Graduation Project in Innovation Management

Sustainable Development in Innovation, Design, and Technology Perspective
Case Study of Volvo Construction Equipment

Mr. Nithiwat Riebroicharoen 821024
Ms. Pim Koykitcharoen 830311

Supervisors: Sten Ekman, Christer Nygren

MIMA-International Business and Entrepreneurship
School of Innovation, Design and Engineering

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Abstract

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Authors: Nithiwat Riebroicharoen 821024-T173
          nrn08002@student.mdh.se
          Pim Koykitcharoen 830311-T101
          pkn08002@student.mdh.se

Supervisors: Sten Ekman, Christer Nygren

Problem Statement: How does Volvo CE facilitate sustainable development in technology, design and innovation perspectives? The purpose of this graduation project is to identify and analyze how Volvo CE improves sustainable development in technology, design and innovation. Volvo CE is chosen as the subject of the study since it is one of the leading companies that claimed to have an efficient implementing system of technology, design and innovation that truly solves the environmental problem that its business can cause.

Methods: Qualitative research methodology was used in this study. Two in-depth interviews were conducted with an environmental manager and an environmental engineer of Volvo CE with a focus on sustainable issues and technologies when the authors visited the manufacturing plant. Corresponding secondary resources from literature, articles, and theories were thus collected to be studied in parallel with the qualitative data.

Conclusion: The research found that Volvo CE has implemented a lot of business activities by applying innovation, technology and design approaches in order to support and improve its sustainable development business concept which covers all social, environment and economic aspects.

Keywords: Sustainable development, Sustainability, Innovation, Design, Technology, Volvo Construction Equipment
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Nithiwat Riebroicharoen

Pim Koykitcharoen
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1. Introduction

Today, global problems, for instance social and environmental problems, have been increasing and thus inevitably affecting human activities. The problems have forced people and societies to think about developing or even changing themselves in order that they and their next generations can sustainably survive. Correspondingly, business concepts and approaches have to necessarily focus on how to run any kind of business without negative consequences that might whether directly or indirectly damage people, societies and environment, whereas they can still maintain good economic situations and benefits simultaneously. For doing so, the sustainable development is an interesting way of new business concepts that can balance the emphasis of economic, social and environmental concerns. The sustainable development is within many forms of business activity, and also contains so many aspects of approach and implementation. Concurrently, innovations, new technologies, and creative designs are having an important role for doing business nowadays. They can create very innovative products and services, productions, business operations and processes, and so on, for gaining competitive advantage, reducing costs, improving quality of human life, and decreasing environmental invasion. Therefore, it is obvious that innovation, design, and technology altogether can additionally help firms to achieve sustainability. As a result, in this research, we will study about the practical implementation of innovation, design, and technology so as to support the sustainable development.

For decades, Swedish Industrial Sectors have tried to promote and implement the environmental concern idea to companies and organizations. The most important concept in managing the business according to the safety of the earth and human beings is sustainable development. Our group chose to study about automotive Industry as the result of serious effect of the environment problem it causes directly or indirectly such as the polluting emission from production process also with the human safety. Our study aims to investigate how we can implement technology, design and innovation to solve these problems.

Our chosen company for the case study is Volvo CE, which is a big automotive company that provides the service to more than 125 countries (Volvo CE, 2008). Most customers of Volvo CE are using machines in quarries & aggregates, energy related industries (oil & gas), heavy infrastructure, utilities, road construction, building, demolition, recycling industry, industrial material handling, and forestry industry which all are concerned as environmental risk. Volvo Group is a perfect case study for our group since it aims to be a leader in environmental care among the world’s top producers of transport related products, equipment and systems according to the corporate social responsible statement. Also, in the official website, there is a part of press release statement that clearly shows company’s environmental friendly vision; “All of this technology, processes, systems and components add up to one thing: a commitment to protecting the world we live in. Volvo lists quality, safety and care for the environment as its core values” (Volvo CE, 2008). With all of these sustainable developments in the implementation process of technology, design and innovation, Volvo is considered as our best case study.
1.1 Company’s Background

Volvo group is one of the world’s leading automobile manufacturers. Its first vision is “to be valued as the world’s leading supplier of commercial transport solutions.” The product line of Volvo includes trucks, buses and construction equipment, which is the main scope for our study. Moreover, drive systems for marine and industrial applications, aerospace components and services. Complete solutions for financing and service are also counted. Currently, Volvo group has about 100,000 employees and has production facilities in 19 countries. It is a publicly traded company that has a headquarter in Gothenburg, Sweden, and it is one name on the list of OMX Nordic Exchange Stockholm (Volvo Group Sustainability Report 2008). Focusing more about Volvo Construction Equipment, the product and service range are offered in more than 125 countries through proprietary or independent dealerships. Most customers of Volvo CE use the machines in quarries & aggregates, energy related industries (oil & gas), heavy infrastructure, utilities, road construction, building, demolition, recycling industry, industrial material handling, and forestry industry. The product range includes wheeled and crawler excavators (diggers), articulated haulers (dumpers, dump trucks), scraper haulers, wheel loaders, pipe layers, demolition equipment, waste handlers, motor graders, pavers, compactors, milling equipment, tack distributors, road wideners, material transfer vehicles and a range of compact equipment such as mini loaders, mini excavators, backhoe loaders and skid steer loaders (Volvo CE, 2008).

1.2 Problem Statement

The sustainable development is very important and necessary for a company like Volvo CE because it can effectively drive all business activities to strive through the turbulent, unstable, and unpredictable change. Moreover, it can also sustain the balance between environment, society, and economic both externally and internally of the company. In parallel, innovation, technology, and design have also taken significant parts in terms of business development when implementing them into all kinds of activity within the organization. Mutually, the sustainable development, and innovation, technology and design can lead the company to survive and succeed in long-run. In order to achieve sustainable goals, Volvo CE has applied and developed innovation, technology, and design throughout its products, productions, working processes, and so on. From doing so, innovation, technology and design could have a potential to additionally support or even improve the sustainable development. Therefore, in this research, we will study;

“How does Volvo CE facilitate sustainable development in technology, design and innovation perspectives?”

1.3 Research Questions

Volvo CE has a very large organization containing many kinds of business activity. However, the company is obviously a construction equipment manufacturer. Therefore it thus mainly focuses on product development, production process, sales and service. For conducting this research, we will study Volvo CE’s sustainable development by mainly emphasizing on its products, product development processes, production processes, and also how the company has enhanced competitive
advantages, in innovation, design and technology implementation perspectives. As a result, we have designed and categorized our research questions as the following;

- How has the company implemented eco innovation, green technology, and sustainable design into its products and product development processes?
- How has the environmental concern led the company to improve and develop its activities within the production processes?
- How has the company reduced environmental impacts throughout its product entire lifecycle?
- What are benefits and profits that the company has attained from the sustainable development?

1.4 Purpose of study

In this research, the researchers aim to identify and analyze how Volvo CE improves sustainable development in technology, design and innovation. Volvo CE is chosen as the subject of the study since it is the one of the leading company that claimed to have efficient implementing system of Technology design and innovation that truly solves the environmental problem that their business can cause. Also, innovations and design related to technology is defined in terms of core competency for sustainable business. In addition, the economical and organizational aspects of an innovation design and technology are discussed after examining Volvo case by focusing especially to how it helps the firm achieve to have sustainability development.
2. Methodology

2.1 Choice of Topics

In today’s world where sustainable development has become an important focus, therefore the topic of this research regarding sustainable development is very interesting. In innovation, technology and design perspectives, the sustainable development can be improved by implementing those three ideas into companies’ business activities. Also, we have decided to select Volvo Construction Equipment as our case study because it is one of the organizations that have effectively factored environmental issues into its core values. Its heavy emphasis on sustainable development is reflected through its environmentally innovative products as well as production methods. With its innovation, Volvo CE is able to generate new ideas and set new industry standards, resulting in products which are beneficial to both the consumers and environment. Ultimately, it is Volvo CE’s approachable culture along with its accessible specialists that have facilitated the ease in collecting accurate information to pursue this write-up. Employing strategies that strive towards sustainable development means that Volvo CE maintains the balance between stakeholders, enabling the realization of solutions for today’s needs without compromising the benefits of future generations.

2.2 Chosen Theories

In accordance with the problem statement, mainly, theories which will be chosen are relevant to the basic knowledge of sustainable development, innovation’s definitions, how to implement innovation in organization for achieving sustainability, sustainable and design thinking for industrial organization. Also, those theories will be collected by concentrating broadly on several perspectives from different authors.

2.3 Collecting Information

First, literature, articles, and theories which link to the research will be brought together. The concept of sustainable development will be studied for clearly making an understanding of its definition. Innovation management and eco innovation including technology that use for sustainable purposes will also be collected. Lastly, the industrial design concept, the design process and the ergonomic of production processes, products and services, and workstation regarding safety and environmental friendly will be considered.

Second, the research will use both primary and secondary data to mainly answer the research question. The study will firstly begin with collecting secondary data of Volvo CE about how the company has implemented innovation that leads to sustainability, how its products, services, workstations have been ergonomically designed, and how green technology it has used, and finally how they altogether can improve the sustainable development. Furthermore, books, journals and other resources of Volvo CE containing important information for finding out the answer of our research question will be collected. Afterward, we will go on to gather important data that is still inadequate in the secondary data by using the qualitative method, direct interviews of people who work in Volvo CE. According to Fisher (2007), the possibility of access to people who can fulfill answers of the research question should
be considered before conducting researches. In this case, the researchers have a very good opportunity to visit Volvo CE manufacturing plant and conduct interviews with the right people in Volvo CE who are directly responsible for sustainable development and environmental engineering corresponding to our research questions. The purpose of this visit was to understand how Volvo CE practiced sustainable strategy in different perspectives. The interview will be conducted at least two times because the researches do not clearly know about how Volvo CE has internally implemented sustainable development into its working operation which is undisclosed in the secondary data. So, in the first interview, open-questions will be asked in order that the interviewees can briefly explain about sustainable development and then make the researchers more clearly understand what and how the company has done so far. Afterwards, the second interview will be conducted by the semi-structure interview method according to Fisher (2007). The questions in the second interview will be designed to direct the interviewees for mainly answering the research questions. And if it is necessary, another interview will be organized later on.

2.4 Information Analysis

After amply collecting both primary and secondary data, empirical data of Volvo CE will be analyzed by matching and comparing with the theories used in this research. Before doing so, the primary data collected from the interview will be combined and overlapped with the secondary data gathered from electronic sources, news and articles regarding the company’s business activities in order to be able to study the empirical data from different points of view. Moreover, another purpose of studying both primary and secondary data is to avoid biased information from personal opinions of interviewees in one hand, and, in the other hand, to understand the company not only from the company’s reports or website, which explain mainly in positive way, but also from practical levels of Volvo CE’s employees.

2.5 Research Delimitation

Due to the scope of the purposed objectives, this research will not explore the engineering technical aspects in detail. As a required objective of the studied field, the research applies and analyzes the procedures of innovation, technology, design, and business management to Volvo CE in order to understand and establish possible solutions in practice to the proposed theories. Moreover, Volvo CE’s sustainable development contains a huge number of activities. Therefore, the research will only focus on activities that are relevant to innovation, design and technology according to the problem statement.
3. Theoretical Framework

3.1 Sustainability and Sustainable Development

The basic meaning of sustainability is the capacity for continuance more or less indefinitely into the future (Ekins 2000, p 70). It seeks to provide the best results for human and natural environments both now and into the indefinite future. Sustainability can also be achieved by seeking the optimally overlapping point between society (people), planet which means environment and natural resources, and finally economic (profit), as shown in figure 1.

However, due to an unstoppably increasing population, people essentially need more materials from any kind of resources to support their existence. Additionally, some human activities can also mainly bring about serious environmental problems, for instance people have unintentionally made greenhouse gas from using refrigerators, and then, of course, it has generated global warming. It means that the increasing population can directly and indirectly affect those problems, and makes them worse.

Furthermore, since long time ago, people have socially traded, exchanged and consumed their goods and products among each others. Therefore, economic thus has had an important, necessary and vital role for being able to live in the global change. According to Commonwealth Association of Architects (2003), the concept of sustainability can be defined as the maintenance and development of environmental, social and economic resources, in order to meet the needs of current and future generations. The three components of sustainability are:

1. **Environmental sustainability** requires natural capital that remains intact. This means that the source and sink functions of the environment should not be degraded. Therefore, the extraction of renewable resources should not exceed the rate at which they are renewed, and the absorptive capacity to the environment to assimilate wastes should not be exceeded. Furthermore, the extraction of non-renewable resources should be minimized and should not exceed agreed minimum strategic levels.

2. **Social sustainability** requires that the cohesion of society and its ability to work towards common goals be maintained. Individual needs, such as those for health and well-being, nutrition, shelter, education and cultural expression should be met.

3. **Economic sustainability** occurs when development, which moves towards social and environmental sustainability, is financially feasible (Commonwealth Association of Architects, 2003).
However, when applying the idea of sustainability into business activities, especially industrial sectors, firms have to maintain harmony between their profits, employees, and also internally and externally environmental cares. Traditionally, the profit and the employee or human workforce have been a key of success and main ideas when conducting policy, strategic and practical implementation, and also almost all kinds of business manner. Nevertheless, nowadays successful industrial companies visualize the idea of sustainability and try to optimally compromise the balance between the important of profit, employee, and environment in order to strongly survive and grow in long-run because, for example, change and uncertainty of markets have been rapidly increasing, environmental problems have been occurring and thus harming human well-being, legislations and regulations of environment and human right have been forcing them more than ever, resources are limited and more difficult to procure, and so on. In general, industrial companies have manufactured their products by using heavy machines and mass production processes that can probably release serious emissions. Those emissions can thus directly threaten the environment for instance air and water resources, and then become serious global problems. Cyclically, they will eventually come back and destroy human well-being. Therefore, industrial firms, when, for example, selecting raw materials, producing products and processing productions, have to minimize environmental impacts, whereas, at the same time, costs and time of manufacturing processes should be minimize in order to possibly maximize profits. Additionally, health and safety of labors and employees including ethic and anti-discrimination also have to be concerned simultaneously with making profit and reducing environment.

Correspondingly, sustainable development definition according to the report “Our Common Future” is "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). The sustainable development is the way that firms can implement to their organizations for achieving sustainability. It aims to improve qualities of human life and altogether with possibly increasing profit without increasing the use of natural resources beyond the capacity of the environment to supply them indefinitely. According to Ekins (2000),
socially sustainable development is likely to improve an involvement, commitment, communication, and relationship among people and societies. Nevertheless, when applying this idea to business firms, people and societies mean all stakeholders that are relevant to them. Furthermore, safety, health, and welfare of labors, a part of stakeholders, have to be concerned in order that firms can achieve social sustainability.

Economically and environmentally sustainable development seem to have a tendency to resist each other because firms have to invest so much in research and development for creating products and services without bringing about any environmental problems consequently. Whereas, in the different way, environmentally successful designed products can economically generate both profit and benefit to firms. However, according to Fussler, although products, production processes and services which have substantial improvement in environmental performance in one hand can create problem in another. For example, mobile-phone can reduce many costs of transportation and also materials for traditional land communications, but many toxic materials are contained in their batteries and dangerous radiations when connecting can directly damage human brains. Therefore, sustainable development requires radical improvement in products and services. They must provide customer satisfaction with much lower levels of environmental impact. But in practice the established technologies and lifestyles which create unsustainable development still maintain and dominance (Fussler 1996, p. 5).

3.2 Innovation’s Definition

Nowadays, large and small firms are considerably flourishing in everywhere of the world. Consequently, it automatically brings about highly competitive situations in any market. Moreover, business environments spinning around firms are unpredictable, unshaped, and rapidly changing all the time. Therefore, firms have to find ways that can drive their organizations to strive through high competitions and changes, and lead themselves in order not to fall behind competitors. New business methods, ideas, and visions which can gain competitive advantages, durably stabilize organizations, and construct flexibility and ability for coping with changes have been implemented into many successful entrepreneurial firms. The new business methods as mentioned have been defined by many researchers and scholars as innovation. The innovation consists of many types of business activities. According to Schumpeter, what considered as entrepreneurial behavior should fall into at least one of the following five types of innovation:

1. The introduction of a new way or improved good or service
2. The introduction of a new process
3. The opening up of a new market
4. The identification of new sources of supply of raw materials
5. The creation of new types of industrial organization (Burns 2005, p. 243)

However, according to Tidd, Bessant and Pavitt, another type of innovation which they added is the paradigm innovation. It can be explained as the change in mental model, for instance, the shift to low-cost airlines, the provision of online insurance
and other financial services, and the repositioning of drinks like coffee and fruit juice as premium ‘designer’ products (Tidd, Bessant & Pavitt, 2005). Furthermore, innovation can be explained as the way which has been successfully implemented on a market or in some other way adding value to a company both internally and externally including to all stakeholders (Ekman, 2009). Innovation is much more than invention because it not only focuses on creating new things or new ways of doing business, but also how to successfully introduce and adapt the things and the ways into markets and customer’s needs.

In general, innovation consists of three levels depending on the degree of value added on a product, a service or a business method, and also the degree of newness for each of them (as shown in figure 2). The three levels of innovation according to Paul Wright (2009), CEO of Invetech, a famous business consultant in Australia, can be classified as following:

1. **Incremental innovation** is unlikely to offer a dramatic change in business performance (Wright, 2009). Normally, this type of innovation merely concentrates on continuous improvements of already existing products, services, and business methods to prevent a firm from falling behind its competitors and also survive in long-run.

2. **Substantial innovation** according to Wright (2009) provides competitive advantages which can drive a firm to have an opportunity to lead the industry by bringing new types of business methods or new technologies in its processes, products and services. In doing so, higher investment is required, whereas higher degree of value-add is achieved than obtaining from the incremental innovation.

3. **Radical innovation** can turn an industry on its head, create new bases of performance, and highly build degree of value-add. It means completely new types of business methods, new products and services which have never existed before. Radical innovation often comes from outside of industry and is frequently technology based of the result of long R&D exercises (Wright, 2009).

![Degree of Value-Add and Newness](http://www.ceoforum.com.au/article-detail.cfm?cid=6143)
The perceived change can be in small incremental steps – doing what we do, but better – or in a more radical way – new to the company or even new to the world - sometimes innovation transforms the society as whole (Tidd, Bessant & Pavitt, 2005). Most innovations today build incrementally on combinations of already existing products, services etc., but not so many radically change in new ways to be new to the world, probably, due to the high investment of long way R&D.

![Figure 3: Three Levels of Innovation](image)

<table>
<thead>
<tr>
<th>Incremental</th>
<th>Substantial</th>
<th>Radical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvements to components</td>
<td>New components for existing systems</td>
<td>Advance material to improve components performance</td>
</tr>
</tbody>
</table>

(“Doing better”) (“New to the enterprise”) (“New to the world”)

3.3 Innovation for Sustainability

According to the meaning of the sustainable development, environment, economic, and people have to be concerned and balanced so that a firm can eventually achieve sustainability. Hence, when looking at sustainable development from innovation point of view, it can be additionally implemented by initiating new business methods in accordance with the definition of innovation. New products and services, processes, raw materials, and so on have to, in one hand, gain competitive advantages for attaining economical benefits, and, in the other hand, minimize negative impacts which can directly and indirectly affect people and environments.

3.4 From Innovation to Eco-Innovation

Eco-innovation means all forms of innovation activities resulting in or aimed at significantly improving environmental protection (European Communities, 2009). In the same way as the traditional innovation, eco-innovation includes new production processes, new products or services, and new management and business processes, but it additionally focuses on how to prevent or substantially reduce the risks to the environment, pollution and any other negative impact of natural resources throughout the lifecycle of related activities. Environmental innovation involves the formulation of demand, invention, innovation and diffusion of a technology or practice with an intension to reduce environmental impact (Buaner, 2007, p. 21). Environmental impacts can create new demands and business opportunities. Environmental innovation’s methods have been developed to identify each type of impact, to assign a value to the effect, and link to the cause of problems. When causes and effects of environmental impacts were recognized or defined, needs of solutions and new regulations would occur afterward. In this point, new demands can be generated in terms of new and proper solutions as a result of environmental regulations and market
needs. According to Tidd, Bessant and Pavitt, sustainability issues are often linked to regulation and such legislation can add additional force to changing the rules of the game. Sustainable innovation arises from concerns in complex social, political, and cultural contexts, for instance health, global warming and threat posed by climate change, environmental pollution, population growth, and declining availability of energy (Tidd, Bessant & Pavitt, 2005).

For the past decade, environmentally sustainable innovation has been needed when operating any kind of production. Actually, there are so many ways that can reduce and avoid environmental impacts during manufacturing processes, but, in fact, some solutions are unsustainable and ineffective in long-run. Unsustainable solutions can accidently generate more environmental problems or make them even more complex because they do not focus on the original symptoms of problems, but those solutions only focus on wiping out the problems in the end of production processes. For instance, some factories which use toxic materials have to find ways to get rid of toxics from emissions and wastes despite they can possibly find non-toxic materials in the first place. Thus, sustainably innovative solutions are more likely to prevent and do not allow environmental problems to occur in the first place, not in the end of pipe (Fussler, 1996). For production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and quality of all emissions and wastes before they leave a process. For products, the strategy focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product (Fussler 1996, p. 124). Moreover, in order to achieve cleaner production, Fussler also pointed out that industrial firms have to, firstly, change people’s, in this case, labors’ and employees’, attitudes toward environmental problems by increasing their awareness of the problems. From doing so, it is thus easier to implement technical solutions into production processes. Secondly, firms should apply know-how of environmental solutions to their employees in order that they can accomplish their environmental jobs effectively. Finally, firms should continually improve and develop proper technologies for tackling environmental problems and enhancing potentials of the solutions throughout entire of production processes.

### 3.5 Innovation and “Green” Technology

The concept of innovation has today a broad meaning and it is not only related to a new product from a technological point of view. It could also be a new process, a new service or a combination of these in technology (Ekman, 2009). However, radical changes in technology may need so much time, effort, and investment. Especially, technologies that can direct firms to the track of sustainability need radically innovative business methods. Sustainable technologies have to not only make profits and competitive advantages to firms, for example hi-tech robotic machines can reduce time for production and inventory as well as lower manufacturing costs, but also minimize negative impacts to people and environments. Unsustainable technologies will eventually be superseded by newer technologies (Fussler, 1996). For example, in very soon decades, vehicles that have equipped oil fuel engines will be replaced by other types of vehicles that can consume alternative fuels although a few decades ago people thought that oil fuel engines were well designed and very hi-tech. Nevertheless, the transition from old to new technology will never be automatic. It is
driven by the energy and vision of innovators who see the potential and make it happen (Fussler, 1996, p. 18).

Green technology means ways to apply scientific knowledge into business processes and activities without environmentally and socially negative impacts. Many firms which concern about environmental issues have implemented green technologies to support their sustainable developments. Buaner pointed out that environmental innovation in terms of technological approach can be done in several areas. He thus listed six types of environmental technologies:

1. Pollution control technologies that prevent the direct release of environmentally hazardous emissions into the air, surface water or soil.
2. Waste management: handling, treatment, and disposal of waste; both on-site by the producer of the waste and off-site by waste management firms.
3. Clean technology: process-integrated changes in production technology that reduce the amount of pollutants and waste material that is generated during production.
4. Recycling: waste minimization through the re-use of material recovered from waste streams.
5. Clean products: products that give rise to low levels of environmental impact through the entire lifecycle of design, production, use and disposal. Examples are low-solvent paints and bicycles.
6. Clean-up technology: remediation technologies such as air purifiers, land farming and bioremediation, which uses plant species to remove toxic materials from contaminated soil (Buaner 2007, p. 25).

3.6 Forecasting and Influencing Future Innovation

According to Bessant & Tidd (2007), forecasting can help to identify what might be required, and to foresee what kind of new products, services, processes, and business methods are likely to be required in the future. Future customer’s demands or market’s trends can be roughly forecasted by some common methods such as trend extrapolation and statistical estimate, for instance regression analysis, from past data. However, some uncertain activities or situations which do not have statistical cause and effect relations or variables, such as new environmental and social regulations including rapid changes of technology development, are difficult to statistically anticipate. The methods of forecasting (Bessant & Tidd 2007, p. 348) comprise of four main types; customers or market surveys, internal analysis for example brainstorming, external assessment, and scenario development. In consumers markets, surveys can be problematic simply because customers are unable to articulate their future needs. In contrast, in industrial markets, customers tend to be better equipped to communicate their future requirements, and consequently, business-to-business innovations often originate from customers. In the internal analysis method, ideas in a particular topic are gathered from brainstorming of employees in different backgrounds in order to forecast market trends or requirements in the future. After that, proper plans for future actions will be generated. In addition, the external assessment is useful where there is a great deal of uncertainty or for long-time horizons. It is the best used in making long-term forecasts and revealing how new technologies and other factors in business developments. Moreover, experts in non-
technological fields can be included to ensure that trends in economic, social and environmental fields are not overlooked. External surveys, communications, social and environmental contributions, and cooperation with others can make companies to clearer understand future trends, and then adapt their organization, business activities, products and services in order to be corresponding to the trends. Finally, the scenario development is a key part of the long-term planning process in those sectors characterized by high capital investment, long lead times and significant environmental uncertainty, such as energy and sustainable future scenarios. It contains the assumptions and inputs used explicit, and form the process of discussion, debate, policy, strategy and ultimately action. The scenario development can be implemented by many forecasting techniques, for instance computer-based simulations. From doing so, companies can assess the impact of each scenario on their business and then plan for better developments in the future (Bessant & Tidd 2007, pp. 349-351).

3.7 Sustainability in the Design Perspective

To identify and analyze how Volvo CE implements innovative design thinking to product development process in order to achieve sustainability, these three books, Design- inspired Innovation by Utterback, Vedin, Alvarez, Ekman, Sanderson, Tether and Veganti (2007), Design for the real world: Human Ecology and social change by Victor Papanek (2004) and Emotionally Durable Design by Jonathan Chapman (2005) will be used as main referent literature in the research. These specified books represent three ideas of how design can be a competitive and a sustainability factor in the development of companies.

*Design for the Real World*

Since old days, human being has always changed himself and his surroundings, but recently the world becomes much more dynamic than ever. With science, technology, and mass production that have advanced, they made changes become more rapid, completed and often less predictable. After these problems occur, we start to define and isolate the problems, to determine possible solutions. There are not so many cases that we would provision about problems first. Consequently, an over technologies, sterile, and inhuman environment has become one possible future (Papanek 2004, p. 28).

To understand the essence of industrial design, the function and the benefit of it, the basic concept of industrial designers is demonstrated. Industrial designers are people who are always counted as one common specialist among other fields. They are the communication bridge between other team members besides doing their normal design task. Most of the time, only teams of specialists who tend to speak only jargon language solved complex problems. (Papanek 2004, p. 28) Therefore, the profession of industrial designer became very important for the reign of dynamic and synergetic working environment of all companies.

Also, the basic concept of industrial design is shown in this short excerpt from Dreyfuss, the founder of industrial design profession’s book called Designing for people. It stated the most fundamental task that every industrial designer has to embark on. The task of industrial design began by taking out the excess of
unnecessary decoration. Then analyzing the product, seeing how does it works, and finding ways to make it looks better. Industrial designers must never forget that beauty is just “skin-deep” (Papanek 2004, p. 29).

The history of this genre of design initiates first in the most famous school of design of the modern era, Bauhaus. It was the first school that considered design as an important part of the production process rather than “applied art” or “industrial arts.” The primary concept that has been adopted by entrepreneurs is stated, “For the Depression market, the manufacturer needed a new sales gimmick, and the industrial designer reshaped his products for better appearance and lower manufacturing and sales costs” (Papanek 2004, p. 31). The essence of industrial design has been shown from this statement. The process of product development by this design art is not only just to improve attractive appearance but also have to be economical in the production process.

To assure the concept of it, Van Doren’s definition of industrial design in the book, Industrial Design, also compliment the basic thought. “Industrial design is the practice of analyzing, creating, and developing products for mass-manufactured at a price permitting wide distribution and reasonable profits” (Papanek 2004, p. 32). The fruitful result of implementing industrial design process is what that makes all the fuss in every business afterward. For example, as this statement, “Transformation of products by industrial design were most impressive but even more impressive were the differences in before and after sales figures” (Papanek 2004, p. 32). Being more attractive and productive means more successful and profitable.

Then after the basic concept of industrial design has been demonstrated, the connection to reach the sustainability state by implanting good concept of design will be shown. According to Papanek (2004), the pollution cycle from making products is more complex than we usually think. It consists of at least minimum state of seven parts:

1. Natural resources are destroyed; and they are normally irreplaceable
2. The way to succumb these resources, for example, strip-mining, open pit mining, and etc. create a pollution phrase
3. The manufacturing process itself creates more pollution
4. The same manufacturing process also brings about worker alienation and anomie.
5. Packaging
6. The use of the product creates more pollution and user alienation and user anomie (phase3)
7. Finally, discarding the product creates even more lasting sources of pollution (phase 4) (Papanek 2004, p. 250).

Although, industrialized production is harmful, we still cannot just get rid of technology since the whole world depends on it. Therefore it is the task of industrial designers, industry, and government that must determine together what kind of social and ecological harm we are doing to the communities and try to find the best possible solution to solve it. Papanek suggests the pioneer awareness of how people and entrepreneurs in developed country that hold a better access of technology should concern more about social responsibility or others well being because industrial
growth that directly exported from fully industrialized countries to those that are still industrializing, has many impacts in social, ecological, ethological, and environmental. Its main negative effects are pollution. And it is such an ironic that in developing countries where people are richer, the living also come with the rising statistics of suicide, vandalism, absenteeism, work sabotage, alcoholism, meaningless violence, crimes against the person, neglect and bettering of children and etc. which are against the will of people well being (Papanek 2004, p. 250).

The solution that can be brought by planning for good design process has been stated according to Papanek’s idea that “intervention of designers must be modest, minimal, and sensitive.” For example, Papanek came up with the example of indigo-dyeing of textiles in west Africa creates major breeding area for flies and mosquitoes which bring forth the problem of malaria and lack of sleeping for people in the community. The suggestion is to concern more about biological controls in the production process of dyeing, not by other means (Papanek 2004, p. 251).

About the idea of good innovative process that can link to achievement of company sustainability, it has been stated in Papanek theory also. As factories and industrial combines grow bigger, more complex and more investment capital, the lack of developing innovation grows. It is a normal thing that the bigger business is the more afraid of changes that may phase out its plants and products entrepreneurs will have. The reason behind it is because changes in the system, the replacements of the system itself or small parts of it can be more costly and more difficult to institute.

According to this fact, the idea of having free thinking space for innovation in a big and stern company has been shown, still, strictly to the basic concept of industrial design that aim for basic function that cost least trouble to the world, consumer rights will come first in priority when designing.

“Change cannot be initiated by big business or the military-industrial complex (or the tame, captive designers working for them) but will be initiated by independent design teams.” But before we begin to design smaller and safer things, I feel that consumers need their own bill of rights-guidelines that might serve them, as well as designers and industry.” This following shows “A Manifesto of Consumer Rights”:

1. The right to safety, to be protected from hazardous goods.
2. The right to information, the right not to be misled by lack of information or manipulated misinformation.
3. The right to basic services, fair prices, and choice- to have access to a variety of products and services and where monopolies do exist, a minimum guaranteed quality at reasonable price.
4. The right to representation, to be consulted and to participate in decisions affecting consumers.
5. The right to be heard, to have access to an ombudsman, to channels for complaints, and to fair and speedy compensation procedures.
6. The right to consumer education, lifelong consumer education from the viewpoint of users themselves.
7. Finally, and of increasing importance, the right to a healthy and safe environment (Papanek 2004, pp. 338-339.).
**Design-inspired Innovation**

According to design-inspired theory, product and service should not be torn apart from each other. They should involve every single aspect of the company working together on the entire customer experience; the same way that product designing team should be people from the different background knowledge. Firstly, customer might know about the product or service through advertisement or showroom and then later on impact across the life of product or through the length of the service. Therefore it is important to have product design teams that have members from different background knowledge of finance, marketing, service, logistics, ecology, environment, transportation and etc. included in the team. (Utterback et al. 2006, pp. 7) This kind of synergetic working environment will bring the unity of various new ideas and finally give birth to the innovative orientated firm.

The findings of this design-inspired theory implies that competitive advantage might be gained by trying to look at traditional products with different perspectives and the approach that might be the new way of using newer materials and design techniques. It is interesting to study the factors behind successful products that they can underline customer convenience and happiness, elegance or beauty, and also the economical view of enduring value in the same phrase line. And also these qualities will increase their value overtime (Utterback et al. 2006, p. Viii). One concept of the design-inspired is to try to find the answer that if great function or cost should be focus on, or might people be more harmonized with symbols and to the meaning to express their use of various products? The main problem has been answered that good design is more about combining “balance and wholeness” in the customer’s perceptions. Successful products must be more than sufficient function it should also consist of quality and have low cost (Utterback et al. 2006, p. xi).

After examine the function of design-inspired innovation, the benefit of it has been demonstrated. Innovation that has been well design will help us to achieve having greater products that are meaningful, reduce waste and fit in our natural and cultural environments. It proves the validation of the later on statement that “Products with both excellence function and elegance beauty, will be both more profitable and enduring” (Utterback et al. 2006, pp.2-3).

Then the practical benefit of design-inspired innovated implementation on production process has been stated in this literature evidence:

“Industrial design in many companies could take on new significance if globalization is managed badly. Design would then be pushed back to the dark ages of skin-deep styling, and the companies will lack of that “meaningful distinction” which as Theodore Levitt rightly argues, that it is so important for the creation of competitive advantage in an era of crowded markets and global competition” (Utterback et al. 2006, pp.3-4).

For the benefit of having an economical production, from this statement, it is true that rarely, products will have high level of interest over such a long period and with widespread appeal geographically. “Most iconic status does so in a single country, and their appeal lasts for a couple of decades at best. As industry and market competition intensifies and become more dynamic, any long-lived design that significantly
reduces the level of product line uncertainty represents a lifeline of stability. The financial benefits of long-lived design are obvious. If design remains viable in the marketplace for a long time, product family sales are likely to be more predictable and the company avoids the costly process of designing replacements for the models. Less apparent is the contribution that classic designs make to simplify the management of product families (Utterback et al. 2006, pp. 36-37.).

Like Buchner, a well-known designer of the Design Continuum said, “Meaning is brought to a design not by the designer but by the consumer, the meaning of the design is in the viewer’s mind, not in the object.” Designer supposes to understand 80% of meaning that lies in the consumer’s mind, including the consumer’s passions. Buchner’s idea compliment Papanek’s theory claimed that design has two parts, the feeling part and the intuitive part. The prior one is the more like a tacit knowledge and pre-consciousness and the latter one focuses on social, ethical, and environmental effects on design of new products that is good and meaningful in a society and tend to improve the quality of everyday life. (Utterback et al. 2006, p.201-202) if we can balance these two parts evenly, we will achieve the most idealistic state of design-inspired innovation.

*Emotionally Durable Design for Sustainability*

Many design concepts recently concern more about designing for lowering environmental impacts, material and energy consumptions, and so on. Designers have tried to minimize the use of raw materials but maximize the product life cycle. In addition, the design for recycling, assembly, disassembly, and re-use including the design of products that can consume alternative energies, for instance solar cell, are now strategic approaches implemented by new designers. According to Chapman (2006), some products are discarded before they are physically worn out or are technically superseded because their designs are out of fashion or inappropriate to change circumstances. He also argued that the design for recycling and re-use are not the best solution for achieving sustainability, whereas these kinds of design could liberate consumer conscience and decrease people’s awareness of reducing consumption. People will consume more recycled-products because they think that it will not harm environmental resources. However, this thinking is probably not a sustainable solution because when consumers use more products and materials even if they are recyclable or renewable, they could generate even more waste and devour energy for recycling processes still.

Currently, many designers have aimed to develop design concepts and design approaches for matching the rapid change of technology and, of course, supporting environmental ideas. However, although some concepts have exploited new technologies to create new designs, they are still not one-stop solutions for completely getting rid of environmental problems. Therefore, at the same time as technology is developing, in parallel, the design by using high technology should concern more about functional use and simplicity, (Chapman, 2006). Moreover, consumer’s expectations and real experiences of designed products should be balanced in order to avoid their disappointment.
3.8 Sustainable Product Life Cycle

Product lifecycle can holistically illustrate the method of how to environmentally deal with every stage since where raw materials come from to the end of products and the links between them (see figure 4). Corresponding to the Life Cycle Assessment (LCA) (Fussler, 1996), sustainable development activities can be implemented in all stages of the product lifecycle. The cycle starts with what raw materials are selecting to build products and how to extract them. After that, in the design and production stage, firms have to think how to sustainably design products and how to allocate and manage plants or factories without environmentally and ergonomically negative impacts throughout production processes. The next step focuses on which operations and distributions lie between a company and end-users. And then, which function that the final product performs while it lasts with consumers in the use and maintenance stage. In the reuse and recycling stage, it concerns what revalorization options can be considered at the end of the product’s service life. Finally, in the stage of incineration and disposal, how can a firm deal with the disposal options of the ultimate waste streams (Fussler 1996, p. 138).

![Product life cycle diagram](http://www.admin.cam.ac.uk/offices/environment/guidance/purchase.html)

3.9 Benefits of Sustainable Development

Mainly, benefits can come automatically once reaching sustainability because the meaning of sustainability itself is to balance and maintain the importance of people, economic, and environment in order that a firm can survive in long-run without harming the world. Generally, the benefits as mentioned are described in the holistic view. However, benefits in the business perspective or in a firm’s point of view are, for example:

- Saving on raw materials and energy
• Elimination of expensive end-of-pipe solutions
• Increasing competitiveness through use of new and improving technologies in process and products
• Reducing risks from on- and off-site treatment, storage and disposal of toxic wastes
• Improving health and safety of employees
• Less pressure from environmental restrictions or prohibitions on business activities
• Improving public image
• Business health and staying power (Fussler 1996, pp. 93-94).
4. Conceptual Framework

In this research, the researchers mainly focus on Volvo CE’s sustainable development in terms of innovation, technology and design activities. The scope of this research thus frames only the company’s innovation, technology, and design which are driving and approaching Volvo CE to sustainability (see figure 5).

Those activities regarding innovation, technology and design will be analyzed and linked with proper theories collected in the theoretical framework. Also, benefits and profits which the company has tangibly and intangibly obtained from its sustainable development will be analyzed by matching with theories. However, due to the time limit of this research, the main aim is then to answer all the research questions.

Figure 5: The research’s conceptual framework
5. Empirical Finding

Since Volvo Construction Equipment is one part of the Volvo group, most of the information we gathered is from the Volvo group sustainability report, official website and the research direct interview. Still, for the product detail, only information from Volvo Construction Equipment will be focused on. In order to understand how Volvo succeeds operating sustainable development, the holistic view of the management will be studied.

As Leif Johansson, the president and CEO of the Volvo Group stated in sustainability Report 2008 that “Sustainability efforts are an important ingredient in competitiveness” (Volvo Sustainability Report 2008, p. 2). During the global financial crisis, the decline in demand as a result of the recession, Volvo has been required to implement savings at all levels and in all areas of the operations. The difficult period made the company regard to sustainable business operations. Active sustainability efforts are counted as the Volvo Group’s competitiveness and the ability to create value that attracts current customers and shareholders.

For Volvo Group, the corporate values; quality, safety and environment care- are the foundation of all company’s activities which lead to sustainable development. They were implement into the three corporate responsibility dimensions; economic, environmental and social.

Economic Responsibility

Volvo depends on sustainable business development in a tremendous way because it creates long-term value for direct customers, shareholders and other stakeholders and the whole society that sounds as if a utopian business and social win-win situation has been created. The ultimate goal that Volvo wants to achieve is the long-term competitive business conditions. In the implementation level, Corporate Social Responsibility is taken care by using the active stakeholder dialogue or the daily work dialogue with employees. The formalized forums such as personal development plan discussions and employee surveys are also used. And for the most inventive method, Volvo has a far vision in well-developed relations with groups such as trade unions, universities and research institutions, media, non-government organizations, government agencies and other public actors. The mass media channel not only helps in publicity but also for the recruitment of new brilliant employees especially for the case of university student contest or scholarship campaign.

According to the company’s sustainability report 2008, the prospective market growth, according to the company’s Scorecard 2008 of Volvo’s is to grow by 10% annually over a business cycle. The recession, which has been deepened by the financial crisis, has severely affected the automotive industry, so the growth and the operating margin declined during 2008. At this time, the goal number of employees working in operations certified according to ISO 14001 will be 100%. However, the proportion of employees working in this type of operations in 2008 was 96%. Still, in the Volvo Group Attitude Survey (VGAS,) March 2008. The number of satisfied employees increased. (Volvo Group Sustainability report 2008, p.6)
During the economic downturn, the uncertainty in the global economy increased and Volvo were forced to adapt all operations and take extraordinary measures such as reducing the number of employees. Blue-collar employees were affected the most while white-collar employees are stopped for the new recruiting. Redundancies are difficult and demanding for everyone involved. Managers receive training and assistance to enable them to handle the situation in the best possible manner. Optimization is put in action to gain the most sustainable management. The code of conduct of Volvo has been adapted lately in 2008 to support the sustainability vision that was recently promoted within the company as a solution to the problem due to effect from economy crisis. To be more specific, when economy crisis occur sustainability development comes to help reduce cost in every process of every operation. For example, fuel accounts for about one third of the customers’ costs and each step of reducing fuel costs results in the increased profitability for customers, while surprisingly reducing the environmental impact.

Also treated in the same way for the international affair, the economic turbulence made Volvo Construction Equipment changed its North American motor grader activities. Normally, Volvo’s Operations were located in Goderich, Ontario, Canada, but recently it was moved to the company’s facility in Shippenburg, Pennsylvania, in the US. The purpose of doing so is to consolidate the industrial operations for road machinery in North America. From this action 500 employees were laid off (Volvo Group Sustainability report p.8). Volvo believes that when economic responsibility creates value for customers, at the end result it also creates value for the shareholders also. For the empirical case, from the interview, Lingong is the Chinese company that Volvo just took control according to the local brand business strategy. The reason behind this acquisition is because Volvo wants to use the low market image of Lingong instead of using the big name in general. With the local brand, it is easier to access local market and provided the cheaper production for the mass market that can be more profitable.

For the business principle, Volvo is like all business operators that were abided by the laws and regulations of each country that it operates. However, it tries to apply its own standards based on the corporate values and culture as much as it possible or when the law does not give any guidance. When conflict between mandatory law and the principles contained in this code, the first priority for the company to choose to act in accordance to is law. From the interview, one of the interviewees, the environmental engineer who works in cooperation with Volvo designing and legal team, suggests that legal statement brings the fairness of trading relation and we can find more detail about how Volvo deal the business with the legal part in Code of conduct. In the action plan level, Volvo’s customers; governments, agencies of government and etc. will not be bribed for any beneficial matter according to the integrity norm. It is a strong prohibition that all Volvo’s employees must not accept any payment or gift from a people who could affect or appear to affect their purpose in the business decisions. All financial transactions, Accounting and Reporting of the Volvo Group must be reported to headquarter in accordance to achieve the most correct and clean business operation state. Also with the same approach, the political involvement of Volvo Group is observed in the neutral way. None of the names and the assets of Volvo Group Company will be stated or used to promote for any campaign of political parties or candidates.
From a sustainability perspective, the Volvo Group aims to provide products, services and transport solutions that offer maximum value to customer. Being aware that the production impacts the environment, Volvo continuously work with development in technology, renewable fuels, more efficient transport solutions as well as other aspects of the production and using method of the products. Otherwise than keeping the business running, to remain competitive and offer environmentally enhanced products, Volvo believes that it is crucial to have the right skills and invest in research and development. During 2008, the investments in R&D amounted to SEK14 billion, approximately 1.83 billion U.S. dollars, and in production plants SEK17 billion, approximately 2.23 billion U.S. dollars. Most of the investments in R&D are related to engine emission reduction. (Volvo Group Sustainability report 2008, p.9)

**Environmental Principles**

For Volvo Group, Resource Efficiency development is always in focus. All Volvo’s products and processes are designed to have the most efficient energy and raw material usage, and waste and residual products are minimized over the products' life cycles. Moreover, Volvo tries to avoid using materials and methods that may cause environmental and health risks when suitable alternatives are available. Volvo has an environmental Performance that regularly audits, follows up and reports. The potential risk of present and future products and operations will be particularly emphasize when reach the evaluating time.

Renewable fuels are treated as a business opportunity for the Volvo Group. Volvo believes that energy efficiency technologies such as hybrid and sustainable renewable fuels when working alongside each other, can improve the situation significantly. Reducing the fuel costs will result in improved profitability, while reducing environmental impact. However, the current use of crude oil is not sustainable and that the pending shortage. Increased volatility in the energy markets is expected in the future. Therefore rules regarding sustainable use of energy in all sectors should be defined and established. This is the reason why ISO certification and economic concerned technology is very important for the sustainability, for it is the strongest competitive advantage of the business to gain a healthy marketing profit and optimizing the production. Without research and development strategy, the environmental technology will not exist.

The environmental policy of Volvo has a holistic approach that focuses on the environmental impact from products and service that should be seen from a lifecycle perspective. It was carried along from the first initial concept until the last disassembly part. Then, the environmental instruction must be composted and monitored in all operations shown as the perpetual improvement. Moreover, the technological development process, which is the composition of environmental demands and the active research and development, will be in focus. Also with the efficient resource utilization process that focus on the entire life cycle of the production process that will make sure that the company will have the most efficient optimum resource utilization.

The global climate change, energy efficient development, renewable fuels and
communication have become areas in focus for Volvo since 2003. To act according to the plan, the strategy process has been announced annually in the company. 96% of the total labors in Volvo Group production plants worked under the code of certified environmental management system ISO 14001 in 2004 that is the year that Volvo first start to implement the ISO certified system (Volvo Group Sustainability report 2008, p.10)

ISO 14001 is an environmental concerned standard with continuous improvements under the applicable laws and regulations that aim to minimize the impact on the environment in organizations. To cope with it more in action, Volvo has an environmental council that is used to control each business area and business unit within the group that is represented by their environmental manager on the council.

And since Volvo has this sustainable development concerns, it has to be ready to follow and be adapted with any legal and rule. For example, according to the United Nation’s Climate Panel, IPCC, greenhouse gases must decline by 50-80% between 2000 and 2050 (Volvo Group Sustainability report 2008, p.12). This means that the carbon dioxide (CO2) emission per person should be 1 to 1.2 tons per year to reach a sustainable emission level. Also, according to the EIA report (international Energy Annual) in 2006, the average CO2 emissions per person per year should be around 4.5 tons on a standard level (Volvo Group Sustainability report p.12). Another measuring source that Volvo look up to is the stern Report that was developed by the British Government, it is estimated that the cost of doing nothing about greenhouse gases is equivalent to 5% of the world’s collected annual GDP (Volvo Group Sustainability report p.12) Therefore, by reducing the greenhouse gases today, the cost of managing the environmental effects could be cut to 1% of the annual global GDP. For the empirical case, the employees within Volvo Group were trained in environmental issues since in 1989, which also include the Volvo Group executive committee. The successful result is first shown in 2003; the Volvo group has reduced its energy consumption per manufactured unit by more than 20%. For Volvo Group, the less energy consumption per manufactured unit is a prioritized environmental target (Volvo Group Sustainability report 2008, p.12).

The recycling process strategy of Volvo is another environmental plan that has been well developed and implemented in Volvo. Since, Volvo’s products are comprised almost of metal, mostly iron, steel and aluminum, they are perfect for recycling and the additional excess materials are mainly plastic, rubber and material from electronics components. With such a complex diversity, the most optimal way to support the knowledge of recovering materials are informative handbooks that show how to disassemble the products. These handbooks are available for most of Volvo’s products. Also, Volvo Group has many disassembly stations around the world.

After visiting one of the Volvo Construction equipment plant, at the last room we visited is the recycling room. All materials are well separated into each genre of waste after they had been disassembled. However, Volvo does not have its own recycling plant but choose to work with the recycling solution company called “STENA.” Also, after asked some more question about other recycling process that Volvo CE has been developed, we found that Volvo CE has the project to developed a “Zero percent toxic water treatment” that will be trade back to the community. At the moment the process of Volvo water treatment is still 50% non polluted water trade to the community according to the interview from the Environmental Manager of Volvo CE.
Product Development

For Volvo, product development is based on customer’s needs, social changes and the coming of new technology. Volvo’s most important task is to find the way to produce products with minimal environmental impacts. By focusing on energy efficiency, the development of existing products, new technological solutions and the renewable fuels, Volvo aims to develop better business solutions for customers and create a sustainable society. Quality, Safety, Environmental Care are fundamental are counted as an ability to make flexible product offerings both for hardware and software. Volvo construction equipment shares the same unique image and powered strength of Volvo diesel engine technology that can easily gain the worldwide respect. However, as basic business diversity, Volvo Construction Equipment succeeds at developing their first hybrid engine that is new to the construction equipment market.

To have the best product development process, Research and Development is crucial to be fully supported both financially and policy. Research and development at Volvo Group is the combined expert group from the different companies in the organization. Volvo coordinates R&D with the general processes and tools across the company. Half of the total R&D of Volvo is conducted in Sweden while the rest half is located to various locations in Europe, the US, Asia and South America.

Since Volvo Group is the series of venture compliances with other companies; it needs various researches and academic institutions to improve the technologies needed for future product development. The Example major programs and partners are FP7 (seventh framework Programmed for Research and Technological Development) and VINNOVA (The Swedish Governmental Agency for Innovation Systems.) Before designing each new product, the process of environmental impact analyzed and specified will come at the first stage. Large number of Volvo products might be identified with many environmental impacts. Therefore the first objective of Volvo’s group is to comply with legislation before improve new technology in product development. And for this process, each new product will have less environmental impact than the one it replaces.

To learn about the overall environmental impact over products entire life cycle, Volvo group manages to do that by using the Life Cycle Analysis (LCA). And the result point out that 80-90% of the total environmental impact comes from the use of the products (Volvo Group Sustainability report p.14). Then the result from these LCAs is adapted into the Environmental products Declarations (EDP) that is especially aim for the use of customers and is available for several products. The EDPs are divided into three sections: production, use and scrapping. The first section provides information about the process of production that contains energy consumption, emissions and the waste. The Second one focuses on the use of presents fuel consumption, emissions and spare parts utility and the third section deals with scrapping. To achieve the most efficient product development, the working process is organized in a dynamic way between multifunctional teamwork. Volvo’s product development process contains six stages cycle which in each stage, different environmental, quality and safety objectives that must be met to proceed to the next development stage are observed and followed. However, the environment issue is always considered and presented right from the first drawings to the end process of production that also include the scrapping and wasting part of the life-cycle analysis.
However, the current legal requirements should be observed first before developing environmental care products. The purpose is to make sure that every of Volvo’s products will not violate the environmental law and succeed to have the most efficient sustainable management. Different authorities are increasing concerned also with more strict requirements to reduce emissions of nitrogen oxides (NOx) and particulate matter (PM) from road transport. According to Volvo’s sustainability report 2008, “NOx contributes to acidification of soil and water and PM may cause asthmatic reactions and cardiovascular problems. The latest regulation, US’07, became effective in 2007. The Volvo Group’s products sold for the European market comply with current product regulations and the future Euro V that will be introduced in October 2009” (Volvo Sustainability Report 2008, p. 14).

For future legal requirements, Volvo group is working on a product development solution that will meet up with the future Euro VI standard that will be introduced in 2013. Diesel engine is what Volvo focuses on most at this time because it is the most efficient energy converter for heavy-duty transport solutions. According to the company sustainability Report, three parallel approaches are applied in product development to meet future regulations.

1. High fuel efficiency but low emissions through all the life cycle.
2. Develop alternatives that complement the diesel engine, such as hybrid drive line that offer potential energy storage.
3. Develop and identify renewable fuels. The challenge is producing and distributing sufficiently large volumes of these fuels (Volvo Sustainability Report 2008, p. 15).

Volvo can solve the problem of noise emission that is a main problem in the urban areas; it will be a great competitive advantage for the company. It is such a great opportunity that when Volvo developed the electric and hybrid engine vehicle; the problem of noise emission has been solved too due to the hybrid technology that when paired with the electric motor, it becomes practically noiseless. However, since there are different rule for noise emissions in each country, for example, EU and Korea have the most restrictive noise level regulations of 80 decibel for heavy duty vehicles, Volvo has to act and develop the products according to the various regulations of each market.

Since Volvo tries to find the best fuel efficiency solution, Hybrid engine technology plays a big role for this. Hybrid is used in city buses, distribution trucks and refuses vehicles. It is a great solution for urban operations because each time that the vehicle slows down or the brakes are step on, the retardation energy will be recovered and stored in a battery. Then the stored energy is used when the vehicle is starting off next time, for initial acceleration or for the hydraulic system in construction equipment. The hybrid technology offers fuel savings possibilities and thereby a reduction in CO2 emissions. The hybrid solution might cost a higher investment, but it will make the long-term operational cost reduces because the fuel cost will be more economical.

Volvo Construction Equipment is a leader in developed hybrid operation for heavy-duty vehicles such as trucks, buses and wheel loaders, and has gain a big commercial success, it has been testing various types of hybrid solutions first since the 1980s and introduce the first demonstration vehicles in March 2006. ISAM (Integrated Starter Alternator Motor) is what Volvo has been developed. It is a system that makes electric
motor and a diesel engine work in parallel. Each of these engines can be used in the areas where they are most effective in certain situation. Volvo believes that hybrid technology will have a great commercial impact in the market for heavy-duty vehicles.

Recently, Volvo Construction Equipment had introduced the first hybrid wheel loader prototype to the world. Wheel loaders are counted as one in the hybrid series since its drive cycle is different from a truck or bus. The first generation of it will save fuel consumption up to 10% and for the next generation the fuel will be saved up to 50% compared to the current fuel consumption level for automobiles. Moreover, seven demonstration trucks with one emission are another successful example of Volvo’s environmental concerned product development. These trucks have diesel engines that have been modified to operate on seven different types of renewable liquid-like or gas fuels. Also with the new generation engines that has been developed under the rule of Volvo Advanced Combustion Technology or V-ACT that reduce the amount of emissions and existing fossil fuel-powered combustion engines that it produces.

After all aspects of environmental concern product development, Volvo CE still has another core product development aspect which called “design to protect”, which is relevant to the company’s main core value, safety. According to the Volvo Construction equipment’s article; Safety... is no accident. These safety rules under the name of “Essential machine safety features” are always applied to every designing product tasks. It consists of 4 rules; Control systems to support operator in the work cycle, Cab comfort to support operator, Easy entry and exit and Easy daily maintenance (Volvo Construction Equipment: Safety… is no accident 2008, p.14)

Want to develop innovative safety design, Volvo’s designing team tries to come up with the innovative solution of anti-slip steps and rails that guide operators into a wide aperture cab since falling from a big construction vehicle has always been one of many accident that occur to Volvo’s customer. Also, the ‘three point’ stance, which is the right move of facing the steps when getting into, and coming down from the cab, has been, published in the instruction handbooks to promote safety. Moreover, Volvo has Machine Tracking Information Service (MATRIS) gives full analysis of the machines condition and performance from keeping record that help ease away the chance of accidents since customers will always know when the machine need some maintenance. In conclusion, Volvo strives to create more productive, more comfortable and safer to use products.

Product line of Volvo Construction Equipment is in all major product categories and in all popular sizes, from one to 70 tones (Volvo CE, 2009). It has the most popular fuel-efficient wheel loaders, which is famous for tough frames, fast acceleration and good penetration. It has high technology Backhoe loaders and a range of skid steer loaders, hauler, a range of the smallest model fits excavators and motor graders, pavers, compaction equipment and milling machines. Also it offers a complete range of Road building product and earthmoving contractors.
Future Prototypes of Construction automobile

Volvo Construction Equipment aims to be slate free and process up to 30 years futuristic design. Although these futuristic designs might not be immediately implemented, they are prospected to gain popularity and will definitely make a lot of profit for Volvo.

From Volvo CE new product catalog, the first prototype is “The Centaur” which is a two-piece haul that has the body that creates a new tipping action that improves stability. The rear section of the body slides into the front section, compressing the load material down and out in a controlled manner. Moreover, it has ability for the front ‘tractor’ to uncouple from the ‘trailer’. It balances using powerful computers and gyroscopes, and can be disconnected so the trailer opens up the possibility to rapidly change the work application. From Volvo’s product brochures “The Centaur can be a hauler one moment, converting to a pipe or log carrier – and then a liquid container the next.”

Figure 6: The Centaur

Then there is “The Gryphin” concept car that has independent wheels that can ‘climb’ to dump load. It has a single spar boom, a zero-emission electric hybrid engine, noiseless electrical wheel motors and intelligent cab glass that automatically heats up in cold weather and darkens in bright light. However, according to the high level of advance, much of the Gryphin’s technology has been still developed.
And the last futuristic concept car is ‘Sfinx’ which is more efficient, reduces weight, saves on steel and reduces the amount of fuel consumption during operation.

Social Responsibility

For Volvo, sustainable business development and profitable operations of the company depend on solid relationship. And to achieve a good relationship between the organization, employees, other business partners and society, Volvo has developed social responsibility plan that cover the welfare of workers, pleasant working ambience to help sustain the best qualified employees and a good public relation to promote the knowledge about the organization to make a good understanding between people in and outside the company.
Corporate Social Responsibility in Volvo consists of many aspects; financial, legal issues, environmental care, human resources, human rights, purchasing, involvement in society and other social aspects. Responsibility for the CSR and legal compliance follows the routine business responsibility. An to achieve the most effective way of working, code of conducts that has these concerning issues are applied to all employees, business partners and stakeholders in order to cover all business principles, environmental principles, human rights and workplace practices. Moreover, to make it easier in the action plan part, a web-based training ethical problems model has been developed to help managers. Volvo encourages all suppliers, dealers, consultants and other business partners to act according to these principles.

Good brand image attracts good employee. And after attracting best quality people to work in the organization, Volvo manage to maintain the utopian working environment in order to keep the satisfaction of the qualified workforce by developing a sustainable plan of safety workplace. In the process of implementing, Volvo has to determine the way to collect and register the data regarding to the task. It has a policy for all employees to report in all accidents that occur which helps investigate the causes of a specific event that can solve the future problem by guiding the way for the company to make a proper safety improvement.

Safety of the employees and visitors come first in every Volvo’s plants. For example, currently, OHSAS 18001 (Occupational Health and Safety Assessment Scheme) certification is applied to five of Volvo’s production plants. Also, another five additional facilities of Volvo will reach certification by the end of 2010 according to the production plan. These international standard help point out a controlling process and help company to improve its safety and health issues that include the management of work environment risks and the process of following up. (Volvo Sustainability Report 2008, p. 28)

For the emotional satisfaction of the employees, Volvo has a benchmarking, Employee Satisfaction Index (ESI) that help improve the working climate and the attractiveness of work places and eventually increase profitability for the company and also Volvo has another annual attitude survey called Volvo Group Attitude survey (VGAS) that uses necessary data such as the working climate, working conditions, diversity and leadership that was collected from employees worldwide. The main reason of doing this is to check the feedback of how employees look at life inside the Volvo Group, and it gives opportunity for all the workers to discuss and create action plans for the future improvement. According to the company, from 92% of Volvo Group employees who took part in the VGAS, 86% of that amount stated that they were satisfied with the workplace. (Volvo Sustainability Report 2008, p. 26) For each improvement conflicts between the working groups inside the company and too slow action time between decisions and implementations are concerned.

For culture and the overall environment of Volvo, it has an international working environment that deal with coworkers, customers and other business partners from all over the world. In Volvo, necessary training is always taken care for employees. Training modules are used according to specific job positions. An annual reviewed personal business plan is observed in order to achieve employees’ competence development. Also, for Volvo, diversity concept has been practically implement in the
company’s code of conduct that describes the behavior that does not contain any bias issues such as gender, race, religion, age, sexual orientation, disabilities and social or ethnic origin. The main reasons that diversity is so important for Volvo Company are because first, it promotes the sense of belonging to the employees. When feeling included and respected, employees will work with the full potential and then when business challenges is match up with diversity, creative and innovative solutions are contributed. Moreover, with diversity competence, local cultures and marketplaces knowledge, Volvo will understand customer demand that later states the market possibility. When new business opportunities appear, the area for long-term business success will be developed. And when the company reaches this stage a healthy company culture is formed and then will attract the most competent people to Volvo.

To publicize about the organization, Volvo has a group document called “The Volvo Way” which best described all values and culture in the organization. It is a guide that tells everything from everyday work of Volvo’s employee that will give a broad business strategy to achieve the long-term business success of Volvo. The successful result is shown according to the Volvo Group’s sustainability report that the growth rate each year is at least increase 10% (Volvo Sustainability Report 2008, p.1). And this profitable growth creates big value to attract shareholders.

From the interview, the interviewee explained about the working environment in Volvo CE. The dynamic corporate working atmosphere is there in the office. Experts in each fields work together in the projects without the line of rigid department or position. This deconstructing in working organization gave birth to innovative ideas and a wonderful cooperation that enable everyone to put in their best effort without thinking that it might or might not be in the limit of their task. For example, the interviewee works in the designing team as an environmental engineer expert. She has to work about law and regulation, but still she does not belong to the legal department. This kind of multi dimension position helps complete the empty gap of the operation and make it reach the most efficient working state. From diagram below the cross-functional corporation between Lawyers, engineers and designers is demonstrated.

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Law and Regulation Manager (Law and Regulation Department)

Environmental Engineer + Engineers

Designer Team Environmental Engineer + Engineers
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Figure 9: Example of the cross-functional corporation
6. Analysis of Finding

6.1 Sustainability of Volvo CE

The holistic view of sustainable development of Volvo CE is to maintain profitability and also customer’s value in long run by combining and balancing three main factors corresponding to the research’s theory of sustainable development which are social, economic, and environmental responsibility. Sustainable development is an important part of Volvo Group’s daily operations since many years. In doing so, the company emphasizes on not only all three kinds of sustainability but also balancing and finding optimal points between them. To describe and analyze the sustainable development of Volvo CE, the three areas of sustainable development (see figure 1) can be connected and compared with the empirical data of the company. As a result, the holistic view of sustainable development activities which have been implemented in Volvo CE can be illustrated as the following.

- Emission Reductions of products and production processes
- Waste Management
- Natural Resources Reduction
- Toxic Reduction
- Diversity
- Training
- Business Ethic
- Profitable Growth
- Operation and Production Cost Reduction
- R&D Investment
- Customer Value Creation
- Company’s Culture (The Volvo Way)
- Working Conditions
- Stakeholder’s Relationship
- Health and Safety
- Global Climate Change
- Environmental Regulation Orientation (ISO 14001)
- Environmental Product Development
- Renewable Fuels (Hybrid Engines)
- Energy Consumption Reduction
- Product Life Cycle Management
- Emission Reductions of products and production processes
- Waste Management
- Natural Resources Reduction
- Toxic Reduction

Figure 10: The holistic view of sustainable development of Volvo CE
In order to clearly explain about the holistic view of sustainable development of Volvo CE (Figure 10), three main activities regarding social, economic and environmental responsibility which have been driven the company to reach the sustainability goal are considered. In addition, activities that can balance the social, economic and environmental responsibility are also explained. The balances between those three factors as shown in figure 6 are not only to balance the two factors alongside them, but also to bring benefits to both. Therefore, activities for achieving sustainability of Volvo CE can be categorized to six aspects which are three activities of social, economic and environmental responsibility, and three of the balances between them. They can be summarized as the following:

**Social responsibility activities**

Social responsibility of Volvo CE can be seen as external and internal ways. Firstly, the Volvo way is the business principle which aims to strategically build and direct the company’s value and culture. The company believes in the Volvo Way that every employee has the capacity to improve its operations. Empowerment, trust and freedom are the business manners that every employee has been offered. In accordance with the research interview, one of the interviewees said that she feels very enthusiastic to work because she is always allowed to freely think, and, importantly, her boss’ door always opens for any question. In this point, it also creates a good working condition. Furthermore, the company’s managers have to demonstrate and communicate the content of the Code of Conduct to their subordinates in order to direct them into the track of business ethic. Volvo Group including Volvo CE evaluates its employees’ satisfaction and attitudes by using the Employee Satisfaction Index (ESI) and the Volvo Group Attitude Survey (VGAS) respectively. The purpose of these two surveys is to improve and develop working climate and the attractiveness of workplaces. Also, all employees are allowed to pose questions directly to the Group’s CEO via the Intranet. Consequently, good working climates and attractive workplaces can encourage all employees to be innovative and creative, and support the company to implement innovation, create new design ideas and develop new technology.

However, basically, when implementing or applying innovation, new concepts, or new ways of thinking which completely different from traditional business activities into firms, employees’ attitudes adjustment sometimes is a huge stumbling block because they are still familiar with their routine daily workings and old established ways of thinking. Volvo CE has tackled this problem since sustainable development has launched within its organization by clearly conducting the idea of sustainability as the main company’s core value. From doing so, strategically, the core value, the code of conduct, CSR (Corporate Social Responsibility) can be passed on from the top management to the bottom of the organization. Gradually, it can make employees to change their attitudes and be ready for new sustainable development activities.

Secondly, external social responsibility activities focus on building long-term stakeholder’s relationships. The company also has well-developed relations with such group as trade unions, universities, research institutions, media, non-government organization (NGO), government agencies and other public actors. In this point, the company can gain competitive advantages and innovations by cooperating with other
organizations for developing new products, processes and innovative activities together.

Economic responsibility activities

Volvo Group sets the goal of increasing the profitable growth rate of at least 10% annually, and over the past five years, the Group could achieve 10.6% of annual growth in average. Nonetheless, according to the Volvo Group Scorecard 2008, the profitable growth has declined since year 2006 due to the global financial crisis. Additionally, the crisis has influenced Volvo Group to reduce redundant costs of its operations. Reducing the number of employees, especially blue collar employees, in some plants is a way of decreasing costs. For example, in North America, Volvo CE moved and downsized its motor grader operations from Canada to Pennsylvania. The purpose was to consolidate its industrial operations for road machinery in North America. In this case, it affected 500 employees. However, cost reductions in the sustainable development and innovation perspective is the way that the company can reduce costs in daily working operations, productions and so on by implementing innovation, design and technology. Furthermore, innovative and well-designed products and services can create value directly to customers, and after that generate competitive advantages to the company. However, for doing so, it needs so much investment in R&D in terms of products and services development, for example Volvo Group invested SEK 14 billion for R&D in 2008, in order to radically create customer’s value and superior products and services. More details will be explained in 6.2-6.4.

Environmental responsibility activities

Most environmental responsibility activities emphasize on how to minimize environmental impacts throughout production processes and the product lifecycle. It can be explained the whole processes of both productions and the product lifecycle initially from materials selection to recycling methods in the end of products’ lifecycle. Waste management, emission controls, non-toxic material selections, and recyclability of products and used materials have to be concerned and implemented. Volvo CE has implemented innovation, design and technology in many kinds of environmental responsibility activities, and the company has had very good results from doing so. More details will be explained in 6.2-6.5.

The balance between economic and social responsibility activities

Volvo CE believes that diversity is an accelerator for innovation and a source of international competitiveness and profitability. The company’s diverse workforce relies on some parts of the Code of Conduct which focus on mixing the workforce of genders, people of many generations, people from ethnically and racially diverse backgrounds without discrimination. When combining this with the Volvo way, it can consequently share and expand many kinds of knowledge throughout the organization. Innovative business solutions can be generated by intersectional ideas and various perspectives of the diverse employees. In this point, it allows Volvo CE to usually find new business opportunities in keeping the company competitive and bringing about long-term success.
According to figure 10, training of Volvo CE drawn in the balance area between the social and the economic responsibility means that it can socially and economically generate benefits to both factors. Training can strengthen the company’s workforce by injecting knowledge to individual levels, therefore once the company has a strong workforce, it can have a tendency to gain profitable growth. However, if the company too much focuses on investing in training, worthless costs will probably be increased and also working time of employees will not be wisely spent.

Business ethic is also the way that the company runs its business. Before launching any product and service, Volvo always concerns about negative social impacts which can possibly harm people.

*The balance between environmental and economic responsibility activities*

In order to balance the environmental and economic responsibility, the company has concentrated so much on its product development, production processes and also daily operations. The balance in this case is the way that Volvo CE can maximize its benefits by innovatively minimizing its costs without any environmental impact. As a result, environmentally innovative products, well industrial design, and also product lifecycle management for sustainability have been implemented within the company. More details will be explained in 6.2-6.5.

*The balance between social and environmental responsibility activities*

Since global warming and climate change became a globally social problem, many environmental regulations and legislations have been released and then forced, especially, industrial companies to follow. Volvo CE is an industrial company which has strictly stayed on those environmental regulations. Currently, the company has implemented ISO 14001 into its all business activities. ISO 14001 is the internationally recognized standard for the environmental management of businesses. It prescribes controls for those activities that have an effect on the environment. These include the use of natural resources, handling and treatment of waste and energy consumption (ISOQAR 2009). This environmental regulation has forced the company to adapt or even change new production processes, plants management, new concepts of product design, etc. Always, ISO 14001 is requested by its customers, so the company must maintain its environmental qualities in order to be on the standard of the ISO. The company has often been assessed by ISO officers. Likewise, according to the interview, the interviewees said “We sale our products to customers as business to business. Our main customers are construction companies, and they always ask and request us about ISO 14001. And if we do not have, we can probably not sale our products”.

Safety and health is also in the company’s core value. Internally, production processes and the company’s plants design have been environmentally well managed for minimizing negative impacts and accidents rate. Also, externally, products and services are not allowed to create any kind of environmental and social negative impact. For example, Volvo CE has launched a realistic simulators driving machine that allows drivers of all skill levels to practice simulative worksite scenarios in a safe environment. Beneath the machine, it is equipped a hydraulic motion platform in order to provide drivers real feelings of everything from basic machine maneuvering
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to complex operations over rough terrain. This innovative machine can teach drivers to understand accidents and use construction equipment safely in real situations.

6.2 Product Development Processes

*Forming the Design Team*

To achieve efficient product development, Volvo CE organizes the work in multifunctional teams, combining employees from different experiences, kinds of knowledge and competencies. Also, in some particular projects, when the product development teams need some experts that Volvo CE does not have, the global organization’s experts will participate. This kind of synergetic working environment will bring the unity of various new ideas and finally innovative and creative solutions (Utterback et al. 2006). In accordance with the interview, one of the interviewees is an environmental engineer of Volvo CE, and she is also responsible for environmental assessments in every product development project although she is not involved in the design teams.

*Inspiration from Customer’s needs*

The product development of Volvo CE is mainly inspired by customers’ needs, changes in society and new technology. Additionally, quality, environmental issues, health and safety are the basic concept design that the company always concerns. In Volvo CE’s research and development, customers’ needs information can be directly gathered from customers because, as mentioned before, the company is a B2B (business to business) company which major customers are construction companies. Thus, it makes Volvo CE to be able to work with its customers as cooperation in terms of product developments. R&D teams also collect data from traditional successful and failed products in the past in order to develop or improve in producing the new one (Utterback et al. 2006).

*Innovative Design for Safety*

Accidental statistics have been collected and categorized overtime for ergonomically improving new designs. In parallel, new technologies have been developed, and the company also tries to find ways to combine and develop traditional technologies in order to support health and safety issues by not only its R&D teams but also externally involving with other companies, for instance FP7 (Seventh Framework Programme for Research and Technological Development). In doing so, incremental innovation of decreasing accidental rates comes from continuous improvements (Wright, 2009), for example the Roll Over/Falling Object cab protection comes from an accidental statistic regarding a possibility of falling objects that can hit drivers. And it can be explained that substantial innovation is occurred when the company gains more effort and investments to develop and apply new technologies (Wright, 2009). For example, modern construction equipments of Volvo CE are fitted with a range of warning lights and sensors that pinpoint areas of attention.
Basic Functionality

Functionality of products is designed and inspired by basic, simple and easy to use concepts. When designing cockpits and cabs, Volvo CE’s designers and ergonomists firstly think about the concept of essential machine safety features which are;

- Control systems to support operator in the work cycle.
- Cab comfort to support operator.
- Easy entry and exit.
- Easy daily maintenance.

After completing drafts of functional design, the design teams then apply technologies to the products and decorate them in the later stages. Correspondingly, Papanek (2004) pointed out that industrial design began by firstly taking out the excess of unnecessary decoration. Then analyzing the product, seeing how does it works, and finding ways to make it looks better. Industrial designers must never forget that beauty is just “skin-deep” (Papanek, 2004). Likewise, the design by using high technology should concern more about functional use and simplicity (Chapman, 2006).

Attractiveness and Quality

Quality is one of the three company’s core values, and it thus strongly embeds in every design concept. Utterback et al. (2006) claimed that qualities can increase values of products to customers’ overtime. A designer of Volvo CE stated in one of the company’s article that “You don’t need to see the prancing horse badge to know that the blood red sports car in front of you is a Ferrari. That is what is known as having a strong brand character” (Volvo CE, 2009). Therefore, the appearance of products is another important concept design. The company’s designers apply this idea when designing products’ appearances in order to enhance the brand character and attractiveness. It can be claimed that attractiveness can build expected quality to customers who see products for the time. And after that, when they buy the products or even take a look in more details, they will experience that the products have very good qualities. In this point, the company can balance expectations and real experiences of customers to avoid their disappointments by optimally developing both qualities and attractiveness of products (Chapman, 2006).

Environmental Design

Volvo CE manufactures several heavy machines which can generate various types of environment impact. The company’s products consume crude oil, generate air and noise emissions, and some parts of the products are made of toxic materials. Also, according to the Life Cycle Analysis (LCA) of Volvo Group, the result indicates that 80-90% of the total environmental impact is generated by the use of the products. However, the environmental design concepts of Volvo CE focus on minimizing environmental impacts throughout the entire product lifecycle. Accordingly, environmental design focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product (Fussler, 1996, p. 124). Thus, 85% by weight of all parts of products is recyclable metal,
mostly iron, steel and aluminum. In addition, some parts of products are made of recycled materials. Moreover, when manufacturing, it takes so much time, and at the same time it also unnecessarily costs if products are difficult to produce and assemble. The design teams tackle this problem by designing products to easily assemble. Easy disassembly design concepts are also implemented because when products need maintenances or reach the recycling stage in the end of their life, it can reduce energy and costs of complex disassembly.

**Development for Meeting Future Requirement**

A tendency of environmentally legal requirements in the future is stricter due to the increasing environmental problems nowadays. Also, when causes and effects of environmental impacts were recognized or defined, needs of solutions and new regulations would occur afterward (Buaner, 2007). Volvo CE applies this issue to its product development so that it can create products to meet the legal requirements. For example, the future Euro VI standard will be introduced in 2013 and US’10. The requirements lead the company to; firstly, attain high fuel efficiency and low emissions throughout the life cycle, secondly, develop alternatives that complement the diesel engine such as hybrid drivelines that offer potential energy storage, and finally, develop and identify renewable fuel.

In summary, futuristic demands, environmental regulations and legal requirements are very important for the direction of Volvo CE’s research and development. Buaner (2007) also pointed out that new environmental regulations can create new demands and business opportunities. Volvo CE can maintain the leading situation of environmental concern among its rivals by reacting to the future regulations as the first mover. In this point, the company thus greatly applies the idea of future requirements into its R&D and product development.

**6.3 Sustainable and Innovative Products**

The soon coming product of Volvo CE is L220F hybrid wheel loader. The machine is the first construction equipment in the world that uses hybrid engine. In 1997, the first vehicle equipped hybrid engine was introduced to car market (HybridCars.com, 2009). However, so far, main purposes of the hybrid engine are, for example, fuel efficiency and low emissions, but they are not likely to create high torque and horse power (as construction equipments need). It was usually equipped in city and compact cars. Nevertheless, technology development of the hybrid engine has extended its potential. For almost a decade, Volvo Group has launched many hybrid-engine trucks and buses which require high torque and horse power. Nowadays, the company’s technology development including other R&D activities can lead Volvo CE to create the L220F hybrid wheel loader. It is radically new to the world (Tidd, Bessant & Pavitt, 2005). Additionally, it is approximately 12 years since the first hybrid-engine car was introduced to the market until now which the first hybrid-engine construction equipment will be soon introduced. It can be claimed that the L220F comes from radical innovation of the company. Wright (2009) stated that radical innovation often comes from outside of industry and is frequently technology based of the result of long R&D exercises. Traditional crude-oil fuel engines will probably soon be superseded by the hybrid technology due to the limit of crude oil resources.
Unsustainable technologies will eventually be superseded by newer technologies (Fussler, 1996).

Benefits in sustainable way of the hybrid engine in construction equipment are in many ways. The hybrid engine mainly aims to reduce negative air emissions and provides fuel efficiency. Also in economic way, the interviewees said that although the price of L220F will be quite expensive comparing to traditional wheel loaders, it can reduce long-term operational cost for customers due to the fuel savings. Wright (2009) explained that radical innovation creates high value to customers. Also, once it can lower operational costs for customers who mainly are construction companies, it probably can enhance economic potentials to construction business sectors as well. Furthermore, the hybrid engine itself is the technology generating low noise emission which can reduce noise pollution when working near to residential areas. The interviewees also pointed out that the hybrid technology will be in the vehicle market for a long time as long as crude oil is decreasing as today. This can also make financial benefits to the company as Utterback et al. (2006) explained that if design remains viable in the marketplace for a long time, product family sales are likely to be more predictable and the company avoids the costly process of designing replacements for the models.

6.4 Green Production Processes

Minimizing Emissions from Production Processes

The company very focuses on minimizing the use of toxic materials in the first place in order to avoid complexities of treatment processes. Black and grey lists of chemicals have been set up in every production process to limit hazardous substances which are difficult to purify in the treatment stages. The Black list is prohibited chemicals and the grey list indicates what chemicals are to be used with restriction. In accordance with Fussler (1996), environmental solutions have to focus on the original symptoms of problems, but those solutions only focus on wiping out the problems in the end of production processes. For example, the company has long-term environmental investments which have resulted in a reduction in the emission of carbon dioxide and solvents in its paint shops. The interviewees explained that it is much easier and cheaper to reduce carbon dioxide and solvents at the pain shops than to clean them in the treatment processes. Moreover, in Volvo CE’s plants, there are a lot of hi-tech manufacturing machines equipped clean-up technologies (Buaner, 2007) which can automatically reduce emissions during production processes. Some machines can decrease complexities in the treatment processes by separating chemical substances in order to easily purify and divide types of waste. In some instances, the company uses automatic polishing machines that can automatically separate iron dust from coolant liquid and lubricant. Another example, emulsion separations are operated by automatic hi-tech machines in order to support liquid waste management. This machine can also separate toxic liquids, sludge and oil from water, and finally make water easy to be purified. These environmental technologies can eliminate toxic raw materials, and reducing the quantity and quality of all emissions and wastes before they leave a process (Fussler, 1996). Additionally, the company has its own water treatment station called “STENA” which can purify waste water from production processes as clean as it can be released back to public water resources.
Low Energy Consumptions

Volvo Group has an important objective which is to cut energy consumptions by 50% per unit of output by 2008. It leads Volvo CE’s plants to expand this objective to every labor. In order to create awareness to all labors, information of how to reduce energy consumptions and some environmental tips are posted in many places inside the plants. In this case, the company can change attitudes of environmental problems by increasing their awareness of the problems. From doing so, it is thus easier to implement technical solutions into production processes. In addition, the company also applies know-how of environmental solutions to their employees in order that they can accomplish their environmental jobs effectively (Fussler, 1996). Moreover, new technologies are used for lowering energy consumptions. For example, spare parts and materials which are already painted do not have to be heated in ovens anymore because they can be suddenly dried by painting machines. This technology can reduce energy consumptions of traditional heating and drying systems which use so much energy from coal and oil.

Waste Management

In Volvo CE’s plants, wastes from production processes are separated by types. As mentioned above, some manufacturing machines can automatically separate material’s substances and particles before they become wastes, whereas some wastes have to be manually separated by labors. Separated wastes will be putted into categorized garbage pails. The pails are labeled in different colors, and each color signifies each type of waste. And then, each type of waste will be moved to different places. Recyclable wastes will be gathered and ready to be transferred to recycling suppliers. Waste water and some of toxic wastes will be transferred to the plant’s treatment station.

Labor’s Health & Safety

The plant is well ergonomically designed to enhance health and safety of labors. Walking ways and lanes for forklifts and trolleys are completely divided by obvious yellow lines in order to reduce a possibility of accident between labors and machines. In addition, labors can use hydraulic lifts instead of ladders when reaching to high storage shelves. Also, air ventilation technology is used for minimizing air pollutions inside the plant. Lighting is amply designed so that labors have very clear visions when working.

6.5 Product Lifecycle Management

The holistic view of the entire lifecycle of Volvo CE called “From the cradle to the grave” (Figure 7) is illustrated that the company environmentally concerns all the stages of its products lifecycle. As mentioned before, Life Cycle Assessment (LCA) according to Fussler (1996) shown that sustainable development activities can be implemented in all stages of the product lifecycle. The management starts since the product development team designs and selects raw material (as explained in 6.2). After that, in production processes, the company also minimizes environmental impacts throughout the processes (as explained in 6.4). Additionally, the rest of stages in the product lifecycle management will be explained as the following.
Product Transportation

Every transport supplier of Volvo Group has to be completely based on the company’s environmental policies. Transport and logistics companies are requested to pass Volvo's engine qualification and have fuel efficiency driver training and environmentally continuous improvements. The environmental requirements are followed up with random sample audits and survey annually. Also, most of the company’s road suppliers in Europe achieve ISO14001 certification. Additionally, according to the company’s survey, 89% of the engines in the truck fleets of suppliers in Europe are equipped for Euro 3 or later emission requirements.

Packaging System

The company has a returnable packaging system used for transport of goods from suppliers to the plants in order to reduce transport volumes and the use of transport materials. The system uses wooden pallets, steel and plastic foldable pallets, and also smaller plastic “blue boxes” in different sizes depending on sizes of goods. The plastic pallet can be reused for five years and the wooden pallet for seven to ten years. Moreover, the packaging materials can be recycled when they no longer meet quality standard, and then become new materials and energy.

Supply Chain

Supply chain management is one of environmental solutions which can reduce redundant energy consumptions as well as lower emissions, and minimize delivery time. An example of efficient and environmental supply chain management of Volvo CE is that the company reduces the requirement to ‘emergency’ deliver parts using air
freight. This project can reduce 30% in the proportion of Volvo parts sent by air by providing more stock availability. Therefore, when the ability of stock supporting increases, the need of emergency shipment by air decreases. More material can be sent by using low carbon transport methods, such as sea freight.

**Product Use**

As mentioned before, 80-90% of the total environmental impact is generated by the use of the products. Apart from environmental product designs and hybrid-engine technology which can minimize environmental impacts in the first place, Volvo CE additionally implements fuel management techniques to its services and product maintenances throughout the time that products are in-use. Furthermore, the information on vehicle such as product’s handbooks can also make drivers to use products efficiently and environmentally.

**Recycling**

According to the interview, the interviewee said that the company is currently planning to have its own regular recycling suppliers which can take care of wastes from expired products dismantlement. It can allow customers to sale their expired products to the suppliers. And after recycling processes, the company can buy recycled raw materials directly from the suppliers inexpensively, and the raw materials will be used to build products again.

**6.6 Benefits of Sustainability**

The benefits of sustainability according to Fussler (1996) can describe what Volvo CE has achieved after implementing sustainable development as the following;

“**Saving raw materials and energy and reducing of expensive end-of-pipe solutions**”

From environmental design, design for easy manufacturing, assembly and disassembly, effective logistic and supply chain management, hybrid engine technology, waste management, recyclable products, and so on, these altogether can minimize energy consumptions and save the use of raw materials in the first place.

“**Increasing competitiveness**”

Due to unstable business situations and the financial crisis, sustainable development can reduce costs, for example production, new materials, energy consumption and operation costs. Moreover, environmental and innovative solutions such as the hybrid engine can directly create a high level of value to customers.

“**Improving health and safety of employees**”

The idea of balancing social and environment sustainability leads the company to concern so much about employees’ health and safety. Ergonomic and environmental factory designs enhance Volvo CE’s employees’ health and safety, and finally generate good working results.
“Less pressure from environmental restrictions or prohibitions on business activities”
Nowadays, environmental regulations and legal requirements are stricter than before. The company always follows the regulations and requirements by implementing them to its entire business processes within the organization. Those regulations and requirements also take place in the environmental responsibility of the company which is a part of sustainable development.

“Improving public image”
From doing social responsibility, Volvo Group has been chosen to be the Sweden’s most attractive employer (Volvo Group Sustainability report p.30). This can attract many competent prospective employees who are fresh graduates from top universities and jobseekers having very good experiences. In addition, public sectors can perceive that the company considerately concerns about environmental and social issues which are the huge problems of the society as well.

“Business health and staying power”
When balancing all social, environmental and economic responsibility, the company can internally achieve strong workforces as well as sustainably economic growth and competitive advantages. Also, externally, it has an environmental-friendly image from public sectors, no pressure from regulators and legislators, and an ability to tackle with energy crisis.
7. Conclusion

After analyzing empirical data by relevant theories, the research shows that Volvo CE has implemented a lot of business activities by applying innovation, technology and design approaches in order to support and improve its sustainable development business concept. Mostly, environmental and social requirements and regulations including customer’s demands have an important role that leads the company to consistently build up sustainable development ideas. Also, it can be claimed that innovation, technology and design are the driving forces which can additionally support the company to transform the social and environmental restrictions to become channels of business opportunity.

Volvo CE has achieved sustainable products, productions and products entire lifecycle mainly by focusing on research and development and good long-term relationship between all stakeholders. In sustainable innovation aspect, R&D and continuous improvements are the origins of incremental, substantial and radical innovations which can not only create values to customers, minimize costs and gain competitive advantages, but also reduce environmental and social impacts. Altogether, they can maintain sustainable growth in the long run without damaging environment and society.

Moreover, in design aspect, apart from good R&D, Volvo CE has an innovative idea about the diversity within its design teams. Because the company is one part of the Volvo Group, which has many sub companies globally, it can hire employees to be contributed in a particular project and share their ideas to have the best design solution. Safe, ergonomic and environmental friendly products and productions have been well designed by combined specialists with divergent ideas.

Volvo CE’s well and environmentally designed products themselves can minimize negative impacts, they also can extend their lifecycles during the period of use and therefore reduce wastes from too early discarding because they can emotionally have an effect on customers who concern about environmental and social issues in parallel with product’s appearance and quality. As well as production processes, well-designed plants and factories throughout the production processes can enhance employees’ health and safety and improve public images toward the company regarding environmental and social issues.

Finally, in technology aspect, Volvo CE has invested enormously in hi-tech machines which can reduce production costs and time, minimize complexity of managing wastes and emissions and augment the standard of labors’ health and safety.
8. Discussion and Recommendation

Many successful industrial firms have implemented the sustainable development idea to their organizations because most of products and services in this business field directly have created negative impacts to the environment and society. Social and environmental regulations including legal requirements have also forced them to reduce the negative impacts from every kind of business activity.

The research shows that Volvo CE has implemented innovation, design and technology to many of its operations in order to support the sustainable development. The company has applied environmental regulations and legal requirements to its business activities and wisely changed those regulations and requirements to become business opportunities. For example ISO 14001, the future Euro VI standard in 2013 and US’10 lead the company to prepare and develop its operations in order to meet them as soon as possible. And if Volvo CE can meet those regulations and requirements before its competitors, the company will gain a competitive advantage in this point. Market needs, customer’s demands and business trend are also very important in terms of business development. Limited natural resources and consumer’s environmental awareness can direct the business trends and market needs in the future as well.

Therefore, after combining all theories regarding the sustainable development, innovation, design and technology together with the research’s empirical data of Volvo CE, thus it can be seen the sustainable development from innovation, design and technology perspectives as ‘an alternative business solution’ for not only industrial firms but also others business sectors.

In summary, Figure 12 gives the analogical example of how the sustainable development in innovation, design and technology perspectives can be a business solution for keeping firms sustainably growing. Firstly, firms have to enhance predictability of future trends, such as future customer’s demands and environmental regulations, in order to create long-term visions and strategic planning. Especially, trends regarding environmental and social issues are an important factor of business development in terms of sustainability. Effective R&D is a way that can enhance the predictability.

Also, good relationship with stakeholders for instance regulators, legislators and customers can help firms to develop and understand business trends in the future by working in cooperation with them. After long-term planning is established, firms can prepare themselves to be ready to change. Policies, ways of thinking, employee’s attitudes, company’s structures and cultures, and so on have to be ready and able to support the implementation of innovation, design and technology.

Then, eco-innovations, green technologies and sustainable design will create innovatively sustainable working operations, productions, products and services in order to gain competitive advantages and customer’s values. Finally, social, economic and environmental sustainability will be achieved. Firms can eventually have strong workforces, good relationships with stakeholders and long-term profitable growths without negative environmental and social impacts.
Future Business Trends, Regulation, and Legislation Predictability

Long Term Vision and Strategic Planning

Preparation for Change

Innovation, Technology, and Design Implementation for Sustainable Development

Sustainable Products, Services, Productions and Working Operations

Social Sustainability

Economic Sustainability

Environmental Sustainability

Strong Workforce and Good Relationship with Stakeholders

Long Term Profitable Growth and Customer Value Creation

Minimal Environmental Impact and Natural Resource Consumption

Figure 12: Sustainable Development in Innovation, Technology, and Design Perspectives
In addition, the Sustainable development is the rule of application that aims to find the balance pathway on how to be successful in management without causing trouble to people and environment in order to gain perpetual well-being of the organization.

However, due to the time limit, this research can be improved by gaining more qualitative data. Additional direct interview from designing and mechanical engineer teams will be greatly helpful to learn more about Volvo CE product design processes which will give a clear understanding on how the company designs and develops its products according to the sustainable core values in the empirical level.

Moreover, the process of quality control of design should be another studied topic. Since sustainable development of innovation, technology and design concerns many multi-principles, business and social regulations and norms. It will be very intriguing to learn on how Volvo CE can manage the highly interactive demand Product quality control process.

Also, after being at the gate of commercialization which is the moment of truth if the end result of all investing and developing products process will be successful in the market or not. Result of the marketing measure in the product development section should be studied further in order to benchmark or measure the success of implementation of the innovation design and technology. However, not only about the time limitation, it is such a hard task to get the confidential information from the company according to the confidential policy.

The only one prospect negative impact from implementing technology that further researches need to follow up is the future problem of hybrid-engine such as waste management, some toxic materials embedded in the machine, or some unexpected problems. Since from the old day of producing diesel-engine automobiles, we human never has any idea about its toxic and environmental harmful aspect came across our minds at that time. And also for the hybrid engine solution that might be a “perfect” environmental harmless solution nowadays, we do not know that probably the problem of overflowed technological waste might be caused by it in the coming future. The same problem of technological waste management of computer and mobile phones toxic parts is a good analogy to this issue. Steadily follow up and be aware of negative consequences of the technology, hybrid-engine can develop a requirement of good planning of hybrid waste management.
References

Books


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Volvo CE, 2009. *What designers do in their spare time... Limited by costs, legislation, specifications, component commonality, customer focus groups and a host of other constraints, industrial designers are seldom given free rein to indulge their creativity. But when they are, as in Volvo Construction Equipment’s Gryphin wheel loader design study, the results can be dramatic*, viewed 19 May 2009, <http://www.volvo.com/constructionequipment/corporate/eng-b/press_room/articles/what_designers_do.htm>


**Figures**


Figure 11: Volvo CE’s Product Entire lifecycle - “from the cradle to the grave”
Source: Volvo CE Environmental Care Internal Presentation 2008
Appendix

The Research’s Interview

First interviewee: Mr. Jan Stighagen, Volvo CE’s Environmental Manager.
Second interviewee: Ms. Susanna Thörn, Volvo CE’s Environmental Engineer.

Location: Volvo Construction Equipment AB, SE-631 85 Eskilstuna, Sweden

Questions for the first interview (17/04/2009)

1. How does environmental issue have a role in the product development process of Volvo CE?
2. Since Volvo is the leader in environmental concern automobile, how it comes up with the new project or product idea?
3. Is sustainable development mainly from marketing department (which include all factors; force from competitor fuel price crisis, customer need etc.) or the division of research and development department (the innovation and designing team.)
4. What is the production process f Volvo CE?
5. How does Volvo implement technology, design or innovation in the production process?
6. What is the sustainable development process of Volvo CE?
7. Could you please give us some example of sustainable development activities that you currently implement in Volvo CE?
8. Is it become beneficial after investing time and money develop the high technology in eco-friendly engine?

Questions for the second interview (21/04/2009)

1. When designing a particular product, how have environmental specialists contributed and participated in the design team?
2. Have environmental issues led the company to change or initiate new operating processes, for instance production processes or product development processes? If yes, how have they changed and what are the new processes that the company has initiated?
3. Has Volvo CE used technologies to additionally support company’s activities to achieve environmental goals? What kind of treatment technology or industrial design, for example factory design and plants’ location, has the company implemented for tackling pollution, noise, and emission from manufacturing?
4. What is the main obstacle when implementing environmental concerns into operating processes? (high investment, disagreement from other working departments, or conflicts)
5. In order to achieve ISO14001, how has the company developed its business activities or changed its operating processes?
6. What are the benefits and profits that the company has attained from ISO14001 and environmental development?
7. How does the company design its products according to the “Easy Recycling” design concept?

8. According to the entire lifecycle “From the cradle to the grave”, when transporting raw materials or spare parts from places to other places, how has the company reduced environmental impacts?

9. Due to the high investment of implementing environmental concerns, how do you think that what the company will achieve in long-run? Is it worth, or not?

10. Environmental regulations in different countries have their own requirements. How has the company dealt with them when exporting products or expanding branches or plants into different countries?

11. What is the social sustainability in Volvo CE’s perspective?