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Integrating Sustainability in the Strategic Stage of an Innovation Process: A Design Brief Perspective

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Abstract

This book chapter explores the uptake of environmental sustainability in the front end of an innovation process, and the outcome of this stage: the design brief. The study is based on a content analysis of 80 design briefs from Belgian enterprises, a focus group with representatives from 14 Belgian companies and an in-depth interview with two Belgian chief executives. The results show an overview of the most and least used environmental sustainability strategies in the design brief and demonstrate a remarkable difference in uptake between large enterprises and small and medium-sized enterprises. Findings show that companies often deal with sustainability on a hidden and decomposed level. Furthermore, a generic model for the design brief process is presented with the different entry points for sustainability. Crucial factors for integrating environmental sustainability in the design brief are discussed in the last section. The paper concludes with a recommendation to integrate ecodesign targets in the design brief and discussing them with the decision makers in all the stages of the design briefing process. With no environmental commitment in the design brief towards the final product, no time, budgets, and staff will be allocated on this subject during the operational stage.

Keywords: design brief, sustainable product innovation, ecodesign, front end innovation, strategic innovation management, new product development

1. Introduction

The very early phase in the innovation process, the so-called front end of innovation (FEI), is often described as being the root of success for any company hoping to compete on the basis of innovation [1]. It is the phase with the largest impact on the end result of the project [1, 2] and the highest payback to one's investments [2]. It is in this phase that companies set their targets and determine which products will pass to further development. The outcome of that process is usually reflected in the design brief [3]. The decisions made in the front end (FE) and the design brief influence all the later phases of the innovation process.

This chapter argues that the uptake of sustainability in design projects would be far more effective if sustainability aspects are written down in the design brief, providing guidance to the design, engineering, marketing, and management team.

Till now, there is limited understanding of how to best bring environmental considerations into the design brief. FEI is a hot research topic, but its relationship with the design briefing process in the FE and design for sustainability has received much less attention in literature and practice. There are a number of tools available to guide designers, engineers, and managers in the design process after the specifications of the product or service are already set, but methods supporting goal finding for sustainable innovations are rare [4].

This book chapter describes a first exploratory study to fill this gap. The research aims at gaining understanding on how environmental sustainability is integrated in the strategic stage of an innovation process, the so-called FE, and the design briefing process. The first part is based on a literature review and elaborates the FE and what is meant by a design brief. The second part looks to the current practice of integrating environmental considerations in a design brief and the FE. Different research results are described and discussed in the penultimate section. The chapter concludes with recommendations for future research.

2. Literature review

2.1 The strategic stage in an innovation process

Innovation projects in industry generally move along three major activity domains: The pre-development activities where future products are defined and decided on (the FE), the development activities where these products are actually developed (the New Product Development phase (NPD)), and the launching or commercialization activities where these newly developed products are brought to the market [2].

The strategic stage in the product innovation process is the stage where product strategy formulation, opportunity identification, idea generation, idea selection, and concept development take place and decisions about new product development are taken [2]. According to Kim and Wilemon [5], the FE starts when an opportunity is considered valuable of deeper exploration and ends when a company concludes to invest significant resources to the development of the idea and launch the project. The FE includes product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and early executive reviews, which typically precede detailed design and development of a new product [5].

According to Crawford and Di Benedetto [6], the FE process answers these five essential questions: what, why, who, when, and how.

- What: project description.
- Why: the strategy behind the project.
- Who: the necessary human resources.
- When: project timing.
- How: describes all the product requirements regarding the new development.

Similar to Jacoby [7], the FE phase in this chapter is defined as “all initial innovation activities, prior to the phase where real new product development starts”.

The FE has typical characteristics; less information is known, there is a high degree of freedom, and the cost for changes is low. Later in the process more information is disposable, but changes will have a higher price [8, 9]. It is under these uncertain circumstances that decisions are made and the design brief is formulated in the FE.

2.2 Importance of the strategic stage

The root of success of innovations can be found in the activities done in the FE [1]. The first phases in the innovation process have the largest impact on the end result of the project and the highest payback to one's investments [2]. Quality, costs, and timings are mostly set during the FE. Important decisions are made here, and will follow the product through the project [8]. Choices made in the FE influence the success of a product on a great extent [7].

The impact decisions can have on the end product diminishes during the project. FE decisions can have an impact on the whole product, whereas NPD decisions only have an impact on partial aspects as the team has to take into account earlier choices [7]. Koen and Bertels [10] also highlight this path-dependency in an innovation process. The most significant benefits can be achieved through improvements of the FE activities [11]. Also a study by Koen et al. [2] states that the FE presents one of the greatest opportunities for improving the overall innovation process. Verworn [12] concludes that a better understanding of the FE increases the success rate of the NPD process.

2.3 The design brief

The outcome of the FE is usually reflected in the design brief [3] and can be seen as the point of transfer between the FE and the NPD [13, 14]. It is a written description, an agreement or contract of a project that requires some form of design between the parties involved in the project [3]. Often, the design brief serves as a point of transfer between different professionals, where the project is handed over from marketing to design, or from a product manager to an external design agency. The role of a design brief is to foresee the base of the design process in the form of a practical paper that reflects the final product's attributes [15].

A good design brief tries to obtain the knowledge of the design and management team, the expert, and the user and the buyer. Formulating a design brief is a creative, iterative, and interactive process and is best developed in partnership [3]. Successful briefing is about clear and comprehensive communication and how information is structured [16]. It is important that the brief contains all the information and data necessary for every stakeholder [3].

A variety of terminologies are used for design assignments in literature and practice. People may refer to the design brief as new product development brief, creative brief, project brief, project sheet, innovation brief, or marketing brief [3, 16, 17]. Design is a broad term, with a variety of design disciplines (e.g. industrial design, package design, and communication design). Each discipline requires different information in a truly useful design brief [3]. The focus of this paper is "Industrial Design Briefs", briefs for the design of a new consumer product or a product-service system.

2.4 Elements of the design brief

While in practice the structure of design briefs may vary, Phillips [3] describes eight elements that he seems essential for a good design brief, as explained in **Table 1**. The table also represents a schematic overview of a good design brief.

Design brief element	Description
(1) Project overview and background	The executive summary of the project. It clearly articulates the scope, the business needs, objectives, desired outcomes and ownership of the project in terms non-design business partners can understand. It contains all the essential information: what, why and who of the project
(2) Category review	The industries in which the product or service is involved, including market positioning, brand and business strategy and significant trends
(3) Target audience review	The target audience(s) description, as completely as possible
(4) Company portfolio	Decription of the company and its activities
(5) Business objectives and design strategy	This section provides a clear understanding of how design strategy is matched to business objectives
(6) Project scope, timeline and budget	Project scope and time-budget requirements in every phase of the project
(7) Research questions	Unanswered questions that are critical to the success of the design project
(8) Appendix	Optional section that might contain documents that summarize research data, competitive analyses and visual material

Table 1.
Essential elements of a good design brief, according to Phillips (2004).

3. Research approach

A variety of authors have recommended to focus on the FEI in the eco-innovation literature in the last decade [17–27] However, with few exceptions [17, 28], little attention is given in the literature regarding the design brief process in the FE in relation to sustainable product innovation. There is still insufficient comprehension of this important matter.

Previous research by Boks [29] has identified the use of environmental checkpoints, reviews, milestones, and roadmaps as an important success factor regarding the integration of sustainability considerations in the early stages of the product development process. As the design brief can be seen as a roadmap and project-tracking tool that defines the various steps that will be followed [3], the assumption was made that the design brief can play an important role in achieving this.

The research in this chapter describes a first exploratory study to fill this gap. It aims at gaining understanding on how environmental sustainability is integrated in the design brief in the FEI. Based on the insights from the literature and previous explorative studies [19, 27–29], the research questions can be formulated in order to address the research objective as follows:

How frequently do companies add environmental sustainability in their design briefing? (1a).

If they do so, which ecodesign principles are requested in the design brief? (1b).

The answer to question “1a” will teach us how frequently environmental sustainability elements in the design brief are mentioned in the data sample. Question “1b” on the other hand will help us to understand in more detail what ecodesign principles are used. Seeking a plausible explanation for the reason as to why certain ecodesign principles are more frequently mentioned in the design briefs than others can only be answered by firstly regarding the design briefing process in the FE, as

there is little research to date on this topic. By having insight into this design briefing process, it would be possible to define the entry points for sustainability and key factors for integrating sustainability in design brief. As such, the next research questions were formulated:

How is the design briefing process established in the FE of an innovation process? (2a).

Where are the entry points for sustainability? (2b).

And what are success factors for integrating environmental sustainability in the design brief? (2c).

Three exploratory studies have been conducted with a focus on Belgium SMEs and large enterprises within various industries to answer the questions above. In order to enhance the credibility in the findings, a between-method triangulation was chosen by involving three research methods.

Because relatively little research has been conducted regarding environmental parameters in a design brief and the design brief process, preference went to a qualitative approach, since the focus lies on a small sample to try to look at a range of interconnected processes and causes.

In the first study, a content analysis of 80 industrial design briefs from 62 Belgium-based companies was used as research methodology. The found ecodesign elements in the design briefs were typified and assigned according to the Ecodesign Strategy Wheel [30].

In study 2, a focus group was organized with representatives from 14 Belgium SMEs and large enterprises, in combination with a double in-depth interview with two Belgian chief executive officers (CEOs). These participatory methods were chosen for some particularly reasons; it allows participants to question each other and to elaborate upon their answers. The participants can develop and influence each other's ideas and opinions in the course of discussion. It is also useful when there is a desire to learn more about consensus on a topic and when one is interested in complex motivations [1]. The research procedure is explained in detail in the next sections.

Sleeswijk Visser et al. [31] have shown the relationships between the various forms of data gathering and their ability to access different types of knowledge. Corresponding with these insights, a mix of different research techniques are used in this study in order to get access to the following levels of knowledge; explicit (interview), observable (content analysis of the 80 design briefs), and tacit/latent (focus group).

4. Study 1: The analysis of 80 design briefs

4.1 Research approach for the analysis of 80 design briefs

A design brief is an essential communication paper between the company and the design bureau. It generally gives an accurate insight in the sustainability ambition a company has for their future product or service. But how often do corporations add ecodesign topics in their assignment? If they do so, which ecodesign principles are requested in the design brief?

To answer these questions, a content analysis of 80 industrial design briefs from 62 Belgium-based companies was used as research methodology. Among those companies, 50% was categorized as small and medium-sized enterprises (SMEs), 41% as large enterprises, while the other 9% were classified as "other" (knowledge institutions, government, universities, or associations of industry-specific institutions). The European definition (EU, 2003) was used to categorize the SME businesses. According to this definition, the main factors determining whether a

company is an SME are number of employees (<250) and either turnover ($\leq \text{€ } 50 \text{ m}$) or balance sheet total ($\leq \text{€ } 43 \text{ m}$).

In all the cases, the companies firstly contact the design team with a request for proposal. This document becomes a design brief after reviewing and discussing the problems and needs with both parties.

The level of innovation proposed in the design briefs in this study varies from average to high. The design briefs can be categorized as open briefs, where the outcome of the project is not yet clearly defined and the product parameters are still flexible. All assignments covered physical, tangible products. More than 95% represents “end products”, while the remaining 5% exists out of semi-finished product.

To get a good view on the daily practice and to close out socially desirable behavior, no one was informed in advance about this study.

4.2 Content analysis of 80 design briefs

Different methods supporting the analysis of a product's impact on the environment can be found in literature and practice. A method was needed to analyze the design briefs that could be applied in the first stage of a product design process, with a general product in mind. Such a method was found in the Ecodesign Strategy Wheel, also called Lifecycle Design Strategies (LiDs) [30]. The method helps to select and communicate strategies to minimize the environmental impact of a design.

The Ecodesign Strategy Wheel provides eight EcoDesign strategies that can be considered systematically, as presented in the **Table 2**. Strategy 0 is either “strategic”, working on the product concept level, while the other strategies represents the product life cycle and relates to the product component, structure, and product level. The strategies are divided into 32 sub-strategies and correspond to possible solutions to improve the environmental profile of a product.

The found ecodesign elements in the design briefs were typified and assigned according to the strategies, and indicated as being quantitatively or qualitatively. No distinction is made in the analysis between projects that are initiated with the intention of doing something sustainable vs. projects without a specific sustainability focus.

4.3 Limitations of the study

The sustainability of the final product cannot be deducted from the design brief, as earlier research showed [17]. The incorporation of sustainability in a design brief does not guarantee results. Several organizational issues could function either as success or failure factors for the entire process. The opposite is also possible; in the case that the design brief does not express any wish or desire for sustainability, it is still possible that the design team may bring sustainability later in the project [28] when new insights are obtained during the innovation process.

Secondly, project leaders and design team members can strongly influence the final outcome of the design brief. Ecodesign push and pull mechanisms can show up in discussions with the company and the design team and often influence the final content of a design brief.

At last, diverse sectors were covered in the design briefs, varying from the electric and electronic industry, lighting, furniture, medical equipment, building, engineering, technology, and polymer industry. This implies a large variety in end products and in terms of production techniques, materials, end-users, market volumes, product function, etc. Therefore, the conclusions to this study can only be indicative.

Lifecycle design strategies				
Product level	Strategy	Sub-strategy		
Product concept level	New concept development	0.1 Dematerialization		
		0.2 Shared use of the product		
		0.3 Integrations of functions		
		0.4 Functional optimization of product		
Product component level	Selection of low impact materials	1.1 Cleaner materials		
		1.2 Renewable materials		
		1.3 Lower energy content materials		
		1.4 Recycled materials		
		1.5 Recyclable materials		
	Reduction of material usage	2.1 Reduction of weight		
		2.2 Reduction in (transport) volume		
		Product structure level	Optimization of production techniques	3.1 Alternative production techniques
				3.2 Fewer production steps
				3.3 Lower/cleaner energy consumption
3.4 Less production waste				
3.5 Fewer/cleaner production consumables				
Optimization of distribution system	4.1 Less/cleaner/reusable packaging			
	4.2 Energy-efficient transport mode			
	4.3 Energy-efficient logistics			
Reduction of impact during use		5.1 Lower energy consumption		
		5.2 Cleaner energy source		
		5.3 Fewer consumables needed		
		5.4 No waste of energy/consumables		
Product system level	Optimization of initial lifetime	6.1 Reliability and durability		
		6.2 Easier maintenance and repair		
		6.3 Modular product structure		
		6.4 Classic design		
		6.5 Stronger product-user relation		
	Optimization of end-of-life system	7.1 Reuse of product		
		7.2 Remanufacturing/refurbishing		
		7.3 Recycling of materials		
		7.4 Saver incineration		

Table 2.
Lifecycle design strategies and sub-strategies according to the product level [30].

4.4 Results of the design brief analysis

4.4.1 Overall uptake

The content analyses of the 80 design briefs have shown that the uptake of environmental considerations into design briefs is limited. There was a remarkable difference between large enterprises, SMEs and enterprises categorized as “other” (knowledge institutions, government, universities. or associations of

Type of company	Uptake (%)
SMEs	43
Large enterprises	64
Other	86

Table 3.
The uptake of ecodesign elements in the analyzed design briefs, split up by company type.

industry-specific institutions). SMEs scored poorly: in 43% of all the SME design briefs, there was an ecodesign component found. The results are presented in **Table 3**.

4.4.2 Uptake on product level

Figure 1 gives an insight into the environmental profile of the design briefs on the different product levels. A distinction is made between SMEs, large enterprises, and “other” companies, demonstrated in the three bars. Large enterprises exceed the SMEs in all the product levels.

4.4.3 Uptake on strategy level

The most frequently used strategies in the design briefs are presented in **Figure 2**. As one can see, most of the strategies fluctuated between 0 and 18%, with an exception for the strategy “optimization of initial lifetime”. This strategy was most popular for all the company types.

4.4.4 Uptake on sub-strategy level

The results on sub-strategy level are presented in **Figures 3** and **4**. Overall, the most popular sub-strategy was reliability and durability (6.1) followed by modular

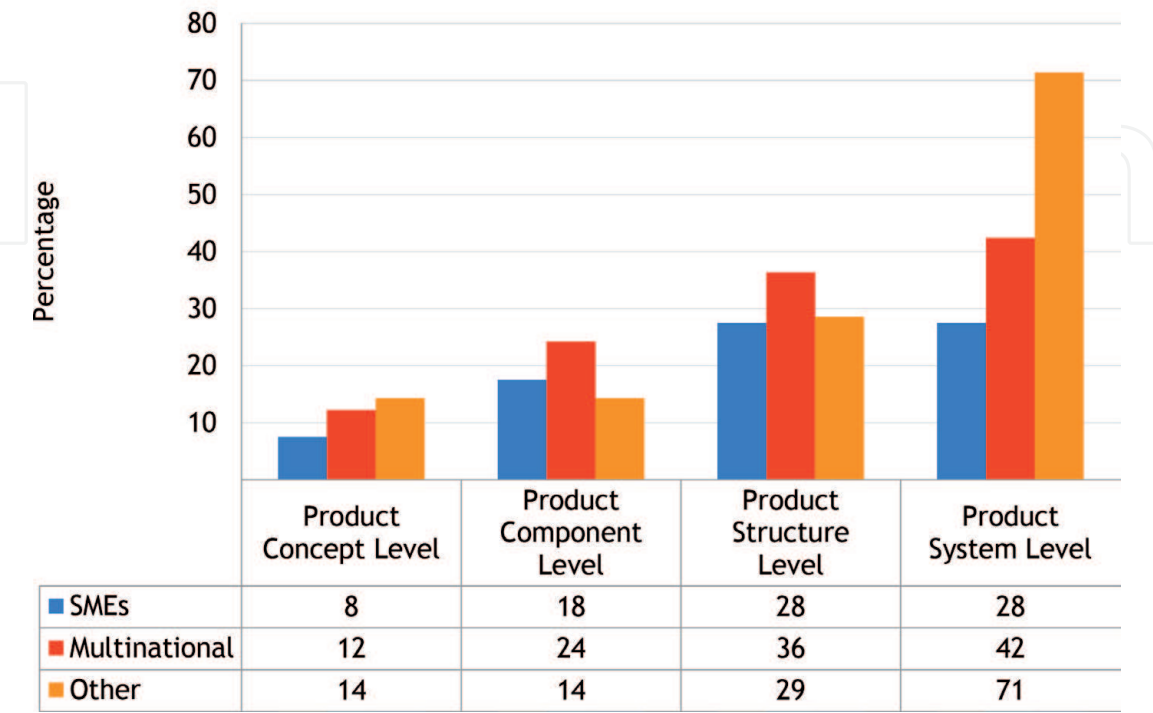


Figure 1.
The integration of ecodesign in the analyzed design briefs on the different product levels (in percentage).

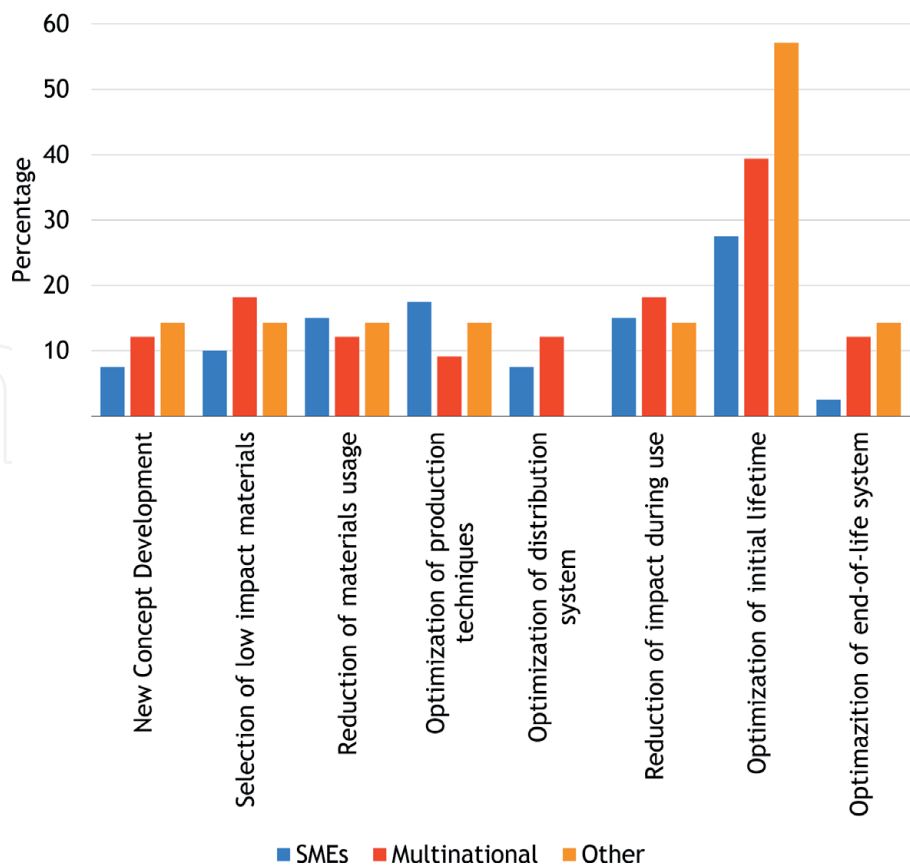


Figure 2.
Environmental profile of the design briefs on strategy level (according to [30]).

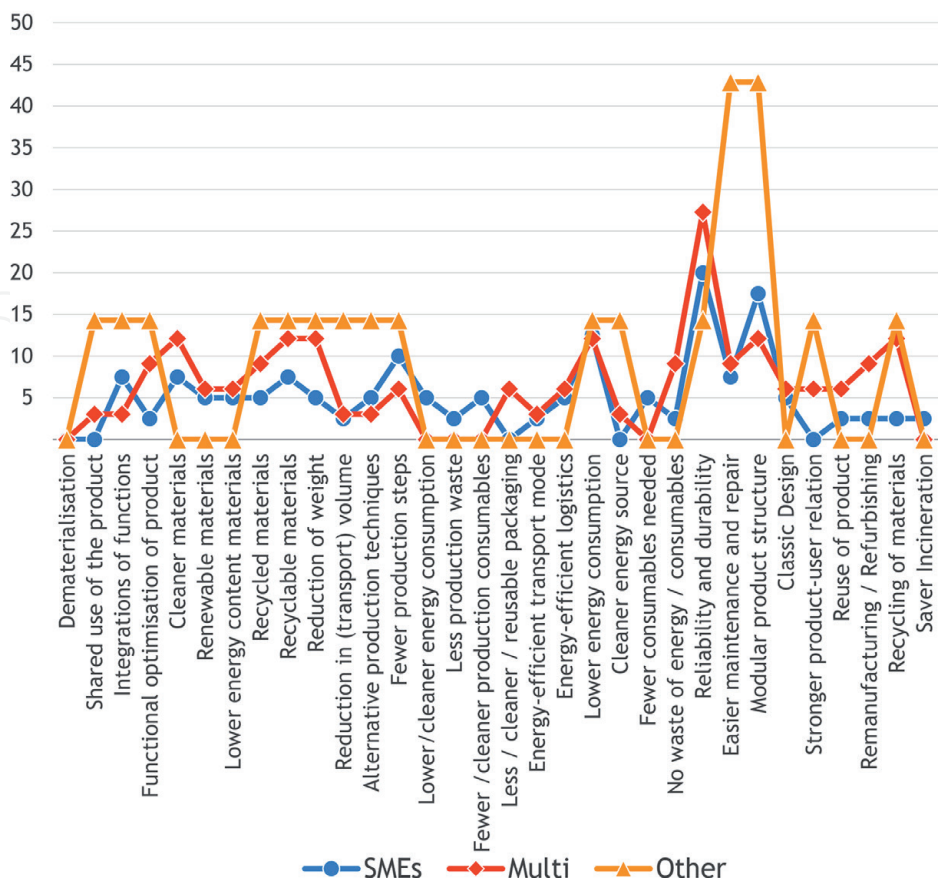


Figure 3.
Percentage of design briefs where a particular sub-strategy occurred, split up by company type.

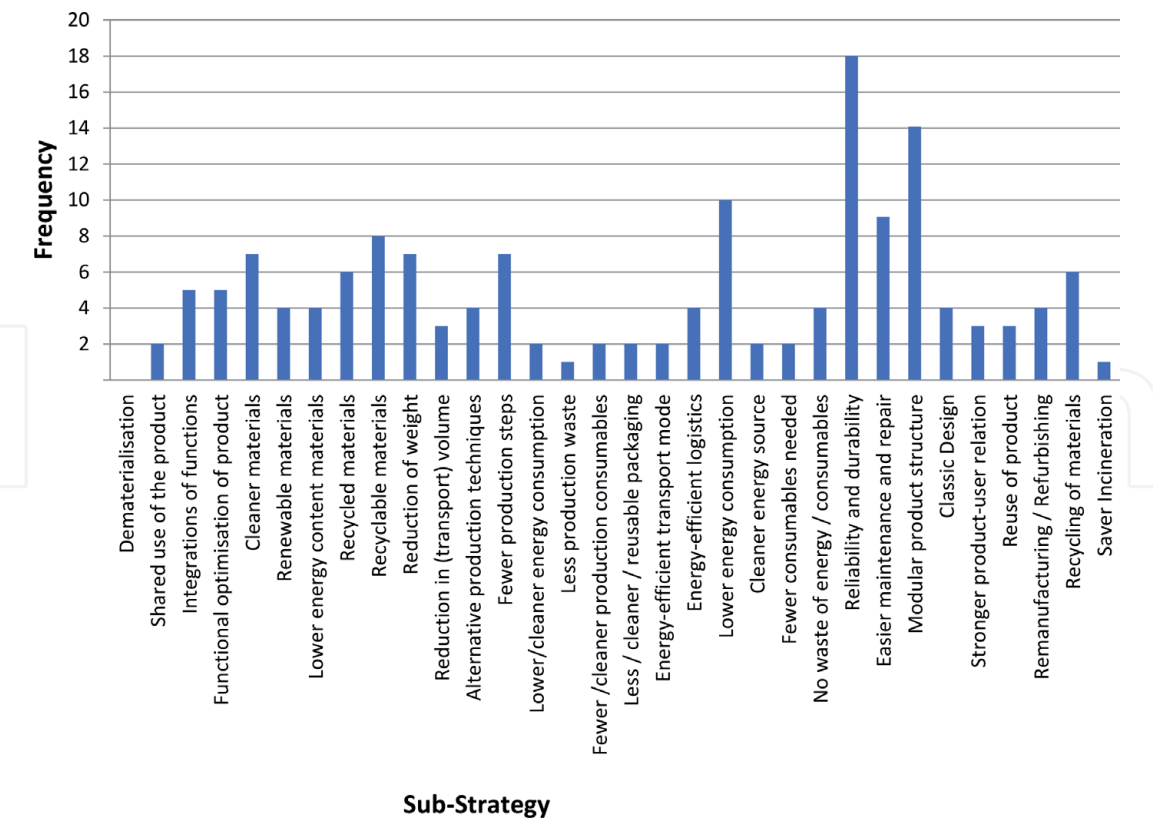


Figure 4.
The frequency of found sub-strategies in the 80 design briefs.

product structure (6.3) and lower energy consumption (5.1). Sub-strategy dematerialization (0.1) was not found once. The least found sub-strategies were less production waste (3.4), saver incineration (7.4), lower/cleaner energy consumption of production techniques (3.3), fewer/cleaner production consumables (3.5), less/cleaner reusable packing (4.1), and energy-efficient logistics (4.3). On average, in each design brief 1.6 sub-strategies were detected.

5. Study 2: focus group and interview

5.1 Research approach

Is there an explanation as to why certain design briefs more frequently mentioned environmental sustainability elements in the design briefs than others? And furthermore, is there a reason as to why certain sub-strategies are more frequently mentioned in the design briefs than others?

Before one can answer these questions, one must first have a clear view on the design brief process in the FEI. The assumption was that by having insight into this design briefing process, it would be possible to define possible entry points for sustainability. To give an answer to these questions, the following study was carried out.

First of all, a focus group was organized with representatives from 14 Belgium SMEs and large enterprises. There were two major criteria to participate in the focus group: being located in Belgium and having an active product development department, either by an in-house design team or in collaboration with an external design agency. All persons volunteered on the focus group after a call for participation. Background of the participants ranged between senior management, project management, product design, engineering, and research and development, as shown in appendix A. The focus group was organized as an interactive group setting where

participants were divided in teams of four and five and lasted 1.5 h. Each team could make notes and schemes on big sheets of paper in order to visualize their thoughts to the other team members.

The following topics were discussed:

In the first part, the participants were asked to visualize and discuss their innovation process with the team members. Special attention was given to the FE of the process and the flow of the design brief. In the second part, the teams shared their experiences in integrating sustainability in the early stages of a design process and the design brief. Findings of the teams were summarized and presented plenary to all the participants of the focus group. In the end, the presented results were discussed with the whole group.

The focus group session and final presentation were recorded with notes and partly with audio. They were transcribed chronologically by use of sentences, key words, and statements. The sheets of paper were analyzed and summarized.

In addition to the focus group session, a double semi-structured in-depth interview with two CEOs from two Belgian SMEs was conducted to further clarify issues. The interview was carried out at the office of one of the CEOs, lasted 1 hour and a half, and was recorded both with audio and notes. The two CEOs were selected on their expertise. Both have a background in industrial product design; one has a specialization in Front End Innovation (>10 years of experience), the other in Environmental Sustainability and Sustainable Business Models (>15 years of experience). None of them has set any of the briefs that were analyzed in 4.1. They are both active in different sectors in product design and consultancy, and do not see each other as competitors. The idea of doing a double interview, instead of separately, came from them, to create a certain dynamic.

The two CEOs were interviewed about their FE innovation process, their experiences in design briefing, and the integration of sustainability in both of them. The interview questions can be found in appendix B of this chapter.

5.2 Findings

This section presents the main results based on the focus group and the interview.

5.2.1 Design briefing process and entry points for sustainability

As many people believe, the design brief is not a single document. Though processes differ from company to company, a multi-step design briefing process at the FE was found at all innovation processes of the participants. During this briefing process, different documents jump back and forward between different people and departments in the company.

With these insights, a new generic model of the design briefing process is presented in **Figure 5**. It shows the various stages of a design brief at the FEI. Although not all companies had such a formal organized process, there was a consensus in the group on the different stages and activities. The process is presented linear, but with different feedback loops. The model does not represent actual time frames. An earlier version of this model is described in another article of the authors of this chapter [20] as a result of a preliminary explorative study.

The various stages of a design brief document are explained in **Table 4**. There is no one-size-fits-all answer to the question “who is involved in the different stages of the design brief process”. Different companies manage innovation in the FE in different ways. Also the decision maker(s) and the decision making process vary from company to company and are project-dependent. The people involved in the

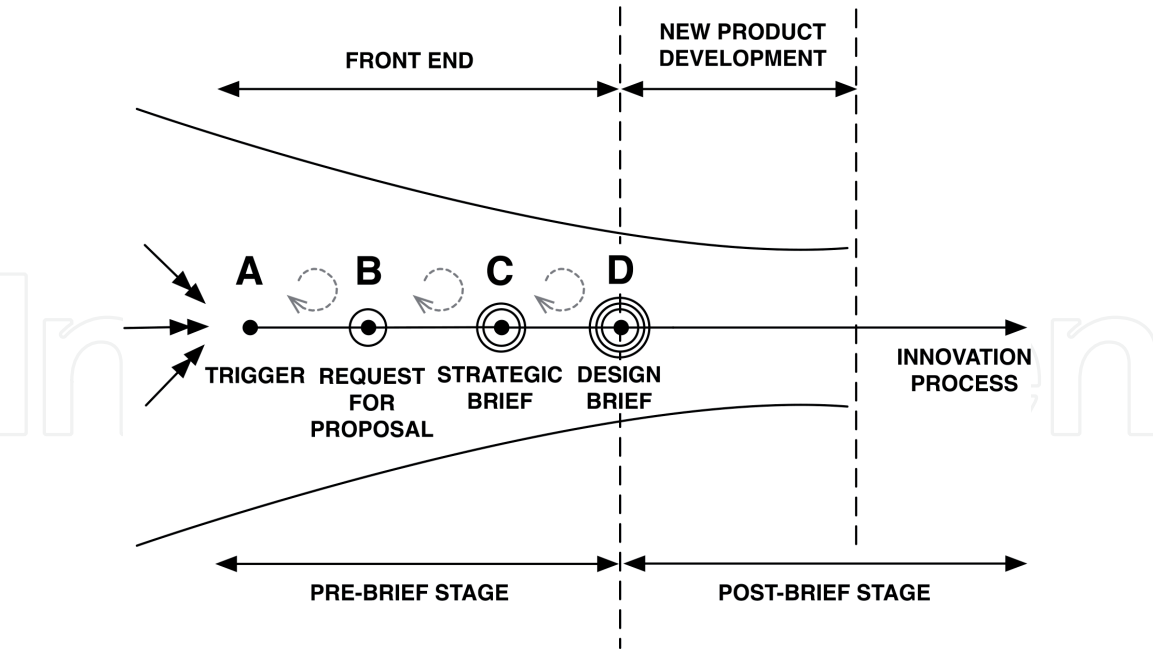


Figure 5.
The various stages of a design brief in an innovation process.

Description	
(A) Trigger	This is the start of the briefing process. Someone in the company defines a business objective or need. It can be a “gut” feeling based on previous experience, a recommendation from a stakeholder, or a result of research.
(B) Request for proposal	This document is sometimes also called “statement of need”. It contains some basic information about the business objective or need and goes to the management level in the organization where the team can decide whether it is worth pursuing, mostly decided after conducting a feasibility study.
(C) Strategic brief	When the projects get a “go”, the request for proposal will be upgraded into a “ <i>strategic brief</i> ” (C). This document is usually created for the in-house design team or for an external design agency.
(D) Design brief	Here the design brief is developed and written, usually in co-creation with the in-house design team or an external design agency after considerable thought and discussion about the project.

Table 4.
The various stages of the design brief.

briefing process can be a fixed team, an ad-hoc composed team, or it can even be one person where the entire FE is in his head.

After the interview it became clear that the converging funnel model, as presented in **Figure 5**, does not reflect the daily reality in many companies. A convergent and divergent stage, as well in the strategic stage as in the operational stage is a more common practice. The British Design Council has described such a model called the “Double Diamond” design process model [32]. Divided into four distinct phases, discover, define, develop, and deliver, it maps the divergent and convergent stages of the design process.

The design briefing process, shown in **Figure 5**, was revised and adapted based on this double diamond model. The result is presented in **Figure 6**.

The different stages in the design briefing process as presented in **Figures 5** and **6**, also mark the different entry points for sustainability. The earlier in the process, the more room there is for improvement.

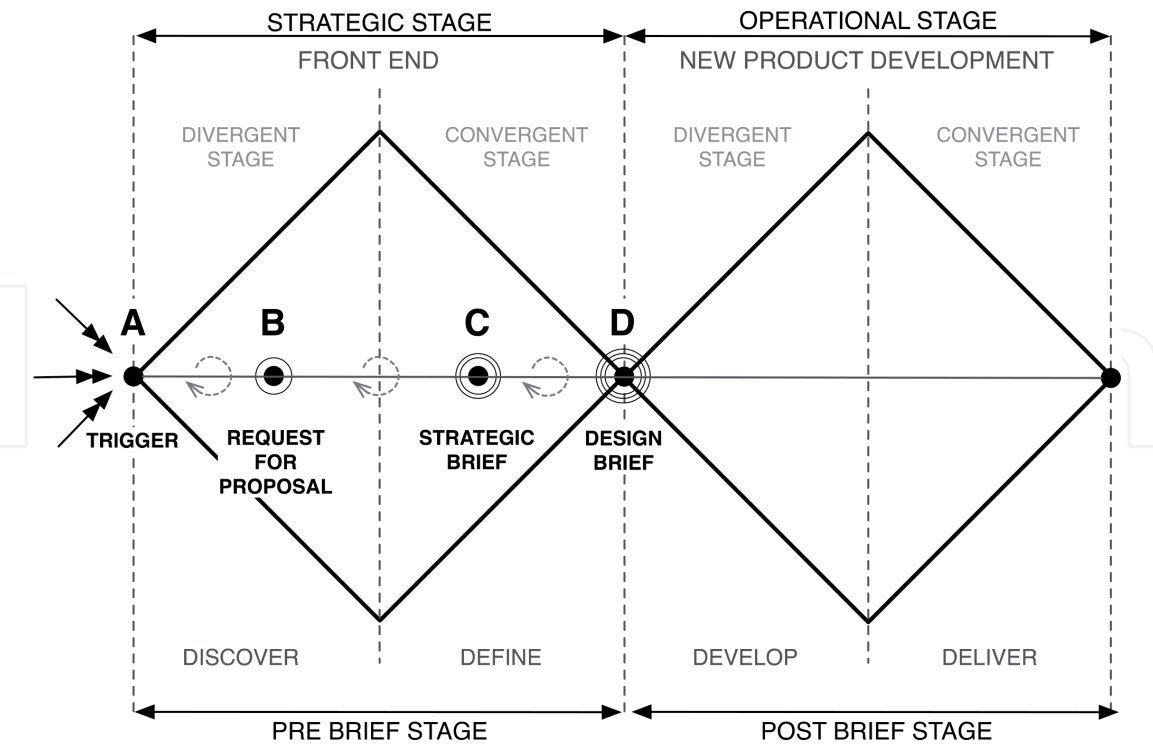


Figure 6.
The design briefing process integrated into the double diamond design process model [32].

5.2.2 Crucial factors for integrating sustainability in the design brief

All participants agreed on three crucial factors for integrating sustainability in the design brief. Firstly, the integration of sustainability in the FE and the design brief largely depends on who is involved in the design briefing process and who is making the decisions in the FE. People are dominant factors; they make decisions, not tools or methods. They determine what will be written down in the design brief and will set, whether or not, the environmental sustainability goals.

A second crucial factor is the commitment of the CEO and the management team. A sustainable product has to be embedded in a strategic sustainable framework, set up in the FE and translated in a design brief. These decisions cannot be taken down the chain; bottom-up does not work on innovation process level for sustainable product innovation without an engagement from the management team.

Thirdly, there are basically two reasons why the decision makers integrate environmental sustainability in the design brief; either they do it because they see business opportunities (market demand, cost reduction, product differentiation, marketing...) or they do it because it is required (legislation, retailer demands...). These drivers are also mentioned in the ecodesign literature [30]. The decision makers need to have a clear view on the business opportunities, needs, risks, and costs of sustainable product innovation in the FE. As long as these topics are not obvious, it will be difficult to convince the stakeholders, and to adapt it in the design brief. Cynically, due to the characteristics of the FE phase as explained in 2.1, it is a very tough exercise, as one has to make decisions in uncertain conditions.

6. Conclusions

This book chapter aims to contribute to the FE of eco-innovation literature. The main research question was whether companies mention certain ecodesign principles

as distinguished in the Ecodesign Strategy Wheel [30] in the design brief, and whether the design brief process or the existence of specific elements in this process can explain this. The study is based on a content analysis of 80 design briefs from Belgian SMEs and large enterprises, a focus group with representatives from 14 Belgian companies and a double semi-structured in-depth interview with two Belgian CEOs.

This study has shown a remarkable difference between large enterprises, SMEs and companies categorized as “other” (knowledge institutions, government, universities, or associations of (industry-specific) institutions) in uptake of environmental considerations in Belgian design briefs. SMEs scored poorly in this study: in 57% of all the SME design briefs, there was no ecodesign component found.

Large enterprises exceeded the SMEs on all the product levels. A possible explanation for this can be found in the literature. Bocken et al. [18] pointed out that eco-innovation in the FE can be more easily mastered in big, resourceful companies. On the other hand, larger companies may have difficulties in allowing the eco-innovation process to be open, informal, and creative, aspects which contributed positively to the success of novel eco-innovations [18]. According to van Hemel et al. [30], larger companies are subject to more and stronger stimuli to take their responsibility towards green products than SMEs. They receive more media attention and are more vulnerable for criticism of external stakeholders.

Integration of ecodesign in the design brief was most frequently found on product system level. The most popular sub-strategy was “reliability and durability”, followed by modular product structure and lower energy consumption. Sub-strategy dematerialization was not found once. The least found sub-strategies were less production waste, saver incineration, lower/cleaner energy consumption of production techniques, fewer/cleaner production consumables, and less/cleaner reusable packing and energy-efficient logistics. This confirms the findings of [28] as the result an explorative study on in-depth interviews with five major Dutch design agencies on how design agencies deal with sustainability issues in the FE; sustainability often appears to be dealt with on a decomposed level, with a focus on, that is, material reduction, or energy efficiency, and not on the holistic concept of sustainability.

Some Lifecycle Design Strategies can be categorized as “hidden sustainability”, for instance reliability, durability, modular product structure, easier maintenance and repair... In some cases, where no explicit request for ecodesign was made in the design brief, still many Lifecycle Design Strategies were found. Often cost optimization, risk management, safety management, distribution planning, product warranty... were the driver, with a more sustainable project as a “side effect”. This also proves the findings of Storacker [28]; agencies try to make sustainable “wise choices” in design, even if this is not something they necessarily showcase to either the customer or the client.

Quantitative environmental targets were absent in all the design briefs. This can be related to the open nature of the design briefs and the high innovation level for the products in this study. Defining quantitative environmental targets in the FE appears to be very difficult for innovation projects where the product parameters are still flexible and the outcome is not well defined.

Another outcome of this study has shown that the design briefing process is not a single activity, but a multi-step process with different actors and decision makers, where different documents, such as the “request for proposal”, the “strategic brief”, and the real “design brief”, jump back and forward between different people and departments in the company. A generic model for the design briefing process (**Figure 6**) was obtained.

The different stages in the design briefing process show different entry points for sustainability; the earlier in the process, the more effective. As product

parameters are then still flexible, there is more room for environmental improvement. Having a good view on the decision-making process and who is making the decisions is crucial for integrating sustainability in the FE. They determine what will be written down in the design brief, and what the external/internal team will do in the operational stage of the innovation process. This study has also shown the crucial role of the CEO and the management team in the uptake of environmental sustainability design brief. Without their engagement, nothing sustainable will happen in the design brief. A sustainable product has to be embedded in a strategic sustainable framework, set up in the FE and has to be translated in a design brief. These decisions cannot be taken down the chain. Similar findings are found in the literature [17, 29, 33].

The decision makers need to have a good understanding of the business opportunities, needs, risks, and costs of sustainable product innovation in the FE. Pushing this information upstream in the briefing process can result in a higher success rate on integrating sustainability into the design brief. As long as these topics are not obvious, it will be difficult to convince the stakeholders, and to include it in the design brief. It sounds obvious, but in daily practice, it is rarely the case, due to the characteristics of the FE as explained in 2.1. One strategy to deal with this is “front-loading”; an approach that aims to boost development performance by moving the identification and solving of problems to the first stages of a product development process [34].

As earlier research by [17] showed, the sustainability of the final product cannot be deducted from the design brief. However, the integration of ecodesign targets in the design brief is recommended. With little or no ecodesign components specified in the design brief, it is very hard for the external/internal design and engineering team to take environmental considerations into account during the operational stage of the innovation process. As there is no commitment in the design brief towards the sustainability of the final product from the client, no time, budgets and staff will be allocated on this subject.

The explorative nature of the research in this study has a few limitations. The design brief sample is limited to Belgian Companies, as such for the participants in the focus group and the interview, although the provided insights may also be relevant to other countries.

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Appendix

A. Focus group participants

NACE stands for “Nomenclature Generale des Activites Economiques dans l’Union Europeenne” (General Name for Economic Activities in the European Union) and is the European standard for industry classifications.

Company ID	Sector	NACE code	Category	Title
A	Machine Construction	28940	Multinational	Mechanical Project Manager
A	Machine Construction	28940	Multinational	Project Manager Electrical Engineering
B	Distribution	46499	SME	Designer
C	Industrial Automation	71121	Multinational	Business Manager
D	Construction	711	SME	Engineering and Planning
E	Metal Processing	29320	Multinational	Product Group Manager
F	Plastics Industry	20160	SME	Mechanical Engineering
G	Consumer Electronics	26400	Multinational	Chief Technology Officer
H	Plastics Industry	20160	Multinational	Quality Engineer
I	Electronic Components	26110	Multinational	Design Expert
J	Metal Processing	31091	Multinational	Mechanical and industrial engineering (Owner)
K	Furniture	46150	SME	Technical Sales Employee
L	Building Materials	46731	SME	Head of product management
M	Building Materials	2332	SME	Senior Product Manager
N	Industrial Design	741	SME	Designer

B. Interview guide: topic list

Background interviewee

- Job title, job content, seniority, and educational background

Company profile

- Employees on the staff list
- Active in which areas
- Clients
- Product portfolio
- Specialization of the company
- Number of offices and location

FE innovation process

- General description FEI
- FE activities
- Duration of the different phases
- Role of the respondent in the process
- FE tools
- Experiences in frontloading

Design briefing process

- Starting point/ end point/ steps in between
- Filter mechanisms
- Decision-making and responsibility
- Characteristics of the design brief
- Entry points for sustainability

Vision and strategy on design for sustainability

- Ambition
- Implementation approach in the FE
- Internal/external drivers
- Factors of resistance
- Used tools
- Knowledge management

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