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Ecodesign:
Analysis of incentives and barriers

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Introduction

Nowadays, one hears more and more about companies engaging in sustainability and greening their processes, products, etc. (Dumaine, 2014). Growing environmental regulations and laws are expected to be respected (Chiu, 2015). Local residents request that organizations control their emissions to the immediate environment. Investment companies do not like to invest in organizations that disregard the environment. The consumer is increasingly attracted to products that generate little pollution. Third parties of an organization do not want to be associated to a company that may damage their image (Demeulemeester, 2008). In this perspective, producing more environmentally friendly products has a central importance. Therefore, companies and designers may need to integrate the environment into their approach and that is where engaging into ecodesign makes sense.

The research question of this master's thesis is: What pushes and prevents companies from adopting ecodesign approaches? The aim of this master's thesis will thus be to highlight the elements influencing companies as far as ecodesign is concerned; why companies decide to get started with ecodesign or why they do not. To answer this question one can start by asking other ones to develop a broad understanding of the concept, its tools and the incentives and barriers. Therefore, the following questions will also govern the progress of this work: What is ecodesign? What is an ecodesigned product? What can a company concretely do? What tools can be applied? What precisely makes the adoption of ecodesign tools difficult? What is problematic? What are the alternatives? What are the incentives to design environmentally friendly products? What internal and external factors play a role? What are the barriers?

In order to answer the above questions, the methodology that will be applied will be to make an extensive literature review as well as a small field research. Starting with definitions of the relevant concepts, the first part will highlight what ecodesign is. Relevant associated concepts will be overviewed in order to put ecodesign in perspective. Also, the method that can be applied (LCA) will be briefly analyzed and the possible alternatives criticized. The second part will focus on the incentives (external and internal) and the barriers or challenges. Possible solutions will be considered when likely. Finally, the third part will go deeper by focusing on information gathered from field players. As one will see later, depending on the size, sector and nature of the company, the incentives and barriers to which it is confronted inevitably vary. Therefore, it was chosen to approach consultancy companies confronted with

organizations engaging into ecodesign. To do so, a member of Greenfish and a member of Climact were interviewed. Plus, to add even more value to the coming results, three other organizations were considered: the UCM which has an ecodesign department subsidized by the IBGE, the OVAM which is a governmental agency involved in ecodesign and Celabor which is a research center that namely performs LCAs.

This work does not intend to give a micro view with a focus on individual firms. Further work might thus be done considering a panel of organizations. As part of this master's thesis, it has been deliberately decided to focus on the macro view by considering literature as well as field workers facing multiple companies involved in ecodesign.

PART 1 - Ecodesign: The broad picture

The first part of this master's thesis intends to give the reader the broad picture on ecodesign. Indeed, as to know why companies do or do not adopt ecodesign approaches, mastering the concept of ecodesign as well as the related tools is essential. Therefore, two chapters will be included in this part. The first one will be focused on ecodesign itself while the second one will focus on the main tool, specifically the Life Cycle Analysis.

Chapter 1 - Perspective on ecodesign

In order to develop a full comprehension of ecodesign, the establishment of a series of definitions is required. Therefore, four main sections will be covered. First, without considering the ecological side, design will be briefly defined. Second, the emphasis will be set on ecodesign by itself as well as related approaches. Third, one will attempt to define what an ecodesigned product is and how to determine whether a product is or is not ecodesigned. Finally, actions that can be undertaken by companies in the framework of ecodesign will be emphasized.

1. What is design?

Designing a product is about the planning and decision-making associated with the production of a product, product being understood in a large sense including goods and services. As defined by the online Business Dictionary (n.d., a), design is the *« realization of a concept or idea into a configuration, drawing, model, mould, pattern, plan or specification (on which the actual or commercial production of an item is based) and which helps achieve the item's designated objective(s) »*. In the design stage of a product, various requirements have to be set about what the product should be, how it should look like, how it should be created, how it should be used, and so forth (Brinkkemper, 1996). In this same logic, when a product is in its design phase, a target value is set for the different components with tolerances. In the Six Sigma language, which is often used in quality management, these tolerances are expressed as specification limits which allow the product to still be of sufficient quality (Demeulemeester, 2008). Briefly speaking, one can consider a product as being of sufficient quality when the values of its different characteristics are somewhere between the

lower and the upper specification limit. Nevertheless, as these considerations about design seem to go beyond the scope of this master's thesis, these will not be investigated further.

Moreover, the design of a product is instigated either by market pull or by technology push (see Fig. 1). Both types of instigators try to satisfy a need, either expressed by the customer (market pull) or created, or at least expected to be created, by the technology (technology push). As can be seen on the figure, both go through the same stages but what initiated the process is different. In this way, one can in a nutshell define design as finding a solution in order to satisfy a need.

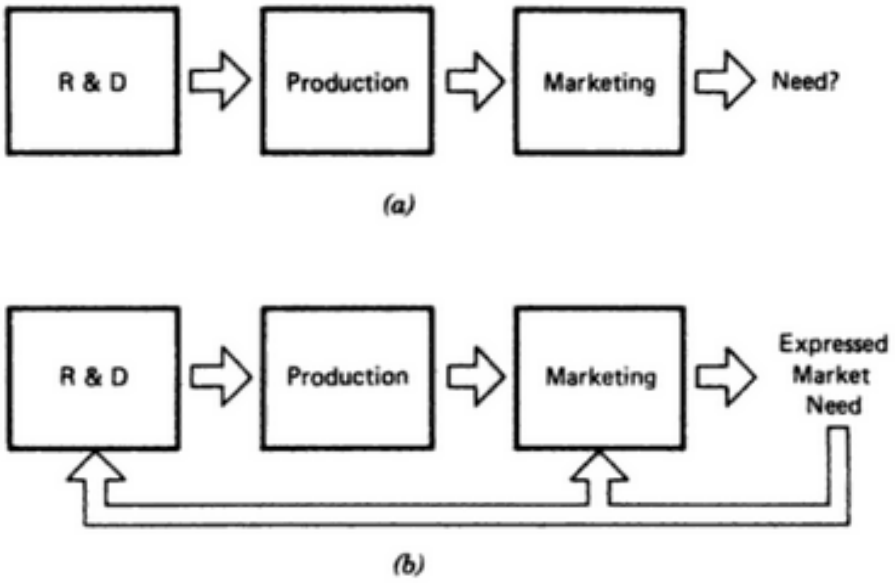

Figure 1 - (a) Technology push vs. (b) Market pull (Martin, 1994, p. 44)

Without really investigating into ecodesign yet, we can already apply those two innovation techniques to so-called ecological or green products. In this way, we can ask ourselves whether products are created in an environmentally friendly way because the company initiated it (technology push) or if a form of market demand has driven the company to answer this particular need (market pull). Another way to understand market pull may be by considering it not as being the expression of a need of the customers but as a response to policies like a disposal tax or extended producer responsibility (EPR). Further, internal and external stimuli can be emphasized within which some elements pushing the company to ecodesign are coming from the company itself and others are engendered namely by legislation. Nevertheless, to be rigorous, one cannot consider regulation as being part of the market so we could conceive that there are three categories triggering ecodesign: technology

push, market pull or regulatory pull. This will be investigated in more detail in the second part where the incentives to engage into ecodesign will be analyzed.

2. What is ecodesign?

2.1. Focus on environmental impacts in a product's life cycle

When the decision to produce a product has been taken, requirements are set in the design stage and there can possibly be new technologies that allow improving production processes. Although technological advances allow multiple advantages for production, this production leads to several impacts such as impacts on human health, overexploitation of resources and all the other environmental impacts (climate change, destruction of the ozone layer, acidification, eutrophication, etc.) (Zwolinski, 2013). Indeed, any product or service has an impact on the environment and these negative externalities are generated on the whole life cycle of the product (see Fig. 2).

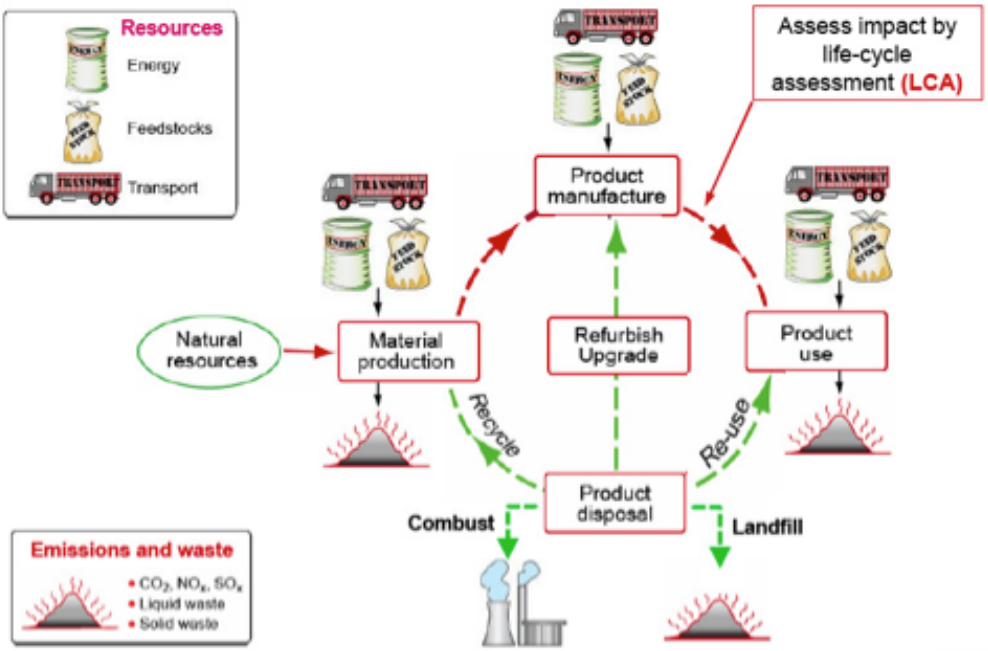

Figure 2 - Life Cycle of a Product (Ashby, 2011, p. 439)

By life cycle is meant all the life steps of products starting from the extraction of materials and their processing, going through manufacturing, being packaged, distributed, used and

finally disposed and possibly recycled (from cradle to grave) (European Union, 2012). At each of these steps, one encounters emissions and waste.

As the different requirements for a product as well as the manufacturing method are determined at the design stage, environmental impacts can be predicted at this same stage. More precisely, at the design stage, approximately 80% of environmental impacts are already determined (Madge, 1997; Margolin, 1998; Pôle Eco-conception, 2016, a).

At the very beginning of environmental awareness, the first actions initiated by industrialists to reduce the environmental impact of a product in the 1970s were to minimize waste. This can be understood as the willingness to reduce waste from a material point of view (avoid excess material use, restrict pollution, etc.) as well as from an energy point of view (efficient use of fossil energy sources and renewable energy development). It was only later that the attention shifted to the life cycle in its wholeness. Indeed, at the beginning of the 1980s, the Life Cycle Assessment emerged (Berneman, Lanoie, Plouffe & Vernier, 2009). More attention will be addressed to the Life Cycle Analysis in the second chapter of this first part.

2.2. Related definitions

Presently, more and more companies are aware of their role on the environmental degradation and acknowledge their duty to improve their processes and thus their goods and services (De Bruijn, Coenen, Kuks & Lulofs, 1992). As environmental impacts can be determined at the early stages of product design, actions can be taken quite soon. To get to the heart of this chapter, the most relevant ideas surrounding the taking into account of environmental issues will be overviewed.

2.2.1. Ecodesign and Design for Environment

Ecodesign, also referred to as design for the environment (DfE), ecological or environmental design, is the fact of taking into consideration, during the design phase, the various environmental impacts engendered by a product in all stages of its life cycle (Berneman et al., 2009; Berneman, Lanoie, Plouffe & Vernier, 2013; Camier, 2015). *« The well-known eco-efficiency concept helps to assess the economic value and resource burdens of potential improvements by comparison with the baseline situation »* (Levidow, Lindgaard-Jørgensen,

Nilsson, Alongi Skenhall & Assimacopoulos, 2014, p. 2113). The aim of eco-efficiency measures is not to reduce production but to produce better by reducing environmental impacts (WBCSD, 2000). In this sense, ecodesign applies the eco-efficiency principle as the latter requests the reduction of environmental impacts of a product. Bovea et al. (2012) consider that, when ecodesigning, the environmental viewpoint has to be integrated early on by keeping in mind the life cycle approach with a multi-criteria approach. Indeed, besides considering the life cycle, different environmental impacts (energy use, material use, solid waste, discharges into water and into air) have to be considered and pollution transfers should be avoided between steps of the cycle as well as between types of pollution. It could thus be defined as an integrated system aiming at internalizing negative impacts on the environment all along the life cycle of a product whether it would be a good or a service. Moreover, ecodesign is not a new method of design; it really is about the taking into account of the environmental parameter in existing methods (UVED, 2013).

As to really develop a clear comprehension of the concept of ecodesign, one should differentiate it, or on the contrary couple it with the other concepts surrounding the taking into account of environmental impacts. Therefore, the different concepts will be overviewed and their relations with ecodesign will be highlighted.

To begin with, the designs for X's that may interest us will be explored. Design for excellence (DfX) or design for X refers to different types of design where the X is an interchangeable variable on which attention is drawn (Bralla, 1996). In our case, design for environment (DfE) and its subcomponents, that is design for environmental processing and manufacturing, design for environmental packaging, design for disposal / disassembly / recycling / reuse and design for energy efficiency, seem to be the most important ones.

Design for environment seems to be the closest to ecodesign as it is *« defined as systematic consideration of design performance with respect to environmental, health, and safety objectives over the full product and process life cycle »* by Ray and Guzzo (1993) and as being the *« product design philosophy that aims at generating minimum waste during product's cradle-to-grave life cycle during production, marketing, distribution, use, and disposal »* by the online Business Dictionary (n.d., b). In this regard, design for environment also develops a life cycle approach in which it integrates the different environmental externalities. According to Simon, Poole, Sweatman, Evans, Bhamra & Mcaloone (2000, p.

368), *« ecodesign is a broader term than Design for Environment, implying a balanced view of the whole product life cycle and design effort focused on reducing the major environmental impacts of a product or service »*. In this definition, the main difference seems to be that ecodesign, in addition to taking the whole life cycle into account, focuses on the most important impacts, neglecting the less important ones. Nevertheless, this difference between both is not clear and there might actually not really be a difference between ecodesign and design for environment or green design. Indeed, different environmental impacts occur along the life cycle and one tries, by ecodesign (or DfE or green design), to minimize them. These impacts refer to every type of impact on the environment. Mainly three categories have to be kept in mind: resource consumption, emissions and miscellaneous covering among others noise. As these impacts are set at the design stage, ecodesigning a product requires considering those externalities at the earliest stages of the product's life cycle (Bevilacqua, Ciarapica & Giacchetta, 2012; UVED, 2013; Avnir, 2016).

When trying to take into consideration the environmental impacts across a whole life cycle, one might need to split things up to focus on one aspect at the time. Therefore, as part of DfE, we can consider having subcategories: design for environmental processing and manufacturing, design for environmental packaging, design for disposal / disassembly / recycling / reuse and design for energy efficiency. These will be briefly defined to ensure a broader comprehension of DfE (IISD, 2013):

- Design for environmental processing and manufacturing focuses on minimizing the negative outcomes of material extraction and manufacturing itself on the environment as well as the human health.
- Design for environmental packaging focuses on the development of environmentally friendly packaging. The use of recycled materials, the development of single-product packaging and the minimization of packaging are among the practices that can be adopted by companies.
- Design for disposal / disassembly / recycling / reuse focuses on the way the product will finish its life. As clearly mentioned in the name of this type of design, different paths can be used. When, from the beginning, it is planned what will happen to the product at its end-of-life, the use of materials can be variable. Practically, products composed of different parts can be designed for disassembly when the parts are easy to separate, free of glue, screws, etc. The components should then be clearly labeled to encourage recycling.

- Design for energy efficiency intends to minimize energy consumption all along the life of the product. From a practical viewpoint, a company can for instance recover heat produced at some point of production to insert it at another point where heat is required.

If we consider ecodesign and design for environment as being sufficiently close to each other, then one can see those sub-categories of design for environment as ecodesign strategies that one should put in place when ecodesigning (Gheorge & Ishii, 2007).

Without going into detail, some consider indeed ecodesign to be synonym of design for environment (Madge, 1997) with the following notions covering different aspects of it: design appropriate to material characteristics, material-efficient design, energy-efficient design, low-pollution design, waste avoiding or reducing design, durable design, recycling-friendly design, disposal-friendly design and logistically friendly design (Econcept, 2007; Yang, Yu & Sekhari, 2011).

2.2.2. Cradle-to-Cradle

So far, the notions covered focus on the life cycle in the classic sense, which means that one sees the life of a product going from the cradle to the grave. Along this life cycle, one can apply techniques to reduce the environmental impact that concentrate on particular steps of it. A step further, we can consider the Cradle-to-Cradle approach (Braungart, 2016). *« Cradle-to-Cradle or C2C is a play on the phrase 'cradle to grave' which, in contrast to traditional linear manufacturing models, promotes the use of non-toxic manufacturing systems where products are designed for disassembly using pure materials which can be safely recycled »* (Howard, Jeanrenaud & Correia, 2012, pp. 1-2). In the Cradle-to-Cradle philosophy, the use of materials is seen as analogous to the taking of nutrients in the natural world. *« C2C (...) promotes non-toxic manufacturing systems where products and materials are designed from the outset to enhance quality-of-life and ensure safe recycling once product life has expired »* (Howard et al., 2012, p. 4). As lots of companies do not even proceed to basic improvements to be more environmentally friendly, in the framework of this thesis, the focus will be kept on ecodesign without going further to Cradle-to-Cradle. Nevertheless, some of the incentives and barriers to ecodesign may be similar to those to Cradle-to-Cradle.

2.2.3. Eco-innovation

« In recent years, there has been an upsurge in the reporting of research in the area of eco-innovation, 'green' innovation or sustainable development innovation » (Pujari, 2006, p. 76). Therefore, the notion of eco-innovation seems relevant to be briefly defined. Without entering into detail, as the aim here is not to develop a complete lexical, eco-innovations can be considered as innovations directed to sustainability (Rennings, 2000). Rennings, Ziegler & Zwick (2004, p. 376) define it as *« new or modified processes, techniques, practices, systems and products to avoid or reduce environmental damage »*. If we consider the definition given by Pôle Eco-conception, a French association whose missions are, firstly, to educate and facilitate the access of SMEs to ecodesign approaches and, secondly, to work for the dissemination of ecodesign in business, one can consider that eco-innovation is the integration of environment to the innovation process. This institution considers that there are two ways to apprehend ecodesign. The first one would be 'eco-redesign' which is about reducing the environmental impact with lower prices and an equivalent margin. The second one would be 'eco-innovation' which would imply offering superior product functions to the customer and charging the product at higher price with higher margins (Pôle Eco-conception, 2016, a). In this way one can say that an eco-innovation is an ecodesigned product but not every ecodesigned product is an eco-innovation.

2.2.4. Environmental management

The International Standards Organization (2016) states that an environmental management system is *« the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy »*. In this way, environmental issues are handled systematically by really integrating environmental management into the daily management of the organization. The Deming cycle (Plan, Do, Check, Act) can then be used in a continuous improvement perspective (Tyteca, 2014). Indeed, the Environmental Management System (EMS) is specific to each company and as the context is continually changing, continuous improvement is required. The company can then file for one of the two most known official recognitions: EMAS or ISO14001.

Without having to dig deeper, it can clearly be seen that an EMS is broader than ecodesign, which can be part of the specific EMS set in place by the company.

2.3. Focus on the life cycle

According to Horvath, Hendrickson, Lave & McMichael (1995), three main objectives have to be pursued to accomplish ecodesign: (1) minimization of the use of non-renewable resources; (2) effective management of renewable resources; and (3) minimization of toxic releases.

As *« the role of ecodesign, in its traditional meaning is to help design so that the environmental impact is reduced during the whole life cycle »* (Gheorge & Ishii, 2007), we can highlight the different steps and discuss what needs to be considered. Figure 3 summarizes the different steps.

Materials are often the first elements to which we are confronted in a life cycle. The reduction of their use constitutes thus a major matter as well for the energy using products as for the others not using energy where it becomes a priority.

Manufacturing is also influenced by the establishment of ecodesign. Indeed, deciding on the introduction of more environmentally friendly techniques or processes will induce a trade-off between the economic and the environmental sides of manufacturing.

Packaging is also an aspect of the product that has to be considered. Its role is multiple: protection, handling, information and marketing about the product are its main characters. When transporting products overseas, the manipulations endured by the product are highly increased. So, the packaging is more likely to be damaged. In this way, if one wants to avoid failure, the product should either be more robust to percussions or the design of the packaging should be more adapted in order to protect the good.

Transport and distribution can also be of great importance. Indeed, with globalization, the distance a product has to travel to get to the consumer can be sharply increased.

As far as the use phase is concerned, for some products, this clearly constitutes the most important environmental impact. Indeed, this can be the case for energy using products as well as for products which make use of consumables. The purpose of ecodesign is thus to reduce the energy consumption for products using energy and to reduce the amount of used consumables for the other category considered (e.g. paper filters for coffee machine).

Finally, end-of life has to be considered. Different aspects about end-of-life govern the way products are ecodesigned: longer life (reusability), remanufacturability and higher recyclability. This rang order may not be preferred depending on the product. Indeed, new technologies might make a new product more environmentally friendly and keep on using an older one will be more damaging than buying the new one. For instance, *« it would be worse extending the lifetime of an old generation fridge with a high energy consumption than recycling and replacing it with a new low energy consumption and CFC free »* (Gheorge & Ishii, 2007, p. 7).

Figure 3 - Summary of steps to be considered in ecodesign (Gheorge & Ishii, 2007)

It is important to note that services can also be ecodesigned. Indeed, some of the above stages are not applicable to services but this does not mean we cannot put in place actions to reduce environmental impacts on the life cycle of a service.

3. Ecodesigned products

3.1. What is an ecodesigned product?

As to succeed in developing an ecodesigned product, different points of view need to be taken into account (economic, social, environmental, etc.). When developing an environmentally friendly product, there always have to be trade-offs. Indeed, you do not develop an ecodesigned product without any effort just like you would have produced a traditional one; changes need to be made.

Nevertheless, an important question can be raised about the scope of ecodesign. Indeed, every single impact will not be erased by ecodesigning the product but at what point can we consider that a product meets the requirements to be designated as ecodesigned? What are these requirements? Many academics agree to say that a product is ecodesigned from the moment when at least three stages of the life cycle have been improved as far as environmental effects are concerned. So, a product for which only one stage of the life cycle is environmentally improved (e.g. optimization of goods' transportation policy) cannot be considered as an ecodesigned product (Vernier, 2013). Critically analyzed, this remains quite vague. One cannot neglect the fact that improving one stage consistently can be globally better than making small adjustments in three or more stages. Moreover, it might be that improving one stage of the life cycle generates a negative impact on another stage of this one. For instance, legislative and environmental pressures have pushed to develop water-based inks instead of solvent-based inks. The term ‘water-based’ suggests something ecological. Sometimes, however, these products may actually require more energy to dry than alternative materials and studying the whole life cycle can reveal they have less positive impacts on the environment than thought at the beginning (EuPIA, 2013).

According to Sempels and Hoffmann (2012), different characteristics are required for a product to be qualified as being ecodesigned:

- It should keep its functionality at reasonable price, which means the ecodesigned product cannot generally be sold for a much higher price than its non-ecodesigned counterpart.
- A reduction of material use going hand in hand with a reduction of non-renewable resource use is required.

- Energy use should also be minimized. Energy consumption should thus be managed along the whole life cycle.
- Use of toxic components should be replaced when possible or at least drastically reduced.
- Companies should make the life of products longer.

These five elements totally match those highlighted by the WBCSD (World Business Council for Sustainable Development) for eco-efficiency to be enhanced: *« (1) Reduce material intensity; (2) Reduce energy intensity; (3) Reduce dispersion of toxic substances; (4) Enhance recyclability; (5) Maximize use of renewables; (6) Extend product durability; and (7) Increase service intensity »* (WBCSD, 2000, p.15).

3.2. Examples

Real world examples may be useful to illustrate what an ecodesigned product actually is. Therefore, three types of products will be considered: a product providing a service (bicycle parking system), an energy-using product (steam iron) and a common good (shoes).

3.2.1. Altinnova: Bicycle parking system

Altinnova's business aims at promoting cycling. As the bicycle is the green transportation facility par excellence, they found it was consistent to develop their products in order for them to have a minimum impact on the environment. As they wanted to do so all along the life cycle, they decided to adopt an ecodesign approach. ALTAO Parco, a bicycle parking system, was their first ecodesign project (Roy, 2011, a).

The racks ALTAO Parco are made of sheet steel cut with a laser and then fold, unlike all competitor products that are made of steel tubes. In this way, Altinnova managed to achieve different advantages: optimization of space (less bulky), optimization of materials (less steel is used) and optimization of transport and storage (reduced volume that reduces transport costs as well as storage space required).

Corinne Verdier, cofounder of Altinnova who received the Engineer of the Year Award 2009, awarded by the magazine Usine Nouvelle (Altinnova, 2009), asserts that the company

recorded gains on their costs (mainly in transportation and manufacturing). Plus, the product has found an audience seeking both products that contrast with traditional racks, having a design side, with good compactness parking that consumes few storage space. The company also benefited from it in the sense that municipalities, which represent their main customers, appreciate the environmental procedures.

3.2.2. Domena: Steam iron

Domena is a French brand specialized in ironing and steam cleaning. Their intention to start on the ecodesign path came from a need for renewal of the steam iron category above 200€ in order to increase the market share. A survey conducted in this perspective showed that customers were waiting for more environmentally friendly products. In this perspective, Domena decided to create a new steam iron which is more compact, more convenient, with less environmental impacts but without reducing the quality (Domena, 2016).

A description of the product EasyBox seems relevant to illustrate what they have done to make an ecodesigned product. Compared to their classic steam iron, they have made a series of environmental improvement along the life cycle. First of all, they used 30% less plastic and replaced it with plant fibers. Secondly, the packaging as well as the manual are made of recycled cardboard and paper respectively, both using environmentally friendly ink. As far as manufacturing is concerned, the weight of plastic parts has been reduced along with waste. Then, transport is reduced to its minimum by producing and selling only in one country, France. Regarding use, an ECO button has been added that allows reducing power consumption by 50%. This can nevertheless been criticized as you are not forced to use it. Finally, at the end-of-life, as previously mentioned, packaging is recyclable, and the product can easily be dismantled for the recycling of parts.

To be consistent in their way of designing products and ensure their commitment to reduce plastic use, Domena developed a self-certification ‘ecofibres’ in 2008 with which it commits to monitor compliance with its charter.

Celine Kohler, the brand responsible, asserts *« the choice of eco-design has enhanced our image, our relationships with our suppliers and providers »* (Roy, 2011, b). Indeed, by creating compacter products, less material was used and costs for those have thus been

reduced. Moreover, by using fibers, products are made lighter and their processing is faster. Adopting this strategy was beneficial to this company since they managed to double their market share in this segment. However, it is difficult to say whether this effect has to be attributed to novelty or to the fact that the product has been ecodesigned (Roy, 2011, b).

3.2.3. Lafuma: Footwear

Lafuma started ecodesigning in 2000 with a backpack. Nowadays, the brand produces at least one ecodesigned product for each product category the band owns (backpacks, outdoor furniture, shoes, etc.). Thanks to this, Lafuma claims to have recorded a sharp rise in ecodesigned product sales attributable to both new customers and an increase in the frequency of purchases. Laurent Noca, responsible for ecodesign at Lafuma, believes the improvement in financial performance may be associated with a competitive advantage built on a lower environmental impact (Vernier, 2013).

As to give a practical example of Lafuma's products, one will focus on shoes. In 2004, Lafuma developed its first ecodesigned shoe *« in partnerships with the Centre Technique du Cuir (technical leather centre) and with the support of the ADEME (French agency for energy and environment management) »* (Lafuma, 2016). For the Djebel Hemp model, one of Lafuma's popular model of shoes, the main component having a negative impact on the environment is the synthetic sole, the replacement of this one was thus the main challenge. Therefore, the use of a natural rubber sole seemed necessary. The replacement of the nubuch by hemp also was beneficial as it allowed a major weight gain. By conducting an LCA analysis, the company managed to highlight the fact that the ecodesigned model was 10% less impactful than its non-ecodesigned counterpart (Institut de l'entreprise, 2005).

4. What can a company do in the framework of ecodesign?

Organizations realize more and more how important it is to pay systematic attention to the environmental aspects of the business and the products and services. Ecodesign is also at the heart of sustainability. Indeed, it seems difficult to accept that a company can claim to be sustainable if it provides products that clearly have a negative impact on the environment (UVED, 2013).

One way to start addressing sustainable development is thus undoubtedly the establishment of an environmental management system (L'Observatoire de l'EcoDesign, 2015). Various external parties set requirements in the field of the environmental performance of an organization. Therefore, the International Organization for Standardization (ISO) has set the ISO 14000 series in place, which is the basis for certification of environmental management. Beside this, EMAS (Eco-Management and Audit Scheme) is an environmental management and audit scheme which is legally established by the European regulation. Organizations that want to commit on a voluntary basis may so evaluate their environmental performance and how to improve it. We will not get into deeper detail as to keep focused on ecodesign.

Then, as already made clear, the integration of a life cycle perspective is inevitably required. Indeed, it is the foundation of the ecodesign definition.

Just like eco-efficiency, ecodesign is not *« a take-it-or-leave-it approach, an either-or (but much more a both-and-and) approach, a solution to all the problems on the way to sustainability, a rigid framework, anyone's single strategy, a management system, a certifiable standard, a reporting format, a cook-book with recipes, something one can buy off the shelf, an assurance against failure »* (WBCSD, 2000, p. 12). As Zwolinski (2013) underlined, there is not a universal methodology for ecodesign, or even adapted to one sector, and it nowadays mainly relies on knowledge of environmental experts.

Without giving an exhaustive list of concrete actions to put in place, there are some tracks a company can investigate. The United States Environmental Protection Agency (2015) has established the following list:

- Evaluate the impacts, whether they would be on human health or on the environment, from their products and / or operations;
- Identify the required data to make the adequate decisions as far as human health and environmental impacts are concerned;
- Assess alternatives;
- Evaluate pros and cons of changing chemicals;
- Reduce the use and discharge of toxic chemicals;
- Implement measures ensuring resource conservation (pollution prevention, energy efficiency, etc.);

- Manufacture reusable and recyclable goods;
- Monitor environmental impacts as well as costs engendered by the developed products and / or operations;
- Realize that evaluations and continuous improvement are required.

In practice, *« to reduce waste associated with consumer products, for example, firms can reduce product weight, including the amount of packaging that comes with a product and make products easier and less costly to recycle. The latter can be accomplished by changing the type of material used in a product, avoiding mixing of materials in a single product, doing and labeling when different materials are used, and designing for ease of disassembly »* (Calcott & Walls, 2000, p.233).

The use of the EcoDesign Strategy Wheel can also make sense in this perspective. This wheel allows visualizing the different strategies in order to select the most appropriate ones and to communicate about it (Brezet & Van Hemel, 1997). Eight strategies can be seen on Figure 4: (1) New concept development; (2) Selection of low-impact materials; (3) Reduction of materials use; (4) Optimization of production techniques; (5) Optimization of distribution system; (6) Reduction of impact during use; (7) Optimization of initial lifetime; and (8) Optimization of end-of-life systems (Van Hemel & Cramer, 2002).

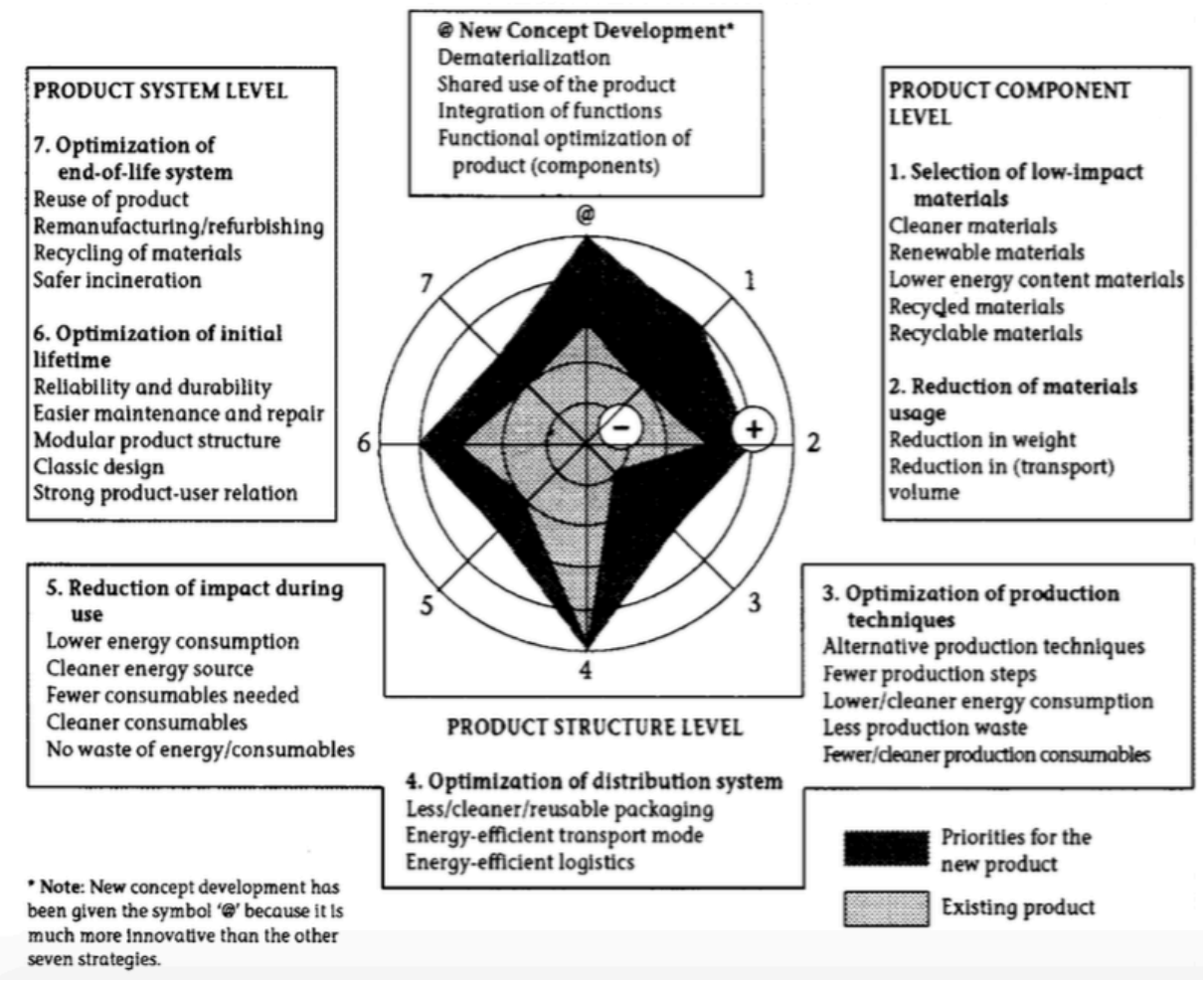

Figure 4 - The EcoDesign Strategy Wheel (Brezet & Van Hemel, 1997)

5. Conclusion

In closing of this chapter, we can clearly say that although researches on ecodesign have been conducted for many years, it is not an extremely rigorous concept. As this thesis namely intended to clarify the notion of ecodesign, one can say that the major defining element is about the consideration of the whole life cycle when designing a product. From what has been found through the literature, one can nevertheless consider it is close enough to Design for Environment to assume they are synonyms in the rest of this work.

About the practical application, there is no framework and specific plan of action. Whatever the sector or type of enterprise, the analysis to do is rather personal and actions to be taken accordingly will inevitably vary.

Chapter 2 - Analysis of tools: Focus on Life Cycle Analysis (LCA)

This second chapter intends to analyze possible tools with a particular focus on LCA. Indeed, this chapter will be useful in the sense that in order to do ecodesign, companies need to have a clear idea of what they are doing and what the impacts of their activities are. Defining most famous tool, analyzing it and go over alternatives will be at the heart of this chapter.

1. What is LCA?

Nowadays, there is not, or at least not yet, an existing methodology aiming at ecodesigning. This means that in order to develop ecodesign approaches, one has to rely on three categories of tools: (1) environmental assessments which allow to have a quantitative analysis; (2) guidelines which are more qualitative; and (3) indicators which are often internal to the company (Zwolinski, 2013, p. 20).

Based on the first of the above categories, the LCA is the most famous technique used. It has been decided to focus on it further because it allows to ecodesign with a systematic approach. This tool has been first developed in order to help companies meeting the requirements of their customers. Indeed, the environmental directives were at first intended for large production companies such as in the automobile or electronic sectors (Le Pochat, Bertoluci & Froelich, 2006). But the suppliers (in many cases SMEs) of these large producers were greatly affected. The problem is that, as their resources are limited, the SMEs could not easily assess their own environmental impact, adapt to the norms and adjust their processes. However, it has been shown that among the companies doing ecodesign, the best performers have conducted an LCA (Berneman et al., 2009).

1.1. Theoretically

Life cycle assessment, often abbreviated LCA, is the reference in terms of environmental impact assessment. Indeed, it is the most efficient and can lead to a very narrow analysis. As each step of the life cycle is considered, the LCA is by far the most accurate and theoretically relevant method (Le Pochat et al., 2006). The method is used to predict impacts of various alternatives in the processes used along the product's life cycle. Using this type of method, one can select the most appropriate path to manufacture the product in an environmentally

friendly manner. It can also be used to assess a current process, and figure out if one or more improvements should be implemented. It is thus a theoretically unquestionable method because, with this approach, one takes into account every stage of the life cycle, and compares the different possibilities (materials, processes, sites location, etc.) in terms of CO_2 emissions, wastes, water and fuel consumption, etc. Experience has proven that being aware of a product's environmental impact will enable to find ways to reduce those impacts (Puaut, 2008; Witczak, Kasprzak, Klos, Kurczewski, Lewandowska & Lewicki, 2014).

The life cycle analysis is a methodological, step by step approach. Four main stages can be emphasized (Williams, 2009; Ng, Ya Hong Dong & Kumaraswamy, 2016; Caillol, 2008; Aït-El-Hadj, 2013): (1) definition and scope of the current LCA; (2) life cycle inventory (LCI); (3) life cycle impact assessment (LCIA); and (4) final report.

The first step is the very beginning of the project. Indeed, it is important to conduct the assessment in a realistic scale and to be aware of the further constraints or obstacles. Are all the necessary data available (and reliable)? How accurate must this evaluation be? What are the legislations that must be taken into account? These are some of the questions related to the first stage. Furthermore, the potential impacts are well identified during this stage, and a first sorting may be applied to select only the main impacts, while neglecting the marginal ones (Caillol, 2008).

Then, the second phase focuses on the use of the input (raw materials, energy consumption) and output (emissions, waste) data. It can be seen as a quantification step, where every life cycle stage (material production, product manufacture, etc., see Fig. 2) is completed with numerical data.

The third step is less straightforward. Indeed, *« the LCIA is a way to interpret how the processes and products in the LCA impact human health and the environment. The LCIA addresses concepts like the depletion of resources and possible health effects by analyzing the stressors found within the manufacturing process or product »* (Williams, 2009, p.12). It uses numerical data but gives more relevant and significant information. This step actually consists of four substeps. First, substances need to be classified. Second, each substance is attributed a factor representing its contribution in the environmental impact of the product. Third, a comparison is made with a reference value to normalize the impact of the product. Fourth,

different values are given to the different impact categories in order to aggregate them into a single score. Within the LCIA, one can highlight the importance of midpoints and endpoints. On the one hand, *« Midpoint impact category, or problem-oriented approach, translates impacts into environmental themes such as climate change, acidification, human toxicity, etc.»* (PRé, 2016). On the other hand, *« Endpoint impact category, also known as the damage-oriented approach, translates environmental impacts into issues of concern such as human health, natural environment, and natural resources. Endpoint results have a higher level of uncertainty compared to midpoint results but are easier to understand by decision makers »* (PRé, 2016). Depending on whether one takes mid- or endpoints, decisions might thus vary; this adds complexity to the whole LCA process.

Finally, the final report represents the interpretation of the results, and the proposition of recommendations. This phase is rather dedicated to decision-makers, because the choices are made at this time of the procedure. Those people have a larger view of their business, and they know the impact of a change on the other products' dimensions (marketing, research and development, etc.) (Caillol, 2008).

The first three phases of a life cycle analysis and their relationships are shown on Figure 5. It is clear that the interpretation of data is ubiquitous in these steps, as described above.

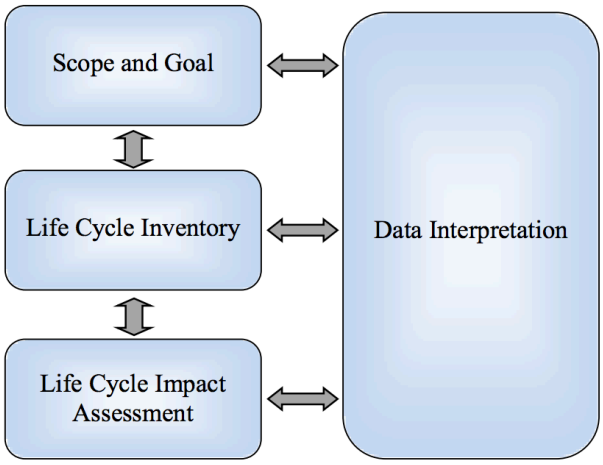

Figure 5 – Steps of a Life Cycle Analysis emphasized in ISO 14040 (Williams, 2009, p. 2)

1.2. Practically

The LCA approach can offer the possibility to analyze the processes' or products' environmental impact, find opportunities through the establishment of new or more efficient facilities, compare different materials or processes and justify the choices by means of their environmental impacts, etc. (Williams, 2009). All the steps are governed by a set of norms ISO (ISO 14040 to 14044) (Caillol, 2008).

Nowadays, a large amount of software is available and they offer the possibility to make LCA from various databases (Berneman et al., 2009). Examples of such tools are: Eco-indicator 99, CML 2001, IMPACT 2002+, EPD, EDIP 2003, etc. (Ng et al., 2016). But this great variety of tools leads to difficulties and barriers. Indeed, each method has its own focus points, geographical validity, units (comparison between tools is thus complicated if the units are not the same) and limitations. Furthermore, some methods do not differentiate equivalently some environmental impacts, so that the environmental impact may be due to different sources, depending on the software (Ng et al., 2016). Hence, the results and their interpretations may differ and the reliability of these tools may be questioned.

Even though the method seems appropriate to be used systematically, the biggest drawback of the life cycle analysis is the need of deep expertise. Only experts can make a proper assessment, because a lot of factors or subtleties must be taken into account (Le Pochat et al., 2006). Also, the difficulty of gathering proper and accurate data is one of the major issues (Witczak et al., 2014; Hetherington, Borrion, Griffiths & McManus, 2014). In the same spirit, an LCA does not take into account the margin of progress: an old and optimized process can be perceived as better than a new technology, but this new technology might have a huge margin of progress, leading to a better process after all (Caillol, 2008). Besides, LCA is time and data consuming. SMEs cannot afford such a deep analysis and they have a limited flexibility, due to this lack of resources (Le Pochat et al., 2006; Witczak, 2014). Furthermore, as they often have a limited impact on the supply chain, SMEs prefer to simply respect the legislations and regulations.

2. Critical elements of the LCA

2.1. Comparison of functions

The Life Cycle Analysis is not supposed to be used to compare whatever kinds of products. Indeed, LCA is used in order to compare functions (Puaut, 2008). For instance, it can be used to compare different dishwashers but those need to be of the same category. One cannot use LCA to compare a professional dishwasher used in restaurants with the one regular households own. Therefore, to be able to say a product is better than another one from an environmental point of view both products need to perform the same function. Companies can thus choose to use LCA in order to compare a current product they produce with a new ecodesigned one. But, practically, LCA is used to assess a current product or process. It only gives information about the current environmental impact, and only allows improving existing products or processes (Caillol, 2008). From this point of view, it would mean that a life cycle analysis cannot help companies to ecodesign, because the true design is already done.

2.2. Boundaries: How far should one go in the analysis?

An important element that can cause problems in the LCA is the fact that one can wonder where to place the boundaries. How far should we go back to take into account the environmental impacts of materials, energy sources, etc.? As a company it might not be easy to get all the data of the materials it uses. Plus, the process would be very time-consuming.

It seems one should try to take into account the whole life cycle of any element occurring in the product's life cycle otherwise you can choose to set the boundaries wherever it is best in order for your product to seem the most environmentally friendly possible. Nevertheless, it might not be easy. For instance, clothing does not use energy as such in the use phase but the cycles in the washing machine and dryer can present an important part of the energy consumption of clothes. Nevertheless, use intensity is variable depending on the consumer.

2.3. How to ensure that what we do at some point of the life cycle does not negatively impact another point of the life cycle?

« Some aspects of recyclability of some kinds of goods are more straightforward to determine than other aspects and other goods. For example, the recyclability of a newspaper is relatively easier to discern than the recyclability of a computer monitor » (Calcott & Walls, 2002, p.22).

The aim will be to avoid pollution transfers, which consist of moving pollution from one stage of the life cycle to another or replacing one type of pollution into another (Puaut, 2008). It might not be that easy. There are transfers that may not be avoided but one has to see what is best in a global approach. Plus, there might be trade-offs to do.

3. Are there alternatives?

Given some difficulties, the LCA approach seems too difficult to implement and requires too much time for SMEs. Also, this analysis is made *a posteriori*, and does not lead to a fundamental ecodesign. Unfortunately, no tool can anticipate environmental impacts and integrate them in the first design phase (Caillol, 2008). One can only use alternatives to an LCA, and try to use it as soon as possible during the design procedure. Some researchers and scientists try to develop implementation methods that are a compromise between simplicity and risks. Although a few tools could be used in SMEs (checklist, guidelines, etc.), some assessment methods are growing on the market, and can be applicable into SMEs (Pôle Eco-conception, 2016, b). They are generally accessible through a software and the user is guided through the entire procedure. Unfortunately, some of the drawbacks remain (need of expertise, time-consuming, etc.), and a trade-off has to be made between simplification and accuracy.

Anyway, a large amount of tools (more than 150) have been developed throughout the years in order to counter the drawbacks of the LCA (Baumann, Boons & Bragd, 2002). Le Pochat et al. (2006) distinguished the tools according to their categories, in the sense that *« two types of tools prove to be essential: tools for producing the environmental assessment and tools for guiding environmental improvement. The greatest number of eco-design tools exist in these*

two categories, but there are also 'related' tools, be they tools for communication, tools for helping in decision making or tools assisting creativity ».

3.1. Simplified LCA

Globally, this tool is the same as the LCA, but some difficulties are bypassed. Instead of requiring precise data for the current processes or products, it uses general databases, which contain general values for the environmental impacts (Le Pochat et al., 2006; Pôle Eco-conception, 2016, b). Hence, it is less time-consuming, and data are easily collected. However, the lack of precision may lead to unreliable results and conclusions because, for example, the water consumption for the production of steel may be different from one plant to another if the flow rate is higher, or if the cooling system is not optimized. Furthermore, SMEs still need to appeal to an expert because it remains complicated. It might therefore cost a lot of money for a method that could not give proper and reliable results.

3.2. Eco-matrix

This tool may be useful in order to compare different materials or processes by choosing a certain amount of indicators. For example, when designing a storage box, different materials can be considered: polymers, metals, wood, etc. The eco-matrix tool could help the producer to select the appropriate material in terms of energy consumption and toxicity. This analysis can be made throughout each stage of the life cycle (ECO3E, 2016).

The biggest advantage of this method is that it requires much less data than an LCA (or simplified LCA) and it is obviously user-friendlier. But the major drawback is that, when the matrix is filled, there is a need for an environmental expert in order to give a relevant meaning of the results, and to propose adequate changes in the design.

3.3. Checklist

The checklist is surely the easiest method to get a comparison between two or more alternatives (either materials or processes). Indeed, the set of questions provided in this approach does not allow making an environmental assessment (Le Pochat et al., 2006), but it

is an easy way to define a reference product, and evaluate the other possibilities by answering the same questions, in comparison to the first one.

3.4. Eco-parametric tool

The eco-parametric method offers the possibility to make an easy environmental assessment, by making a mathematical link between the product's parameter (for example the mass of material used) and the environmental impact. Indeed, *« the parametric description of the reference product correlates technical and environmental data. This is done to track and influence the environmental contribution of each extracted parameter (e.g. type and amount of materials used, process technologies, surface treatment, etc.) »* (Ostad-Ahmad-Ghorabi, Bey & Wimmer, 2008). Again, a clear comparison can be made between a reference system and its alternatives. It is important to use this approach in the early stages of the design because, the less constraints (geometry, material, etc.) there are, the easiest it is to identify good alternatives and opportunities.

The problem with this tool is that the results are reliable only if: (1) the environmental impacts are well defined and identified; (2) a large database is available, in order to get the widest range of alternatives; and (3) if the impacts can be easily linked with the product's parameters. It is also important to bear in mind that a proper procedure and a good interpretation of the results requires knowledge in the field of environment. In this sense, the eco-parametric tool cannot always be applicable in SMEs (Le Pochat et al., 2006).

3.5. Eco-points

Eco-points are very similar to the eco-parametric tool. It is a measure of the global environmental impact of a product, a process, etc. since it aggregates the different impacts giving them weights. They can help the designer to make environmentally friendly choices, by choosing an appropriate material or manufacturing process. They can be a good indicator for the consumer and for the authorities. Indeed, *« they can be used on ecolabels, in design and rating tools, for education and to inform policy. Ecopoints encourage improvements in sustainability and inform decision-makers by translating environmental life cycle assessments into a single score that is relevant and recognizable »* (EDGE Environment, 2016).

Eco-points are calculated from a life cycle assessment, by considering the total amount of water or energy consumption, the total CO_2 emission, etc. In this approach, general databases are commonly used (similar to the simplified LCA tool). After that, as for the eco-parametric tool, relationships between the quantities (materials, emissions and waste) and the environmental impact must be applied. For example, one must make the link between the emission of a toxic by-product and the impact on the human health. Then, a scaling (normalization) must be performed: each source of environmental impact is divided by the total annual national impact caused by an average citizen (EDGE Environment, 2016; Ng et al., 2014). Finally, a weighting can be applied in order to prioritize the different categories of impact (toxicity, greenhouse effect, etc.). The final eco-point of the product is thus the sum of the weighted results.

3.6. Guidelines

This approach does not provide and environmental assessment, but it can help SMEs to adapt themselves and adjust their processes, by following some common rules. It is straightforward and simple, but some changes and adjustments may need knowledge, know-how and a large database to be able to choose the best solutions (Le Pochat et al., 2006).

3.7. Manual

A large amount of researches and general rules concerning ecodesign can be found into manuals. But these rules remain theoretical and not applicable in practice, since they are too vague to be materialized (Le Pochat et al., 2006).

4. Conclusion

As secondary question of this work, one wanted to know which tools could be applied in the framework of ecodesign as well as the difficulties and possible alternatives. This chapter briefly analyzed the LCA method. Indeed, as the central element of ecodesign is the consideration of the life cycle, the life cycle analysis immediately pops up as the most appropriate tool. Nevertheless, some problematic elements were highlighted: (1) the fact that one needs to compare functions; (2) the fact that placing boundaries may not be trivial; and (3) the fact that pollution transfers may exist. Especially for SMEs, this tool does not seem

easy to use. Therefore, the most famous simplified alternatives were overviewed to allow seeing LCA is not the only method.

PART 2 - Why do companies engage into ecodesign?

Although some studies aim at proving the profitability of the establishment of ecodesign techniques, some skepticism remains, especially as far as small and medium sized enterprises are concerned (Le Pochat et al., 2006). Indeed, a large part of industrialists are not convinced and a wide room for improvement is still possible. As a matter of fact, in France, an INSEE survey showed that only 18% of industrial companies testified they had launched themselves in ecodesign approaches in 2011 (Commissariat Général du Développement Durable, 2014). Moreover, there are some preconceived ideas about ecodesign that hinder its application: it engenders a high cost, specialized skills are requested, the way the organization is managed needs to be adapted, etc. (Berneman et al., 2013). As there are still a lot of firms that have not taken the plunge yet, it might be interesting to investigate what are the incentives (external and internal) for taking the environment into account while designing or redesigning a product. Positive outcomes as well as negative outcomes will also be respectively considered as incentives and barriers. Conversely, highlighting the current barriers could allow understanding why firms do not invest in greening their production.

Two chapters will thus compose this part. The first one will focus on the incentives and classify those in two categories: external and internal. The second one will focus on barriers that companies can encounter when deciding to adopt ecodesign approaches.

Chapter 1 - What incentivizes firms to adopt ecodesign approaches?

As briefly discussed in Part 1, technology push and market pull play a role in the design of new products. Nevertheless, regulation also plays an important role. As it is external but not directly linked to the market, it is best to consider those three categories separately (Debref, 2012; Rennings, 2000). Figure 6 illustrates these three types op triggers for eco-innovations, which is thus also applicable to ecodesigned products.

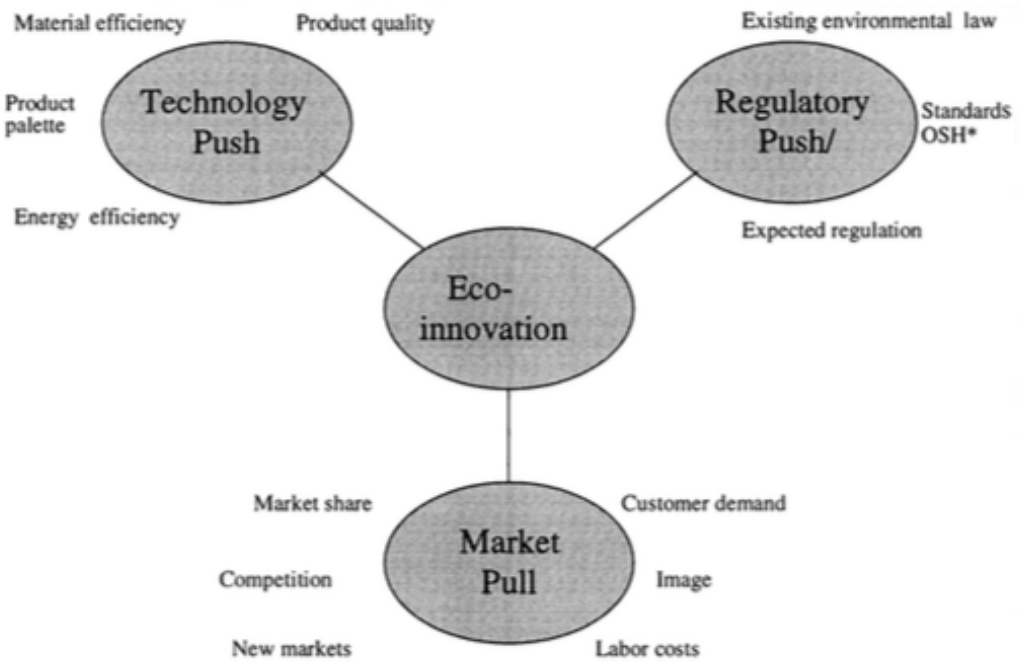

Figure 6 - Factors triggering eco-innovation (Rennings, 2000)

Figure 7 summarizes the ins and outs of ecodesign. Further attention to those elements will be spent in the subsections of this chapter.

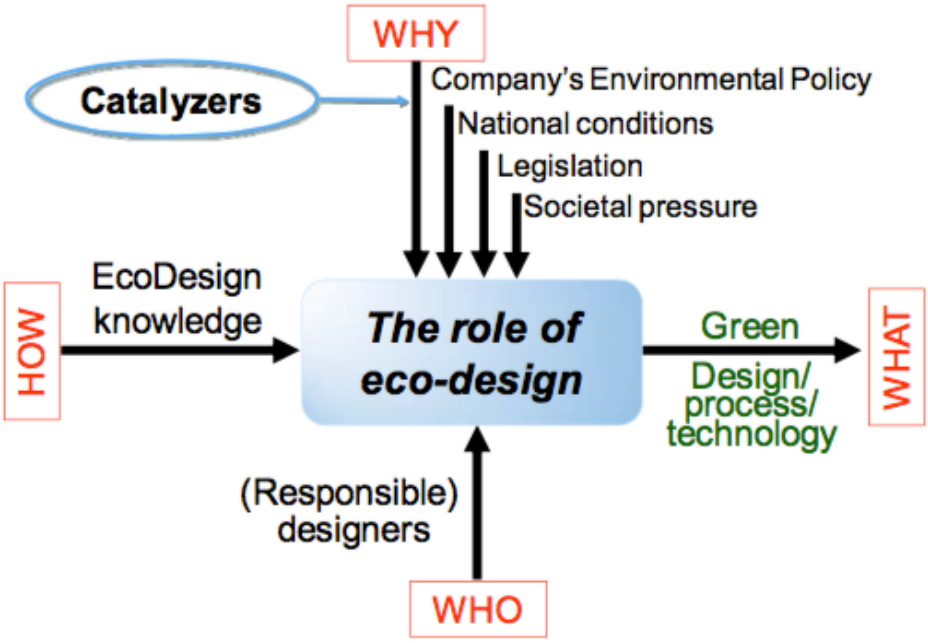

Figure 7 - The role of eco-design with emphasis on inputs (How, Why, Who) and outputs (What) (Gheorghe & Ishii, 2007)

What triggers the setting in place of ecodesign approaches can thus be different. Some companies may be confronted to a constraining legislation that pushes them to act towards those approaches while for others it can really be a willingness (Cognasse, 2014). In this view, we will try to highlight external and internal stimuli according to whether the willingness comes from the outside or from the inside of the organization.

Except for the part on legislation, which will mainly use economical literature, the following will use a study from 2008 conducted by HEC Montréal and l'Institut de développement de produits of Quebec where thirty companies from France, Quebec and Europe were studied as well as a study from 2013 conducted by the Pôle Eco-conception and l'Institut de développement de produits of Quebec which further builds on the previous one with a hundred and nineteen companies. The main conclusion was that ecodesign is a win-win solution for the economy and for the environment without having a negative impact on the company's profitability (Berneman et al., 2008; Pôle Eco-conception, 2016, b). Elements from the study of Johansson, Widheden & Bergendahl (2001) will also be used even though Berneman et al. (2009) have emphasized three major limits of this one: (1) only companies producing energy-using products were targeted; (2) only successful companies were targeted which does not allow to answer the question whether ecodesign is or is not profitable; and (3) there were not any interviews conducted. These studies will be used as a foundation that will be completed by other literature sources.

1. External incentives

1.1. Legislation

1.1.1. The role of the government

Any company can try to be eco-efficient by engaging in ecodesign approaches for reasons of its own. Nonetheless, legislation can play a role to push firms on this road or to amplify the willingness that companies already have to start ecodesigning. In this view, the regulator needs to be aware of the influences and pressures coming from outside the business. Plus, the outcomes of possible new rules should be identified (WBCSD, 2000).

Figure 8 *« describes the channels along which a business strategy for eco-efficiency can help decoupling between use of nature and growth in an economy. It also shows how policy measures can amplify the effectiveness of these channels »* (WBCSD, 2000, p.24).

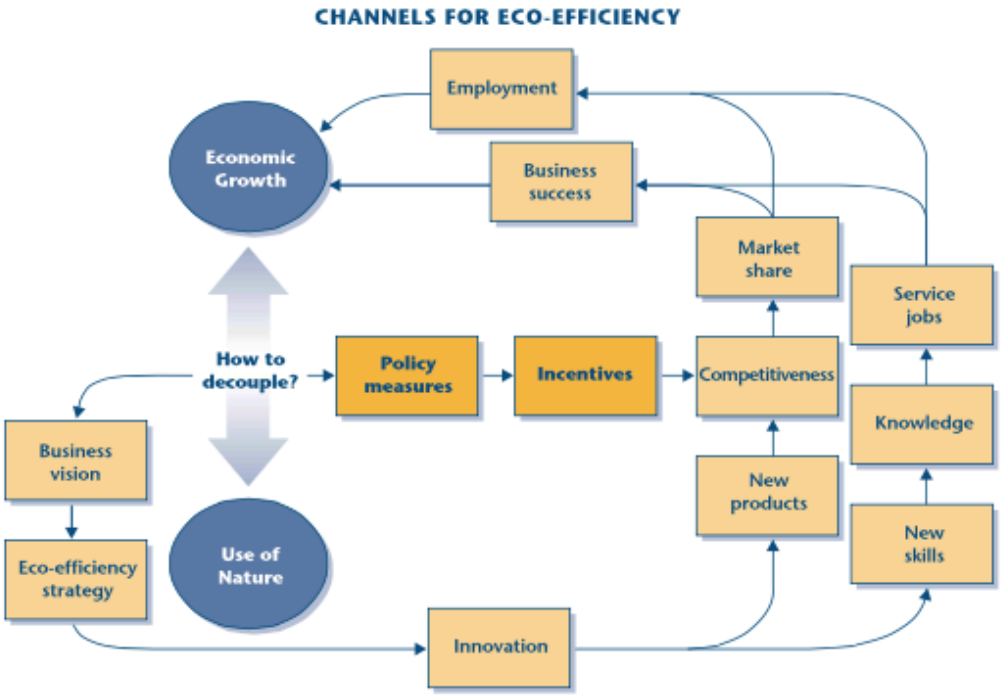

Figure 8 - Channels for eco-efficiency (WBCSD, 2000, p.24)

As can be seen on the above graph, different incentives exist for a company to decouple between use of nature and economic growth. Policy measures can also strengthen these incentives: governments can thus set in place policies that are both beneficial for economic growth and for the environment (reduction of pollution, resource use) by fostering eco-innovation. Five political measures to foster business' readiness to do ecodesign were highlighted by WBCSD (2000, p.25) and Schiesser (2012):

- *« Identifying and eliminating perverse subsidies »*: There still are regions where there exist subsidies supporting behaviours that are not sustainable. Deciding on the suppression of these perverse subsidies seems appropriate.
- *« Internalizing environmental costs »*: Pollution and social damage caused by production in some sectors are not comprised in the selling price of products. In this way, no signal about the damage engendered by the product is given and polluting firms thus lack the stimuli to modify their products.

- *« Shifting tax from labour and profit to resource use and pollution »*: Avoidance of economic effects that destruct value can be realized by shifting tax but this shift should not be weighing the tax burden already supported by organizations.
- *« Developing and implementing economic instruments »*: Emissions trading can indeed push companies to design their product in a greener way.
- *« Promoting voluntary initiatives and negotiated agreements »*: Voluntary initiatives should be encouraged by policies. Governments can also develop plans in order to make their economy more eco-efficient with companies engaging into ecodesign as part of these plans.

1.1.2. Legislation as an incentive

The taking into account of the environment was initially limited to curative measures. In a typical manner, regulations were set in place so that whenever an environmental impact was observed, end-of-pipe systems were set in place. With time, the focus has shifted to preventive measures. So, technological solutions and organizational measures are set in place as soon as an environmental impact is observed (UVED, 2013).

Nowadays, with the different laws in place, companies can be confronted to some duties as far as environmental impacts are concerned. Therefore, some firms are willing to anticipate the various requirements and make from ecodesign a competitive advantage (Camier, 2015; Triebswetter & Wackerbauer, 2008). A first external incentive is thus to answer regulations. In this sense, one can say that companies adopting ecodesign approaches are proactive towards legislation. Indeed, ecodesigned products help meet increasingly demanding regulations.

1.1.3. Focus on European legislation

The prevention of pollution as well as the conservation of resources have been the major elements prioritized in the current environmental legislation.

Different regulations may have an influence in Europe, the most important ones being:

- Ecodesign directive (Directive 2009/125/EC)
- Waste Framework Directive (Directive 2008/98/EC on waste)

- Registration, Evaluation, Authorisation and Restriction of Chemicals (EC 1907/2006)
- Waste of Electrical en Electornic Equipment (Directive 2002/96/EC)
- Restriction Of The Use Of Certain Hazardous Substances In Electrical And Electronic Equipment (Directive 2011/65/EU)
- End of Life of Vehicles (Directive 2000/53/EC)
- Packaging and Packaging Waste (Directive (EU) 2015/720)

It might be interesting to briefly discuss these major elements of legislation.

1.) Ecodesign directive

The ecodesign directive focuses on energy-using products (EuP) and energy-related products (ErP) (e.g. air conditioners and comfort fans, circulators, computers, domestic cooking appliances, electric motors, external power supplies, household dishwashers, etc.). The purpose of this directive is to set requirements about performance of these different types of goods in order to eliminate the least performing ones from the market (European Commission, 2016, b). This law really is about energy-efficiency in the use phase (Sanyé-Mengual, Pérez-López, González-García, Lozano, Feijoo, Moreira & Rieradevall, 2014).

In some way, this directive can constitute an incentive to engage into ecodesign since remodeling the design could allow improving the use phase. Nevertheless, this directive seems to be misnamed. Ecodesign has been previously defined and with the focus being set on the use phase of energy-using products, only a small part of it is covered. It is thus quite confusing since the Ecodesign directive is not actually about ecodesign.

2.) Waste Framework Directive

The Waste Framework Directive sets the orientation of the waste management policy (the polluter pays principle, proximity principle and extended producer responsibility). Establishing a hierarchy of waste, this directive requires Member States to establish waste prevention programs (European Commission, 2016, a).

As will be seen in a following section about extended producer responsibility this type of legislation may not be a good incentive for ecodesign.

3.) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

REACH (standing for Registration, Evaluation, Authorization and restriction of CHemicals) is a regulation established by the European Union since 2006 concerning the use of chemicals by companies. In vigor since June 2007, this regulation forces companies to proceed to registration, monitoring and evaluation of chemicals used downstream, upstream and within the organization. The purpose of this law is to ensure a high level of protection of the environment and human health (European Chemicals Agency, 2016).

This legislation can be an incentive to do ecodesign since the use of less harmful or an optimized use of chemicals may require innovating in the design. The company using chemicals becomes legally liable for risks associated with their use and, in an anticipative and precautionary mindset, ecodesigning can be useful.

Nevertheless, this regulation has been under some criticism. While going into detail is beyond the scope of this work, it may be helpful to cite them: (1) some dangerous chemicals are not excluded from use; (2) positive synergies between products are not considered; and (3) extensive justification about the use of dangerous products may suffice to use them (Simon, 2011). One might thus wonder if, as an industrial company, one should consider investing to go further than legislation. Plus, this regulation also only focuses on a specific aspect of ecodesign. Reducing use of harmful chemicals or substituting them might suffice without having to ecodesign the company's product.

4.) Waste of Electrical and Electronic Equipment (WEEE)

The WEEE Directive tackles the e-waste issue. Through this directive, each producer becomes responsible for the collection, treatment, recovery and disposal of new waste of electrical and electronic equipment or at least their financing. This clearly is an application of the concept of producer responsibility (European Commission, 2016, e). *« The directive states that the producer can choose to fulfill this obligation either individually or by joining a collective scheme. Moreover, they are responsible for financing the historical e-waste by one or more systems to which all producers contribute proportionately »* (Favot, 2014).

As being responsible for the end-of-life of their electrical and electronic equipment they produce, one might think that such a directive incentivizes producers to engage into ecodesign. Nevertheless, this might not be the case. Indeed, it is often easier for companies to design their products without especially caring for the environment and imagining an end-of-pipe solution afterwards.

5.) Restriction Of The Use Of Certain Hazardous Substances In Electrical And Electronic Equipment (RoHS)

In vigor since July 2006, the RoHS directive limits the use of different hazardous materials (six at first and ten since March 2015) for the production of electronic and electrical equipment (European Commission, 2016, d).

Closely related to the WEEE directive, this law could constitute an incentive to remodel the design. Nevertheless, it also only focuses on hazardous materials without forcing to do ecodesign.

6.) End of Life of Vehicles (ELV)

This directive on end-of-life vehicles determines targets for reuse, recycling and recovery of end-of-life vehicles as well as their parts. The purpose of this directive is to ensure more environmentally friendly disassembly and recycling of vehicles at the end of their life (European Commission, 2016, c).

As has been seen earlier, design for disassembly as well as design for recycling can be considered as strategies to adopt in the framework of ecodesign. This directive could thus force vehicle manufacturers to take the end-of-life of their vehicles into account from the beginning, in the design stage. Nevertheless, this directive only focuses on the final stage of the car's life cycle and could thus be a good incentive for recycling but not for ecodesign as such. Furthermore, the type of product considered is quite specific; it only is about vehicles.

7.) Packaging and Packaging Waste

This last directive sets measures concerning packaging and packaging waste. The purpose of this directive was to harmonize what was individually done in the different member states and to provide increased environmental protection (European Commission, 2015).

Focusing exclusively on packaging, one cannot say that this directive particularly will encourage companies to engage in ecodesign. Nevertheless, packaging is also an element of a product's life cycle and if companies already do better as far as packaging is concerned, one already does a step towards more sustainability.

1.1.4. Conclusion

It seems that none of the laws in vigor is perfectly playing the role of incentive for ecodesign as such. All focusing on certain types of products or on a specific phase of the life cycle, they can nevertheless incentivize firms to improve their designs to be more environmentally friendly since ecodesign can help to meet the requirements (Deutz, 2009).

The study by Triebswetter et al. (2008) has highlighted the fact that eco-innovations driven by regulation have not different competitiveness benefits than those voluntarily started. In this way, one clearly sees the important role to play for governments.

1.2. Risk reduction

Risk reduction can be understood in different ways as there are different types of risks that can be reduced via ecodesign.

1.2.1. Regulation

In the same line as legislation, risk reduction can be an important incentive to ecodesign. Indeed, depending on the industry in which you are active, the risk of non-conformity can be present and taking the lead to be ahead of legislation can be beneficial (Berneman et al., 2008; Pôle Eco-conception, 2016, b). A company becomes then proactive regarding regulations.

1.2.2. Operational risk

By being greener in the production and so reducing waste to landfill, reducing or suppressing the use of toxic materials, and reducing pollution to air and water, a company can reduce its exposure to various risks. These avoided risks can be multiple: less risk of accidents, health for employees, pollution of the site and its neighborhood. For instance, Chrysler, in the 1980, decomposed its different processes in individual operations to highlight individual costs. In this way, the company could realize the hidden costs of the use of toxic materials which were usually aggregated in the general costs of the company (assurance costs, medical supervision, secure storage areas, etc.) (Teulon, 2014).

1.2.3. Social acceptability

Social acceptability concerns what the company offers and the conditions of its availability over the entire value chain. Thus, the use of product materials or components in factories in developing countries where human conditions are violated could lead to a diversion of consumers to other products. Although this example is not about the environment, the same reasoning can be attributed to environmental impacts (Teulon, 2014): what is the social acceptability of products generating negative impacts on the environment? To avoid this type of risk, the setting in place of ecodesign can be an answer. Plus, it can give the company the satisfaction to answer a social demand for a more sustainable development.

1.2.4. Security of supply

By reducing product mass and reducing the amount of raw material required, the exposure of the company to a supply risk is reduced. Moreover, newspapers have now since decades announced the end of oil and although this is not actually the case, tensions on the commodity markets are increasing. Thus, limiting the consumption of raw materials and focussing on recycled materials comes to reduce these tensions (Teulon, 2014).

1.3. Consumer demand

Final consumers are becoming more sensitive to the environmental performance of the products they are buying (Johansson et al., 2001; Vernier, 2013; Teulon, 2014). There even is

a small fraction of people, LOHAS (Lifestyles of Health and Sustainability), which is *« a market segment focused on health and fitness, the environment, personal development, sustainable living, and social justice »* (LOHAS, 2016). In the United States, more than 13% of the market is considered as being part of this market by the LOHAS Group (2016). Still, all products are not ecodesigned and sustainability in production does not seem to be the main concern of the majority of consumers. Yet, expanded business and market opportunities are thus created when deciding to engage in ecodesign (Berneman et al., 2008; Pôle Eco-conception, 2016, b).

The environmental side can be a criterion of choice customers consider when deciding on buying something. Mobilizing some marketing literature allows highlighting some trends:

- For products considered as being of the hard / tough category, as opposed to the soft / gentle one, sustainability does not seem to fit. This is called the sustainability liability. For instance, baby shampoo (soft) and environmental friendliness do fit while it would not be the case for a car detergent (hard). Therefore, communicating on the environmental friendliness of your product is more suitable for products where soft functionalities are at stake. Nevertheless, sustainability does not seem to hurt the product where hard functionalities are required when beside the environmentally friendly side, it is communicated on the toughness of the product (Luchs, Naylor, Irwin & Raghunathan, 2010).
- When consumers are primed to feel environmentally conscious, they are more tempted to make purchases consistent with this trait of character. The technique of social labeling can thus enhance pro-environmental behaviours (Cornelissen, Dewitte, Warlop & Yserbyt, 2007).
- Consumers may also be competing for status by trying to be seen as relatively more altruistic. Indeed, in some way, consuming green products can be seen as an altruistic action since it is better for the environment than using regular products. Some marketing literature considers that consuming environmentally friendly products is thus a part of the status-building process as it communicates pro-social behavior and it also communicates the ability to incur costs since most people consider green products as being more expensive. Driving a Toyota Prius is then a signal of pro-social behaviour (Griskevicius, Tybur & Van den Bergh, 2010).

- Finally, in the same logic as the previous trend, there may be a difference between private and public consumption. Indeed, people tend to consume different products in public situations or choose different products in stores depending on whether they feel watched or not. So, an experiment has shown that preference is oriented to green products rather than classic ones in the public condition (Griskevicius et al., 2010).

1.4. Improved image and reputation

Beside influencing the environmental performance of a company, engaging into ecodesign has also the power to influence its image (Gheorge & Ishii, 2007; Camier, 2015). Often considered as being more dynamic, more innovative, the image of the company directly benefits from ecodesign (Johansson et al., 2001; Bernaman et al., 2013). On the contrary, doing nothing may harm the company's image. It may thus be necessary to take environmental impacts into account to keep an acceptable image.

Some see ecodesign solutions as a factor of competitiveness and innovation (as will be seen in the following section of this chapter) while others fear it is also used as a means of greenwashing. Indeed, with a flexible definition of ecodesign, it may be possible to communicate about the ecological side of the company without actually doing much. For instance, a green roof conveys a positive image but does not mean the product is done in an environmentally friendly manner. One should actually be careful. Environmental overcommunication can discredit the environmental cause. Advertising, slogans and other excess ecological communication overwhelm the public with information and reduces the consumers' willingness to buy (Le Blog De L'Eco-Conception, 2010).

1.5. Improved relations with stakeholders

Ecodesign has the ability to improve relations with the stakeholders (Berneman et al., 2008; Pôle Eco-conception, 2016, b). Doing ecodesign is a strategic decision that affects relationships with customers and suppliers (Zwolinski, 2013).

To begin with, companies may be willing to protect themselves against complaints linked to negative impacts induced by a traditional, non-ecodesigned product. By engaging into

ecodesign, a company can lower pollution, which can be appreciated by locals and by society in general.

According to the World Business Council for Sustainable Development (2000), investors select leaders as far as sustainability is concerned since they consider these have the ability to outperform their competitors with their eco-efficiency strategy. *« Eco-efficiency has moved from being concerned with making resource savings and preventing pollution in manufacturing industries to becoming a driver for innovation and competitiveness in all types of companies. Financial markets also start recognizing the value of eco-efficiency because there is growing evidence that eco-efficient companies produce a better performance financially »* (WBCSD, 2000, p.14). Indicators exist to evaluate the sustainability. Namely, the Dow Jones Sustainability Indices (DJSI) are indices set for the largest 2,500 companies listed on the Dow Jones Global Total Stock Market Index. These indices are based on a corporate sustainability assessment. Launched in 1999, the DJSI are nowadays *« recognized by investors as the leading benchmarks for corporate sustainability »* (RobecoSAM, 2016).

Engaging into green design can also allow to be chosen as supplier more easily (Ambec & Lanoie, 2008). For instance, a company caring about the environment may be primarily attracted to suppliers with the same vision as them (Vernier, 2013).

Finally, relations with media, non-governmental organizations, government, etc. can be improved since these might be more attracted to companies that ecodesign. This is beneficial since they have the power to convey easily information, either good or bad (Teulon, 2014).

2. Internal incentives

2.1. Conviction

A real conviction from the founder or decision makers can often be at the origin of ecodesign (Berneman et al., 2008; Pôle Eco-conception, 2016, b). Just like there are consumers who care about the environment (e.g. LOHAS), some executives are committed to reduce their impacts on the environment. As larger actors in the environmental degradation than individual consumers, some companies believe they can act more respectfully. Moreover, it has been demonstrated that personal awareness and willingness to be more sustainable are more

important drivers for ecodesign than legislation. Motivation and a shared vision will then be the key of success (Chiu, 2015).

2.2. Competitiveness

It can also be argued that engaging into ecodesign can be economically beneficial (Porter & Van der Linde, 1995). Three main categories will be analysed: cost savings, increased revenues and improved staff productivity. The conclusions of the Berneman et al. study (2009) show hopeful economic results.

2.2.1. Cost savings

Ecodesign methods seem to go hand in hand with cost savings. Indeed, reducing non-renewable energy consumption and overall consumption during manufacturing reduces the energy bill. Similarly, a product using fewer raw materials and producing less waste will have reduced overall costs. The principle of doing more with less seems to be applicable (UVED, 2013). In some way, ecodesign can thus be used in a cost leadership strategy.

Plus, in most cases, ecodesign engenders more stable costs of natural resources. Indeed, when a product is adapted via ecodesign, its costs will stabilize or even decline. This will not be immediate because of the costs of the investments but in the medium or long run, production costs will at least stabilize (Eco-design Pole, 2016 b). Via an LCA, it will be possible to consider reuse or recycling at end-of-life. This can turn out to be a barrier because in order to consider reuse or recycling, a collection method for used products needs to be organized otherwise the product will simply be disposed of with other waste, and reuse or recycling will not be possible even though the used materials would have allowed it. This can be expensive and quite time-consuming. Plus, since the design has been remodeled, more appropriate material selection can be made. In this way, materials whose supply is stable with relatively fixed prices can be used instead of others. With ecodesign, losses during production are also tried to be avoided, it reduces thus the need for materials while also reducing waste.

The costs of ecodesign are often significant because of the required changes but in a global cost approach, the company will usually reduce its overall costs. Paying less tax on pollution, water consumption and energy, carbon emissions, costs related to installations classified for

environmental risk, etc., ecodesign can cause reductions in several expense categories: (1) easily recyclable; (2) recycled content; (3) management of risks related to materials and substances; (4) renewed materials; (5) optimized materials; (6) optimized logistics; (7) energy savings; (8) renewable energy; and (9) sustainability strategy (Berneman et al., 2009).

According to this same research (Berneman et al., 2009), actions can be undertaken at these nine levels in order to reduce costs and the following possibilities are proposed. If the product can be created with a single material, the cost price will be reduced and the ease of assembly as well as the ease of retrieval when the product is disposed of will be increased. The use of recycled material may be less expensive. Avoiding to use toxic materials can be cheaper as it reduces the risks incurred by workers as well as the service and maintenance costs (Johansson, Widheden & Bergendahl, 2001). Renewable materials can be less expensive but one cannot expect them to be less expensive if they are of the same quality, this would not make any sense. As far as optimized materials and logistics are concerned, several possibilities exist. For instance, reducing packaging will allow optimizing material use and will also positively impact the supply chain (e.g. storage facilities, transportation). Plus, improving the energy efficiency of a product reduces the bill too as less energy is needed for each unit. Further, the use of non-exhaustible renewable energy can also generate savings namely through the obtaining of subsidies. Finally, adopting a sustainability strategy and choosing to ecodesign one's products can result in cost savings but also improve revenues (as will be seen later) and improve consumer loyalty.

So there are additional costs to incur in the short term but these can pay off in the medium or longer run. If the best strategy does not hurt in the short term, then we have never to think about the long term. Indeed, if the best strategy is just the sum of the best short-term strategies, then the long term is not to be considered in the balance. Trade-offs have to be made and benefits do not especially come immediately but it is possible to hurt now to grab the benefits later on.

2.2.2. Increased revenues

By increasing the added value of its products, profit margins, and opening new markets by improving its processes, the company can expect increased revenues. Moreover, being able to

respond to changing needs, to improve product quality and to better differentiate give the company the chance to retain customers more easily, also giving the ability to increase revenues (Berneman et al., 2009; Ambec & Lanoie, 2008).

The study conducted by le Pôle Eco-conception and l'Institut de développement de produits (Pôle Eco-conception, 2016, b) shows that for 85% of the companies that were part of the study, ecodesigned products have seen their sales increase compared to their non-ecodesigned counterparts. This study also showed that these companies have mainly reviewed their raw materials and the end-of-life of their products, these two stages being considered as easier to adapt. The most profitable firms of the study also adapted the use phase by ensuring waste and energy consumption is reduced during this stage of the life cycle. Plus, ecodesigned products can differentiate themselves from competitor's products which can be beneficial in a differentiation strategy.

2.2.3. Improving staff productivity

Employees are proud to work in a company that respects the environment (Berneman et al., 2013; Camier, 2015). By improving the image of the company, the pride of working for a company that respects the environment, etc., a reduction in absenteeism and an improvement in productivity can be observed (Pôle Eco-conception, 2016, b). Mobilization of the workforce is increased (Berneman et al., 2009). This can thus lead to a reduction in costs as well as an increase in revenues.

2.3. Opportunities for innovation

Stimulation of innovation is an important contribution of ecodesign. Indeed, innovation is stimulated as the whole design of the product is revised. In this process of redesign, creativity and new ideas are sought. Indeed, it has been shown that in general the ability to produce new products has increased for companies engaging into ecodesign (Camier, 2015).

According to the study conducted by the Pôle Eco-conception and l'Institut de développement de produits (Pôle Eco-conception, 2016, b), on average, ecodesign approaches have allowed companies to improve two functional aspects of the product. This illustrates the improved value proposition made to the customer. Indeed, products that have been ecodesigned have

increased functional attributes in half of the cases and in more than a third of the remaining cases the improvement brought by the redesign has led to the decision to withdraw the non-ecodesigned counterpart from the product offer (Berneman et al., 2009).

Ecodesign also forces the company to analyse a product from an environmental point of view. In this way, the possible use of non-sustainable resources or the development of techniques that are not viable for the future will be emphasized and the need for innovation thus highlighted.

Also, innovation can be the major driver for an eco-efficiency strategy with the creation of new products and skills. New products can then lead to higher competitiveness while new skills increase the knowledge base as well as the possibility to offer new services. These two improvements can then clearly lead to growth (WBCSD, 2000).

An important element with innovations, and thus also eco-innovations, is that positive spillovers exist. These spillovers concern the positive impact on the environment as well as the generation of new knowledge or novel ideas. Therefore, the double externality problem, which is a non-technological factor, arises and reduces the incentives company have to innovate and thus to invest in redesign and all kinds of eco-innovations (Rennings, 2000; Beise & Rennings, 2005). Indeed, when novel techniques that have a positive impact on the environment are adopted, the whole society will benefit from it. In this sense, the innovator finds it difficult to appropriate the benefits, and thus profits, from its investment (Gheorge & Ishii, 2007). To counter this problem, innovation policy and environmental policy should be related because incentives need to be given to companies to engage in greener production.

2.4. Technology push

Technologies allowing being greener are more and more present. Companies can then make their processes more environmentally friendly with the use of these newer techniques, putting older technologies offside. Indeed, when technology is available, designers cannot ignore them and can then be used even when there is no particular willingness to be a green company.

3. Conclusion

Various incentives and advantages of ecodesign do exist and these can be classified as being internal or rather external. Nevertheless, it could not be that easy to differentiate among those because a company might do ecodesign because it is internally motivated, even if a stringent EPR applies. Therefore, one can say that the different stimuli are interrelated and that explaining the reasons why a company engages into ecodesign is not limited to external or internal stimuli. The presence of an external stimulus does not mean that internal stimuli did not play a role.

One also needs to note that there are different levels of engagement in ecodesign. Some companies just test ecodesign without integrating the approach in depth; they might not start over again. Others have chosen to use ecodesign systematically but only on one or some series of products, they have not chosen to adopt ecodesign as an integrated part of their business. This really raises the question of whether the company actually is sustainable or not. Indeed, by just choosing to ecodesign one product out of a range of products, it may occur to us that this has been done only with the purpose to differentiate in order to enter new segments and thus grab the largest market share possible. Going further it can still be distinguished between two types of ecodesigning companies. First, there are those for whom ecodesign is one of the elements of their sustainability strategy, which also considers larger concerns such as social and societal ones. Second, companies can be fully based on ecodesign and rely on it for each of their new developments (Berneman et al., 2009). The advantages encountered can thus also vary according to how deep an organization goes into ecodesign.

Chapter 2 - What prevents companies from engaging into ecodesign?

The most recent publications have been developed by the Pôle éco-conception or the ADEME, and they seem to only focus on trying to convince companies of the benefits of it. But, when deciding on the design or redesign of products to make them greener or at least to reduce environmental impacts along the life cycle, constraints inevitably appear.

SMEs are especially struggling to get started because there are many preconceived ideas that prevail around the greener design: expensive, not easy to get the funds, change is not easy, expertise is needed, etc. Big companies often have stronger incentives to act in favour of the environmental cause because they are namely more exposed to the media world and bad actions could ruin their reputation. Indeed, as communication spreads quickly, their vulnerability to outside criticism is greater (Van Hemel et al. 2002).

The barriers considered as being most important will be dwelled on in the following sub-sections. Ecodesign is often considered to be complicated, nevertheless, we will not develop one of the barriers as being complexity but different elements coming from the different barriers engender indeed complexity.

1. Informational shortcomings

One of the main elements that come out of the literature is the lack of knowledge. According to most literature, SMEs particularly face this problem.

1.1. Lack of expertise from the organization

Ecodesign requires technical but also organizational competences. These can be outside the company and can relate to any phase of the life cycle (Le Pochat et al., 2006). Indeed, most of the expertise related to environmental impacts has not yet been formalized for the design so that companies just have to adopt a clear framework (Millet, Coppens, Jacqueson, Le Borgne, & Tonnelier, 2003). Worse, the general lack of knowledge of some SMEs with regard to possible environmental improvements can be the cause of inaction. Thus even companies being in good faith could be inactive towards environmental issues just because they do not

know what to do and have not the qualified personnel (Berneman et al. 2013; Camier, 2015; Klewitz, Zeyen & Hansen, 2012; Pluchart, 2012).

As the expertise related to ecodesign is quite new, environmental divisions are often used. The knowledge is thus not really integrated in most companies and a so-called 'green wall' is created because of the separation engendered by the use of an environmental division. The complexity brought by such a functioning mode may be a problem. The way projects are handled need to be thought out carefully (Zwolinski, 2013).

In some way, one can speak about information asymmetry because the required expertise to adopt ecodesign approaches may exist but not within the company. Some solutions do exist for firms to get started with ecodesign. Indeed, they can hire consultants to help them. Moreover, there are some existing institutions that may help (Hansen & Klewitz, 2012). For instance, in France, l'Observatoire de l'EcoDesign, which is a collaboration platform, was founded in 2010 to promote ecodesign among the industrial world (Camier, 2015; L'Observatoire de l'EcoDesign, 2016).

1.2. Information asymmetry and adverse selection

Some kind of information asymmetry exists. Asymmetric information happens when, in a market transaction, one party knows more than the other (Akerlof, 1995) and this is the case at two levels: (1) the organization might not possess knowledge that nevertheless exists; and (2) producers may not be able to clearly transfer information about the environmental benefits to their customers. The latter can engender adverse selection. If we assume that there are two types of producers, those of high quality goods and those of low quality goods, the second type of producer will get an advantage because of adverse selection. Moreover, as information cannot be transferred clearly, even though consumers may have a higher willingness to pay for the high quality goods, the producers will not be able to get the wanted price since the good will be undervalued (Söderholm & Tilton, 2012). The same can be transposed to ecodesigned goods. Nevertheless, informational measures can help such as labels. When you buy a washing machine, a label is on it concerning energy consumption. It does not say whether the product has been ecodesigned or not but at least you know more about its energy efficiency.

1.3. Bounded rationality

In most economic models, consumers are considered to act rationally. Nonetheless, it has been highlighted in cognitive psychology and behavioral economics literature that one rather faces bounded rationality. In this case, consumers are indeed rational but as they cannot process all existing information, they apply some rules of thumb to make their decision-making easier. Then, the relatively low demand for 'green' products can be interpreted through status-quo biases where terms like recycled have a bad connotation and directs the customer to choose traditional products (Samuelson & Zeckhauser, 1988; Söderholm & Tilton, 2012). Again, as far as policy measures are concerned, informational measures can help to mitigate the problems.

2. Financial barriers

Ecodesign has the reputation of costing too much. As one does not make production processes cleaner without any investments (Ambec & Lanoie, 2008), this can constitute a barrier. Moreover, particularly for SMEs, getting financial resources might not be easy and as to optimize those resources in the short run, those companies go over ecodesign. Nevertheless, these barriers tend to decrease and will probably decrease further. Indeed, as has been explained earlier in the first chapter of this second part, companies are more and more evaluated on their environmental footprint with namely the DJSI.

3. Organizational inertia

The Berneman et al. study allowed highlighting a barrier thanks to one of the affirmations they make about entrepreneurs. Indeed, the study has shown that entrepreneurs can be attracted to ecodesign because they start from a clear board. For incumbent companies, the way the organization is currently functioning could be impacted by technological change, which is inevitable (Gilg & Kelly, 2000), and mankind is by nature reluctant to change (Lefkoe, 2011; Prosci, 2014; Rick, 2015). This being said, one can see organizational inertia as being a barrier since the company already is in a momentum that makes it more difficult to change. Therefore, it might be needed to really consider change management and to train the staff.

Innovation management and policies in place in the company can be a barrier. When habits are in place as far as decision-making is concerned, it may not be easy to come up with new ideas. Indeed, the budgets may be more easily attributed to the parts of the business that have already shown to be successful.

Further, the infrastructures the company already owns can also be a type of barrier. The devolution of machines and other equipment can be slower in some very polluting sectors. Indeed, machinery for the textile or metallurgy industries is amortized slower. In newer businesses where technological innovation is faster such as the electronic industry, changes in the processes are more regularly (Boiral, 2004).

The implementation of ecodesign and other environmental strategies still leaves some industrialists rather skeptical. Some namely doubt the profitability of those strategies and this is quite important since the most important lever for ecodesign seems to be the economic argument (Berneman et al., 2009). Indeed, they know what results are brought from what they are doing currently and may not feel the urge to adopt changes.

4. Company and product specificities

Intrinsic characteristics of the company can be a barrier. For instance, the Belgian chocolate manufacturer, Belvas, intends to be the ultimate ecological, biological and fair-trade chocolate factory of Belgium (Belvas, 2016). Nevertheless, some elements of these three categories of constraints may conflict. In this way, it might not be possible to find bio ingredients that are also produced locally, which thus make them less ecological than other local products. In the same view, in the electronic industry, miniaturization of components is heavily used and this can make recycling of rare metals difficult (Keyes, 2000). The product in itself makes it thus difficult to be truly ecodesigned.

In addition, it is not because one decides to implement ecodesign approaches that one can forget the function the product offers to the customer. The redesign of a product to make it more environmentally friendly can therefore be limited because of the function it needs to fulfill. So it may be impossible excessively reduce material use for mechanical reasons (UVED, 2013).

5. Legislation

As previously mentioned, laws can be of insufficient help to incentivize firms to do ecodesign. But how is it possible for them to go further and even be a barrier? If legislation just gives a good incentive to do something about the end-of-life of the product, companies may only focus on this without going further and extend their efforts to the rest of the life cycle.

5.1. EPR programs and their flaws

The polluter pays principle (PPP) is a well-known principle as far as environmental impacts are concerned. With this principle, the polluter is entitled to bear the costs related to these negative impacts. Different approaches can be used to implement the PPP (Bernard, 2015):

- Command and control (CAC)
    - Environmental taxes
    - Technology subsidies
    - Etc.
- Market-based economic instruments (EI)
    - Emission trading programs
    - Extended Producer Responsibility (recycling fees, tax-subsidy and norms)
    - Etc.

In the framework of this master's thesis, it has been decided to focus on Extended Producer Responsibility. As the ultimate objective of this type of programs is to give incentive to firms to change their products and procedures towards ecodesign (OECD, 2006), it seemed appropriate to spend some time on this.

Extended Producer Responsibility stands for the fact that different parties on a product chain should be responsible for the environmental impacts engendered by the product along its life cycle, including those coming after the product has left the company's property to be owned by the customer. The main focus of EPR actually is on waste disposal from the moment it is not owned by the company anymore. Take-back policies are the most representative requirements linked to EPR (Deutz, 2009; Palmer & Walls, 1999; Favot, 2014; Brouillat & Oltra, 2012).

Pollution Haven Hypothesis (PHH), also called the Pollution Haven Effect does that, when confronted to environmental regulations, companies that are polluting chose to locate their activities in countries where regulations are not as stringent as their country of origin (Levinson, 2008). In this perspective, EPR regulations need to be accompanied by the adequate incentives in order to drive ecodesign, otherwise, global pollution will not be reduced. Indeed, when large differences are observed between two countries as far as waste regulation is concerned, EPR programs give the bad incentive to firms to reduce the reusability of their product and when shipments (illegal) are possible, waste can be dumped in developing countries with loose laws (Bernard, 2015).

When the decision to set in place an EPR program is made, there still are remaining choices to do. Indeed, liability, financial responsibility, physical responsibility, informative responsibility and ownership have to be defined in this perspective (Favot, 2014). Then there still is a distinction to make between individual and collective responsibility. On the one hand, the company is individually concerned with its pollution while, on the other hand, the industry is collectively responsible. In the Individual Producer Responsibility (IPR) the company will be uniquely benefiting from its investments while these will be shared in the case of Collective Producer Responsibility (CPR). Therefore, one can easily suppose, using innovation management theory, that IPR will be most appropriate to drive changes in design. Indeed, for a company to be willing to introduce novelties, appropriability must be ensured (Van Looy, 2015; Toffel, 2003). According to Favot (2014), supported by many researches, there are strong incentives that come from the IPR concerning design modification but as far as large practical solutions and scale economies are concerned, CPR is more appropriate.

Overall, EPR programs give a good incentive to take back and/or recycling. Indeed, it makes the producer accountable for the end-of-life of its product (Bernard, 2015). Nevertheless, they do not provide a good incentive to do green design. In current applications such as the WEEE directive, it has been proven that the policy does not push firms to adopt ecodesign approaches and that financial mechanisms are better instrument to motivate companies in doing green design (Favot, 2014). Indeed, Palmer et al. (1999) and Brouillat et al. (2012) proved that UCTS (upstream combined product tax and recycling subsidy) are more effective as far as costs, comprising transaction costs, are concerned than take-back policies. Plus, this appears to be the only system leading to major changes in design.

5.2. Lack of appropriability of innovations

Market imperfections concerning innovations exist (Söderholm & Tilton, 2012). There often is a lack of incentive for R&D activities because of appropriability problems. Indeed, as an individual company, one will support the cost of investing in innovation but one will not be the only one benefiting from it and grabbing the profits since knowledge is considered being a public good (Van Looy, 2015). Patents as well as subsidies for R&D are then often considered as a solution but none of those is perfect. A similar reflection can be done for ecodesign. When investing into greener processes, green sourcing or whatever changes that make the business more sustainable, one undergoes the costs while not being alone benefiting from it.

5.3. Uninternalized externality

When companies produce goods, they have an impact on the environment, which impacts the whole society. In this sense, society undergoes a damage for which the producer does not incur the cost. One can talk of an externality that is not internalized. Indeed, the producer does not feel responsible for the product anymore once this one has left its property and that the customer has bought it. In our current system, prices are inefficient since they do not internalize the environmental cost (Söderholm & Tilton, 2012). Instances responsible for waste recovery or recycling will then be more burdened and incur a higher cost for the product that has not been designed to be easily recycled or remanufactured. Once the producer has sold its product, he does not care anymore about the waste. But, how can we make sure companies internalize these uninternalized externality? Generally, when one talks about emissions or pollution, eco-taxes are considered to be a good way to internalize the externality. Nevertheless, in the case of ecodesign, it is more complex. A clever tax could be imagined. If there is a tax of X€ on each product, whether it is ecodesigned or not, then there will not be any incentive for companies to do ecodesign. But, a clever tax that is digressive when one engages into ecodesign could be a solution. Also, vertical integration would be the best solution but you cannot force companies to own their own waste recovery or recycling company. It just is not possible. Nevertheless, with new business models this could be achieved. If a company retains the ownership over the product, then it will also be responsible for the end-of-life and then it may act in a more responsible way. But, this opens up an entire new set of questions and problems. Indeed, new business models could present a solution but

why would companies switch to these new business models? For more information, the reader is invited to consult the works of Manzini, Vezzoli & Clark (2001), Mont (2002), Tukker (2004) and Osterwalder & Pigneur (2010).

6. The identification and management of environmental impacts

Some impacts are difficult to measure in the short run. Moreover, verifiability of what producers say they do as far as the environment is concerned requires a minimum of transparency. This may not be granted because of secrecy concerning other parts of the business. The inability to be transparent could constitute a brake to the willingness to do ecodesign (Berneman et al., 2013).

Then, as an individual company, environmental impacts related to logistics and supply chain may not be easily managed. If some parts are outsourced, or that for instance different means of transportation are used depending on the destination, the taking into account of the impacts will not be easy.

Then, an important challenge of ecodesign is to find the suppliers of raw material that will improve the environmental performance of the product. Indeed, companies can generally find theoretical solutions that are not easy to reproduce in practice (Cognasse, 2014). Cognasse (2014) emphasized that 20% of companies believe they cannot easily collect environmental information from their suppliers and that 30% of suppliers only are active in the ecodesign initiatives of their customers.

One can say that there is a kind of confrontation between ecodesign at the level of one company and ecodesign throughout the value chain. To do ecodesign in the most effective way, some coordination across the value chain will be required. Ideally, all the actors on the value chain should be able to share their viewpoints in order for the product to be as efficient as possible from an ecodesign perspective. Nevertheless, in general, each firm is uncoordinated on the value chain. Due to this lack of coordination, one will always be confronted to ecodesign that is less optimal than what could be done with real coordination.

7. Current economic model and mindset

The economic model in which we are also plays a role. As previously mentioned in the characteristics required for a product to be considered as an ecodesigned product, in a sustainable perspective, a longer lifetime of the product is desirable (Sempels et al., 2012). Nevertheless, profitability is based on the sales volume which gives thus an incentive to companies to reduce the lifecycle of their products (planned obsolescence) in order for customers to have to buy a new one. Plus, trying to be more efficient as far as material use and energy use are concerned might not be a solution to environmental damages and climate change (WBCSD, 2000). Indeed, in a growth perspective, one wants to sell more and if products are more environmentally friendly but that they are sold in larger amounts, the damage will be relatively decreased compared to the case where one does nothing but globally, one can be worse off.

Further, the usefulness of the product is not addressed by ecodesign since one considers a product to be relevant from the moment it has customers. One can indeed wonder if a product is necessary or even if functionality (transition from ownership to rental) would suffice. For instance, light bulbs are not a product that have a meaning to consumers, only the services they provide (lighting) makes sense. Radical innovations and focusing on new business models like functionality where one focuses on the services provided by the product may be better than incrementally improving products to achieve environmental improvements.

8. Conclusion

As has been demonstrated, there are both stimuli and barriers to ecodesign and even though several studies have focused on ecodesign for decades, challenges remain. The different barriers that were identified highlight difficulties that still can be encountered by companies. To begin with, informational shortcomings can make the adoption of ecodesign complicated, especially for SMEs. Then, the engendered costs can constitute a brake. Further, organizational inertia as well as specificities of the company and its product can also be an important element preventing companies from engaging into ecodesign. Legislation also has its importance. Finally, the identification of the impacts as well as their management can be problematic. For instance, as to produce an ecodesigned product, supply conditions might have to be reviewed which might be a difficult task. Companies could find theoretical

solutions to improve their products but might not be able to find the appropriate suppliers (Berneman et al., 2013; Vernier, 2013; Zwolinski, 2013).

PART 3 - Field expertise

As this master's thesis intends to give a macro view on the subject, it has been decided not to focus on individual companies. Therefore, it was judged relevant to analyze the points of view of different stakeholders confronted to companies that have decided to engage in ecodesign. This final part will thus be divided into two chapters. The first chapter will present the organizations that have been interviewed in the framework of this work as well as the purpose of these interviews. The second chapter will be intended to analyze the main findings and confront them to what has been found previously.

Chapter 1 - Field research

To get information and expertise on the subject, different field players from businesses concerned by ecodesign have been interviewed in the framework of this work. The first section will overview those. The second section of this chapter will give an overview of the usefulness of those interviews.

1. Field players

1.1. Sampling strategy

To begin with, it has been chosen to get information from consultancy companies operating in this area. Therefore, four agencies were contacted: Greenfish, Climact, EcoRes and RDC Environment. Two people have agreed to meet, a member of Greenfish and a member of Climact. Then, to add even more value to the coming results, three governmental agencies were contacted: the FEAD, which did not answer, the IBGE and the OVAM. The IBGE redirected us to the UCM (Union des classes moyennes) with its Cellule Eco-conception, which is subsidized by the government. Interviews have thus been conducted at the UCM as well as at the OVAM. Finally, LCA practitioners seemed relevant players to interview too. EcoRes, RDC Environment, EBPA Consulting and Celabor were thus contacted in this context. A member from Celabor, a research center that namely performs LCAs, has been interviewed. EBPA was removed from the list of interest because of their too limited activity and Ecores and RDC Environment were not able to response to the request. An explanation

on the core business of each of the five considered organizations and their relation to ecodesign will follow.

1.1. Greenfish

Created in 2010, Greenfish is a consultancy company specialized in sustainable engineering. They hire engineers in their four areas of expertise: sustainable construction services, QHSE (Quality, Health, Safety & Environment) services, energy services and industrial engineering and optimization (Greenfish, 2016).

The very important point is that all the projects are or at least tend to be green (interview Greenfish, De Poorter). Nassim Daoudi, managing director, states *« At Greenfish we strive to provide our clients with smart solutions for environmental challenges with the aim to make the world a more sustainable place, together »* (Greenfish, 2016).

As part of their business, they provide companies with experts in the environmental and energy sectors. Currently working on a dozen projects involving ecodesign, this consultancy company seemed particularly relevant to provide their expertise.

1.2. Climact

Created in 2006, Climact's mission is to help companies or public institutions to reduce greenhouse gas emissions. This consultancy company works at different levels with the authorities or private companies. Climact has different areas of expertise: the first is about designing low carbon roadmaps for countries and territories, what is called prospective analysis. Therefore, they also participated in a global project. The second focus of their business is regulatory affairs which is everything related to issues concerning legal aspects of the transition to a low carbon society, so the energy system has to change, what does this involve for the government. The third component focuses on private businesses in order to work on their energy and carbon efficiency for them to fit into this transition. And the last part is third party project financing. Some of their customers want to implement projects but this is not their core business so they want a financing service and therefore Climact develops it for them (Climact, 2016; interview Climact, Vermeulen).

Companies take contact with Climact when they have an environmental impact that they want to understand, control and reduce. Practically, Climact will then proceed to a diagnosis. Then, measurements will be done and measures will be highlighted to reduce the environmental impact. There is then also support in the implementation of these reductions. Climact is not specialized in ecodesign but it is a subject that they master sufficiently to help industrial customers in a global diagnostic and to highlight which elements should be worked on: logistics, specific products, data centers or other dimensions (interview Climact, Vermeulen).

1.3. UCM Cellule Eco-conception

Since 2012 the UCM Cellule Eco-conception assists Brussels companies from all sectors in the efficient integration of the environment in their economic activities. It is a unit fully subsidized by the government (UCM, 2016).

The two employees of this department aim at helping very small enterprises and possibly small and medium-sized enterprises via a diagnostic method based on the pre-diagnosis method of the French Pôle Eco-conception. This method consists in a qualitative life-cycle assessment without going into a quantitative analysis. Then they make a more thorough analysis in company to see what it already does, where it wants to go, what is preventing the company to do so, what pushes it, what investments they are willing to do, etc. Then, a research is made on everything that is done in the field of ecodesign, all environmental approaches that could be associated, specific tracks for the company, contacts to help achieve them, a legal study to see if there are laws that are changing and that will force the company to go to it or if there are laws that prevent to do what is proposed by the UCM. A report is finally issued which is a debriefing that depends on the time the company is willing to spend. Then, depending on what the company decides to do, the UCM is responsible for the diffusion. It puts the company in a network; it promotes the company in all their events, in all their communications (interview UCM, Collin).

Beside the above, the UCM also works with professional federation to propose global solutions that can be adopted by members of the sector. The UCM has namely worked with Brussels' hairdressers, since it is one of the most represented activities in the area.

As far as their target audience is concerned, this cell targets VSEs and SMEs from Brussels. Since there are not a lot of production facilities in Brussels, the UCM has decided to mainly develop the ecodesign of services, services where at the end something is given to the customer. In this perspective, a website, a restaurant dish, etc. are things on which the UCM will work but they will not be active in services rendered by liberal professions (interview UCM, Collin).

Since they promote ecodesign and help companies in their undertaking, it seemed relevant to have an exchange with this organization. Moreover, their target audience are mainly VSEs, which allows having an emphasis on what drives very small businesses and entrepreneurs.

1.4. OVAM Ecodesign.link

Since 1981, OVAM works for a quality and efficient waste-, materials- and soil management in Flanders. As the Flemish waste agency, they have two big departments: (1) soil remediation, which consists in cleaning polluted soil, and, (2) materials management (interview OVAM, Ulburghs).

As part of the activities of OVAM, there is an enterprise division, which is a team that works at supporting companies and designers about how to apply ecodesign. Via OVAM Ecodesign.link, the meeting point for all those engaged in sustainable product innovation, OVAM brings its tools visible and promote ecodesign. OVAM want to be seen as a partner for all actors in the life cycle of products. The three main activities are: (1) inform and sensitize; (2) conduct innovative research and pilot projects with a strong link to the needs of and feedback of the target groups; (3) build a network through partnerships (OVAM, 2016).

It was relevant to consider the OVAM into this project because they do research, elaborate tools related to ecodesign and communicate.

1.5. Celabor

Celabor is a center of scientific and technical services recognized by the Région Wallonne that conducts private developments and research for companies. Celabor provides scientific

and technical support to companies in the fields of food, environment, packaging, paper and textiles (Celabor, 2016).

Companies taking contact with Celabor are mainly SMEs but some bigger groups such as Carrefour have also engaged the services of Celabor. Mainly conducting tests, Celabor propose various sets of tests to their customers according to their expectations (interview Celabor, Joppin).

This organization accompanies companies in their quality initiatives by conducting tests on products from the several fields in which they are active. In this logic, they namely conduct LCAs from companies interested in evaluating the environmental impact of their product or designs, which is why interviewing a member of Celabor made sense as part of this work.

2. Interviews

In order to obtain the information required to deepening this work, it was decided to conduct semi-structured interviews with questions about the previous chapters of this thesis. Indeed, the elaboration of the interview guide was based on the previous findings. Those interviews were thus focused on the definition of ecodesign, Life Cycle Assessment, incentives to ecodesign and barriers to ecodesign. The general interview guide is reproduced in Appendix 1. Note that depending on the company that was interviewed, elements of the interview guide were slightly adapted or elements were added. For instance, Celabor, which conducts LCAs, was mainly questioned on this tool.

As five organizations were considered, five field players have been interviewed:

- Greenfish - Gaëtan De Poorter: Responsible for Marketing and Communication
- Climact - Pascal Vermeulen: Managing Partner
- Cellule Eco-conception UCM - Perrine Collin: Advisor in Ecodesign
- OVAM Ecodesign.link - Wouter Ulburgh: Responsible for ecodesign innovation & policy
- Celabor - Xavier Joppin: Department Manager Textile

It was relevant to focus on those organizations because they allow giving a broader view on the subject than individual companies. Indeed, they all five work with companies that have engaged into ecodesign and therefore allow to give the bigger picture. The five interview transcripts are reproduced in Appendices 2 to 6.

Chapter 2 - Analysis of research findings

When discussing the subject with field players, different novel elements arise. Following the main lines of part one and part two, one will review the main findings from the interviews of the different actors. This chapter will allow seeing that everything is not white or black but that a major grey area remains. Three subsections will be covered. The first one will come back on the definition of ecodesign. The second one will briefly add some elements on LCA and alternative tools. The last subsection will develop the incentives and barriers highlighted by the interviewees considering a series of aspects.

1. Focus on ecodesign and its definition

Focusing on the definition of ecodesign, all five interviewees agree that the approach consists in designing and producing products or services taking into account the environmental impacts throughout the life cycle. Nevertheless, as previously mentioned, this is a nice definition but the notion of ecodesign is not that easy to define rigorously. Mr. Ulburghs from the OVAM stresses the fact that an ideal ecodesigned product would preferably handle all the impacts of the product. One clearly sees that this is an ideal scenario which seems unachievable and that numerous products are considered being ecodesigned while not fulfilling the latter. Plus, critically analyzed, considering all impacts on the life cycle without necessarily going into details may eventually lead to a superficial job. For instance, efforts on only one stage might in some cases be more efficient globally than small improvements on several stages. Mr. Ulburghs was also the only one of the five considering defining ecodesign to be a difficult question.

Further, although the notion seems known, Mr. Vermeulen, managing partner at Climact, believes ecodesign does not seem to be a concept that industrials master. It is not rooted in the practices.

2. Tools at the heart of ecodesign

2.1. Practical use of LCA

Even though Life Cycle Analysis is the most famous tool to analyze the various impacts of a product, it is indeed considered to be difficult to set in place by our different contacts.

As a matter of fact, Celabor is the only one conducting LCAs as such. They confirmed the theoretical functioning which was highlighted in the second chapter of part one. Indeed, practically, they start by defining the field of the study. With the concerned company, the functional unit allowing doing the measures will be defined. Then, they proceed to the Life Cycle Inventory and define the limits of the system to study. For the inventory phase, commitment from the company is required and this is not always easy. The company has to collect the needed information, note energy use, etc. Concerning the limits of the system, these are determined on a case-by-case basis. It will mainly depend on the relevance of the data Celabor can gather. The goal is actually to consider the entire chain, the entire life cycle. The more easily data is available, the wider the field of the study can be. Then, once everything has been set, Celabor uses a software, SimaPro, where all the data can be integrated and simulations can be done. As far as data used is concerned, Celabor tries to create their own data for each studied product because data available through the software might be too general. Regarding pollution transfers, the software allows them to make constrained optimization permitting to set constraints on the different types of pollution as well as on the different phases of the life cycle.

2.2. Used alternatives: The work of the OVAM

The OVAM has developed tools that can help companies to get started with ecodesign. The following tools were developed by the OVAM:

- Ecolizer tool: This tool provides the user with a simplified life cycle analysis of its product. By introducing the different materials, processes, etc. into the system, the user gets an overview of the environmental impacts engendered by its product. Nevertheless, this simplified tool does not give tracks on how to do better as far as these environmental impacts are concerned.

- Guidelines: The OVAM developed a series of guidelines which intend to facilitate communication between production organizations and organizations responsible for waste and recycling. Indeed, when waste agencies are confronted to some electronic waste, they might not know how to dismantle the product just because of poor communication.
- EHO tool: This tool supports the integration of ecodesign within education. It is about sensitizing education programs to the environmental issues and encouraging actions towards sustainability through ecodesign.
- OVAM SIS Toolkit: The SIS (Sustainable Innovation System) Toolkit has been developed to serve companies with more practical and strategic solutions. It goes further than the Ecolizer tool by proposing practical solutions following the inventory of the situation.

Nevertheless, only a few companies take contact with the OVAM to get help and support with the use of these tools. As the OVAM acts as a regulatory organism, companies do not consider it as a partner to support them and rather head toward consultancy agencies.

The most appropriate tool developed by the OVAM to help companies to get started with ecodesign is the OVAM SIS Toolkit. In order to provide guidance about the use of the OVAM SIS Toolkit, the OVAM has certified counselors qualified to help organizations in their projects with the OVAM SIS Toolkit. Perrine Collin from the UCM Cellule Eco-conception is namely one of those counselors. The training consisted of two days with the OVAM on this tool. The tool was presented during the first day and then, a practical exercise had to be worked on on the second day. Although Mrs. Collin is included in the list of advisors, there are not any companies contacting the UCM Cellule Eco-conception in order to get help with this tool. Therefore, Mrs. Collin believes this tool is relevant but communication about it should be developed.

The OVAM intends to become a partner and hopes to evolve towards this but at the moment, they do not have the staffing to do so and are not willing to disturb the market that is in place with the various consultancy agencies that exist.

2. Aspects driving and preventing from engaging into ecodesign

Based on what was said in the five conducted interviews, a series of aspects could be highlighted. Some of them constitute incentives or barriers by themselves but often, two sides exist and within a same aspect, one can highlight an incentive as well as a barrier. Two tables showing all the incentives and barriers identified by the five respondents were established in Appendix 7. A number in brackets was placed in front of each element, which represents the order in which the respondent gave this answer. When X is used instead of a number, it means that the element has been highlighted in another part of the interview.

2.1. Financial aspect

From what was said in the five interviews, the cost structure mostly is considered to be one of the main drivers for ecodesign. Adopting ecodesign approaches is considered to allow controlling costs by namely reducing energy consumption and optimizing material use. Choosing to go for ecodesign will at first engender a higher cost that will allow a reduction in variable costs directly related to the production of the product. Nevertheless, this seems a nice theoretical argument that makes it difficult to understand why every company does not ecodesign its products. Anticipating on the financial barriers that will be seen, one can affirm that ecodesign might not be cost-reducing overall.

Although all five respondents agreed cost reduction or control is part of the incentives to ecodesign, they also considered financial aspects as being a barrier. Indeed, investments are required from the beginning in order to get started with ecodesign; this will thus bring additional costs that otherwise would not have existed. To finance these, companies may lack the resources.

According to Mrs. Collin and Mr. Ulburghs, there is also a part that comes from the impression it is too expensive. Indeed, companies may think it will be too expensive and finally decide not to go for it.

According to Mr. Joppin from Celabor, overall, ecodesigning is more expensive. Variable costs can be reduced but conducting an LCA, getting a software, possibly outsource to a research institute, etc. will be additional costs that may not be counterbalanced by the savings.

2.2. Legislative aspect

In the part on external incentives, it has been highlighted that from a legislative point of view, political measures could be taken to encourage ecodesign. One of those was about the promotion of voluntary initiatives and agreements and one saw that in this framework, governments could set up plans in which they consider sustainability. In this view, the region of Brussels adopted the PREC (Programme Régional en Economie Circulaire) on the 10th of March 2016. This regional plan for circular economy incorporates lots of business models such as the economy of functionality, circular economy, industrial ecology and short circuits (Collin, Interview UCM).

Thanks to the interview with Mrs. Collin, one could also highlight that legislative constraints are not directly targeting small businesses. Nevertheless, there are a lot of small companies and even if those have a small individual impact on the environment, one cannot deny that aggregated, the impact of small companies can be important.

According to Mr. Ulburghs from the OVAM, legislation is only a small part in incentives for ecodesign in the sense that ecodesigned products are probably not on the market because of legislation and that legislation is more intended to those who are lacking behind and are not ecological at all.

As far as the internalization of externalities is concerned, lots of products are just too cheap on the market. If you see what costs they engender for society, recycling, etc. if you would take the cost and apply it on the product, the products will be much more expensive and consumers will react accordingly and designers and companies will then think about how to lower the integrated costs more (interview OVAM, Ulburghs).

2.3. Marketing and consumer demand

The marketing side seems also to have its part to play in practice. By ecodesigning, a company becomes more respectful of its environment and can thus convey a better image to society, media, etc. Moreover, it is also believed that adopting ecodesign approaches will allow companies to be ahead of competition. By being more ecological, a company can create a competitive advantage based on this differentiation.

Along with marketing aspects, consumer demand is in the literature a rather important element supposed to be driving ecodesign. Nevertheless, we have highlighted previously that there might only be a small fraction of people really interested in green products. According to Mr. Vermeulen, Mr. Joppin and Mr. Ulburghs, it seems that a price differential would be difficult to accept by customers, except for some consumers like the LOHAS. But, at the same price, an ecodesigned product clearly has a superior perceived value (Teulon, 2014). An additional sales argument can also be found in the fact that some ecodesigned products, if the use phase has been optimized, will be less expensive once owned by the customer. The product could thus have a lower total cost of ownership. For instance, a washing machine that is performing particularly well as far as consumption is concerned (A+++) compared to other ones (B, C, D or E) will probably be more expensive but will engender lower costs during its life. These types of products seem thus easily saleable to non-LOHAS consumers.

Nevertheless, consumers might not be that claimant of ecodesigned products. Moreover, as discussed with Mr. Vermeulen, if a price differential exists, consumers may not be willing to buy ecodesigned products at all except for a limited market segment. Mr. Joppin believes that there maybe is a lack of information and that consumers are not sufficiently informed, which does not increase their willingness to pay for ecodesigned products.

The interview with Climact and the OVAM also allowed emphasizing the fact that tenders more and more include requirement concerning environmental friendliness and ecodesign.

2.4. Innovation

Innovation was also mentioned as a driver for ecodesign. Mr. De Poorter from Greenfish focused on the decision-making side by noticing that when proactivity and new ideas are valued, innovation management can push to adopt new technologies, new processes and new designs. Mr. Ulburghs explained that companies eager to be more innovative and improve would be receptive to ecodesign.

On the contrary, as highlighted by the Greenfish employee, if an innovation management system, or at least a structured decision-making system, is in place, and that decision makers in the company are rather short-sighted with well working habits, it can be a quite important

barrier. There might thus be a desire at some level of the company to engage into ecodesign but this can be slowed down by higher-level management. This joins what has been pointed out by Climact's managing partner. What Mr. Vermeulen highlighted is the fact that when deciding to ecodesign from the beginning, one sets a frame beyond which one cannot go and this makes possibilities of new product developments more limited. Industrialists may thus wonder why they should engage into ecodesign while, on the one hand the consumers will not require it, and, on the other hand, it will limit the creativity of the teams. It would probably be easier to develop whatever product you would like to develop and then eventually see what can be done as far as waste is concerned by for instance providing end-of-pipe solutions.

2.5. Technological aspect

The only interviewee really mentioning technology was Mr. De Poorter from Greenfish. He illustrated it by an example. A Belgian nuclear plant made a tender for a project to fix damages in their buildings. Major construction and consultancy companies then came up with their project and Greenfish did too and offered to do it in a sustainable manner. The project was thus to propose a construction plan implementing innovations in the field via the use of new materials, etc. At first sight, they were not really open to that because all that seemed to matter was speed, efficiency and costs. As Greenfish could come up with a project that was competitive on those three axes with in addition an ecological side, the implemented project was thus greener than expected not because of a willingness but simply because it was possible using new techniques and technologies.

2.6. Conviction

According to the ecodesign unit from the UCM, the main driver for small companies will be a convinced manager. The interview with a member of the OVAM also went into this direction by underlining the fact that most popular and best examples are with companies where management is convinced. As highlighted by Mr. De Poorter who is responsible for communication at Greenfish, personal satisfaction is an important element to earn from ecodesign. According to him, it is a satisfaction to know that what you do in life really brings a positive impact.

2.7. Knowledge / Expertise

Lack of expertise can be an important barrier. It has been highlighted by the respondents that becoming green is not easy and that the companies may lack the necessary competences. There are sectors where there are sector research institutes that try to overcome the knowledge barriers. Then tools have to be used and these may not be designed for those who have not been trained to use them.

Beyond expertise, Mrs. Collin has emphasized the fact that lots of small businesses with whom the UCM has worked have never even thought of it.

2.8. Current functioning of the organization

2.8.1. Work load

Greening one's production requires time besides capital. One does not engage in ecodesign overnight. Celabor, for instance, provides companies with services like LCA and makes propositions for improvements but even when one works with such a service provider, one has to get involved in the process.

As far as small businesses are concerned, Mrs. Collin assures that in her experience, the companies with whom the UCM has worked are often focused on their core business and are not willing to spend time on ecodesign.

2.8.2. Organizational change

As it is rather complicated to put in place, changes in the way of working will be inevitable. Nevertheless, this was not an element every respondent mentioned. Mrs. Collin considered it as a particularly important element and by extension, one could say that small firms might have more difficulty with the changes that ecodesign will engender.

Further, ecodesign often is considered as an additional element to consider when managing a business because it does not especially fit in the business model that is in place.

2.8.3. Long-term orientation

Ecodesign implies a long-term vision. As most SMEs are focused on their daily activities with a less long-term vision, SMEs do not especially invest in such assessments as LCA and without adopting a systematic analysis, the adoption of ecodesign might not be possible or at least not in an efficient manner.

3. Conclusion

As previously mentioned, this chapter allowed to see that a major grey area subsists as far as ecodesign and what pushes and prevents from engaging into it are concerned. On the one hand, financial aspects, innovation and legislation may constitute both an incentive and a barrier to ecodesign. On the other hand, a series of incentives add up without one being strong enough to somehow force to engage into ecodesign. Depending on the sector and the size of the organization, incentives and barriers may vary.

Most aspects seem to be shared among the met stakeholders and join what has been highlighted through the literature. Nevertheless, thanks to this field research, more nuances were brought. For instance, most studies have shown the importance of cost reductions but, eventually, this does not seem to be that trivial.

General conclusion

The aim of this master's thesis was to foreground what pushes and what, on the contrary, prevents companies from engaging into ecodesign. Developing a broad understanding of the subject, including the most famous tool (LCA), was also part of this thesis as it contributes to unravel the factors influencing companies who may adopt ecodesign approaches.

By first defining the relevant concepts, the first part of this work was intended to develop the understanding of the concept by the reader. Applied methods with a particular emphasis on LCA constituted the second chapter of this first part. The second part could plunge the reader to the heart of the matter by focusing on the incentives (external and internal) and the barriers or challenges. Finally, the purpose of the third part was to bring out field expertise by focusing on information gathered from field players.

By way of conclusion, three major findings will be reviewed.

Firstly, the adoption of ecodesign is not an easy task. Ecodesign is not a turnkey solution. To get started with it, a thorough analysis needs to be done and therefore, the life cycle analysis can be helpful. Nevertheless, this tool also presents flaws and might not be adapted for smaller firms. In addition, it does not provide the user with solutions to the environmental impacts engendered along the life cycle. LCA allows highlighting where the impacts are and where the most important ones are and coming up with solutions is then up to the user. To get concrete solutions, companies, which often lack the qualified staff, can turn themselves to consultancy agencies or associations working on ecodesign. Nevertheless, the perfect solution to adopt does not seem to be known and striving to produce the most environmentally friendly possible product will require a real willingness to do so.

Secondly, some grey area subsists as far as the driving and preventing forces of ecodesign are concerned. On the one hand, financial aspects, innovation and legislation may constitute both an incentive and a barrier to ecodesign. For instance, as far as financial aspects are concerned, cost reductions are considered an important driver for ecodesign, nevertheless, a series of costs will also increase by engaging into ecodesign and depending on the company and choices made, nothing ensures that the overall costs will be decreased. On the other hand, a series of incentives add up without one being strong enough to somehow force to engage into

ecodesign. Depending on the sector and the size of the organization, incentives and barriers may vary. For instance, as a small enterprise, costs engendered by new installations will probably constitute a way more important barrier than for a big company.

Thirdly, an important room for improvement remains on the government's side. Incentives lack from a legislative point of view. Indeed, with EPR policies, governments may not be incentivizing companies to engage into ecodesign. Plus, for a small company, incentives are very limited and regulation does almost not play a role. Nevertheless, one cannot let aside the fact that even if individual SMEs have a small impact on the environment on their own, taken together, this impact increases. Furthermore, currently, costs engendered by traditional products on the environment are not integrated in the price of those. If one decided to integrate the costs undergone by society, recyclers, etc. and apply it on the product, products would be more expensive and ecodesign could be encouraged to drive prices down.

For further research, one might wonder if ecodesign as we currently know it is really a solution. That is to say, as has been highlighted in the third part of this work, ecodesign can be considered as an additional constraint that does not fit into the current business model. How could it thus be better integrated to facilitate its adoption?

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