmental aspects in their development processes.

During the cause of the project the purpose was expanded to also include proposals on how different tools for environmental management in general could be used to improve the conditions for considering environmental aspects of the product development process.

The expected benefits for DeLaval were defined as:

- All people involved in the development process should take environmental consideration into their work
- All new launches from 2011 and onwards should document the environmental profile of each solution
- That DeLaval should have the ability to communicate the environmental performance of their products to authorities, organizations and others
- To increase the sustainability and reduce the environmental impacts of products
1.3 Limitations

This master thesis resulted in a proposal on what development tools DeLaval could integrate in the development model DCS 015. However, the project did not result in the actual implementation itself due to limitations in time and resources.

During the master thesis, a limited number of corporate representatives from DeLaval and other development companies were interviewed. From these interviews, an interpretation of how the companies work with environmental aspects in their development processes has been performed and this guided the analysis and inspired the proposals. To obtain a completely accurate picture of the corporate environmental work a larger number of interviews would have been necessary, but that would have required more time than was allowed within this master thesis.

The master thesis was focused on environmental aspects and to some extent the social aspects of sustainable development. The work had this focus despite the fact that DeLaval works towards realizing Sustainable Dairy Farming, a concept also encompassing farm profitability and animal welfare.
2. Research approach

This part of the report describes the methods that have formed the basis for this master thesis. The methods that have been used during the master thesis are presented in regard of; a literature study, interviews and a proposal.

2.1 Literature study

The literature study was performed to extend the knowledge within the field of environmental work and sustainable development. It was also performed to obtain a general view of which environmental methods and tools that were available to integrate in a development process.

The extent of the literature study was discussed and settled in consultation with the supervisors from DeLaval and KTH. It was also discussed which books and articles related to the subject that was relevant to read to cover the whole extent of the literature study. The result from the literature study is presented in chapter 3. Sustainable development and 4. Environmental methods and tools.

Parallel with the literature study information about DeLaval’s development model DeLaval Corporate Standard 015 (DCS 015) was gathered to obtain knowledge about how the model is structured and how it works. The information about DCS 015 is presented in chapter 5. Presentation of DCS 015.

2.2 Interviews

To obtain information about how environmental work have been performed at DeLaval, how environmental work is performed at the moment and how the development process DCS 015 works in practice, interviews with eight selected employees was performed. To get in touch with employees that work with product development or have knowledge about environmental work at DeLaval, the employees to interview were chosen in consultation with the two supervisors at DeLaval. Interviews were conducted until the answers became equivalent and further interviews would not contribute to new information.

To obtain information about how other companies work with sustainable development and environmental aspects in their development process, interviews with employees at ten external companies where conducted. Environmental managers and other employees with environmental positions at ten large external companies with an environmental profile were interviewed. To obtain information about environmental management interviews with a doctoral candidate in Industrial Economics and Organization and a director of operations from the foundation The Natural Step were conducted.

All interviews executed during this master thesis are qualitative and structured interviews based on an interview guide in Swedish. The interview guide was prepared before the interviews started and the questions were discussed with the supervisors at DeLaval and KTH to cover the whole extent of this study. All interviews have been
executed face-to-face or by phone if the interviewed person did not have the opportunity to meet for a face-to-face interview. The result from the interviews is presented in chapter 6. Findings from the interviews within DeLaval and 7. Findings from the external interviews.

2.3 Proposals
Knowledge from the literature study and the interviews were used to evaluate the described methods and tools in chapter 4. Environmental methods and tools. The information was also used to present proposals as to which methods and tools that could be profitable for DeLaval to implement in DCS 015 and how to improve their environmental management. The environmental methods and tools were evaluated in regard of several criteria and attributes that were stated during the interviews. The methods and tools suitable for implementation in DCS 015 have been re-designed into proposals adapted to fit specifically for DeLaval. The proposals are presented in the chapter 10. Proposals.
3. Sustainable development

It is important to clearly describe the theoretical fields which the report is based on, because if there is not a consensus in the definition of terms the result may be inapplicable. Therefore, a short background to environmental work and a thorough definition of sustainable development will be presented in the following chapter of the report.

3.1 Background

Ever since the industrialization of our society, mankind has strived to find a better and more efficient way of producing the everyday things needed. This drive to excel has contributed to the fact that 20 percent of the earth’s inhabitants consume 80 percent of the world’s resources (Svensk Byggtjänst, 2004). According to the same source, tens of thousands species of animals and plants, 20 percent of the tropical rainforests and 20 percent of the topsoil have been lost during the last 50 years. During the same period, we have consumed as much metals, minerals and fossil fuels as throughout the entire previous history of the world.

A contributing cause to these environmental impacts is that we consume raw materials more rapidly than they can re-grow. Due to this unbalance in raw material flow, nature is unable to process the emissions caused by raw material use and local pollution occurs. Imagine a factory producing products and dumping the waste in the nearest water catchment, see Figure 1 (SOU 1989:32). The environment does not stand a chance to take care of all the waste produced from the factory. It is clear why environmental aspects need to be considered during development processes.

![Figure 1. Local pollution from a factory dumped in a nearby water catchment. (SOU 1989:32)](image)

It was in 1962, when Rachel Carson wrote the book *A silent spring* about the environmental consequences of using chemical pesticides, that the debate on environmental impact due to human interference arose. Before the publishing of Rachel Carson’s book, most people was unaware of humankind’s impact on the environment.
According to Magnus Enell our society has gone through three phases of environmental awareness since the 1960’s (Enell, 2009). The period from the 1960’s represented a phase of *awakening*. Various environmental problems were discovered, the environmental protection agency was formed, international conferences were held and laws to protect the environment were legislated. The period from the 1980’s was when *companies took environmental responsibility*. The Brundtland commission published the report *Our Common Future*, environmental labels were introduced and large companies hired environmental auditors and presented environmental audits (WCED, 1987). The latest phase, which we have been in since 1995, is called *global sustainability*. Environmental management systems such as Eco Management and Audit Scheme (EMAS) and ISO 14000 were introduced and there was a widespread environmental awareness within the society.

### 3.2 Sustainable development

In the latest phase of environmental awareness, information about sustainability and sustainable development becomes more available. But what do we mean by sustainable development? There are various definitions of sustainable development, but even though the wording is different the basic idea remains the same. In the report *Our Common Future* from the World Commission for Environment and Development, sustainable development is defines as (WCED, 1987):

> “A development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

In the year 1992, the UN held a conference in Rio de Janeiro where an international plan of action regarding sustainable development, called Agenda 21, was adopted. Agenda 21 provides goals and guidelines to obtain a sustainable development through the interlined fields of socially, economically and ecologically sustainable future (Svensk Byggtjänst, 2004), see Figure 2. But these ideas have actually existed a bit longer. In the 1970’s, economists began using the term Triple Bottom Line (TBL). The TBL stands for a development being; economically viable, environmentally sound and socially responsible (Enell, 2009).

---

**Figure 2. The three fields of sustainable development.**
So, sustainable development can be defined as the three parts of ecology, economics and sociology, but how can we define these terms? If you look it up in an encyclopedia, it will say (Wikipedia, 2009):

Ecology – is the interdisciplinary scientific study of the interactions between organisms and the interactions of these organisms with their environment.

Economics – is the social science that studies the production, distribution, and consumption of goods and services.

Sociology – is the study and classification of human societies.

A description of the term ecologically sustainable development can be found in the Swedish governments writing to the parliament; Ekologisk hållbarhet (Reg.skr.1997/98:13). This writing can be summarized in three main goals, translated into English, called: environmental protection, a sustainable consumption and an efficient use.

Environmental protection means that emissions and waste are not to harm the health of people or exceed nature’s ability to receive and process them. Naturally existing materials should be used in a way that preserves the natural cycle. Health and environmental hazardous materials should in the near future be forbidden in the environment. The biological diversity should be preserved and precious cultural environments protected.

A sustainable consumption means that the ecosystem’s capacity for production has to be secured in a long-term perspective. The consumption should be based on a sustainable use of renewable resources. Considering this, the consumption cannot exceed the pace with which the natural resources re-grow and the materials used should be recycled. It is also important to save the non-renewable resources and constantly strive to find renewable replacements.

An efficient use means that the present use of energy and natural resources can be optimized. The energy and material flows can be restrained to be compatible with sustainable development. The planning of society, technical development and investments should therefore be focused on resource sparse products and processes.

DeLaval has, since 2008, an internal concept related to sustainable development and it is called Sustainable Dairy Farming (SDF). SDF has been defined in the text Principles & Practices for Sustainable Dairy Farming 2009: “Dairy producers aim to ensure that the safety and quality of their raw milk will satisfy the highest expectations of the food industry and consumers. In addition, on-farm practices should ensure that milk is produced by healthy cattle under sustainable economic, social and environmental conditions”.

DeLaval defines SDF as: “The goal is to continuously reduce the environmental footprint of farms, while improving milk production, farm profitability and the well-being of the people and animals involved”. DeLaval divides SDF into four pillars;
animal welfare, farm profitability, environment and social responsibility, see Figure 3. According to DeLaval, these four areas, referred to as the pillars of SDF, combined provide the foundation of a sustainable development of dairy farms and the concept of SDF.

![Figure 3. The four pillars of sustainable dairy farming at DeLaval. (DeLaval International AB, 2009)](image)

Two of DeLaval’s four pillars of SDF were in focus for this master thesis, namely environmental and social responsibility. The context of the pillar environment was described by the fields of methane, water, energy and waste, see Figure 4. When considering the environmental aspects of the customers and therefore the business of DeLaval, one must integrate the methane produced by the cows, the water and energy use and the waste produced both by usage and manufacturing of the products sold.

![Figure 4. The context of the pillar environment. (DeLaval International AB, 2009)](image)

The context of the pillar social responsibility was described by DeLaval as the fields of milk quality, the consumer, worker safety and community, see Figure 5. When considering the social aspects of the operations of DeLaval one must integrate the quality of the milk, what the consumer wants and needs, the safety of the workers and respect the surrounding community.
Economically sustainable development will not be discussed in this master thesis. This is due to that DeLaval, a producing development company, would not develop a product or service that was not economically viable.

In literature, socially sustainable development consists of building a stable and dynamic society where basic human needs are fulfilled. This kind of development, with human needs and wellbeing in focus, is built on democratic basic principles with health, participation and safety as guiding stars. A socially sustainable development strives towards a society which all humans, indifferent to sex, age, economical distinction and ethnical or cultural origin can profit from (Länsstyrelsen Gävleborg, 2005). To concretize the term socially sustainable development, The Swedish National Institute of Public Health has presented 11 indicators (Statens Folkhälsoinstitut, 2003). The indicators can function as a measurement on how well a society has adapted the socially sustainable development.

- Participation and influence in society
- Economical and social safeness
- Secure and well established child growth conditions
- Increased work related health
- Sound and safe environments and products
- A more health contributing medical treatment and health care
- Well established protection against infection spreading
- Safe and sound sexuality and reproductive health
- Increased physical activity
- Well established eating habits and safe provisions
- Decreased usage of tobacco and alcohol and a society free from drugs, doping and vandalism caused by exaggerated gambling
3.3 Society’s environmental strategies

If you count the edition of Rachel Carson’s book as the initialization of environmental awareness, our society has been ‘aware’ for almost 50 years. But what has happened since 1962 and where do we stand today?

In an ideal world, all companies and citizens would be environmentally aware and sincerely driven towards making a contribution to decreasing the environmental impacts of our society. But since that is not entirely the case, means to control the environmental impact of our society and force individuals and companies into obedience have been introduced. Examples of these means are legislative demands on waste produced or pollutants emitted and directives from the EU like RoHS, REACH and WEEE.

RoHS is the acronym for Restriction of Hazardous Substances and is an EU directive regarding hazardous substances in electrical or electronic equipment (Kemikalieinspektionen, 2009). RoHS took effect in the 1st of June 2006 and restricts the use of lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr⁶⁺), polybrominated biophenyls (PBB) and polybrominated diphenyl ether (PBDE) in electrical and electronic products launched on the market.

The 1st of June 2007, the EU’s decree on the chemical council, called REACH, was adopted. REACH is short for Registration, Evaluation and Authorization of Chemicals, and is a legislative demand considering chemical substances (Swedish Government). In short, REACH demands that new substances and the ones already present on the market should be registered, risk assessed and approved. REACH considers both the substitution principle and the precautionary principle, meaning that hazardous substances should be exchanged to less hazardous ones if possible and that a person carrying out an activity must take the precautionary measures needed if the activity can contribute to danger to human health or the environment. REACH is to be directly applied by the companies, which now are forced to give an account of that the substances they manufacture, release on the market and use are not hazardous to human health or the environment (Kemikalieinspektionen, 2009).

WEEE is the acronym for Waste Electrical and Electronic Equipment and is an EU directive that aims to decrease the amount of electrical and electronic waste produced in society (Europaparlamentet, 2009). If the generation of waste cannot be avoided it should be reused or recovered for its material or energy. The WEEE directive covers the following equipment areas;

- Large household appliances
- Small household appliances
- IT and telecommunications equipment
- Consumer equipment
- Lighting equipment
- Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
- Toys, leisure and sports equipment
- Medical devices (with the exception of all implanted and infected products)
- Monitoring and control instruments
- Automatic dispensers

To explicitly indicate what equipment contains a WEEE-core and therefore, should not be thrown in the bin, a common symbol have been agreed upon, see Figure 6. The symbol is a crossed-out wheeled bin and must be printed visibly, legibly and indelibly.

![Figure 6. The common symbol printed on equipment containing a WEEE-core. (Europaparlamentet, 2009)](image)

Another strategy for society is to measure and communicate the environmental situation and thereby educate and motivate citizens and companies to act. New ideas of how to measure environmental load are continuously introduced and one of the most recognized methods is called Ecological Footprint (EF). The EF measures the amount of biologically productive land and sea area an activity needs to produce the resources it consumes and absorb the waste it generates. The land and sea area needed is then compared to the actual land and sea area available (The Global Footprint Network, 2009). The EF method is widely used as a resource accounting and management tool amongst governments, businesses and educational institutions.

The Global Footprint Network gives an example by establishing that: “If everyone lived the lifestyle of the average American we would need five planets” (The Global Footprint Network, 2009). Figure 7 illustrates that if we continue our way of living we will be in need of 2.5 earths in the years 2050.
3.4 Companies’ environmental strategies

Even though the environmental awareness has increased, the concrete action taken in companies is not enough (Enell, 2009). There are all kinds of methods and tools to environmentally improve a development process, but few companies actually use them. Today, it is common for larger companies to market themselves as environmentally aware, but what is the urge to their environmental commitment? It is important to be aware of why the urge to environmental commitment arose within the company in the first place.

"Would you tell me, please, which way I ought to go from here?" asked Alice.
"That depends a good deal on where you want to get to," said the Cat.
"I don't much care where…" said Alice.
"Then it doesn't matter which way you go," said the Cat.

This quotation from the book *Alice’s Adventures in Wonderland And Through The Looking Glass* by Lewis Caroll represents the importance of ‘being aware of where you are heading’ (Caroll, 2003). If a company is environmentally profiled only to obtain credits from consumers the concrete environmental work performed will not be nearly as profitable as if the company had an actual drive and sincere motivation for the environmental work.

A company can work with sustainable development in three different ways; *reactively*, *actively* and *proactively* (Enell, 2009), see Figure 8.

![Figure 7. Possible EF development of our world in the year 2050. (The Global Footprint Network, 2009)]
Being a reactive company means that legislative demands and customer requirements are the only reason for the environmental work performed. The optional initiatives have not yet been developed in the company and the environmental work existing is separated from other fields of work.

An environmentally active company is characterized by an established environmental work with focus on both direct and indirect aspects of environmental impact. The term sustainable development is not yet integrated in the company, but the external and internal environmental communication is initialized.

In a proactive company, the environmental work is fully integrated with the additional fields of work within the company. The most important difference is that a proactive company has realized that environmental work is profitable and learned the importance of communicating the environmental work.

According to Magnus Enell, 75% of the Swedish companies are reactive, 20% active and 5% proactive (Enell, 2009). This can be interpreted as that the benefits and profitability of environmental work is not yet efficiently communicated to the companies.

According to Martin Charter and Anne Chick, our society has evolved from a mere environmental awareness to a new way of thinking (Charter and Chick, 1997), see Figure 9.
Instead of just repairing and refining products, we need to integrate environmental aspects earlier in the development process and re-design and re-think the solutions. For example, it is easier to disassemble a product consisting of various parts if the product was designed for disassembly, not just designed to be incinerated.

To re-think how a product is designed means to be aware of the entire life cycle of the product. If you, in the innovation phase of development, are aware of how raw materials will be extracted, the product will be manufactured and what the end of life phase consists of, the recycling of raw materials used in the product can be improved.

It would actually seem like we are entering an era of re-thinking, as predicted by Charter and Chick (Charter and Chick, 1997). One example of this concerns the view on life cycle perspective. The life cycle perspective of a product used to be described as ‘from cradle to grave’ and consideration were to be taken from the extraction of raw materials to the deposit of the used product. Now, ideas of another kind of life cycle perspective are in motion. Instead of following a product from cradle to grave, how about from cradle to cradle? This idea was first introduced by Walter R. Stahel and later re-introduced by William McDonough and Michael Braungart in an article and a book called *Cradle to cradle*. The authors point out that our society’s environmental work has a good thought to it, but we will never be rid of all the environmental problems with this tactic. Instead of trying to make human production and industry ‘less bad’ we need to re-think the whole concept.
“What if humans designed products and systems that celebrate the abundance of human creativity, culture and productivity? That are so intelligent and safe, our species leaves an ecological footprint to delight in, not lament?” (McDonough and Braungart, 2002)

Instead of purging the airborne emissions produced by factories, what if there were no emissions? Or even better, what if the actual emissions were cleaner than the air itself?

“Consider this: all the ants on the planet, taken together, have a biomass greater than that of humans. Ants have been incredibly industrious for millions of years. Yet their productiveness nourishes plants, animals and soil. Human industry has been in full swing for little over a century, yet it has brought about a decline in almost every ecosystem on the planet. Nature doesn’t have a design problem. People do.” (McDonough and Braungart, 2002)

Cradle to cradle challenges our way of thinking suggesting we must change the entire industrial structure, not just reduce the contributions of the environmental load caused by it (McDonough and Braungart, 2002). Even if these thoughts only may seem as future dreams, the vision itself is important.
4. Environmental methods and tools

There are numerous methods and tools to use when considering the environmental aspects of a development process. All of these methods and tools provide ideas and practical advice on how to adapt the development process to have as little impact on the environment as possible. A few examples of recognized methods and tools are presented in the following chapter of the report, structured in an order of similarity.

4.1 Environmental audit

An environmental audit describes a company’s current environmental impacts due to the entire corporate operations. The purpose of an environmental audit is to map the company’s environmental impacts and investigate how well the company fulfills their requirements from legislation. There are no standards of how to do an environmental audit but Institutet för Verkstadsteknisk Forskning (IVF) has presented a template consisting of eight steps (IVF, 2000).

The first step is to map the material flow within the factory. How large quantities of raw material, components, chemicals, packaging and other additive materials are bought? How many products are manufactured and sold? What kind of waste does the company produce? Why is the waste produced and how is it handled?

The second step consists of estimating the flow of goods and the emissions from the transports. Even the business trips and travelling to and from office should be mapped.

In the third step, the company’s electricity and heating consumption are compiled. A mapping of what kind of energy is used should be presented together with a description of the processes with extra high energy consumption.

The fourth step is to inspect which laws, regulations and other requirements that affect the company. The environmental requirements from the customers and special requirements on the product should also be identified.

In the fifth step, the company’s impacts on its immediate surroundings are inspected. The pollutants emitted to the air, ground and water should be identified and consideration should be taken to possible interrupting noises from fans or transports due to the area of work. The surrounding grounds should also be inspected for pollutants.

The sixth step is to make a list of the chemical products that the company is using to investigate if any chemicals, harmful to the environment or people’s health, are used.

The different risks due to the company’s area of work are identified and inspected in the seventh step. Examples of such risks could be fire or leakage.

In the eighth and last step the results from the earlier seven steps are compiled to a report. In the report all material and energy flows are gathered together with a list of the environmental aspects and all the proposals of improvement that has arisen during the audit (IVF, 2000).
4.2 Environmental Management System

Environmental Management System (EMS) is a method for companies to organize their environmental work so their way of working contributes to less environmental impact. There are two kinds of standards for EMS, the international ISO 14001 and the Environmental Management and Audit Scheme (EMAS) that is more common in EU. If the company fulfills the requirements in the standard it can be certified by a certifying authority. There is only a small difference between the two standards; EMAS is based on ISO 14001 but have, unlike ISO 14001, a yearly public report integrated. According to ISO 14001 the method is divided in five steps (IVF, 2000): policy, plan, carry out, follow up and attend to, see Figure 10.

![Environmental management system methodology according to ISO 14001.](IVF, 2000)

The step policy consists of making a public environmental policy to decide on which level the company wants to put their environmental work. Is the company satisfied by only fulfilling laws and requirements or do they want to be environmentally market-leading?

The step plan consists of identifying, valuing and prioritizing the company’s environmental aspects. The standard has no determined way of how to analyze the identified aspects; it is up to the company to decide how the analysis will be performed. From this analysis, the company decides which environmental aspects they should work on and how to deal with them.

Carry out is when the company actually carries out the environmental actions planned to reach their goals. Depending on what kind of company and what environmental impacts they contribute to, different approaches are needed to reach the environmental goals. One goal can be reached by giving the company’s personnel environmental
education and another goal can be reached by drawing up guidelines for the product development.

Follow up is a continuous supervision of the goal and criterion that have been established and can also function as a check point if anything has gone wrong. The company should establish routines for how to investigate and attend to faults and failures to avoid repeating them. Follow up is also a chance to make sure everyone is performing the planned actions.

According to ISO 14001, attend to is a periodic estimation of the environmental work by the management. The management should estimate if the work will give the expected result, if it can give even better results and if there is something in the approach that there is a reason to change (IVF, 2000).

4.3 Resource efficiency

All impartial future scenarios show that a radical increase of resource efficiency is needed if we should be able to sustainably supply the earth’s population with western welfare. At the beginning of the 1990’s, the Factor 4 concept was launched. The Factor 4 concept means that to keep up a sustainable western welfare throughout the entire earth, we must be four times more efficient using our resources in the next 25 years. Since then, the Factor 10 concept has evolved. The Factor 10 means that we must use our resources ten times more efficiently in the next 50 years to gain the same outcome as in Factor 4 (Swedish Council for Planning and Coordination of Research, 2000).

To work according to the Factor 4 theory, a company should prepare a plan for how to double their resource efficiency in 5-10 years. With the tool Resource efficiency, the company can present a five-step action plan for increased resource efficiency and new business opportunities.

The initialization of the work when using Resource efficiency consists of a seminar. It is important to gather people from the company’s different departments, such as; production, marketing, construction, purchase, environment, quality, personnel and management. During the seminar, the five steps are presented and discussed. The first step for the team at the seminar is to gather ideas of how to improve the resource efficiency for the chosen product. All ideas are taken into consideration and critique against an idea is not allowed (IVF, 2000).

The second step for the team is to sort the ideas according to a scheme. Every idea is then estimated in regard of the product and the daily situation. The ideas should be estimated on the basis of how the products resource efficiency, marketing value and news value would changed if the idea were carried out.

After all ideas have been estimated, the third step for the team is to choose three ideas for further consideration. The rejected ideas are documented for possible future use and the chosen ones are re-estimated. This time, the ideas are estimated according to the
company’s capacity to carry out the idea, the potential marketing value and if a competitor already has a similar idea.

The fourth step consists of valuing the ideas that have been estimated in step three. The ideas should be valued on a scale from one to five according to company suited criterions. And the fifth step is to present the estimation of every idea in a graphical scheme for resource efficiency.

After the seminar, the company, by themselves or with external supervisors, prepares a plan of action for how to perform the ideas from the seminar (IVF, 2000).

4.4 Life Cycle Assessment

Life Cycle Assessment (LCA) is one of the most established methods for estimating the product’s and processes’ environmental impacts. The first known LCA was carried out in the United States of America in the end of the 1960’s and was conducted within the field of energy consumption in chemical processes and production systems. The International Organization for Standardization (ISO) published the first version of the standardized Life Cycle Assessment methodology ISO 14040 in the year 1997 (Brohammer, 1998).

An LCA is an analysis of a product’s environmental impact during the entire life cycle, from cradle to grave. An LCA based on the ISO 14040 is divided in four parts; goal and scope definition, inventory analysis, impact assessment and interpretation, see Figure 11 (Brohamer, 1998).

![Figure 11. The four parts of an LCA according to ISO 14040 (Brohammer, 1998).](image)

*Goal and scope definition* is the part where the analysis’ purpose, extent, functional unit and target group is defined. The analysis’ extent is defined by system boundaries that regulate which processes, during the product’s life cycle, that are included in the analysis (IVF, 2000). The functional unit is established on basis of the product’s function or gain. The functional unit is the common denominator and foundation for the
calculations. Principles for possible allocations in the inventory analysis should also be defined.

**Inventory analysis**, also called energy and material flow analysis, is a systematic collection and calculation of data for in- and outflows of material and energy to the product system including metadata (Ryding et al, 1995). The in- and outflows that should be taken into consideration are the ones regarding use of energy and material, raw material choice, pollution to water, air and land, usage and other environmental impacts during the product’s life cycle (Brohammer, 1998).

**Impact assessment** is the part of the analysis where the collected data from the inventory analysis is gathered and the product’s potential environmental consequences is valued. To facilitate the valuing of the different environmental impacts the product has contributed to, the ISO-standard divides the assessment in tree parts: classification, characterization and valuing. Classification is a grouping of the results from the inventory analysis in different categories of environmental effects, for example acidification, greenhouse effect and ozone layer diluter. Characterization means that the different categories of environmental effects are multiplied with specific characterization factors. This enables a comparison amongst the different categories to see which ones have a significant impact on the environment. Valuing is when the categories of environmental impact are being weight to each other (Ryding et al, 1995).

**Interpretation** is the last part of the LCA where the results from the impact assessment are weight together to give a collected picture of the product’s total environmental impact during the entire life cycle. Apart from only interpretations of the results from the impact assessments, the analysis limitations should be evaluated and explained. The interpretations should be compiled to recommendations or enclosed summarized in the results report (Brohammer, 1998).

Since it is an extensive work to do a complete LCA there is different kinds of simplified LCA’s. A simplified LCA does not demand the expert knowledge that a complete LCA does, but it is neither as accurate. Because it is not as accurate, the analysis will not be suited for marketing but can instead be suited for intern comparison of own prototypes or products. A simplified LCA is based on compiled environmental impact points for different materials and processes. The compiled environmental impact points are based on weighting from a complete LCA, often with average data. There are a lot of different systems of compiled environmental impact points; two examples are Eco-indicator and the Swedish system Environmental Priority Strategies (EPS).

The diverse systems are based on different opinions of what a healthy environment is and the environmental impact points for materials and processes are calculated in different ways. The compiled environmental impact points in the EPS system are based on the payment will to restore or replace the caused environmental damages. Simplified LCA’s can be done by hand or with a computer program (Norrbloom et al, 2000).
4.5 MET-matrix

MET-matrix is a matrix over Material, Energy consumption and Toxic discharge. The MET-matrix can be used as an aim to survey a product’s environmental impact during the entire life cycle (Norrblom et al, 2000). It is a structured and qualitative method that is divided in four main steps (IVF, 2000); discussion about the product’s function, definition of functional unit and system boundaries, listing of information in the matrix and evaluation.

Discussion about the product’s function is a general discussion on the basis of a template checklist available for the tool.

A definition of functional unit and system boundaries is made to limit the analysis. The functional unit should be defined as the function of the product that should be analyzed. When two products are compared, it is important to have a clear functional unit so that it is the same function that is compared.

Listing the information in the matrix is when all information regarding material, energy and toxic discharges used during the product’s entire life cycle, production of material and components, manufacturing, distribution, usage and waste disposal is listed in a matrix (IVF, 2000), see Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Energy consumption</th>
<th>Toxic discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of material and components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste disposal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation of the information in the matrix is performed to identify the most significant environmental impacts (IVF, 2000).

4.6 The Ten Golden Rules

The Ten Golden Rules is a pedagogic summary of ten generic guidelines that is suitable to use in the goal and specification phase in the product development process. The Ten Golden Rules are generic and therefore, they have to be customized by every company to be company and product specific and to be useful in the company’s development process (Luttropp and Lagerstedt, 2006). The rules are organized according to a product’s life cycle and not in a priority order, see Figure 12.
The Ten Golden Rules are the following (Lutropp and Lagerstedt, 2006):

1. Do not use toxic substances and utilize closed loops for necessary but toxic ones
2. Minimize energy and resource consumption in the production phase and transport through improved housekeeping
3. Use structural features and high quality materials to minimize weight in products, if such choices do not interfere with necessary flexibility, impact strength or other functional priorities
4. Minimize energy and resource consumption in the usage phase, especially for products with the most significant aspects in the usage phase
5. Promote repair and upgrading, especially for system-dependent products
6. Promote long life, especially for products with significant environmental aspects outside the usage phase
7. Invest in better materials, surface treatments or structural arrangements to protect products from dirt, corrosion and wear, thereby ensuring reduced maintenance and longer product life
8. Prearrange upgrading, repair and recycling through access ability, labeling, modules, breaking points and manuals
9. Promote upgrading, repair and recycling by using few, simple, recycled, not blended materials and no alloys
10. Use as few joining elements as possible and use screws, adhesives, welding, snap fits, geometric locking etc. according to the life cycle scenario.

4.7 Eco Design Strategy Wheel
The Eco Design Strategy Wheel is a tool that can be used as a checklist, suited as help to get new ideas of how to improve a product to be more environmentally sound. It is
especially useful in the initial phases of the development process. The Eco Design Strategy Wheel is based on the following eight strategies (IVF, 2000): new concept development, selection of low-impact materials, reduction of materials usage, optimization of production techniques, optimization of distribution system, reduction of impact during use, optimization of initial lifetime and optimization of end-of-life system, see Figure 13.

Figure 13. Eco Design Strategy Wheel. (Matbase, 2009)

Each of the eight strategies has a list of proposals and possibilities of how to improve a product environmentally. When a new product idea comes up, the lists can be used as a checklist to compare if the new idea, through the proposals, is more environmentally sound than the previous product (IVF, 2000).

4.8 Chemical lists

Chemical lists are, as the name indicates, restriction lists of chemicals. There are lists of chemicals that are not allowed to be used in the production, called black lists, and chemicals that should not be used if they could be exchanged for a better alternative, called grey lists. There are also white lists containing materials which are preferable to use. The Volvo concern is well known for their black, grey and white lists and many companies have emanated from these lists when constructing their own lists (Norrblom et al, 2000).
4.9 Environmental Effect Analysis

Environmental Effect Analysis (EEA) is a qualitative method that sometimes also is called Environmental Failure Modes and Effects Analysis (FMEA). The aim of an EEA is to, early in the development process, try to compile and prioritize the work areas to reduce the product’s environmental impacts. The method is not based on objective environmental impact numbers but on a group of people valuing different environmental aspects. Therefore, it is important that these people have a good competence both within the environmental area, the product itself and the field of production (IVF, 2000).

An EEA starts with a definition of the goal and system boundaries for the analysis and the product’s function. The next step is to assign the people that will be integrated in the cross functional team which will value the different environmental aspects. To obtain sufficient competence both within the environmental area, the product itself and the field of production the team should consist of people from different departments, such as; construction, production, marketing, purchase, service, recycling and waste management.

When the cross functional team is appointed, the work with identifying all product related environmental requirements is initialized. The product’s life cycle should be identified and illustrated in a process tree – a flow scheme for the processes in the product’s life cycle. Afterwards, the environmental aspects during the different phases of the product’s life cycle are identified and documented in an EEA-matrix (IVF, 2000), see Table 2.

<table>
<thead>
<tr>
<th>Nr</th>
<th>Life cycle phase</th>
<th>Activity</th>
<th>Aspect</th>
<th>Impact</th>
<th>seriousness</th>
<th>Requirement</th>
<th>Impact</th>
<th>Priority</th>
<th>Possible measures</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The importance of the environmental aspects are valued in three steps according to how serious environmental impact the environmental aspects can cause, a comparison with the identified requirements from authority, market and intern legislations and in consideration to the opportunity to improve the actual environmental aspect. A final contour from the three valuing steps presents the environmental aspect with greatest importance (IVF, 2000).
4.10 Environmental labeling type I and II

There are three types of environmental labeling, type I, II and III. Type I is the environmental labeling that the consumer can see on the products in a store. There are various type I labeling such as; EU Ecolabel, Rainforest Alliance Certification, Energy Star and Swedish labeling called Svanen and Bra Miljöval. The criterion to obtain a type I environmental labeling are set by an organization, which also grant the labeling of a product after an application from the company. The criterion is often based on a life cycle assessment (Moberg et al, 1999).

The type II labeling is an internal labeling and therefore, there is no external review. It is the company itself that sets the criterion and grants themselves the labeling. This kind of labeling is often used as a mean to emphasize separate products from the entire internal product span (Moberg et al, 1999).

4.11 Environmental labeling type III – Environmental Product Declaration

Environmental Product Declaration (EPD) is an ISO 14025 certified environmental product declaration that declares a product’s environmental characteristics. To obtain a certified declaration, the declaration has to be reviewed and certified by an external and objective third part. The EPD is based on information from an LCA, where the product’s environmental impact during the entire life cycle is taken into consideration (IVF, 2000).

The process of performing an EPD can be divided into eight steps (IVF, 2000); bring up proposals of product specific rules (PSR), hold an open support meeting, PSR approves, an LCA is carried out, EPD is drawn up, LCA is reviewed, EDP is certified and EPD is registered.

Proposals of PSR can be conducted by several companies producing similar products, together with the industry organizations or by a particular company alone. An open support meeting is held for purchasers, consults, researchers, wholesalers – people who in the future can have a connection to the EPD. The meaning of the meeting is to gain an approval of the PSR and to present a proposal of the EPD´s design. The proposals of PSR approves after a review by a technical committee from the Swedish Environmental Management Council. An LCA is often carried out parallel with the PSR decision, because it is the most time-consuming part of the process of doing an EPD and the LCA can give valuable information for how the PSR should be drawn up. The EPD is drawn up in agreement with the directions of how an EPD should be designed. The LCA is reviewed so it fulfills the requirements of how an LCA should be performed on the basis of ISO 14040-43; it is reviewed by a certifying authority. The LCA should also fulfill the established PSR for the product. The EPD is certified by an accredit certifying authority that review the EPD so it fulfills the laws and regulations. The company should have routines to keep the information in the EPD updated. Finally, the Swedish Environmental Management Council registers the EPD and makes it public on the Internet (IVF, 2000).
5. Presentation of DCS 015

This part of the report covers information on DeLaval’s development model DCS 015, its structure, logical disposition and process map. All information and figures presented in this chapter is collected from DeLaval International AB.

DeLaval Corporate Standard 015 (DCS 015) is the development model used at DeLaval. This development model is used in all development projects within DeLaval, indifferent to location and country. DCS 015 is a web based tool accessible at the DeLaval Intranet and structured as a stage-gate model. A stage-gate model is a development process designed for turning a project from idea to product launch. A stage-gate model consists of different stages and gates. Each stage consists of different defined actions which the project team has to execute before proceeding to the following gate. Gates are meetings where a designated management group verifies if the project fulfills the gate demands. The management group decides whether the project should continue to the next stage or if some actions have to be performed again before continuing with the project.

There are six main stages in DCS 015 called; generate idea, formulate concept and prove feasibility, develop product, create solution, launch solution and post launch management, see Figure 14.

![Figure 14. The stage-gate structure of DeLaval development model DCS 015.](image)

At the moment, DCS 015 is being updated, contributing to that the stages develop product and create solution will be combined in one step, called develop solution. This will however, not affect this master thesis thus the environmental aspects needs to be considered in an earlier stage of the process. Therefore, the previous version of DCS 015 will be described in the following parts of the report.

5.1 Structure

DCS 015 is structured as a stage-gate model, where demands at a gate must be fulfilled before the project can continue to the next stage. DCS 015 contains six stages which are to be performed in a predetermined order. Each stage consists of a detailed flow chart, describing what work needs to be done, in what order and which documents are needed. Four of the stages are individual projects with gates represented by decision points.
In the stage *generate idea*, the objective is to capture, evaluate and filter out potential business propositions. The required documents in this stage are idea description and business proposal.

The following stage is *formulate concept and prove feasibility* where a business case is built and its risks are reduced by the selection of concept for product, market and supply chain. The documents required are; marketing plan, requirement specification, design specification, supply chain concept specification, marketing plan, high level launch plan and business case.

The next stage is *develop product* where the stakeholder’s requirements are fulfilled, ready to ship according to forecast. The required documents are; test specification, product documents, test report, major investment decision (tool decision), inspection report, pre-series decision, pre-series report and release from develop product.

In the stage *create solution* the product offering is dressed with a verified marketing package ready to launch. Required documents are; marketing plan specification, sales promotion brief, marketing plan final, pilot report and release from create solution.

The stage *launch solution* contains information on how to make the developed solution available to the sales companies and local sales organizations and have it ready to take orders and install. The required documents are; launch plan, checklist launch solution, sales company forecast and launch result.

The stage *post launch management* consists of information on how to analyze the project and eventually close it.

At the present, no environmental aspects at all are integrated in DCS 015. In the previous version DCS 010, which was taken out of use the 1st of January 2009, some notations as to ‘consider the environment’ existed, but there was no concrete information on how to actually consider the environment.

### 5.2 Logical routing

DCS 015 is structured as a flow chart in four different levels with logical circuits to enable the process to proceed. In all levels, there is a start and end point, and the activities between them can be approached in four different ways called; *sequential routing, parallel routing, conditional routing* and *iterative routing*. The green boxes in the figures represent tasks and activities.

*Sequential routing* is the simplest routing, represented by a straight path where all activities should be performed from start to end. First task A then B and then C, see Figure 15.

![Figure 15. The logic of sequential routing.](image-url)
Parallel routing means that two or more tasks can be executed in an optional order or simultaneously. The parallel tasks do not affect each other, but all parallel tasks must be completed before the process flow continues. The tasks A and B should be performed in any order, see Figure 16.

Figure 16. The logic of parallel routing.

Conditional routing indicates a choice between different paths in the process flow, a choice between the tasks A and B, see Figure 17.

Figure 17. The logic of conditional routing.

Iterative routing indicates that a task should be performed until a condition is satisfied, see Figure 18.

Figure 18. The logic of iterative routing.

These four routings are the only possible ones when orientating through the flow chart in DeLaval development model DCS 015. An example of the flowchart in DCS 015 is illustrated in Figure 19. The figure contains examples of sequential and iterative routing.
Figure 19. Part of the flow chart structure in DeLaval development model DCS 015.
6. Findings from the interviews within DeLaval

During the master thesis, eight employees at DeLaval were interviewed to investigate whether environmental aspects have been integrated in the development process and how the practical environmental work is carried out. For a list of the people interviewed see the reference list. All the interviewed employees have different positions within DeLaval and have a different view on the daily environmental work. In addition, two separate interviews with focus on environmental management have been conducted. The result has been divided into five parts regarding the development model, environmental methods and tools, environmental priorities, environmental awareness and environmental management.

6.1 DCS 015

In DCS 015 there are no specific decision points regarding environmental considerations. The only stage consisting of environmental aspects is the formulate concept and prove feasibility, in the part where materials are chosen. All of the interviewed employees believed that environmental aspects should be implemented as early as possible in the development process, as the greatest chance to affect the outcome is in the beginning of a process. All of the interviewed employees thought that a first environmental decision point should be placed in the formulate concept and prove feasibility stage. One employee thought that environmental aspects should be implemented in the sub-operation part evaluate concepts. In that part, concepts are evaluated with regard to estimated development, product costs and concept risks and therefore, it should be natural to include environmental aspects in the concept evaluation.

6.2 Environmental methods and tools

A majority of the interviewed employees mentioned that DeLaval are certified in two management systems, ISO 14001 that is an environmental management system and ISO 9001 that is a quality management system. The only environmental tool that employees mentioned being used at DeLaval was the DeLaval black and grey lists which designers use in the stage formulate concept and prove feasibility as well as a document regarding environmental legislative demands. The DeLaval black list is a list of materials that are not allowed to be used and the DeLaval grey list is a list of materials that should be avoided if any alternative material, with a lower environmental impact, can be used instead. The document regarding environmental legislative demands affecting DeLaval is called AQ0008-02(02) and, according to one of the interviewed employees, is poorly updated and nearly impossible to find.

A majority of the interviewed employees also mentioned the method Life Cycle Assessment (LCA). LCA is not used in the development process at DeLaval. However, in 1999 a master thesis consisting of an LCA of a liner was performed. According to two of the employees, a result of the master thesis was that it was very time and
resource demanding to perform an LCA and that this contributed to the fact that DeLaval performed no further work with the LCA method.

All of the interviewed employees agreed that an environmental tool should be designed as clear and easy as possible in order for anyone to be able to use it intuitively. Two of the interviewed employees thought that no education should be needed before using such a tool, a short introduction should suffice. According to a majority of the interviewed employees, a useful tool should also be easily accessible and preferably measurable too.

One of the interviewed employees mentioned a tool used for choosing materials. The materials were chosen with regard to consumption and cost and the employee explained that although no environmental consideration was integrated at the moment it could be a future upgrade for the tool.

One of the interviewed employees mentioned the tool FMEA (Failure Modes and Effects Analysis), a tool which is used at DeLaval in risk analyses of development projects. Since the employees are already comfortable with performing an FMEA, environmental aspects could be integrated in the tool as well. According to the interviewed employee, this would be easier than introducing a completely new environmental methodology.

6.3 Environmental priorities

The legislative demands affecting DeLaval which were mentioned during the interviews were REACH, RoHS, WEEE and individual legislative demands from the countries which DeLaval operates in. A company called Teknikföretagen surveys new legislative demands from the EU and arranges seminars and provides education when a new demand affects DeLaval.

The view on motivation for corporate environmental practice varies amongst the interviewed employees. A majority of the employees believe that it is DeLaval’s reputation as a company contributing to a sustainable way of life that motivates the corporate environmental work. Other motivators mentioned were demands from customers and laws, public opinion, cost efficiency, commitment of project managers and unit managers and finally the belief that the environmental work will be needed in the future. According to one of the interviewed employees, the management has stated that financial issues always will be given a higher priority than environmental ones and that employees will not be rewarded for environmentally sound work if it is not requested. This statement can be verified by the environmental revision performed by VEGA in 2008. One of the interviewed employees expressed that the CEO and management only show interest in Sustainable Dairy Farming (SDF) when it is profitable for the company while others claim that the Rausing family’s commitment motivates the environmental work throughout the company.
A majority of the interviewed employees believe that energy consumption and water usage are the focus areas which contribute to the greatest load on the environment and should thus be prioritized in the environmental work. Other focus areas mentioned were heavy metals, material consumption, material recycling, rubber, detergents, methane, chemicals, steel and waste. One of the employees interviewed pointed out that the official answer should be water, energy, methane and waste, since the environmental pillar of SDF mentions these four areas. Before SDF was defined within DeLaval there was an environmental project called Eco Blue. Eco Blue was a program to spread knowledge, invent ideas and develop environmentally sound products. The four focus areas from the environmental pillar of SDF were agreed upon in the Eco Blue project but no actual measuring was performed.

All employees interviewed expressed that it would be preferable with measurable results of the environmental work, and to make this possible environmental indicators are needed. One of the employees thought it would be good to connect the environmental indicators with the focus areas and describe the environmental work with regard to water usage and energy consumption. Another employee wanted all products to be environmentally described with the environmental pillar of SDF; water, energy, methane and waste. One employee mentioned that the environmental load caused by a product could be measured per liter of milk to make the result comparable.

6.4 Environmental awareness

To communicate the environmental work for the Tumba site, the management performs an environmental survey twice a year. At the first survey meeting, the site’s environmental goals are presented and at the second, a follow up of the goals is reported. This is a demand to retain the ISO 14001 certification. Another demand to retain the certification is to environmentally educate all employees in a certified corporate operation. This however, was an ISO 14001 review area that DeLaval Tumba received a remark upon in the latest revision. In December 2009, an Environmental and Social Report will be published for DeLaval, which will be used for both internal and external communication. Environmental work is also communicated through the Intranet, a BI monthly report and a strategic plan.

A majority of the interviewed employees found it hard to navigate on the Intranet and, when asked to, cannot find the relevant environmental information. According to one of the interviewed employees, the documents related to environmental work need to be connected with DCS 015 so that they are easier to find and the information in the documents needs to be audited.

Most of DeLaval’s environmental work is performed under the name of SDF. A majority of the interviewed employees were unaware of the definition of SDF and thought that SDF had nothing to do with their daily work. The person responsible for SDF clarifies that the work performed within SDF is closer to the customers’ operation than DeLaval’s own and that it is a vision to strive towards, not a goal that can be
readily achieved. Parts of DeLaval have been very provincial and therefore, the environmental work has been described for each facility, instead of globally. One of the employees thought that the SDF logo was an internal environmental labeling connected to low energy and water usage but according to the person responsible for SDF this is incorrect. The SDF logo is only a communication tool and not an environmental label.

The environmental awareness within DeLaval varies with the position of the employee. The interviewed employees with higher positions and an environmental responsibility believe that the environmental awareness is widespread throughout the entire company. According to the interviewed employees with lower positions however, the common knowledge of environmental aspects is low. They felt that the environmental aspects were not low enough on Maslow’s hierarchy of needs and that additional environmental work would be too time-consuming. One of the interviewed employees thought that the best solution would be to hire a consultant to work only with environmental aspects in all development projects. The interviewed employees with environmental responsibility however, thought that the designers and developers should know environmental aspects as well as milking, electronics or any other field relevant to the project. A majority of the interviewed employees agreed that the environmental work, primarily goals and results, needs to be communicated more actively through meetings, presentations and reports. One employee mentioned that the work with SDF is neatly wrapped and works well externally but internally it is too abstract to provide useful information in the daily work. A majority of the interviewed employees felt that to increase the environmental awareness throughout the company a personal commitment from the management is needed.

6.5 Key findings regarding product development within DeLaval

The key findings regarding the interviewees’ view of product development within DeLaval are presented below.

- Environmental aspects should be implemented as early as possible in the development process
- A first environmental decision point could be placed in formulate concept and prove feasibility
- An environmental tool should be intuitive, simple and provide a measurable result
- Environmental documents are hard to locate and have inconsequent names
- The document regarding legislative demands needs to be reviewed regularly
- Environmental work could be communicated through meetings and presentations
- The management needs to be more environmentally committed and motivate the employees in environmental work
6.6 Environmental management within DeLaval

The interviews regarding environmental management at DeLaval have been executed with the Quality and Environmental Manager for the Tumba site Kenneth Hermansson, the Process Manager of Develop and Maintain solutions for DCS 015 Mikael Gissleghård and the Manager of the Sustainable Dairy Farming Office Jan Agri.

According to Mikael Gissleghård and Jan Agri, the management has a strong commitment to environmental work as a part of the SDF initiative. (Agri and Gissleghård, 2009). Mikael Gissleghård said (translated from Swedish): “The problem is not money or resources” (Gissleghård, 2009). He went on to state that DeLaval still has a lot to learn about how to address environmental aspects in research and development projects and that this lack of know-how had contributed to making the progress of 2009 slower than expected. Jan Agri stated that by keeping the research and development budget for the development of more sustainable solutions in a year when DeLaval had to dismiss a large number of employees, top management had clearly showed that they viewed environmental work as important (Agri, 2009). Other employees on the other hand, did not perceive the management’s environmental commitment as being strong.

Mikael Gissleghård stated that (translated from Swedish): “To be able communicate there has to be a substance to deliver” (Gissleghård, 2009). Both communication and education are tools that need a substance behind them. At the moment, Kenneth Hermansson is planning an environmental education for new employees and employees that have not yet attended an environmental education. The education will contain fundamental information about ecology, environmental threats, environmental management systems and what environmental work is being carried out at DeLaval. Kenneth Hermansson believes that the employees have more fundamental knowledge about the environment nowadays than a couple of years ago due to that the subject getting more medial exposure. Therefore, Kenneth Hermansson is trying to mediate a wider environmental focus area during the education. An external consultant will be hired to talk about fundamental information regarding the environment, Kenneth Hermansson will talk about his environmental work at the site in Tumba and Jan Agri will contribute to the education and by talking about DeLaval’s work with SDF. Kenneth Hermansson has expectations for further education in the future; he would like to have specific educations for different occupational groups such as construction, production and purchase. Kenneth Hermansson hopes that in the future there will be enough funds and resources to execute environmental educations 2-3 times a year.

According to Jan Agri, goals regarding waste, water and energy consumption for DeLaval’s facilities have recently been developed (Agri, 2009). Kenneth Hermansson believes that all departments of the company should have individual environmental goals. Kenneth Hermansson also indicated that the goals should be divided into concrete tasks for the employees so that everyone can contribute to reach the goals (Hermansson, 2009). At the production department, costs for quality deficiency and re-assembling are measured and the goals and actual costs are presented to the employees at a monthly
meeting in the factory. Kenneth Hermansson asserts that environmental goals can be measured and reported in a similar way.

At the moment, no specific meetings regarding environmental questions, apart from meetings on ISO 14001, exist at DeLaval. According to Jan Agri and Mikael Gisslegård, there are too many areas that managers should communicate to the employees, which makes it difficult to demand extra focus on environmental work from the managers (Agri and Gisslegård, 2009). Kenneth Hermansson thought that a special forum for environmental questions would be preferable. He emphasized that DeLaval could profit from implementing an environmental council with representatives from each of the company’s departments. The representatives would act as the departments environmental coordinators and have the responsibility to communicate the information from the meetings to the other employees (Hermansson, 2009).

The employees at the factory in Tumba have a proposal activity for environmental improvements; they can provide ideas or proposals on how to reduce material use or other things resulting in less environmental impacts. At the moment, the proposal activity is poorly used but Kenneth Hermansson believes that if environmental aspects were a natural part of the daily work, the employees can provide important proposals (Hermansson, 2009).

6.7 Key findings regarding environmental management within DeLaval

The key findings regarding the interviewees’ view of environmental management within DeLaval are presented below.

- All of the available budget for the development of more sustainable solutions was not used in 2009
- According to Mikael Gisslegård, DeLaval still has a lot to learn about how to address environmental aspects in research and development projects
- Insufficient environmental education, as it was not offered in English nor adapted to different occupational needs
- Insufficient communication flow between managers and employees, as what is communicated by the top management was sometimes unknown by the interviewees
7. Findings from the external interviews

During this master thesis, employees at external companies have been interviewed to investigate how environmental aspects have been integrated in their development processes and how their practical environmental work is carried out. In addition, two separate interviews with focus on environmental management have been conducted. The result has been divided into five parts regarding the development model, environmental methods and tools, environmental priorities, environmental awareness and environmental management. For a full list of the employees and companies interviewed, see the reference list on oral references.

7.1 Development process

All of the interviewed companies, except ABB and ÅF, work with stage-gate processes. ABB works with a gate-process with 6-7 gates. The working process between the gates is not controlled as in a stage-gate process. The project leader is responsible for organizing the work so that the gate-demands are fulfilled, which will allow the team to proceed with the work. In gate 1 and 2 ABB have a checklist to secure that the environmental work has been performed. Because ÅF is a consultancy firm they do not have a development process of their own, instead they adapt to their customers processes.

ITT W&WW have a stage-gate process with six gates. They make an environmental consequence analysis in stage 2 which is then controlled in toll gate 2. Christian Wiklund at ITT W&WW thinks it would be a good idea to take the environmental aspects in consideration already in gate 1 (Wiklund, 2009). Vattenfall and Volvo Trucks integrate environmental aspects as a decision point in all the gates.

A common opinion among the interviewed companies was that environmental aspects should be taken into consideration as early as possible in the development process. In the beginning of the project, the possibility to affect the result is better. Per Stoltz at IKEA thinks the environmental aspects should be taken into consideration when the project is defined (Stoltz, 2009). Both Magnus Enell at Vattenfall and Lars Mårtensson at Volvo Trucks think that environmental aspects should be taken into consideration during the entire process (Enell, 2009 and Mårtensson, 2009).

7.2 Environmental methods and tools

One tool that all of the interviewed employees mentioned was Life Cycle Assessment (LCA). The common opinion of LCA was that it is a time consuming tool that requires proficient personnel. Several of the interviewed companies have performed a complete LCA for a standard product to find out where, during the products life cycle, the significant environmental load can be identified. Vattenfall was the only company that made complete LCA’s for products during the development process. Some of the other companies made simplified LCA’s for products or components during the development
process. The results were used as an internal comparison to previous products. For example, ÅF is using a simplified LCA-tool called EcoScreening and The Natural Step is using a simplified LCA-tool, which is called Sustainability Life Cycle Analysis (SLCA).

All of the interviewed companies, except IKEA, are certified by the international standard ISO 14001. IKEA has chosen not to be certified by any environmental management systems. Per Stoltz at IKEA said (translated from Swedish): “We do not want the environmental work just to be a document that shows we are certified, we want the environmental work to be considered at all times” (Stoltz, 2009). Some of the companies are also certified by the international quality standard ISO 9001 and the Euro directive Eco Management and Audit Scheme, also called EMAS. EMAS aims to create a more effective and improved environmental work at companies and also to transmit a credible message to the market through an approved environmental accounting. ABB, ITT W&WW and Vattenfall are also certified according to the international standard ISO 14025. That is a standard that establishes the principles and specifies the procedures for developing Type III environmental declarations, so called Environmental Product Declarations (EPD). EPD is used to communicate a product’s environmental performance.

Different types of chemical lists are used as a tool by all of the interviewed companies, except Vattenfall. ABB, Alfa Laval, IKEA and ITT W&WW have black and grey lists. The black list consists of materials not allowed to be used in products. The grey list consists of materials which should be limited in use or replaced by another material if possible. Volvo Trucks also works with black and grey lists but in addition, they have a white list. The white list consists of materials that can be used to replace materials on the black or grey lists. Electrolux have a restricted material list, which consists of materials that they classify as; banned, restricted and substances of concern.

At Electrolux a document called Environmental guidelines is used during the development process. The document consists of guidelines for how to produce a product with low environmental impact during the entire life cycle. IKEA have a similar tool which is called the Strategy tool. The Strategy tool is used in the beginning of a project during the idea generation phase. It consists of eight points to consider when producing a product with low environmental impact. The eight points are in consideration of choosing materials, using smart production and considering the product’s usage phase and recycling. IKEA also works with an assessment tool during the project. The assessment tool is used to make sure that as low a quantity of materials as possible are used without consequences to the product’s quality or life span.

ABB have a checklist with five points which is used to make sure that the project’s environmental work has been carried out properly. The five points are as follows; check against the black and grey lists, check laws and requirements that affect the product,
define risks, check the energy efficiency and see if there are any questions about the end-of-life phase of the product.

Electrolux and IKEA make a risk analysis with environmental aspects in the beginning of the project and continue to work with it during the entire project. At Volvo Trucks, the designers work with representatives from other parts of the company performing an Environmental Effect Analysis (EEA) as an inventory of the products environmental aspects.

A common opinion among the interviewed employees is that a useful environmental tool should be so intuitive and easy to use that anyone can do it without previous education. Another reason to why the tool should be intuitive is due to the fact that complicated tools lead to decreased usage. Lennart Swanström at ABB thought a simple and useful tool should be designed like a checklist (Swanström, 2009). A useful tool should also be more inspiring than controlling. Per Stoltz at IKEA mentioned that an environmental tool should indicate the effect of the environmental work to the employees (Stoltz, 2009). This will contribute to employees feeling what difference their environmental work leads to. Another common opinion was that the tool should be based on life cycle thinking. Petter Svanbom at Electrolux emphasized that it is important that environmental aspects are at the same precision level as other aspects of the same stage in the development process (Svanbom, 2009).

### 7.3 Environmental priorities

The legislative demands on the interviewed external companies differ depending on what kind of products the companies are producing. For example, Volvo Trucks have legislative demands from Euro directives on emissions and noise produced by their trucks. A majority of the external companies were affected by the Euro directives REACH and WEEE and therefore, adapted their chemical lists to match the directives. In addition to REACH and WEEE, Electrolux and ITT W&WW were also affected by the RoHS directive. Petter Svanbom at Electrolux mentioned that in the field of dish washers, no further environmental progress will occur without stricter legal demands. No profit will be gained by being environmentally superior to the competitors, but much can be lost by not being equally good (Svanbom, 2009).

The motivation for corporate environmental practice differs between customer demands, legal demands, image profit and a genuine will to contribute to an improved environment. All of the interviewed companies are affected by legal demands but ABB, Alfa Laval and Volvo Trucks are also affected by customer demands. A majority of the interviewed companies agreed on the importance of having an environmentally committed management to actually make progress in the environmental work. The environmental commitment will only permeate the company if the management emphasizes the importance of environmental work through their own actions. All companies find a profit gain in profiling themselves as environmentally aware and for some companies this is enough motivation to initialize the environmental work.
However, it is important to make environmental work profitable; otherwise it will not be executed on a long-term scale.

A majority of the interviewed external companies agreed on energy efficiency and carbon dioxide footprint being two major focus areas for the company’s environmental work. Alfa Laval, Electrolux, IKEA and Vattenfall also agreed on that the use of materials, chemical substances and resources are an important part of the environmental work. The importance of the focus areas differ with what kind of products or services a company develops. For a company like IKEA, the greatest environmental load is generated by the products themselves. A majority of IKEA’s products consist of furniture and interior design and therefore, the use of materials and resources must be considered during the development process. For a company like ABB or Alfa Laval, the product portfolio consists of products such as engines, transistors and heat exchangers and therefore, the product’s energy usage during the usage phase contributes to the greatest environmental load.

When measuring the environmental load caused by a product the indicators for environmental load must first be identified. A majority of the interviewed companies have used LCA to identify these indicators. An LCA can present information on which product phase that contributes mostly to the environmental load caused by the product and thereby, indicate where the environmental work initially should be performed. By using this method, ABB, ITT W&WW and Electrolux have identified that the usage phase causes the greatest environmental load for their products. However, the result of this method greatly depends on the functional unit chosen for the LCA. To be able to fully compare products by the results of an LCA the functional units of the products need to be the same. According to Lennart Swanström at ABB, Göran Finnveden has said that (translated from Swedish): “An LCA can never tell you that one product is better than another but if you are aware of this, you can use the LCA as a comparative tool” (Swanström, 2009). This means that an LCA is a good comparative tool if the analysis is performed in the same way both times and the products have the same functional unit. At ÅF, a method called EcoScreening is used to identify related indicators. Exactly how the EcoScreening is performed is confidential, but it works like a simplified LCA to scan the entire life span of the product. Some of the indicators identified by the external companies are carbon dioxide, materials, energy, water usage, toxicity and resource depletion. The importance however, always seems to be that a new product must be superior to the older version when comparing them using of the indicators.

7.4 Environmental awareness

To communicate the environmental work ABB, Alfa Laval, ITT W&WW and Volvo Trucks produce a sustainability report each year. A sustainability report covers the company’s sustainability performance during the entire year and can easily be presented both externally and internally. At ITT W&WW, Vattenfall and Volvo Trucks,
environmental performance is communicated by EPD according to ISO 14025. Each product is described by an EPD and the EPDs can then be internally compared to communicate which product is the most environmentally sound one. At ABB, IKEA and Volvo Trucks the internal communication is mainly executed by human contact via meetings and presentations. Furthermore, at IKEA the employees are invited to information meetings, workshops and exhibitions to raise their environmental knowledge and ambitions. At Vattenfall, internal environmental education is an important part of the environmental communication.

At ITT W&WW environmental work is documented in the same system as all other information within the company. At Volvo Trucks on the other hand, a separate support system exists where environmental work is documented. All environmental work is communicated externally to customers and authorities but most importantly it is communicated internally to the employees. This communication ensures that employees are aware of what environmental work is carried out and this will create a better understanding and commitment throughout the company. IKEA agrees with these values and emphasizes the importance of giving employees feedback on their environmental work and having a committed management. According to Per Stoltz at IKEA (translated from Swedish): “The environmental work has to start internally, within the company itself. Every employee must make the right choices to ensure that the company’s work is sustainable” (Stoltz, 2009).

To work with environmental questions can either be a relative or an absolute work. At Alfa Laval, the environmental motto goes: “Create better everyday living conditions” and Björn Wilhelmsson at Alfa Laval feels satisfied with the environmental work carried out today (Wilhelmsson, 2009). Therefore, the environmental work at Alfa Laval is absolute. At ABB, IKEA and ÅF the environmental work, on the other hand, is relative. Lennart Swanström at ABB said (translated from Swedish): “To work with environmental questions signifies striving towards a more environmentally sound product – the environmental concept is always relative” (Swanström, 2009).

At Electrolux, efforts are made to give the consumers power to affect the environment through their own choices. There is often an ‘eco’ button on a dishwasher which enables a user to get the dish washed over a longer period of time but at a lower temperature. IKEA is also working on giving the consumers tools to change their own actions towards a more sustainable environment. At the moment, box systems to simplify the sorting of household waste and low-energy bulbs are available at the department stores. At Electrolux, the cost is decisive in the choice of materials but ideas on presenting a product portfolio with ‘green’ products consisting of recycled materials exists. In a best case scenario, the company’s entire product portfolio would be ‘green’ but at the moment, the work has to start with a ‘green’ product section for the consumers who are willing to pay extra. IKEA agrees with these thoughts but emphasizes that a company must strive to present a ‘green’ product portfolio for the entire company, it will not do with only a ‘green’ section.
Jessica Lagerstedt Wadin at ÅF said (translated from Swedish): “You need knowledge to make a decision and therefore, the management is utterly important” (Lagerstedt Wadin, 2009). To change the managements view on environmental work it is advantageous to find ‘champions’ within the company. A ‘champion’ is an environmentally enthusiastic person with a rather low corporate position. These ‘champions’ can be the environmental ambassadors within the company and affect the management to produce a strategic plan for the environmental work.

During the external interviews the importance of communication, management commitment and environmental goals have lead to the conclusion that something more than an environmental tool is needed to successfully integrate environmental aspects in a company. An environmental tool, regardless of how superior it is, will not have any effect on the company’s environmental work if the employees lack the essential knowledge and motivation to use it. Knowledge and motivation are factors which can derive from accurate management and therefore, additional interviews within the field of environmental management were performed.

7.5 Key findings regarding product development from external companies

The key findings from the external interviews regarding product development are presented below.

- The environmental aspects should be taken into consideration as early as possible in the development process
- An environmental tool should be intuitive and easy to use, more inspiring than controlling and indicate the effect of the environmental work
- An environmental tool could be based on life cycle thinking
- The environmental aspects should be at the same precision level as other aspects attended to at the same stage in the development process
- The management’s environmental commitment is important to the company’s environmental work
- The environmental work must be profitable
- A new product should be superior to the older version when comparing them in regard of the environmental indicators
- Internal environmental communication is important to motivate the employees
- Give the consumers power to affect the environment through their own choices
- ‘Champions’ within the company could be used to motivate the environmental work
- To successfully integrate environmental aspects in a company, a combination of an environmental tool and environmental management is needed
7.6 Environmental management

During the previous interviews, the importance of corporate environmental management was emphasized and two additional interviews were conducted. This part of the chapter covers the result from the external interviews in the field of environmental management. Information on what environmental management is, why it is important and how a company can implement it are presented.

According to Jonas Oldmark at The Natural Step, it is a corporate responsibility to secure that the company belongs in a sustainable future by striving towards it (Oldmark, 2009). Jonas Oldmark mentioned that (translated from Swedish): “A company needs to combine the customer’s benefit within the frames of what is environmentally and socially sustainable” (Oldmark, 2009). To secure that the corporate business is within these frames, The Natural Step uses four system conditions which can be defined as follows (The Natural Step, 2009): “In the sustainable society, nature is not subject to systematically increasing; concentrations of substances extracted from the Earth's crust, concentrations of substances produced by society and degradation by physical means. In that society people are not subject to conditions that systematically undermine their capacity to meet their needs”.

Our society’s development is not sustainable and people are, according to Jonas Oldmark, growing aware of this (Oldmark, 2009). Soon it will not be acceptable to drive a SUV or depend on German coal power plants for providing power to the company’s production. Hence, it is important for companies to identify the caused environmental load and take action in a proactive way.

Annika Skoglund at Industrial Economics and Organization emphasized that it is important to combine environmental tools with environmental management (Skoglund, 2009). The right mixture will contribute to a more efficient environmental work. The environment is important to the private life of the employees and, according to Annika Skoglund, it is individually important to work at an environmentally profiled company (Skoglund, 2009). She also mentioned that (translated from Swedish): “The best future engineers will be attracted by a company with serious environmental work” (Skoglund, 2009).

To implement environmental management in a company, both Jens Oldmark and Annika Skoglund agree that the management is crucial (Oldmark, 2009 and Skoglund, 2009). The management needs to show that environmental work is important and provide the employees with data on work progress and results. This kind of behavior from the management will motivate the employees and create a commitment throughout the company. To obtain a committed management Jonas Oldmark mentioned that the management could be exposed to good examples of environmental work and how new possibilities can be developed from these (Oldmark, 2009). Environmental management systems are not enough – environmental work needs to be integrated in the company’s strategies and be visualized in concrete action plans.
To be able to communicate the environmental work within the company, a common language is needed. Jonas Oldmark mentioned that a common environmental education with focus on society and the company could provide this (Oldmark, 2009). Both Jonas Oldmark and Annika Skoglund agree that an environmental education needs to be concrete and adapted to each individual employee to be efficient (Oldmark, 2009 and Skoglund, 2009). The education could be managed by an external consultant as long as the wider picture is mediated – society, the company and the individual employee. Annika Skoglund further mentioned that to secure that the environmental education is being conformed to, a reward system or individual reporting system could be implemented (Skoglund, 2009). The most efficient system would be if the employees realized that the environmental work is important and tried to carry out the environmental work themselves.

According to Jonas Oldmark, a company needs competence to communicate the environmental work and motivation to keep up the good work (Oldmark, 2009). The management must see to this.

7.7 Key findings regarding environmental management in the external companies

The key findings from the external interviews within the field of environmental management are presented below.

- It is important to combine environmental tools with environmental management
- The management is crucial when implementing environmental management in the company
- The management’s actions need to show that environmental work is important
- A common environmental language is needed within the company
- Environmental education needs to focus on society, the company and the individual employee
- A reward system could be implemented to secure that the environmental management is being conformed to
8. Analysis of findings – environmental methods and tools

This part of the report covers the results from the interviews and literature study regarding environmental methods and tools. The results have been divided into three parts: evaluation of environmental methods and tools, proposal of environmental methods and tools and integrating environmental methods and tools in DCS 015.

The environmental aspect of product development is a new field within the area of business operations and there is still additional progress to be made. According to Lennart Swanström at ABB, the current environmental methods are more theoretical than practical and therefore, more academically designed than adapted to work practically in corporate operations (Swanström, 2009). At the same occasion, Swanström mentioned that the environmental question has been made more difficult than it actually is and that there is a general overconfidence in methods and tools. According to Swanström (translated from Swedish): “Environmental tools cannot be expected to provide a solution; they can only provide an indication of what is wrong. For example, a tool for creating a budget plan will not provide more money but a mere indication that the expense is larger than the income” (Swanström, 2009).

According to Swanström, an environmental method or tool needs to be based on scientifically correct methods with corporate relevance. Swanström stated that the method or tool also needs credible methodology from research and development in cooperation with society and should provide business operations with environmental information adapted to decision taking, see Figure 20 (Swanström, 2009).

![Diagram](image)

Figure 20. An environmental method or tool needs to be coordinated with research and development, society and business operations. (Swanström, 2009)
8.1 Evaluation of environmental methods and tools

To perform an evaluation of the described environmental methods and tools an evaluation system is needed. During the literature study and the conducted interviews, several criteria and attributes requested of the environmental method or tool were stated. The environmental methods and tools will be evaluated in regard of these attributes, which are summarized together with the reason of its importance in Table 3.

Table 3. Summary of the requested attributes of an environmental method or tool.

<table>
<thead>
<tr>
<th>Desired attributes of an environmental tool</th>
<th>Reason to the attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>An environmental tool should be intuitive</td>
<td>Otherwise the environmental tool will not be utilized</td>
</tr>
<tr>
<td>An environmental tool should be simple to use</td>
<td>To ensure that all employees will be able to use it without extensive education</td>
</tr>
<tr>
<td>An environmental tool should provide a measurable result</td>
<td>Indicate the effect of the environmental work to motivate the employees</td>
</tr>
<tr>
<td>An environmental tool could be based on life cycle thinking</td>
<td>All aspects of the products life cycle will be taken into consideration</td>
</tr>
</tbody>
</table>

The following paragraphs will present a short evaluation of the described environmental methods and tools to clarify whether they are suited for implementation in DeLaval development model DCS 015 or not.

DeLaval Tumba has, in cooperation with De Norske Veritas (DNV), executed an environmental audit in 2008. Since DeLaval Tumba recently has executed an environmental audit with DNV there are in the present situation no requirements to execute a new audit. An environmental audit is used to describe the company’s current environmental impacts due to the entire area of work. Therefore, it is not a tool particularly used in product development processes. Thus environmental audits will not be suitable for implementation in DSC 015.

DeLaval Tumba has, in cooperation with De Norske Veritas (DNV), executed a life cycle assessment (LCA) as a master thesis. Since the master thesis showed that LCA is a time demanding method that was not...
suitable for DeLaval’s work, the work with LCA was not continued. A common opinion amongst the interviewed employees at external companies with experience of LCA was that it is a time and resource demanding method that requires knowledgeable employees. An LCA could be used to identify the focus areas of a corporate operation and compare similar products but since DeLaval provides over 40 000 products, the method is too complex to be used generally in DCS 015.

The MET-matrix is a life cycle based method used to identify possible environmental impacts due to materials, energy and toxic discharge. The tool is simple to use because of the predefined matrix which is to be completed and when completed, it provides a measurable result with information connected to all the products life stages. This tool would be preferable to implement in DCS 015.

The Ten Golden Rules (10GR) is based on the same methodology as the Eco Design Strategy Wheel (EDSW) and consists of guidelines for product development (Wikid, 2009). These tools are specifically designed for a company’s development process which gives the tool designer space to make them both intuitive and simple to use. The tools are also based on life cycle thinking and can be designed to provide action plans for all stages of the product’s life cycle. Due to the tools’ advantageous attributes, it would be preferable to use them for corporate environmental work.

Chemical lists are a suitable way of documenting which materials are preferable to use while developing and producing a product and which are forbidden. The tool is both intuitive and simple to use due to the familiarity of a list and the uncomplicated structure. Chemical lists already exist at DeLaval but could be further integrated in the development process.

An Environmental Effect Analysis (EEA) is a risk analysis with environmental aspects included. The tool is based on life cycle thinking and provides a measurable result but it is complicated to use. EEA consists of a complex predefined matrix where information on numerous aspects is needed to complete the matrix. The environmental aspects are weighted on seriousness and priority and this system enables severe miscalculations. For example, the use of an almost safe material in large quantities can be weighted a higher priority than a dangerous material in minor quantities. Due to the miscalculation risk and the complexity of EEA, this tool is not suitable for implementation in DCS 015.

Environmental labeling type I is not a relevant labeling for DeLaval because it is granted by an external organization and the label is marketed in sales stores. DeLaval’s products are marketed through internal Local Sales Organizations and therefore, an environmental labeling type II would be more suitable. This tool would be simple to use due to the criterion to grant the label is decided by the company itself and can therefore be designed to fit the company’s development process.

Environmental labeling type III, Environmental Product Declaration (EPD), is based on information from an LCA of a product and is used to communicate the product’s
environmental impacts to the customers. Since DeLaval does not execute LCA’s and communicate their environmental work through Sustainable Dairy Farming (SDF), EPD will not be relevant for DeLaval and therefore, not suitable to implement in DCS 015.

The evaluation of the environmental methods and tools is summarized in Table 4 and the environmental methods and tools preferable to implement in DCS 015 are marked in the table.

Table 4. A summary of the evaluation regarding the attributes of environmental methods and tools.

<table>
<thead>
<tr>
<th>Method</th>
<th>Intuitive</th>
<th>Simple to use</th>
<th>Measurable result</th>
<th>Life cycle thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental audit</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>EMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCA</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>MET-matrix</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>10GR</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDSW</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical lists</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EEA</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labeling type II</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPD</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

8.2 Proposal of environmental methods and tools

The following paragraphs will present how the theoretical methods and tools suitable for implementation in DCS 015 can be re-designed into proposals adapted to fit specifically for DeLaval.

The MET-matrix is a simple tool to present environmental aspects in a comparable way. The tool could be re-designed to fit the corporate operations of DeLaval considering the four focus areas of the environmental pillar of SDF; methane, water, energy and waste, see Table 5.
Table 5. The MET-matrix re-designed to fit the corporate operations of DeLaval.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of material and components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[milking system]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[milking system]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[milking system]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[L of milk]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste disposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[milking system]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The four focus areas need to be measured in specified units to be comparable, and during the usage stage for example, the measure unit could be per liter of milk. To complete the template in Table 3 one needs to answer the questions: “How many liters of water are needed during the usage phase to produce one liter of milk?”, “How many kilos of methane are emitted during the usage phase due to the production of one liter of milk?”

The Ten Golden Rules (10GR) and Eco Design Strategy Wheel (EDSW) are based on the same methodology, but the guidelines of EDSW would be more applicable at DeLaval and therefore, only EDSW was turned into a proposal. The guidelines from EDSW could be re-designed to be relevant questions for DeLaval’s product development process. The questions could then be divided into parts according to a products life stages. The questions should be answered by a yes or no, and if the answer is yes a proposal of a suitable measure should be presented. If the answer is no, a motivation for the negative answer should be presented instead.

DeLaval’s Chemical lists are functional in their current execution, but they have to be continuously updated. To get the chemical lists further integrated in the development process the lists should be linked to the relevant activities in DCS 015. It could also be verified in the following decision point that no hazardous materials or chemicals on DeLaval’s Black list have been used in the solution. In the same way, it should be verified that no hazardous materials or chemicals on DeLaval’s Grey list have been used if there are an alternative with decreased environmental impacts available.

Environmental labeling type II is also a tool which would be suitable to implement in DCS 015, and especially in combination with the MET-matrix. Jan Agri, the Manager of Sustainable Dairy Farming Office at DeLaval, has stated that SDF at the moment is used as a mean for communication and not at all as an internal environmental labeling (Agri, 2009). But if SDF could become an internal environmental label, a system for granting the SDF logotype to a solution would be needed. The data from the MET-matrix could function as the foundation of that system. A discussion between Jan Agri
and the product owner in regard of the MET-matrix could establish whether the solution has qualified to be granted the SDF logotype or not. In this case, a clear description of why the SDF-solutions have been granted the SDF logotype can be provided and communicated both internally and externally.

DeLaval has a list with legislative demands that affect their organization and product development. The list should be further integrated in the development process through linking the list to the relevant activities in DCS 015. The list is functional in its current execution but the list has to continuously be updated to contain the present legislative demands.

During the interviews within DeLaval an employee mentioned a material tool that is used when materials are chosen in a development project. At the moment, materials are chosen in regard of consumption and cost. The material tool could be further upgraded so that the environmental aspects of the materials also are taken into consideration when materials are chosen.

8.3 Integrating environmental methods and tools in DCS 015

During the conducted interviews a few criteria of where to implement environmental methods and tools in development models and DCS 015 were stated. These criteria are summarized in Table 6.

**Table 6. Summary of the requested criteria regarding implementation in DCS 015.**

<table>
<thead>
<tr>
<th>Desired criteria on implementation in DCS 015</th>
<th>Reason to criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental aspects should be implemented as early as possible in the development process</td>
<td>In the beginning of the project, the possibility to affect the result is larger</td>
</tr>
<tr>
<td>A first environmental decision point could be placed in formulate concept and prove feasibility</td>
<td>The technical specifications are completed in that stage</td>
</tr>
<tr>
<td>Environmental aspects could be implemented in the sub-operation evaluate concepts</td>
<td>The concepts are evaluated in regard of estimated development, product costs and concept risks and therefore, an environmental evaluation could be added</td>
</tr>
</tbody>
</table>

The following paragraphs will present proposals to where environmental methods and tools could be suited for implementation in DeLaval development model DCS 015. Since DCS 015 is accessible from the intranet and related documents are linked to it, it would be preferable if the environmental documents could be integrated in DCS 015 as well. Most of the proposals are based on that additional environmental documents are linked to specified actions in DCS 015.
In D-010-050 Create and evaluate technical proposal a technical proposal in regard of technology and production is established. In this stage functionality risks are considered and a proposal is to integrate environmental risks as well. The environmental risks should be at the same precision level as the functional risks, i.e. not particularly detailed but provide an overview of the most distinct risks. The functionality risks and environmental risks could be added to the business proposal under the heading Technical evaluation in the stage D-010-080 Compile business proposal.

In D-020-020 Analyze technical feasibility one action is to analyze all risks associated with the product. At the moment, the user of DCS 015 is urged to consider the environmental impacts and risks during the product’s entire life cycle but no follow-up is performed. A proposal is to use the environmental risks identified in the business proposal, verify if they still are valid and update and develop them to cover the entire life cycle of the product. In DP5 – Approve feasibility, a verification of that the environmental risks are relevant and reasonable could be executed. The environmental risks could be updated and documented in the Risk report in D-020-060-040 Analyze concept risks.

In the stage D-020-050 Formulate Concept Proposals DeLaval’s black and grey lists and the list of legislative demands could be linked to DCS 015. In this stage, the concepts are specified in such detail that they can be judged from a technical and economical point of view. Also, there are other documents to take into consideration and therefore, it would be natural to consider an additional two lists. In DP5 – Select concept, a verification of that the lists have been considered in the concept selection could be executed. D-070-020 Analyze Technical Feasibility is the corresponding stage to D-020-050 Formulate Concept Proposals for chemicals instead of mechanical engineering. Therefore, the same lists would be preferable to link to DCS 015 for the same reasons. In DP5 – Select concept, a verification of that the lists have been considered in the concept selection could be executed.

In the stage D-020-110 Formulate supply chain concept suitable suppliers are identified, ideas for material flow are established, a packaging system is defined and a transport solution is developed. The purchase department should establish guidelines for sustainable suppliers and demand that they are followed. The guidelines could, for example, consist of prevention of child labor, forced and bonded labor, discrimination, severe environmental impacts and safety hazards. Resembling guidelines for prevented in the areas of material flow, packaging and transportation could also be established. The guidelines could be coordinated with, or developed from, the DeLaval Group Code of Business Conduct. In DP6, a verification of that the guidelines are followed could be executed.

In the stage D-030-060 Design the series version a number of product documents should be created. The product documents consist of CAD models, drawings, material bills and other documents which can only be produced when the product is completely
developed. Since the product is fully developed, all required information needed in a MET-matrix is available and the MET-matrix could be preferable to implement as a product document. In DP5 – Approval of major investment, a verification of that the product documents are completed could be executed.
9. Analysis of findings – environmental management

This part of the report covers the results from the interviews and literature study regarding environmental management. Environmental management consists of how to administer the corporate environmental work and is not related to the management system ISO 14000. The results have been divided into three parts; internal communication, motivation and environmental education.

For a company to be truly successful in the field of environmental work it is important to integrate the environmental aspects throughout the whole company, not just as a side track (Erhardsson and Björnsjö, 1997). Therefore, in addition of environmental tools and methods, environmental management is needed.

Environmental management can be defined as (Shing Huang and Hsing Shih, 2009): “Managing human affairs so as to achieve acceptable balance between the quality of the human environment and the quality of the natural environment”.

According to IVA (Royal Swedish Academy of Engineering Science), there are five steps to follow when implementing environmental thinking into corporate daily operations (IVA, 1995):

1. Decide strategic positioning and establish management commitment
2. Identify and support key individuals/pivotal job-holders
3. Adapt systems and organizational structures to new strategy
4. Create awareness and skills
5. Communicate clearly with stakeholders

These steps emphasize the importance of a committed management, an environmental commitment, awareness and competence throughout the entire company and a clear environmental communication. These ideas match the key findings regarding environmental management and the following results are based upon them.

9.1 Internal communication

At DeLaval, the intranet is one of the most important tools used for documentation, internal communication and information sharing. Recently, the intranet has been redesigned and this have contributed to that some of the employees no longer find the requested information. The environmental documentation is hard to find if you do not know where to search and it is often named inconsequentially. The environmental information needs to be more accessible if the employees are to utilize it.

To alter this, an important thing to start with is localizing all environmentally related documentation, review it and name the documents in a logical and consequent way. The environmental documents could then be linked to DeLaval’s development model DCS 015 in the appropriate development stages. This would contribute to that the employees
would know where to find the environmental information and when to use it during the development process.

Another proposal, which could be performed simultaneously or in addition, is to create an environmental storage space on the intranet where all information on environmental work is accessible, see Figure 21. It would be preferable to have a list of all environmental documents with clear explanations of what the document contains and when to use it. This storage space could also be used to communicate the management’s environmental goals and give the employees feedback on how well the goals are fulfilled.

![Figure 21. The environmental work could be accessible on the intranet.](DeLaval International AB)

When the environmental information has been made easily accessible, it is important to continuously update the storage space so that the employees always know where to find the latest information regarding environmental work and Sustainable Dairy Farming (SDF).

During the interviews, the importance of the management’s commitment has been emphasized and therefore, it is vital to assure that the information flow from management to employees is functional. The level of the management’s commitment will be indifferent if the employees never obtain knowledge about it. At DeLaval, this problem is common for all information flows within the company according to Mikael Gisslegård (Gisslegård, 2009).

The external interviews showed that human contact is important when sharing information, building competence and motivating employees. Therefore, environmental information could be communicated through meetings and presentations where the minutes from the meetings and presentation material are published at the intranet. This would make sure that the employees interested can easily find the requested information even if some of the meetings are held with an attendance limit.

At DeLaval, information from the management is successfully spread to the 100 top managers but then the information flow is somewhat ceased. To make sure the environmental information is mediated all the way from management to employee measures needs to be taken. It would also be efficient to identify employees with an individual environmental commitment, called champions, and make them ambassadors of environmental information as Jessica Lagerstedt Wadin at ÅF suggested (Lagerstedt Wadin, 2009). In this way, the top managers could report the management’s information to their champions who will spread the information to their co-workers.
The environmental work at DeLaval is divided into SDF and local environmental work at the different facilities. In addition, SDF is focused on the customer’s environmental impact and the local environmental work is focused on the factory. There is a gap between these environmental focus areas and the entire focus area of product development is missing. The environmental work within DeLaval needs to be synchronized and coordinated to contribute to the greatest environmental improvement. An environmental council could be established from which all environmental work is coordinated. The environmental council could contain representatives from each department such as; production, development, purchase and the environmental managers at the specific site. The environmental goals from the management’s strategic plan could then be divided into intermediate goals which each department could take responsibility for and report the progress back to the council. The information provided to and from the environmental council could also be published on the intranet to make the environmental information accessible to all employees.

9.2 Motivation

During the interviews at DeLaval, a majority of the interviewed employees felt that the management had no particular interest in environmental work. But during an interview with the Manager of the Sustainable Dairy Farming Office and the Process Manager of Develop and Maintain solutions, another view upon the management’s environmental commitment emerged.

According to IVA (Royal Swedish Academy of Engineering Sciences) it is important that the management communicate that environmental aspects are taken seriously within the company and also shows that in action, not just in words (IVF, 1995). Jonas Oldmark at The Natural Step had a similar idea and said (translated from Swedish): “If the environmental work should be important for the employees at the company it also has to be important for the management. The management has to show that environmental work is important to them, show the employees how they work with it and also present the results of the environmental work” (Oldmark, 2009).

Since the employees were unaware of the management’s environmental commitment and the managers, who work closer to the management, instead felt the opposite it indicates insufficiency in the communication to the employees. To motivate the employees to perform environmental work it is, according to Jonas Oldmark, important that the management shows that they have a strong commitment to the environmental work (Oldmark, 2009). It is important that the management’s commitment reach out to all employees at the company and not only to the top managers. If the management cannot reach out to all employees it is important that the managers mediate the management’s commitment.

A proposal for DeLaval to increase the motivation amongst the employees could be to implement a measurable environmental tool in the development process. According to the interviews with employees, both within DeLaval and on external companies, a
common opinion were that an environmental tool should be measurable and indicate the effect of the environmental work to the employees. If the employees see that their work make a difference and leads to less environmental impacts, they will be motivated to continue with the environmental work.

Another proposal to increase the motivation could be to introduce a reward system. According to both Jonas Oldmark at The Natural Step and Annika Skoglund at KTH, it could be motivating for the employees to see that environmental work is rewarded (Oldmark, 2009 and Skoglund, 2009). A reward system could focus on either the individual employee or an entire department depending on how the environmental work is measured. It can be difficult to distinguish what part of the environmental work was performed by which employee and in such cases; an environmental measurement of the entire department is preferable. Proposals on how a reward system could be designed are; balance score card, follow-up of SDF projects, proposal box and self-reporting.

_Balance score cards_ already exist within DeLaval and are individual score cards for the managers. The corporate goals from the management’s strategic plan are divided in different bonus areas which appear as goals on the managers’ balance score cards. Recently, SDF has appeared as an intermediate goal on some of the managers’ score cards and for the local sales organizations. A proposal to increase the motivation for environmental work could be to integrate environmental aspects in the shape of SDF in not just some but in all managers’ balance score cards. This will contribute to that all managers will motivate their employees to constantly work to decrease the department’s contribution to environmental impacts. In addition, a competition between the departments in regard of best performed environmental work during a year could be introduced. The environmental work could be measured in a few focus areas which can be applied to all departments and in the end of the year, an honorable prize is distributed.

Another proposal on how to motivate environmental work amongst the employees could be to _follow-up of SDF projects_. When developing an SDF solution a comparison of what environmental impacts are caused by the SDF solution and a regular solution could be performed. The comparison could be performed in regard of the four focus areas of the pillar of environmental sustainability; _water, energy, methane and waste_. The result could be formulated as: “With the regular solution 10 liters of water are needed to produce 1 liter of milk, but with the SDF solution only 5 liters of water are needed”. This would contribute to that the employees become aware of what difference their environmental work actually leads to and can be proud of their contribution towards a sustainable society.

A _proposal box_ is a reward system which, according to Kenneth Hermansson, already exists at DeLaval but it is poorly used (Hermansson, 2009). The idea is that the employees, who know the corporate enterprise best of all, can identify insufficient environmental work and report this to a manager in the shape of a proposal. When using
the proposal box, it is important to make sure that everyone who delivers a proposal receives feedback on the idea within a short time. The best ideas are to be realized and the inventor of the proposal is to be rewarded. This will contribute to that the employees are motivated to consider what environmental impacts their daily work leads to and how it can be prevented. Minor activities which affect the environment will be identified more rapidly than if a manager tried to identify them alone.

Annika Skoglund at KTH mentioned that the best way to motivate the employees to perform environmental work was, obviously, if they were motivated by themselves (Skoglund, 2009). The hard part is to figure out how to realize this. A proposal on how to achieve this is self-reporting. If the management makes a statement saying that environmental work will be rewarded and all employees are free to send in a monthly or yearly report of their environmental work, self-reporting will probably commence automatically. When a prize is distributed the employees will be aware of that the promised reward has been realized and the self-reporting will continue in the hopes of winning the next prize. This will contribute to that all employees strive to perform as efficient environmental work as possible and that new problem areas and improvement possibilities will be identified.

Research has shown that a company’s ethical responsibility taking is important for the employees. The company’s ethical responsibility taking contributes to a pride for the company and the employees are getting motivated to work at the company (Karlöf, 2006). This can be interpreted as being a proudly environmentally profiled company can contribute to attracting the best employees and can therefore, be profitable.

9.3 Environmental education

Environmental education is both a mean for communicating environmental work and sharing environmental knowledge. Even though environmental education is important and useful, it cannot function sufficiently without additional measures taken. A basic structure for the environmental work needs to be implemented in the company before the environmental education is carried out. When the employees have performed the education they have to be able to use their new knowledge immediately or most of the environmental education will fall into oblivion.

At the moment, DeLaval Tumba has one kind of environmental education. It is in Swedish even though the corporate language is English and the education is the same for all employees in Tumba regardless of what they work with. Each employee attends the education on a single occasion and they receive neither feedback nor further environmental education afterwards.

According to Jonas Oldmark at The Natural Step, it is important to have different environmental educations for different occupational categories (Oldmark, 2009). The general information about environment and sustainable development in society and at the company should be the same for all employees. This will provide the employees with the same basic knowledge and a common environmental language. In addition to
this, a more specific environmental education adapted to each occupational category could be performed. This will contribute to a more concrete education which can consist of firm instructions of how occupational category should perform their job sustainably. Jonas Oldmark also mentioned that the environmental education should combine an understanding for how the environment is affected by the society, the company and the individuals in their everyday life (Oldmark, 2009).

A proposal for all of the DeLaval Group to improve their environmental education would be to work in line with Jonas Oldmark’s ideas and make one part of the education specific for different occupational categories. It is important that the education is well prepared; if a consultant is hired to hold the education it is important that he or she have sufficient knowledge about the company to make the education relevant for the employees. The part of the education that is specific for different occupational categories should contain concrete examples of how the employees can affect the company’s work towards a sustainable development in their daily work. After the education the employees should have the knowledge, will, motivation and means to apply environmental aspects in their work.

Another proposal could be to introduce additional environmental education. By offering further environmental education for the employees, they can keep the information from the fundamental education present and obtain a deeper and more occupational specific knowledge. The additional education could be a web-based education tool that the employees can carry out when they have some spare time. The education can be divided into a couple of steps that can be performed separately. To be able to continue to the next step the previous step has to be passed with a sufficient percentage of correct answers. According to Erhardsson and Björnsjö, the employees must obtain sufficient education and knowledge to understand and know how to work with environmental aspects if the company should attain success with their environmental work (Erhardsson and Björnsjö, 1997).

The proposals of how the environmental management at DeLaval could be improved in all three focus areas are summarized in Table 7.
<table>
<thead>
<tr>
<th>Action</th>
<th>Cause</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create a storage space on the intranet with environmental information</td>
<td>The environmental work needs to be easy accessible to all employees</td>
<td>The employees will be able to see the environmental progress on the intranet</td>
</tr>
<tr>
<td>Link the environmental documents to DCS 015</td>
<td>The environmental work needs to be implemented in all development stages</td>
<td>The employees will easily find the environmental documents</td>
</tr>
<tr>
<td>Establish environmental meetings to spread environmental information</td>
<td>The information flow from management to employee is insufficient</td>
<td>The environmental awareness within the company will increase</td>
</tr>
<tr>
<td>Identify champions amongst the employees</td>
<td>Champions have proved to be a good source for spreading information</td>
<td>The environmental awareness within the company will increase</td>
</tr>
<tr>
<td>Establish an environmental council to coordinate the environmental work</td>
<td>The environmental work needs to be coordinated</td>
<td>Global environmental work could be established with improved documentation</td>
</tr>
<tr>
<td>Mediate the management’s environmental commitment to the employees</td>
<td>The management needs to show that environmental work is important</td>
<td>The employees will be motivated to perform environmental work</td>
</tr>
<tr>
<td>Implement a measurable environmental tool in DCS 015</td>
<td>The employees need to see the result of the environmental work</td>
<td>The result of the environmental work will be indicated</td>
</tr>
<tr>
<td>Introduce a reward system</td>
<td>The employees need motivation for the environmental work</td>
<td>The employees will be motivated by seeing that good work is rewarded</td>
</tr>
<tr>
<td>Execute different educations for different occupational categories</td>
<td>Different occupational categories are in need of different environmental knowledge</td>
<td>The employees will obtain the specific environmental knowledge needed in their daily work</td>
</tr>
<tr>
<td>Introduce additional environmental education</td>
<td>The employees need to keep the environmental knowledge present and update their knowledge</td>
<td>The employees will keep the environmental knowledge present and obtain additional knowledge</td>
</tr>
</tbody>
</table>
10. Proposals

This chapter will combine the findings from environmental methods and tools as well as environmental management into a more detailed set of proposals on how DeLaval could integrate environmental aspects in the development process DCS 015.

The most important conclusion presented in the result section is the connection between environmental management and environmental methods and tools. To sufficiently implement corporate environmental work, a combination or symbiosis of environmental management and environmental methods and tools is required. The proposal is formulated as a series of actions which can be performed separately or, preferably as a whole.

10.1 Consensus in the corporate environmental work

It is important that the environmental work is spread throughout the entire company and that the work is adapted to the employees’ different occupations. This could be obtained by having an environmentally committed management, make the environmental information easy accessible to all employees and conduct environmental educations, both in general and adapted to each occupational group. All these proposals are further described in chapter 9. Analysis of findings – environmental management.

To obtain an environmental education that is concrete for all employees at the company, the method Eco Design Strategy Wheel (EDSW) described in chapter 8.2 Proposal of environmental methods and tools can be used as template for the education. The guidelines of EDSW have been re-designed to be relevant questions for DeLaval’s product development process, see template in Appendix 1. The template contains questions regarding material choice, optimization of the product and production techniques, reduction of environmental impacts and efficient distribution systems. The questions have been grouped according to a product’s life stages. Each question should be answered with a yes or a no and in addition, a proposal of a suitable measure for the positive answer or a motivation for the negative answer should be presented. From the answers regarding measures an own action plan should be developed. The own action plan is what each employee can do in their daily work to develop a more environmentally sound product. If all employees develop their own action plans for all the re-designed guidelines of EDSW for a predetermined test product in the environmental education, they will get concrete examples of what they can do in their daily work to contribute to a more sustainable development. Because EDSW is best suited for usage as material for environmental education no recommendation as to where in DCS 015 the method would be preferable to implement will be presented.

10.2 Measure the corporate environmental work

To keep the employees motivated to perform environmental work it is important to communicate the result of the environmental work. This could be obtained by creating a
storage space for environmental information on the intranet, establish an environmental
council to coordinate the environmental work, hold environmental presentations and
integrate a measurable environmental tool in DCS 015. All these proposals are further
described in chapter 9. Analysis of findings – environmental management.

Another proposal on how to measure the corporate environmental work is called the
**MET-matrix.** The MET-matrix methodology is based on a simplified LCA where the
flow of raw materials, consumables and emissions are mapped. The three measuring
ranges are based on the four focus areas of the environmental pillar of SDF; methane,
water, energy and waste. Since the amount of methane emitted mostly is due to the
cows and not the production and usage of a milking system it would be more accurate to
process the methane emission in a separate system – an additional MET-matrix.
Therefore, the methane as a measuring range has been excluded from this MET-matrix,
see Table 8.

**Table 8.** MET-matrix with the three measuring ranges; water, energy and waste and
with the values measured in the unit per milking system.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing [milking system]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution [milking system]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use [milking system]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste disposal [milking system]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total value</strong> [milking system]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The basic idea of how to complete the MET-matrix template is to keep track of all
material flows concerning the products entire life cycle. The values regarding the usage
phase can be measured or calculated when the product is active and the values regarding
production have to be obtained from the subcontractors. If completely accurate
information is hard to obtain a reference value can be used.

To clarify the results the values in the MET-matrix can be presented in the units *per milking system*, see Table 8, or *per liter of milk*, see Table 9. The unit *per milking system*
is better suited for comparison between milking systems which only differ in a level of
details. If two completely different milking systems are compared it will be more
distinct to present the values in the unit *per liter of milk*. In such a comparison, it is
important to make the calculations according to the same capacity of milked cows and
an equal lifespan. Even though a comparison between two completely different milking
systems is misleading, the result will be more lucid if the unit *per liter of milk* is used.
Since the MET-matrix is based on a simplified LCA system boundaries have to be defined. To sufficiently specify the complete range of the system boundaries of the MET-matrix additional information from a live project is needed. The MET-matrix could be tested on a live project and then adapted to suit all projects controlled by DCS 015. A proposal of the system boundaries which limit the range of the MET-matrix are presented below. After testing the MET-matrix on a live project these system boundaries might be in need of a tweak. When a proposal to the system boundaries was developed, Anna Hedlund Åström at KTH helped determine that the limitations were relevant and realistic (Hedlund Åström, 2009).

The measuring ranges in the MET-matrix should include the following phases of the concerned products life cycle; production of material and components, manufacturing, distribution, use and waste disposal.

Production of material and components consists of extraction of raw materials, transportation of raw materials and refining of raw materials.

Manufacturing consists of production of components by subcontractors, manufacturing of the product, assemblage of the product and packaging.

Distribution consists of transportation of semi finished products from contractors to manufacturers and transportation of the product to the users.

Use consists of usage of the product at the final customer.

Waste disposal consists of end-of-life solutions such as recycling, re-use and energy recovery.

In addition to the limitations due to the phases of the products lifecycle, boundaries regarding; the products life cycle, the life cycle of other products, the product’s level of details and time are set.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of material and components [/L of milk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing [/L of milk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution [/L of milk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use [/L of milk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste disposal [/L of milk]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total value [/L of milk]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Boundaries within the product’s life cycle:

- Processes and operations which together contribute to less than one percent of the product’s entire environmental impact within each MET-matrix category (water, energy, waste and methane) can be excluded.
- Possible maintenance and repairs of the concerned product during the entire life cycle can be excluded from the MET-matrix.

Boundaries regarding the life cycle of other products:

- Environmental impacts from the production and maintenance of the machines and tools used for producing the concerned product or solution is not included in the MET-matrix.
- The MET-matrix does not include contributions from the production of vehicles distributing raw materials, parts and products.
- Environmental impacts from the production of maintenance equipment can be excluded from the MET-matrix.

Boundaries regarding the product’s level of details:

- Energy consumption and emissions from the manufacturing of parts integrated in the concerned product which contributes to a maximum of five percent of the products total weight.

Boundaries in time:

- The inventory data should be representative for the manufacturing of the product during the time period when the MET-matrix was completed.

These system boundaries exist to secure that the MET-matrix is completed in the same way every time. This will contribute to that the results are internally comparable.

To complete the MET-matrix lots of information needs to be obtained internally and through subcontractors. This can be a time consuming activity and therefore, it is preferable to start working with the MET-matrix as early as possible in DCS 015 and in the development project. When a first MET-matrix has been completed some of the information obtained can be re-usable in other MET-matrixes and therefore, the required time to perform a MET-matrix will decrease. In DP5 – Approval of major investment a verification of that the MET-matrix has been completed could be integrated as a gate in DCS 015.

The expected benefit from the MET-matrix is a measurable method which can be used to compare products and solutions internally.

10.3 External communication

To profit from the environmental work it is important to communicate what has been done externally. When DeLaval’s corporate environmental work is evaluated and clear...
information about what environmental work is performed and what it contributes to exist, it would be preferable to communicate this information externally. This could be obtained by additional information on the webpage, sustainability report, folders and labeling.

Another proposal on how to obtain a sufficient external environmental communication is called **three risks**. This proposal is developed from the Environmental Effects Analyses (EEA) but instead of identifying all environmental risks and weighting them in regard of seriousness, only three risks are identified at two times. Firstly, the three risks that could have the greatest impact on the environment are identified. These dangerous risks often have a low probability of actually occurring, but it is advantageous to have them identified. When the risks are identified, a low-force project with minor resources should be started to prevent the three risks from occurring. This approach is a precaution, because if one of the risks should transpire the management can clarify that knowledge of the problem already exists and that resources have been allocated to mitigate the issue. This will appear as a more responsible solution than if the management just states that no knowledge of the problem existed or that no further comments will be provided. These risks could be identified during the stage **D-020-060-040 Analyze concept risks** in DCS 015.

Secondly, the three risks that are the most profitable to market and communicate are identified. When the three risks are identified, a low-force project with minor resources should be started to research how to market the environmental work in the most efficient way. Even if the outcome of the three risks is a minor environmental problem, it is always profitable to communicate that environmental efforts are made. These risks could be identified in the stage **D-010-050 Create and evaluate technical proposal** in DCS 015. A simple template for documenting the findings of using the method three risks is provided in Table 10.

**Table 10. A template used to identify environmental risk used for external communication.**

<table>
<thead>
<tr>
<th>Risk</th>
<th>Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the three environmental risks with the greatest environmental impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify the three environmental risks which are the most profitable to market</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Another proposal on how to obtain a sufficient external environmental communication is called **environmental labeling type II**. At the moment, DeLaval has 14 solutions presented on the webpage as Sustainable Dairy Farming Solutions and they are all described in regard of the four pillars of SDF. According to Jan Agri, Manager Sustainable Dairy Farming Office, SDF is not an internal labeling but means for communication (Agri, 2009). If SDF could be used as an internal labeling, new solutions and products could be marketed with this information. The criteria for granting environmental labeling type II is determined internally by the company itself and consequently, the Manager Sustainable Dairy Farming Office and the product owners could discuss the environmental benefits with each new product and solution. The result of the discussion will provide a thorough description in regard of the four pillars of SDF for each product or solution. With this information as the foundation, the Manager Sustainable Dairy Farming Office and the product owner can then decide to grant the product or solution the SDF-labeling. This decision must be taken in the stage **D-030-060 Design the series version** in DCS 015 at the latest. It would be preferable if all products granted the SDF-label could receive the SDF-logotype as a distinct marking on the product itself, see Figure 22.

![SDF-logotype](image)

**Figure 22.** The SDF-logotype could be used as an environmental label.
*(DeLaval International AB, 2009)*
11. Discussion of the master thesis

This chapter will provide a discussion of the master thesis in general. The discussion will focus on the chosen approaches and evaluate what could have been done differently, what that could have contributed to and present a recommendation for further work. The discussion will be divided into four parts regarding: literature study, interview, proposal and recommendation for further work.

11.1 Literature study

When the purpose of the master thesis was decided on, four weeks was spent on an initial literature study. The studied literature was agreed upon in discussion with the supervisors at DeLaval and KTH and was intended to provide an overview of the field of sustainable development and corporate environmental work. The theoretical field of sustainable development was thoroughly covered during the literature study but additional information on corporate environmental work would have been useful. We found it hard to locate reliable and informative sources in the field of corporate environmental work and therefore, the conclusions are mainly based on the interviews. Even if a more detailed literature study would have been preferable, it would not have been advisable to spend additional time to the literature study.

It would also have been advantageous to use a larger amount of international sources. We have obtained a relatively clear view of how sustainable development and corporate environmental work are defined and executed in Sweden but knowledge of the environmental work in other countries is not conclusive. Additional international sources could have provided a valuable comparison between different countries in regard of corporate environmental work. Published international sources in that area have been hard to locate due to that the field of corporate environmental work is relatively new and unexplored. The most concrete published sources are case studies of environmentally committed companies, and many of them are confidential.

11.2 Interviews

All interviews executed during this master thesis have been structured face-to-face interviews or telephone interviews which have been fairly time-consuming to perform. To obtain information in a more efficient way it could have been an alternative to send a questionnaire to the interviewed employees instead. The information gained from a questionnaire is more quantitative than qualitative, and in this case we believe this would not have been preferable. Important information that has been obtained through attendant questions from the questions in the interview guide would have been missed in a questionnaire. Even if the questions in the interview guide were discussed with the supervisors it is difficult to say if the interview guide was sufficient and covered the whole extent of the theoretical field. The results from the interviews could have been different if the interview guide had contained other questions or if the questions had been asked in a different way. Still, we are confident that the results from the interviews
are on a more accurate and comparable level due to the usage of an interview guide. If the interview guide had not been used the obtained answers would not have been as comparable as in our case.

The interviewed employees at DeLaval, of who most works as managers for different departments, were chosen in consultation with the supervisors at DeLaval to obtain information about the product development process and the corporate environmental work. Interviews were conducted until the answers from the employees became equivalent and further interviews would not contribute to new information. If additional employees with lower positions, not working as managers, had been interviewed it could have contributed to new information and our view of the company could possibly have been different. Since DeLaval is an international company with a wide product range the external companies that were chosen to be interviewed were large international companies with wide product ranges and a pronounced environmental profile. The result from the external interviews could have been different if employees at a smaller company or at a company in the same industry that DeLaval had been interviewed. The result could also have been different if employees at additional companies had been interviewed, but due to lack of time it was not feasible to execute interviews with additional companies. Alike the interviews at DeLaval, the interviews with employees at the external companies were executed with different kinds of managers. The result could have been different if interviews had been conducted with employees with a lower position or if more than one employee at each company had been interviewed.

Since interviews only have been executed with a couple of employees at DeLaval it can be discussed how credible the conclusions drawn from the interviews really are. Considering the time limit for this master thesis it would not have been possible to interview as many employees as should be needed to get a precise and accurate view of the company and the corporate environmental work. Therefore, it is important to take the results from this master thesis for what they really are – observations and proposals made by two external consultants who have had insight in the company during 20 weeks. We are satisfied with the obtained results and believe that DeLaval could profit from implementing some, or preferably all, of our proposals.

11.3 Proposal

During this master thesis, DeLaval’s previous and current corporate environmental work has been investigated and compared with the work of external companies. Initially, the master thesis was just supposed to result in a proposal as to how DeLaval could implement environmental tools to consider environmental aspects in their development model DCS 015. But during the interviews with external corporate representatives we realized that it would not be sufficient to only implement an environmental tool. For a company to be successful in the corporate environmental work, environmental management is also required. With this insight, we performed
additional interviews with people specialized in management and environmental management. Even though we expanded the range of the master thesis and prioritized time and resources to obtain a result for DeLaval to use within the field of environmental management we believe it will be useful. It does not matter how good of an environmental tool there is in use, without the aid of proper management, education and follow up the result will never be as good as with the right environmental management integrated.

When the ideas on environmental methods and tools were to be evaluated and some of them were chosen to be further developed and implemented in DCS 015 we created an evaluation tool. The evaluation tool was based on the criteria and attributes requested of the environmental methods and tools during the conducted interviews. Since we did not find any information about advantages and disadvantages of how the methods and tools work in practice in any literature, we had to evaluate the tools solely based on information from the interviews. It could have been more efficient to expand the literature study to search for further sources describing what benefits could be gained from each environmental tool or method. In the end we decided that the opinions of the interviewed corporate representatives were the most important since they would be the ones to use the environmental tools once implemented.

In the beginning of this master thesis we received a short introduction of DCS 015, its structure and how it works in theory. During the interviews with employees at DeLaval we got a view of how the development model works in practice and where the employees thought it would be preferable to implement environmental aspects. But when we tried to understand what actions were executed in the different activities in DCS 015, to investigate where it would be preferable to implement environmental aspects, it was difficult since we had no practical experiences of the development model. We have presented proposals of activities in DCS 015 where we believe it would be preferable to implement environmental methods and tools and also where it would be preferable to link environmental documents. Since we do not have the knowledge about in which activities the employees already have a heavy work load, it would have been beneficial to discuss where environmental methods and tools could be implemented in consultation with an employee that have carried out a project within DCS 015. Even though such a consultation would have been preferable, it would have been hard to realize. Most employees at DeLaval do not have the environmental knowledge required to fully see the potential of where environmental aspects could be integrated in DCS 015. It is also problematic that DCS 015 has not been used over a long period of time and therefore, most employees have not completed an entire project within the development model.

The presented proposals have been developed from ideas on how to implement environmental aspects in DCS 015 during a short period of time. Additional time would have been needed to present the proposals in a more detailed and company specific
manner. To thoroughly develop and adapt, for example, the MET-matrix to DeLaval an additional master thesis would have been needed.

We chose to use the *Eco Design Strategy Wheel (EDSW)* as material for education instead of presenting it as a tool to be integrated in DCS 015. This decision was based on the fact that some of the questions in EDSW were at a basic level and risked resentment from experienced employees. We thought that if the questions were used as material for education instead, each employee could create an own action plan in regard of EDSW. This action plan could then be applied on the commitment level that the employee felt satisfied with and therefore, contribute to a daily sustainable work at a reasonable level. Even though EDSW is used in other development processes, we felt that would be more beneficial to DeLaval if the EDSW was used as material for education.

The questions in EDSW regard the entire life cycle of the product and can be used as a check list to confirm that all environmental aspects have been considered. All of the questions will not be relevant in all development projects and to all employees. The expectation is that all employees will consider all of the questions of EDSW and decide for themselves which questions can be relevant in the daily operations. This will contribute to the largest improvement from EDSW.

The *MET-matrix* is the most detailed proposal presented in this master thesis and therefore, also the most complicated. The MET-matrix will provide the most accurate comparable result between two solutions when performed in exactly the same way. To secure this, the system boundaries exist. To be able to design the system boundaries in a correct and effective way a lot more experience than we have is needed. We produced a proposal of system boundaries which we discussed with a teacher at KTH familiar with the methodology of LCA. The presented system boundaries are a good basis for performing the MET-matrix but if the proposal would be implemented, additional resources to develop the system boundaries would be preferable.

It is important to be aware of that an LCA cannot be used in purposes of external marketing without first being critically reviewed. According to the Swedish Standards Institute, the critical review must be performed by an internal or external expert or a panel of interested parties (Swedish Standards Institute, 2006). Due to this the result from a MET-matrix, which is based on the LCA methodology, must be critically reviewed before being used for external marketing.

The proposal *three risks* are a tool which both indicates the company’s environmental risks and communicates the company’s environmental work. A benefit with the tool is that the company will be aware of which environmental risks their product development contributes to and can thus start working to prevent that those risks occur. Another benefit is that it could be profitable for the company’s reputation to market that the company is aware of the environmental risks with the product development and that they work to prevent the risks from occurring. This proposal is foremost a mean of
external communication which will enlighten all the corporate environmental work externally and mediate that the company is aware of all environmental risks regarding the product development.

During this master thesis it was unclear for several employees whether the SDF-logotype was an internal labeling or just a logotype. If this uncertainty also exists externally it would be advisable to straighten out the definitions. To use the SDF-logotype as an environmental labeling type II would not only clarify for the employees what SDF is, it would also be useful for external environmental communication and marketing of the products. We believe this would be a simple and effective tool for creating a common environmental language throughout the company and spread the ideas of SDF amongst the employees.

In the purpose of the master thesis a list of four expected benefits for DeLaval was presented. The expected benefit “All people involved in the development process should take environmental consideration into their work” is represented by the heading 10.1 Consensus in the corporate environmental work. The expected benefits “All new launches from 2011 and onwards should document the environmental profile of each solution” and “To increase the sustainability and reduce the environmental impacts of products” are represented by the heading 10.2 Measure the corporate environmental work. Finally, the expected benefit “That DeLaval should have the ability to communicate the environmental performance of their products to authorities, organizations and others” is represented by the heading 10.3 External communication.

Even though the headings are named differently, the result and analysis of the master thesis meets the expected benefits from the initial purpose.

11.4 Recommendation for further work

It is important to realize that environmental work is never finished; it is not a single goal that actually can be achieved. Environmental work is all about adapting the company and its operations to contribute to as little environmental impacts as possible. It would, of course, be preferable if the companies could reform their operations to provide a more prosperous environment than it would have been if the operation did not exist. But this kind of actions will probably not occur in a near future.

This master thesis could be continued by actually implementing some of the described ideas and proposals at DeLaval and evaluate the result of that action. Would an implementation of a MET-matrix contribute to more environmentally sound products and solutions or would such an implementation only bring extra workload and no profit? Questions as these can only be answered if an actual implementation takes place.

It would also be interesting to use the same question formulation at a foreign company and evaluate how the corporate environmental work is performed. What differences and similarities can be found between DeLaval’s corporate environmental work and that of a foreign company?
12. References

Internet sources


Oral sources – within DeLaval

Jan Agri, Manager Sustainable Dairy Farming Office
Interview (2009-11-02) and (2009-11-27)

Kenneth Hermansson, Quality and Environmental Manager
Interview (2009-10-20) and (2009-11-25)

Lars-Erik Larsson, Manager Technical Administration
Interview (2009-10-19)

Lennart Johansson, Former Director Quality Assurance and Environment
Interview (2009-10-09)

Mikael Gisslegård, Process Manager Develop and Maintain solutions
Interview (2009-11-27)

Nils Álveby, Polymers Specialist
Interview (2009-11-02)

Otto Hellekant, Manager Mechanical Engineering
Interview (2009-10-08)
Tord Ringenhall, Product Manager Supply Systems
Interview (2009-10-26)

**Oral sources – external**

Anna Hedlund Åström, Scientist at Systems and Component Design, KTH
Interview (2010-01-08)

Annika Skoglund, Doctoral candidate Industrial Economics and Organization, KTH
Interview (2009-11-18)

Björn Wilhelmsson, Manager R&D, Alfa Laval
Telephone interview (2009-10-15)

Christian Wiklund, Project Manager Product Development, ITT W&WW
Telephone interview (2009-10-07)

Erika Nilsson, Environmental Coordinator, Alfa Laval
Telephone interview (2009-10-05)

Jan Johansson, External Environmental Consultant, Electrolux
Interview (2009-10-27)

Jessica Lagerstedt Wadin, Manager EcoDesign Center, ÅF
Interview (2009-11-06)

Jonas Oldmark, Director of Operations, The Natural Step
Telephone interview (2009-11-23)

Kristoffer Lundholm, Advisor Sustainable Innovation & Design, The Natural Step
Interview (2009-10-22)

Lars Mårtensson, Environment Director, Volvo Trucks
Interview (2009-10-22)

Lennart Swanström, Senior Principle Scientist, ABB
Interview (2009-10-29)

Magnus Enell, Senior Advisor Sustainable Strategies, Vattenfall
Telephone interview (2009-10-28)

Olle Blidholm, Development Manager Group Sustainability, IKEA
Telephone interview (2009-10-28)

Per Stoltz, Head of Green Living Projects, IKEA
Telephone interview (2009-10-27)

Petter Svanbom, Project Manager Dish Care, Electrolux
Interview (2009-10-27)
Published sources


Erhardsson, R., Björnsjö, U. (1997), Miljöförbättringsboken, Erlanders Berlings AB (In Swedish)

Europaparlamentet, (2003), Europaparlamentets och rådets direktiv 2002/96/EG om avfall som utgörs av eller innehåller elektriska eller elektroniska produkter (WEEE ) (In Swedish)


IVF, (2000), Miljöverktyg - En sammanställning av 17 metoder, Mölndal: Sandstens tryckeri AB (In Swedish)


Kemikalieinspektionen, (2006), Fakta RoHS-Direktivet (In Swedish)


Länsstyrelsen Gävleborg, Socialt hållbar utveckling – i Gävleborgs län, Rapport 2005:21 (In Swedish)


**Appendix 1 – Eco Design Strategy Wheel template**

An example of the guidelines for the Eco Design Strategy Wheel (Wikid, 2009) adapted to fit DeLaval’s corporate operations.

<table>
<thead>
<tr>
<th>New concept development</th>
<th>Yes</th>
<th>No</th>
<th>Measure/Motivation</th>
<th>My action plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integration of functions</strong>: Can we combine the functions of different products in to one product?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Select low-impact materials</th>
<th>Yes</th>
<th>No</th>
<th>Measure/Motivation</th>
<th>My action plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-hazardous materials</strong>: Are any of the selected materials on the DeLaval Black list?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-hazardous materials</strong>: Are any of the selected materials on the DeLaval Grey list?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recycled materials</strong>: Do we need to use virgin material?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recyclable materials</strong>: Is it possible to use materials that can be recycled?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction of materials</th>
<th>Yes</th>
<th>No</th>
<th>Measure/Motivation</th>
<th>My action plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduction in weight</strong>: Can we reduce the weight of the product by using less material or lighter materials?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reduction of (transportation) volume</strong>: Can we reduce the volume of the product to optimize transportation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reduction of the number of materials</strong>: Is it possible to use less different materials?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optimization of production techniques</th>
<th>Yes</th>
<th>No</th>
<th>Measure/Motivation</th>
<th>My action plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative production techniques</strong>: Are there production means available that are less harmful to the environment?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fewer production processes</strong>: Can we produce the same product by using fewer production steps?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Low/clean energy consumption</strong>: Can we choose cleaner production methods?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure/Motivation</td>
<td>Yes</td>
<td>No</td>
<td>Measure/Motivation</td>
<td>My action plan</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----</td>
<td>----</td>
<td>-------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Low generation of waste:</strong> Is it possible to reduce or reuse the waste generated during production?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Few/clean production consumables:</strong> Can we use fewer and less hazardous consumables during production?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Efficient distribution system</strong></td>
<td>Yes</td>
<td>No</td>
<td>Measure/Motivation</td>
<td>My action plan</td>
</tr>
<tr>
<td><strong>Less/clean packaging:</strong> Can we reduce the use of packaging material or use less harmful materials?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Efficient transport mode:</strong> Have we chosen the most efficient mode of transportation for the product?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Efficient logistics:</strong> Can we improve our logistics?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reduction of environmental impact during the user stage</strong></td>
<td>Yes</td>
<td>No</td>
<td>Measure/Motivation</td>
<td>My action plan</td>
</tr>
<tr>
<td><strong>Low energy consumption:</strong> Can we minimize the product’s energy consumption?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clean energy source:</strong> Is it possible to use a cleaner energy source?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Few consumables needed during use:</strong> Can we minimize the use of consumables?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clean consumables during use:</strong> Is it possible to use less harmful consumables?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Optimization of initial lifetime</strong></td>
<td>Yes</td>
<td>No</td>
<td>Measure/Motivation</td>
<td>My action plan</td>
</tr>
<tr>
<td><strong>Reliability and durability:</strong> Can we improve the overall reliability of the product?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Easy maintenance and repair:</strong> Is the product easy to maintain and repair?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Modular product structure:</strong> Is it possible to use standard components to repair the product?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Optimization of end-of-life system</strong></td>
<td>Yes</td>
<td>No</td>
<td>Measure/Motivation</td>
<td>My action plan</td>
</tr>
<tr>
<td><strong>Reuse of product:</strong> Is it possible to give the product a second life?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remanufacturing/refurbishing:</strong> Can we fix and reuse (parts of) the product?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recycling of materials:</strong> Can we recycle the materials used in the product?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clean incineration:</strong> Will incineration of the product create low or no emissions and waste?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C