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REPORT ON

CHALLENGES AND SOLUTIONS OF
SUSTAINABLE APPAREL PRODUCT
DEVELOPMENT

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Advance in Apparel Manufacturing Technology

Declaration

We are declaring that this is a project thesis report is submitted for fulfillment of the requirement of BSc in Textile Engineering Degree of Sonargaon University (SU). We completed the paper with the help of a knit composite industry. We collected all information, reports from the industry. All information in this paper is genuine & correct. We also declare that neither this report nor any part of this report has been submitted elsewhere for award of any courses.

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ABSTRACT

CHALLENGES AND SOLUTIONS OF SUSTAINABLE APPAREL PRODUCT DEVELOPMENT

This paper reports on a case study of the product development experience of an apparel firm's sustainable sweater program. The three-fold purpose of this study is to document current challenges the firm experienced, discover product development strategies that were implemented in fulfilling its sustainable business goals, and determine the principles guiding the design team and its interaction within the upstream supply chain.

The case company is Eileen Fisher, a brand name international women's fashion apparel firm which is committed to social and environmental initiatives. Data were collected from thirteen in-depth interviews conducted with members of the case company and its vendors. Secondary data analysis from the case company's website and archival records provided supplementary information. The qualitative data were analyzed with the use of NVivo9 software.

The study identified five challenges encountered by the Eileen Fisher design team in developing its organic and fair-trade cotton sweater program which include concerns with perceived value, process timing, quality standards, supplier capacity, and price. Corresponding solutions that were put into place include heightening creativity and innovation, optimizing timing and resources, interfacing hands-on "upstream", managing relationships responsibly and for the long term, and making trade-offs based on cost and values. Furthermore, the study identified five principles which guided the design team

and its interaction within the upstream supply chain for sustainable design practices; they are the prerequisite of a company mandate, match of core values, gathering and diffusion of information, cross-functional organization to support sustainability initiatives, and the significance of the supply chain arrangement. This study hopes to provide guidance for apparel manufacturers and suppliers for surmounting the challenges facing product development of sustainable apparel products.

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CHAPTER 1: INTRODUCTION

1.1 Background

The textile supply chain is of a highly complex nature requiring extensive international supply chain networks that must respond to the frequent changes in product lines and styles (Forman, 2004; Pan, Leung, Moon, & Yeung, 2009). According to Victor Fung of Hong Kong's largest trading company Li & Fung (Magretta, 1998), yarn for fabric is bought in Korea and dyed and woven in Taiwan. Zippers and buttons are procured from Japanese companies in China and sent with fabrics to Thailand to be manufactured into garments among multiple factories. The finished products are shipped to North American retailers to be purchased by consumers. In addition, conventional fiber production, dyeing and processing, garment assembly, transportation, and use and maintenance of the garment create enormous streams of waste (Bhamra, 2007; Chen & Burns, 2006; U.S. Environmental Protection Agency, 1996). Principles of practices in other industries that lead in sustainability, such as architecture and engineering, are being implemented in the textile and apparel industry. As apparel companies undertake the mission of sustainable design, they are focusing on the planning stage of the supply chain, that is, the design phase, because that is where most decisions are made that potentially impact the entire lifecycle of the product (Bhamra & Lofthouse, 2007).

This research focuses on the experience of an apparel firm's sustainable sweater program. The particular purposes of this case study were to document challenges the firm experienced, discover design and product development strategies that were implemented in fulfilling its sustainable design business goals, and determine the principles guiding the design team and its interactions with the upstream supply chain. As such, the following

research inquiries were posed: (1) what are the product development challenges encountered in the creation of a sustainable product line? (2) what solutions were implemented to support sustainability objectives and (3) how were relationships within the case company and its upstream supply chain affected in the process? In support of the stated research inquiries, and to establish a frame of reference, this study also questions how the case company defines sustainability and what its sustainable design objectives are.

1.2 Justification/ Significance of Study

Ample research exists on reducing the environmental impacts of textile and apparel production (Allwood, Laursen, Russell, & Malvido de Rodriguez, 2008; Chen & Burns, 2006; Muthu, Li, Hu, & Mok, 2012; Bevilacqua, Ciarapica, Giacchette, & Marchetti, 2011). In addition, studies on textile and apparel sustainability have been conducted from the point of view of effective supply chain management (Cao, Zhang, To, & Ng, 2008; Chi, 2011; Forman, 2004; Kogg, 2003; Morana & Seuring, 2011). Practices for teaching sustainable apparel design, in the context of university level educational courses, have been reported (Cao, Frey, Farr, & Gam, 2006; Gam & Banning, 2011; HaBrookshire & Norum, 2011). Armstrong and LeHew (2011) reviewed sustainable product design literature in engineering and industrial design fields and compared them to the textile and apparel industry processes. They called for a new paradigm under which the apparel industry operates and putting into use new patterns of practice to position the industry for the future. Niinimaki and Hassi (2011) conducted a qualitative study by surveying consumers' perspectives on their concerns and attitudes about environmental issues in the textile and apparel industry, and how likely they were to engage in the environmentally friendly design strategies that emerged, such as slow fashion,

customized clothing and co-creation, to mention a few. The business report from DEFRA (2011) recapped progress that has been made in improving environmental performance, consumption trends and behavior, education, creating market drivers, supply chain and accountability in the textile and apparel industries in the UK. A case study on Gap, Inc. reported on its sustainable practices achieved through supply chain collaboration and organizational restructuring (Worley, Feyerherm, & Knudsen, 2010).

In addition, studies suggest that sustainably designed soft goods cannot be successfully developed without a better and more comprehensive understanding of the supply chain (DEMOS, 1994; Easton, 2007); however apparel industry studies on integrating sustainability with the product development process and the supply chain are few. Although a model called Cradle to Cradle for Apparel Design (C2CAD) (Gam, Cao, Farr, & Heine, 2008) introduces an apparel design and production process that emphasizes sustainability, it lacks clarity on tools for successful supply chain interactions. Case studies on Patagonia's switch to organic cotton (Chouinard & Brown, 1997) and Nike's sustainable Considered Boot (Jacques, Agnolino, & Guimaraes, 2010; White, Stewart, Howes, & Adams, 2008) have been informative, but by no means exhaustive. Considering this combination of factors, scholarly research on industry practices of sustainable apparel product development is needed to help explicate a comprehensive picture of product development for sustainable apparel design.

This research is of interest not only to apparel manufacturers, designers and product developers, but also to textile suppliers, supply chain managers and consumers. As a result, apparel manufacturers may learn how to structure their organizations for sustainable design and provide designers and product developers tools for successful sustainable outcomes. In addition, textile suppliers and supply chain managers may learn

new ways to optimize interactions with designers to encourage sustainable programs.

Finally, consumers may benefit from higher quality, better value, and more transparent product offerings, while being advocates of intergenerational equity.

1.3 Purpose

This research focuses on the experience of an apparel firm's sustainable sweater program. The particular purposes of this case study were to document challenges the firm experienced, discover design and product development strategies that were implemented in fulfilling its sustainable design business goals, and determine the principles guiding the design team and its interaction with the upstream supply chain. In support of the stated research inquiries, and to establish a frame of reference, this study also questions how the case company defines sustainability and what its sustainable design objectives are.

1.4 Objectives

The following were the objectives of this study:

- O1: To identify the case company's product development challenges that were encountered in creating a sustainable product line.
- O2: To identify and evaluate solutions that assist in realizing sustainability objectives.
- O3: To identify and evaluate interactions within the case company and with its upstream suppliers that support sustainability objectives.

1.5 Research Questions

In support of the stated objectives, the following research questions are proposed:

RQ1: What were the design and product development challenges encountered in the creation of a sustainable product line?

RQ2: What solutions were implemented to support sustainability objectives?

RQ3: How were relationships within the case company and its upstream supply chain affected in the process?

1.6 Limitations

The sources of data collected for this case are limited to one apparel manufacturing company (case company) and some of its suppliers. The case company is located in the New York metropolitan area and its suppliers are worldwide. As such, the case company and its upstream suppliers represent only a small sample of a supply network in the textile and apparel chain, and do not address the many other functions in the supply chain that shape sustainability of a product.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Product Development Considerations

The design stages of the product development process have a direct influence over the final product as this is where the most critical decisions are made, including cost, appearance, materials selection, innovation, performance, sustainability and quality (Bhamra & Lofthouse, 2007). The designer must evaluate the needs of all stakeholders to determine how to proceed with a design concept and make choices according to the risks and benefits (Howarth & Hadfield, 2006). For instance, design choices about cost and aesthetics influence sales while choices about disassembly or re-usability are linked to recovery operations. A product development process integrating sustainability issues requires modifications from traditional practices. The following sub-themes, which have been frequently reported in other industries, are reviewed here as they potentially apply to the apparel product design process.

2.1.1 An organization's values

Effective sustainable product development exists as a result of a firm's strategic commitment and orientation toward sustainability (Rossi, Charon, Wing, & Ewell, 2006). Systems-based thinking is required for implementing a sustainable design process and sustainability must underlie the ethos of the organization before designers can take action (Hong, Kwon, & Roh, 2009). A sustainable design effort that is analytical in defining the problem, innovative in its exploration of potential solutions, and practical in implementing them, is more likely to be successful when it is a result of an organization's strategic green orientation. Research shows that such a strategy is a long-term business

decision and can be an effective response to gain a competitive advantage (Hong et al., 2009).

2.1.2 Integrative product design

A single functional group, such as a design team, is not equipped to successfully identify and launch viable sustainability options on its own (White et al., 2008). Apparel designers cannot be expected to obtain and integrate all necessary information for achieving sustainable solutions since such information is often outside of the designer's realm. For example, if a company decides to make garments using recycled fiber, dye the fabric with benign dyes, manufacture garments in a responsible production facility, and set up a closed loop system in order to reclaim these goods when the customer is finished using them, what is required is the sum total of not only designers' knowledge, but that of other experts in the respective fields. First the team must identify appropriate materials, chemically test dyes to make sure they meet toxicity standards, procure the selected materials, design, develop and prototype the garments, source the factories to make sure they meet standards, ensure their quality, and market them accordingly, and create reverse logistics systems.

Research suggests that sustainable design requires an integrative approach using the expertise of wide variety of organizational actors who cooperate to develop a product with internal alignment between designers, merchandisers, business strategists, production teams, marketing staff, end of life managers, and corporate responsibility managers to align sustainable options with customer value (Hong et al., 2009; White et al., 2008). A philosophy that originated in the engineering field, integrative product design underscores the importance of multidisciplinary teams and cross-functional organizations (Mentzer, et al., 2001; White et al., 2008).

2.1.3 Assessment Tools

Life cycle analysis (LCA) is the method most often used for pinpointing potential improvements in the process by assessing environmental impacts associated with all stages of a product's life (Seuring & Muller, 2008). LCA has been used by apparel and footwear companies such as Patagonia and Nike by assessing the primary materials of their garments by tracking energy consumption, CO₂ emissions, waste generation and water use (Nike, 2010; Patagonia, 2011). Herman Miller and McDonough and Braungart developed a tool, Design for the Environment (DfE), which evaluates how well the product meets the cradle to cradle ideal of being made from 100% biological and/or technical nutrients, and answers question regarding materials content, recyclability, and disassembly (Rossi, et al., 2006). The Eco-Index is another system used by companies to rate products for internal review. The tool's success is based on how much is known about materials' supply chains (Oakes, 2011). A scorecard for determining risks and benefits of all types of products have been created by Howarth & Hadfield (2006) to determine the top ten risks and benefits for the social, environmental, and economic aspects of sustainable development aspect. There is some debate, however, that using a "tool driven" approach such as LCA, as opposed to a "goal driven" approach like the cradle to cradle framework, undermines sustainability because fulfilling the tool loses sight of the goal, or the intended goals may be intentionally hidden. Rossi et al. (2006) purport that LCAs typically don't evaluate the hazards or composition of the chemicals used in the materials; nor do they meet the needs of creating safer products that use materials in a continuous loop. A goal-driven approach, however, keeps the focus on attaining what is desired, rather than on the results the tool can deliver (Rossi, et al., 2006).

2.1.4 Materials

Materials selection is known to determine the metrics of performance for a product, among them environmental impact (Huang, Liu, Zhang, & Sutherland, 2009). For clothing, approximately 80% of its impact is determined at the design stage (European Commission, 2011). Furthermore, defining disposal methods for the end of the product's useful life is crucial at the design stage as it is likely to determine materials usage. (Unruh, 2008; White et al., 2008).

Chen and Burns (2006) have analyzed the life cycle of a full range of textiles for environmental impacts and conclude that virtually all have a negative environmental impact. Product designers are encouraged to practice materials recycling by using recycled components, biodegradability, or re-use of post-consumer products (Unruh, 2008). Young, Jirousek, and Ashdown (2004) have referred to cradle to cradle principles for recycling PCR clothing (made with post-consumer recycled plastic soda bottles) by using it as materials for new clothing manufacture. This is not truly cradle to cradle because it cannot be maintained in an indefinitely closed-loop; the fiber will down-cycle because it is not of virgin quality. Although such a solution is cost effective and reduces environmental harm, it is not fully recyclable, a point the authors do not address.

Multiple authors (McDonough & Braungart, 2002; MacPherson, 2004; Unruh, 2008) purport limiting and simplifying the number and types of materials, which helps cost-effective recycling; screening out toxic and risky materials to use only environmentally compatible dyes and chemicals; up-cycling by using proper quality virgin materials; and procuring organic naturally grown/humanely sheared fibers blended for compost-ability. Case studies describe how carpet and upholstery companies have successfully employed McDonough et al.'s (2003) twelve principles of green engineering

for textile products (Mehalik, 2000; Segars, Bradfield, Wright, & Realff, 2003). Shaw's nylon carpet uses only two pure fibers, enabling easy disassembly of the face fibers from the back fibers. High quality nylon 6 fiber is used on the face, instead of the less expensive nylon 6,6 which cannot be depolymerized effectively for recycling. Shaw developed and substituted polyolefin material for the polyvinylchloride (PVC), traditionally used for the back. Both the nylon and polyolefin continually circulate in closed loop cycle (McDonough et al., 2003). Cao et al. (2006) discuss the industry case studies of these same industrial carpet and upholstery companies in order to develop a teaching course as examples to designers on how to eliminate environmental problems by substituting materials in the development of new apparel products.

In some cases, material substitutions have higher costs than the original toxic material. In the case of the Herman Miller Mirra chair, polyvinyl chloride (PVC) use for the arm rests did not meet cradle to cradle requirements. The recommended substitution was thermoplastic urethane (TPU) however it was more expensive. The management at Herman Miller chose to use the acceptable TPU at a higher cost, and offset that cost by other material and design choices that lowered the total cost of the chair (Rossi, et al., 2006). This supports research that states that optimizing choices of materials and making trade-offs between cost and environmental impact is required for achieving sustainable design (Huang et al., 2009)

Humblet's (2006) case study discusses Patagonia's Common Threads Initiative where customers send back their Capilene® underwear to be recycled in a cradle to cradle closed loop. Research shows that the environmental impact of recycling worn-out Capilene® base layers into one new polyester fiber is significantly lower than making that same fiber from virgin materials and uses less than one fourth less energy. A challenge

of applying cradle to cradle principles to apparel is that clothes are often comprised of variety of materials (linings, shells, buttons, zippers, interfacings), and often the fabrics are made of multiple fibers. This doesn't lend itself to easy disassembly for continuous circulation in closed loop processes, particularly since the nature of fashion goods often runs counter to fabric simplicity, color, and other materials. Furthermore, data on sustainability attributes for particular materials are often proprietary and difficult to obtain when companies want to make makes choices based on environmental or social concerns (Mehalik, 2000; Waage, 2007). This obstacle was overcome in the case of Ciba when they eventually agreed to follow the cradle to cradle protocol and adapt the dyes to meet toxicity standards (Mehalik, 2000; McDonough et al., 2003).

2.1.5 Design Innovation

Using fewer materials to design sustainably can foster creativity and resourcefulness (MacPherson, 2004; Unruh, 2008). Unruh (2008) suggests basing designs on a general purpose platform by leveraging standard materials and cyclic production systems; basically making the most of fewer materials. Trade-offs based on customer value, sustainability metrics, and cost are becoming part of the design process (Waage, 2007; Huang et al., 2009). For example, Ciba Chemical differentiated itself with its dyes that fix easier to fabric while requiring less salt (Reinhardt, 1999).

Designing for disassembly and recyclability are purported to be ways to build in the recovery value at the outset (McDonough & Braungart, 2002; Rossi, et al., 2006; Unruh, 2008). Herman Miller created certain requirements for ease of disassembly such as ability to separate homogenous materials, ability to use common tools to dismantle the product in under 30 seconds by one person, and making sure all materials are identifiable and marked so that disassemblers know how to separate them. It also evaluated the

recyclability of the material content to determine if it is a technical or biological nutrient which can be recycled or composted, if it can be down-cycled and if there is a recycling infrastructure to collect and recycle it, or if there is no recycling potential. This precipitated the innovation of a solution to redesign the spine of the chair so that it would be sustainable. The new spine turned out to be less costly than the original spine, which offset the cost of replacing the PVC armrests with TPU (Rossi, et al., 2006).

Research shows the most significant environmental impacts arise from use and maintenance rather than the manufacture (Bhamra, 2007), so apparel designers and consumers are being challenged to consider garment maintenance. Laundering requirements are dominated by the use of electricity, water, and detergents. Energy use, particularly for cotton products, is highly significant (Allwood, Laursen, Russell, & Malvido de Rodriguez, 2008). Solvents used in traditional dry cleaning methods contain halogenated compounds such as tetrachloroethylene, which have relatively high toxicity and are persistent pollutants when released. Conservative care labeling as well as educating consumers regarding their laundry habits have the power to drastically alter the environmental impact of apparel maintenance (Allwood et al., 2008). In addition, researchers insist that partnerships must emerge between the apparel sector, appliance manufacturers, and detergent manufacturers if the industry is to address the environmental impact of apparel maintenance (Bhamra, 2007).

May-Plumlee & Kenkare (2005) purport virtual design technologies such as product visualization, virtual fit, electronic communication, and networking can potentially reduce waste and maximize design. By working alternately in a 2D textile design environment and a 3D virtual product environment, the designer can create and evaluate textile and product designs without the cumbersome process of sampling and

improving each step along the way. Such technology has the potential of reducing fabric usage while enhancing communication among stakeholders. There is some concern about achieving a seamless interface between technologies, the cost of implementing them, and the fact that users may miss the tactile interaction with the fabrics.

2.2 *Supply Chains*

A supply chain is defined as “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer” (Mentzer, et al., 2001). As apparel companies search for economical, quality materials, they have sought out highly complex networks of suppliers which span globe. Consequently, it is critical for these supply chains to be managed to optimize overall performance. In the effort to produce more sustainable apparel products, sustainability is a concept applied to the management of the supply chain. In addition, relationships among supply chain partners are considered integral to the success of the product (Rossi, et al., 2006). These themes are reviewed as they apply to the concerns of sustainable apparel product development.

2.2.1 *Apparel Supply Chains*

The apparel supply chain is comprised of fiber producers, yarn manufacturers, fabric manufacturers, fabric finishers, apparel product developers, product manufacturers and contractors, and channels of distribution including wholesalers, retailers, and consumers. It also includes the auxiliary services such as design bureaus, sourcing providers, sourcing agents, factors, patternmaking services testing labs, consultants, warehouses, shipping companies, and advertising agencies (Keiser & Garner, 2008, p. 5). Historically, a supply chain operated in a linear fashion with members of the supply chain working somewhat independently. However, over the past three decades of increased

competition, information technology, and global sourcing, members of a supply chain have become interdependent, resulting in an interconnected supply network (Cao, Zhang, To, & Ng, 2008; Keiser & Garner, 2008; Masson, Iosif, MacKerron, & Fernie, 2007).

Cao, et al. (2008) reported that traditionally, the focal company was the brand owner who coordinated the apparel supply chain through a cumbersome transfer of information between different supply chain members. However, more recently there are three other coordination practices. Type I, the vertically integrated type is proprietary ownership of the entire supply chain. It enables smooth information flow and easy integration of R&D, lending itself best to high fashion products and requires an agile supply chain. Type II, the efficiency oriented supply chain, is run by a powerful garment manufacturer and requires collaboration between members of the supply chain to maximize customer value while minimizing waste, otherwise known as *lean* (Lean Enterprise Institute, 2009). Type II coordination is better configured for mass fashion due to the relatively stable nature of that business. Type III, the third party or 3P-hub consists of the powerful trade agency which, not owning any manufacturing facilities, acts as the core textile-apparel supply chain manager. The 3P-hub is agile and lean, and information flows smoothly. Both mass fashion and high fashion lend themselves to this format.

Due to the variety of materials and functions for fulfilling fashion requirements, communication and collaboration between design and its upstream suppliers is crucial to effective supply chain management (Cao et al., 2008). Often each of the materials comes from different countries and or locations resulting in complex supply networks which require high levels of coordination (Forman, 2004). Furthermore, many of the suppliers

that are interacting with each other may not have worked together previously; hence cooperation must be fostered and administered by supply chain managers (Seuring, Goldbach, & Koplin, 2004).

2.2.1 Sustainable supply chain

Whereas supply chains are managed to maximize efficiency, quality, waste reduction, and inventory control; more recently, sustainability initiatives are believed to be another tool to optimize supply chain operations. Sustainable supply chain management is defined as:

The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements. In sustainable supply chains, environmental and social criteria need to be fulfilled by the members to remain within the supply chain, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria (*Seuring & Muller, 2008, p. 1700*).

In building their framework, Seuring & Muller (2008) refer to one supply chain strategy as “supply chain management for sustainable products.” This strategy defines life-cycle based standards for the environmental and social performance of products and helps managers identify opportunities which can be implemented throughout the supply chain. The ultimate aim is to satisfy customers and gain a competitive advantage in the market. Life cycle assessment is the method most often used to identify potential improvements in the process (Seuring & Muller, 2008). Frequently, LCA’s require focal companies to work with suppliers to develop suitable sustainable alternatives, which involves looking at the various stages of the supply chain and exchanging a considerable amount of information (Kogg, 2003). The need for such cooperation among partnering companies seems to be greater in research on sustainable supply chains than on conventional supply chains (Seuring & Muller, 2008).

Literature on sustainable supply chain management tends to focus on environmental rather than social issues, with research purporting that green (environmental) supply chain management can lead to improved economic performance and competitive advantage (Bhamra, 2007; Cheng et al., 2008; Forman, 2004; Rao & Holt, 2005; Unruh, 2008; Varmazis, 2008). In a survey of a variety of Southeast Asian manufacturers of various industries Rao and Holt (2005) found that greening the supply chain has the potential for cost savings in raw materials, water, energy usage, and waste reduction by improving resource utilization. Despite surveys reporting a positive correlation between environmental and economic performance, Seuring and Muller (2008) believe the underlying question of sustainable supply chains fulfilling the triple bottom line (social, economic, environmental) is still a subject for further research.

Corporate social responsibility (CSR) describes the other type of supply chain management strategy which manages for risks and performance (Seuring & Muller, 2008). CSR is the way in which a company's operation practices (policies, processes, and procedures) affect its stakeholders and the natural environment. With the apparel supply chain spanning the globe, focal companies may be held responsible for the environmental and social performance of their suppliers (Seuring & Muller, 2008). This was the case with brand owners Nike, Levi's, Gap, and Adidas, who came under pressure from activists for abusive labor and human rights issues practiced by some of their suppliers (Seuring & Muller, 2008; Waddock & Bodwell, 2004). They subsequently adopted internal corporate responsibility management systems for their supply chains which were meant to ensure company standards of conduct and prevent a repeat of problems that affected their reputations and profits. Furthermore, in the case of Gap, Inc., measures which were taken to manage its supply chain also stimulated the restructuring of its

product development process (BSR, 2008), underscoring the interdependency between supply chains and product development.

2.2.2 Relationships between Focal Company and Supply Chain

Research states that cultivating strong supply chain relationships is important for developing sustainable products (Rossi, et al., 2006). For example, the length and strength of the relationship between a focal company and its suppliers was found to determine the leverage it has (Levenson, 2008). Petersen, Handfield, and Ragatz's (2005) findings on integrating suppliers into new product development support how critical supplier selection is; collaborators' capabilities must be considered, as well as the compatibility of business cultures between the firms. Knowledge sharing was found to enhance competitive advantage; and trust positively impacted knowledge sharing among competitive and co-operative firms in green supply chains (Cheng, Yeh, & Tu, 2008). Furthermore, early supplier involvement enabled knowledge sharing, which is crucial to the development of successful products (Petersen et al., 2005). Research has also stated that supply chain transparency is believed to create an environment that leads to greater accountability (Doorey, 2011). Overcoming the information sharing challenges within the supply chain of replacing toxic materials with the invention of safe ones was reported in various case studies (McDonough, Braungart, Anastos, & Zimmerman, 2003; Rossi, et al., 2006; Segars, Bradfield, Wright, & Realff, 2003). In addition, studies on solving sustainability problems by implementing strategies such as information sharing and integrative product development have also been documented (Kogg, 2003; McDonough et al., 2003; White et al., 2008)

CHAPTER 3: METHOD

This research focuses on the experience of an apparel firm's sustainable sweater program. The goal of this research was to document challenges encountered by the firm in designing a sustainable product line, discover design and product development solutions that were implemented to fulfill its sustainable design business goals, and determine the principles guiding the design team and its interactions with the upstream supply chain. This study also questioned how the case company defines sustainability and what its sustainable design objectives are.

3.1 Research Design

The research design employed a case study approach. Merriam (2009) describes *case study* as an “in depth description and analysis of a bounded system” (p. 40). The bounded system is the case company and its supply chain partners. Yin argues that the case study has a distinct advantage over other research methods such as experiments, surveys or questionnaires, when asking “how” or “why” questions which require in-depth descriptions about a contemporary set of events (Yin R. K., 2008, p. 4). Furthermore, the case study enables data collection from multiple sources of evidence to triangulate the data (Yin R. K., 2008, p. 114)

A qualitative method of inquiry was adopted which derived from a reflective and grounded process of data generation and analysis. Qualitative methods of inquiry focus on process, understanding, and meaning. They deliver, through an inductive process, a richly descriptive product (Merriam, 2009. p.14). Qualitative methodology was appropriate for this case study research since it investigated a case company in a real life

context, for insights, problems, and discovery of solutions in the practice of sustainable design.

3.2 Sample Selection

Pilot interviews took place in 2010; three soft goods manufacturers were purposefully selected based on the researcher's contacts to determine which company was suited for the study and willing to participate. Case company criteria included the development of textiles and apparel through a global supply chain and engaging in sustainable design practices. Exploratory interviews of approximately 45 minutes with key contacts at each company were conducted to test and refine the research instrument. Of the three potential case companies, all met the criteria; however two companies declined participation for the main study. Pilot and main study interviews were conducted by the same interviewer, in order to maintain the validity of data. Prior to each interview, the interviewer informed each participant about the voluntary nature of the study and addressed any questions or concerns the participants from the case company had about study participation. (See appendix A for Human subjects IRB-061-12H exemption).

Participating individuals for the main study were recruited through purposeful sampling methods, within the case company and among two of the case company's suppliers. A cross-section of employees who engage in the sustainable design and product development process from a variety of departments were identified through collaboration between the researcher and the case company's key contact. Fourteen potential participants who met the criteria were invited for interviews with the researcher, of which thirteen agreed.

3.3 *Data Collection*

Each interview took 30-60 minutes. The interviews were performed by telephone to accommodate the interviewee's schedules, with the exception of one which was performed in person, by request, during the researcher's visit to the case company. Each interview consisted of a set of twenty-five questions which varied somewhat according to the job function of the interviewee. All questions were purposefully composed to guide the conversation and allow for follow-up, if necessary. The researcher made a field visit to the case company where she gathered background information about the company, met the key contact and the participants, and conducted one interview in person. The researcher collected data in the form of notes, photographs, and direct observations of the case company headquarters, its separate sales showroom, and several of its retail stores. Third party archival documents about the case company and its suppliers were also used as information sources.

The following protocol was followed to insure validity: (1) interviews were audio-taped with the participant's permission and transcribed verbatim, (2) verbatim transcriptions of interviews were entered into NVivo program as individual files, (3) transcriptions were coded through the use of "nodes" reflecting thematic content, (4) nodes reflected questions asked, as well as new themes that emerged from the data, (5) nodes were organized according to research question, (6) an iterative approach was taken of coding and recoding, for the sake of accuracy, (7) memos were taken and relationships and patterns were noted, (8) summaries, memos, examples, charts, diagrams were recorded for evidence.

3.4 Data Analysis and Validation

Data were coded and manipulated using the NVivo 9 software program, in order to find both pre-determined and new themes related to each research question. A process of constant comparison was used to refine themes, discover relationships and identify broad patterns presented in the research findings (Glaser and Strauss, 1967). Validity and reliability of the research findings were supported through various practices as recommended by standard case study methodology (Yin, 2003). Construct validity was demonstrated through (1) the convergence of patterns from multiple sources of data to provide triangulation, (2) the chain of evidence from questions to results, (3) the key contact's confirmation of the initial report, and (4) the participants' review of results of the study (there were no concerns or comments). The research case consistently adhered to the protocol created for the study, and all data were maintained in a research database, thus supporting the procedural repeatability (i.e. reliability) of the study.

3.5 Implications

The goal of this research was to document sustainable practices of an apparel firm, discover design and product development strategies that the firm implemented, and determine principles guiding the design team and its interaction with the upstream supply chain. The implication is that this study will be used to guide industry and researchers in advancing sustainable product development solutions in the apparel industry and enable more textile and apparel companies and their suppliers to undertake sustainable practices.

CHAPTER 4: MANUSCRIPT

ABSTRACT

The three-fold purpose of this study is to document current challenges the apparel industry experiences in developing sustainable apparel, discover product development strategies for fulfilling sustainable business goals, and determine the principles guiding the design team and its interactions with the upstream supply chain. This study adopted the case study format, with a particular aim to identify and communicate practical challenges and solutions of an apparel manufacturer. Data were collected from thirteen in-depth interviews conducted with members of the case company and its vendors, and secondary data analysis from the case company's website and archival records provided supplementary information. The qualitative data were analyzed using NVivo9. The study identified five challenges encountered by the case company; five solutions the company put into place; and four principles practiced by the case company which guided the design team and its interaction with upstream suppliers. This study hopes to provide guidance for apparel manufacturers and suppliers for surmounting the challenges facing product development of sustainable apparel products.

INTRODUCTION

The textile supply chain is of a highly complex nature requiring extensive international supply chain networks that must respond to the frequent changes in product lines and styles (Forman, 2004; Pan, Leung, Moon, & Yeung, 2009). In addition, conventional fiber production, dyeing and processing, garment assembly, transportation, and use and maintenance of the garment create enormous streams of waste (Bhamra,

2007; Chen & Burns, 2006; U.S. Environmental Protection Agency, 1996). As apparel companies undertake the mission of sustainable design, they are focusing on the planning stage of the supply chain, that is, the design phase, because that is where most decisions are made that potentially impact the entire lifecycle of the product (Bhamra & Lofthouse, 2007).

This research focuses on the experience of an apparel firm's sustainable product development program. The particular purposes of this case study were to document challenges the firm experienced, discover design and product development strategies that were implemented in fulfilling its sustainable design business goals, and determine the principles guiding the design team and its interactions with the upstream supply chain. As such, the following research inquiries were posed: (1) what are the design and product development challenges encountered in the creation of a sustainable product line? (2) what solutions were implemented to support sustainability objectives? and (3) how were relationships within and between the case company and its upstream supply chain affected in the process? In support of the stated research inquiries, and to establish a frame of reference, this study also questions how the case company defines sustainability and what its sustainable design objectives are.

JUSTIFICATION/SIGNIFICANCE OF STUDY

Ample research exists on reducing the environmental impacts of textile and apparel production (Allwood, Laursen, Russell, & Malvido de Rodriguez, 2008; Chen & Burns, 2006; Muthu, Li, Hu, & Mok, 2012; Bevilacqua, Ciarapica, Giacchette, & Marchetti, 2011). In addition, studies on textile and apparel sustainability have been conducted from the point of view of effective supply chain management (Cao, Zhang, To,

& Ng, 2008; Chi, 2011; Forman, 2004; Kogg, 2003; Morana & Seuring, 2011). Practices for teaching sustainable apparel design, in the context of higher education, have been reported (Cao, Frey, Farr, & Gam, 2006; Gam & Banning, 2011; Ha-Brookshire & Norum, 2011). Armstrong and LeHew (2011) reviewed sustainable product design literature in engineering and industrial design fields and compared them to the textile and apparel industry processes. They called for a new paradigm under which the apparel industry operates and putting into use new patterns of practice to position the industry for the future. Niinimaki and Hassi (2011) conducted a qualitative study by surveying consumers' perspectives on their concerns and attitudes about environmental issues in the textile and apparel industry, and how likely they were to engage in the environmentally friendly design strategies that emerged, such as slow fashion, customized clothing and co-creation, to mention a few. The business report from DEFRA (2011) recapped progress that has been made in improving environmental performance, consumption trends and behavior, education, creating market drivers, supply chain and accountability in the textile and apparel industries in the UK. A case study on Gap, Inc. reported on its sustainable practices achieved through supply chain collaboration and organizational restructuring (Worley, Feyerherm, & Knudsen, 2010).

In addition, studies suggest that sustainably designed soft goods cannot be successfully developed without a better and more comprehensive understanding of the supply chain (DEMOS, 1994; Easton, 2007); however apparel industry studies on integrating sustainability with the product development process and the supply chain are few. Although a model called Cradle to Cradle for Apparel Design (C2CAD) (Gam, Cao, Farr, & Heine, 2008) introduces an apparel design and production process that

emphasizes sustainability, it lacks clarity on tools for successful supply chain interactions. Case studies on Patagonia's switch to organic cotton (Chouinard & Brown, 1997) and Nike's sustainable *Considered Boot* (Jacques, Agnolino, & Guimaraes, 2010; White, Stewart, Howes, & Adams, 2008) have been informative, but by no means exhaustive. Considering this combination of factors, scholarly research on industry practices of sustainable apparel product development is needed to help explicate a comprehensive picture of product development for sustainable apparel design.

LITERATURE REVIEW

Product Development Considerations

The design stages of the product development process have a direct influence over the final product as this is where the most critical decisions are made, including cost, appearance, materials selection, innovation, performance, sustainability and quality (Bhamra & Lofthouse, 2007). The designer must evaluate the needs of all stakeholders to determine how to proceed with a design concept and make choices according to the risks and benefits (Howarth & Hadfield, 2006). For instance, design choices about cost and aesthetics influence sales while choices about disassembly or re-usability are linked to recovery operations. A product development process integrating sustainability issues requires modifications from traditional practices. The following sub-themes, which have been frequently reported in other industries, are reviewed here as they potentially apply to the apparel product design process.

An organization's values. Effective sustainable product development exists as a result of a firm's strategic commitment and orientation toward sustainability (Rossi, et al., 2006). Systems-based thinking is required for implementing a sustainable design process

and sustainability must underlie the ethos of the organization before designers can take action (Hong, Kwon, & Roh, 2009).

Integrative product design. A single functional group, such as a design team, is not equipped to successfully identify and launch viable sustainability options on its own (White et al., 2008). Research suggests that sustainable design requires an integrative approach using the expertise of wide variety of organizational actors who cooperate to develop a product with internal alignment between designers, merchandisers, business strategists, production teams, marketing staff, end of life managers, and corporate responsibility managers to align sustainable options with customer value (Hong et al., 2009; White et al., 2008). A philosophy that originated in the engineering field, integrative product design underscores the importance of multidisciplinary teams and cross-functional organizations (Mentzer, et al., 2001; White et al., 2008).

Assessment tools. Life cycle analysis (LCA) is the method most often used for pinpointing potential improvements in the process by assessing environmental impacts associated with all stages of a product's life (Seuring & Muller, 2008). LCA has been used by apparel and footwear companies such as Patagonia and Nike by assessing the primary materials of their garments by tracking energy consumption, CO₂ emissions, waste generation and water use (Nike, 2010; Patagonia, 2011). Herman Miller and McDonough and Braungart developed a tool, Design for the Environment (DfE), which evaluates how well the product meets the cradle to cradle ideal of being made from 100% biological and/or technical nutrients, and answers question regarding materials content, recyclability, and disassembly (Rossi, et al., 2006). The Eco-Index is another system used by companies to rate products for internal review. The tool's success is based on how much is known about materials' supply chains (Oakes, 2011).

Materials. Materials determine the environmental impact of a product (Huang, Liu, Zhang, & Sutherland, 2009). For clothing, approximately 80% of its impact is determined at the design stage (European Commission, 2011). Chen and Burns (2006) analyzed the life cycle of a full range of textiles for environmental impacts and concluded that virtually all have a negative environmental impact. Researchers purport limiting and simplifying the number and types of materials for more sustainable design (MacPherson, 2004; McDonough & Braungart, 2002; Unruh, 2008).

Design innovation. Using fewer materials to design sustainably can foster creativity and resourcefulness (MacPherson, 2004; Unruh, 2008). Making trade-offs for sustainability based on customer value, sustainability metrics, and cost, become part of the design process (Huang et al., 2009; Waage, 2007). Designing for disassembly and recyclability builds in recovery value at the outset (McDonough & Braungart, 2002; Rossi, et al., 2006; Unruh, 2008). Considering garment and textile care during the design process can drastically alter the environmental impact of apparel maintenance (Allwood et al., 2008), since the most significant environmental impacts arise from use and maintenance rather than the manufacture (Bhamra, 2007).

Relationships with the supply chain. Research states that cultivating strong supply chain relationships is important for developing sustainable products (Rossi, et al., 2006). For example, the length and strength of the relationship between a focal company and its suppliers was found to determine the leverage it has (Levenson, 2008). Petersen, Handfield, and Ragatz's (2005) findings on integrating suppliers into new product development support how critical supplier selection is; collaborators' capabilities must be considered, as well as the compatibility of business cultures between the firms.

Knowledge sharing was found to enhance competitive advantage; and trust positively impacted knowledge sharing among competitive and co-operative firms in green supply chains (Cheng, Yeh, & Tu, 2008). Furthermore, early supplier involvement enabled knowledge sharing, which is crucial to the development of successful products (Petersen et al., 2005). Research has also stated that supply chain transparency is believed to create an environment that leads to greater accountability (Doorey, 2011).

Overcoming the information sharing challenges within the supply chain of replacing toxic materials with the invention of safe ones was reported in various case studies (McDonough, Braungart, Anastos, & Zimmerman, 2003; Rossi, et al., 2006; Segars, Bradfield, Wright, & Realff, 2003). In addition, studies on solving sustainability problems by implementing strategies such as information sharing and integrative product development have also been documented (Kogg, 2003; McDonough et al., 2003; White et al., 2008).

Product development research on successful process, organizational, and technical practices from various industries was reviewed. Of particular interest of this literature review were the considerations of an organization's values, integrative product design, assessments, material choices, innovation, and supply chain relationships. Research and reports from other industries were included to give a context for, and help understand, the concerns apparel product developers face.

METHOD

The purpose of this study was to gain an in-depth understanding of a case company's sustainable apparel product development practices. Therefore a case-study approach was adopted, enabling data collection from multiple sources of evidence to triangulate the data and because such a situation is not easily investigated using other

techniques such as experiments or surveys (Yin R. K., 2008). A qualitative method of inquiry was followed which derived from a reflective and grounded process of data generation and analysis. Rich descriptions answering “How?” or “Why?” questions about a contemporary set of events (Merriam, 2009; Yin R. K., 2008) were drawn from thirteen participants; they included eleven employees of the case company and two members of two different supply chain partners. A pilot interview was deemed appropriate to select a company whose approach to sustainability came from the product development perspective.

SAMPLE SELECTION AND INSTRUMENT DEVELOPMENT

Pilot interviews took place in 2010; three soft goods manufacturers which had been known for their sustainability practices were selected to determine which company was suited for the study and willing to participate. Case company criteria included the development of textiles and apparel through a global supply chain and engaging in sustainable product development practices. Exploratory interviews of approximately 45 minutes with key contacts at each company were conducted to test and refine the research instrument. Of the three potential case companies, all met the criteria; however two companies declined participation for the main study. Pilot and main study interviews were conducted by the same interviewer, in order to maintain the validity of data. Prior to each interview, the interviewer informed each participant about the voluntary nature of the study and addressed any questions or concerns the participants from the case company had about study participation (IRB-061-12H).

Participating individuals for the main study, conducted in 2011, were recruited through purposeful sampling methods within the case company and among two of the

case company's suppliers. A cross-section of employees who engage in the sustainable design and product development process were identified through collaboration between the researcher and the case company's key contact. Fourteen potential participants who met the criteria were invited for interviews with the researcher, of which thirteen agreed. Each interview took 30-60 minutes, and the interviews were performed by telephone to accommodate the interviewee's schedules, with the exception of one which was performed in person, by request, during the researcher's visit to the case company. Each interview consisted of a set of twenty-five questions which varied somewhat according to the job function of the interviewee. All questions were purposefully composed to guide the conversation and allow for follow-up, if necessary. The researcher made a field visit to the case company where she gathered background information about the company, met the key contact and the participants, and conducted one interview in person. The researcher collected data in the form of notes, photographs, and direct observations of the case company headquarters, its separate sales showroom, and several of its retail stores. Third party archival documents about the case company and its suppliers were also used as information sources.

The following protocol was followed to insure validity: (1) interviews were audio-taped with the participant's permission and transcribed verbatim, (2) verbatim transcriptions of interviews were entered into NVivo program as individual files, (3) transcriptions were coded through the use of "nodes" reflecting thematic content, (4) nodes reflected questions asked, as well as new themes that emerged from the data, (5) nodes were organized according to research question, (6) an iterative approach was taken of coding and recoding, for the sake of accuracy, (7) memos were taken

and relationships and patterns were noted, (8) summaries, memos, examples, charts, diagrams were recorded for evidence.

DATA ANALYSIS AND VALIDATION

Data were coded and manipulated using the NVivo 9 software program, in order to find themes and sub-themes related to each research question. A process of constant comparison was used to refine themes, discover relationships and identify broad patterns (Glaser and Strauss, 1967). Validity and reliability of the research findings were supported through various practices as recommended by standard case study methodology (Yin, 2003). Construct validity was demonstrated through (1) the convergence of patterns from multiple sources of data to provide triangulation, (2) the chain of evidence from questions to results, (3) the key contact's confirmation of the initial report, and (4) the participants' review of results of the study (there were no concerns or comments). The researcher consistently adhered to the protocol created for the study, and all data were maintained in a research database, thus supporting the procedural repeatability (i.e. reliability) of the study.

PROFILE AND HISTORY OF THE COMPANY

The case company of this study is a brand name women's fashion apparel firm named Eileen Fisher (EF). Founded in 1984, EF supplies women's fashion apparel to department stores, specialty stores, and its own free-standing stores throughout the US and around the world. The privately held company is headquartered in New York, employs 875 people, and as of 2010, reported sales of \$300 million (Welch, 2010). As explained by its website and interviewees, EF maintains a commitment to being socially conscious and engages in initiatives and grant programs focused on individual

wellbeing, human rights in the workplace, environmental stewardship, support of women and girls, and partnerships with the community.

As early as the 1990's, following the sweatshop scandals that revealed Kathy Lee Gifford and Nike apparel goods were made under poor and exploitative working conditions, EF made a commitment to improve the human rights conditions of its upstream supply chain partners. The company began to require all factories which produced its clothing to apply the SA8000 comprehensive workplace standard to their facilities. Subsequently, around 2006, the company made an equal commitment to environmental sustainability which was initiated through a groundswell of interest in environmental stewardship by EF's employees, as well as by the strong personal commitment of the company's owner. EF's mission statement was updated to reflect the new strategy and a formal environmental initiative was launched which coincided with inception of the Peru Project, a sustainable initiative and focus of this study.

The product line of EF's Peru Project is comprised of fully fashioned knit sweaters. The sweaters are made of 100% long staple organic cotton which is grown, spun, and knit in Peru by suppliers that work within a fair trade model. Fair trade enables workers to receive a living wage, promotes social investments in the workers' communities by the employers, and ensures the work environment to be safe and healthy (Kocken, 2006). EF's environmental sustainability leader described the Peru Project as "a nice marriage between the two [environmental and social components]; it is a local supply chain totally, from fiber all the way to the finished garment, and [the product] is organic and it's dyed in a responsible way." In order to keep the participants anonymous in this paper, the names of individuals and suppliers were arbitrarily renamed by the researcher. See Table 1 for a summary of participants and demographics.

Table 1.
Participants' Job Titles and Corresponding Demographics

<i>JOB TITLE</i>	<i>YEARS AT COMPANY</i>	<i>YEARS ENGAGED IN SUSTAINABILITY</i>
Sustainability Director	5	10
Fabric Developer	n/a	n/a
Account Manager	4	n/a
Vendor /Agent	18	4
VP Manufacturing	19	17
Director Social Consciousness	18	14
VP Product Development	9	6
Design Process Facilitator	6	3
Designer	18	12
Designer	3 ½	3 ½
Recycle Operation Manager	n/a	n/a
Vendor / Agent	15	15
Retail Director	10	3

The Peru Project was the result of EF’s decision to engage with a contractor called Design Inheritance (DI), a socially responsible small business which specializes in apparel made from environmentally friendly fibers and dyes, and provides sustainable work to artisan cooperatives at fair trade wages. Design Inheritance contracts work to Peru Plan (PP), a Peruvian apparel cooperative which provides training and work to women who make environmentally friendly products and use natural Peruvian fibers such as long staple cotton, merino wool, silk, and alpaca. Peru Plan workers knit products at home-based facilities in remote areas, as well as in a central manufacturing facility. EF’s desire to use sumptuous yarns that are environmentally friendly accorded with the organic cotton yarns of Peru known for their high quality. In addition, its social-minded tradition of empowering women fit with the work model of the suppliers in the chain. EF,

therefore, saw that making sweaters that were sustainably designed and produced within the Peruvian supply chain was an opportunity to differentiate its product and tell a compelling supply chain story that reflected the company's own mission.

With all parties on board to fulfill EF's strategic initiative for a sustainably designed sweater program, what followed was a series of challenges for the design department. The cottage industry sweaters from Peru had to blend in with the rest of the company's high quality products that were being made in China. Although the sustainable aspect of the product was important, first and foremost, the product had to stand on its own aesthetic merits. As Lauren explained, "Our customer responds to beautiful product. If it's sustainable, that's a bonus." This case study explains how EF succeeded in overcoming challenges with its product and processes through the efforts of the company's design and product development departments as well as with its upstream supply chain partners.

RESEARCH FINDINGS

Definition and Objectives of Sustainability at Eileen Fisher

To provide a context for the EF's sustainable design initiatives, it was necessary to understand how the concept of sustainability was understood by all participants. The data revealed that the term sustainability was used to describe the environmental part the company plays in its larger role of social responsibility. Participants noted that environmental issues are linked to social and economic ones and they all come under the umbrella of social consciousness. EF has a longer history in human rights practices than it does in environmental ones; however both were considered crucial to its role of being socially responsible. When asked how they compare, Debra conveyed:

I would say frankly that our human resource aspect is much more [longstanding]...because we've been involved with human rights and human ecology...for many more years... It's been since the early 90's that we've been auditing our suppliers for human rights and social conditions. And the ecologic, frankly it's been about half that time; we started really seriously to study it just since the early 2000's. (Debra)

Nevertheless, about half of the respondents described the term sustainability as a combination of social, economic, and environmental dimensions to maintain social wellbeing, but asserted that its basis was in environmental stewardship. Alicia summarized:

Do we talk about the sustainability of workers or cultures or other issues? Yes... There are a lot of interconnected pieces like any food web... I think in general, in the company, we see sustainability defined in many ways, but to the outside world, it's an environmental issue. (Alicia)

Sustainability was also discussed as mostly an ecological issue to be addressed from the standpoint of materials and their environmental impact. EF's position on sustainable versus conventional materials was to take strategic incremental steps towards reducing harm to the environment. EF made the decision to use organic cotton even if other environmental practices were not being observed:

At this stage our position is really to support the use of organic cotton, even if it doesn't have certification at the final level, but if it is using certified organic yarn, because for us, the goal is to ultimately sustain this demand for cotton. Many times the mills would say, 'What if it isn't dyed in a certain way that satisfies the GOTS [Global Organic Textile Standard] certification?' Well, we say that's still of interest to us because it still does use organic cotton which is organic fiber and supports farmers throughout the world and supports the agriculture without certain toxic inputs. (Beverly)

The importance of tracing the upstream supply chain and developing relationships with its members was underscored when sustainability is an objective.

We are looking a little deeper into in the supply chain trying to understand more, and streamline and be able to control it more, so we can be more directive to the vendors- you know, use this dye source, use this fiber source. It's kind of like the more you

develop these relationships, the stronger your argument [for sustainability] becomes, because there is more of a partnership. (Beverly) Participants' understanding of sustainable design included closing the loop in the supply chain, with an acceptance of it not yet being entirely realistic for EF:

My personal vision is that one day we will be able to take any garment that we make, throw it in the river and it becomes fish food, and make the river healthier. Obviously, not in my lifetime. It would be great but I don't see us moving in that direction. Part of the problem is that we built our brand recognition reputation on the comfort of organic cotton, but there is still 10% Lycra to give it the stretch that mature women need. So, having said that, the closest we are getting right now is thinking about the end use of the product in terms of recycling. We have not been able to move to breaking the fabrics down because even if it's not done with Lycra, it's often a blend. (Joy)

The company vision for environmental sustainability is depicted in Figure 1, the Vision Tree (Eileen Fisher, 2012). As explained by the sustainability director, it addresses the three ideas called *Design*, *Connect* and *Imagine* and illustrates each idea with correlating actions. Under the category of a *Design*, the EF designer, as stakeholder, has influence in shaping the product so there is a responsibility for determining and developing the most eco-responsible product she can. The category of *Connect* is about people (consumers) and the social issues that may lead to changing their habits into more eco-friendly ones; it is about EF engaging people to become equal stakeholders in the eco process. The category *Imagine* is about EF being inspirational; it is the creative force that enables problem solving. Ideas such as reducing fabric scraps, re-use, recycling by having customers bring in their old EF garments to be resold, activism, political involvement, etc. are all ways EF attempts to inspire progress in sustainability. The data describe EF's goal of environmental sustainability as a balance of these factors. The sustainability director described it as a dynamic process, "I never see sustainability as a destination- it's a journey of continuous improvement." The owner of DI accorded that

he sees sustainability on a continuum of “moving the needle” towards the final destination. He said “It’s an approach rather than just a word.”

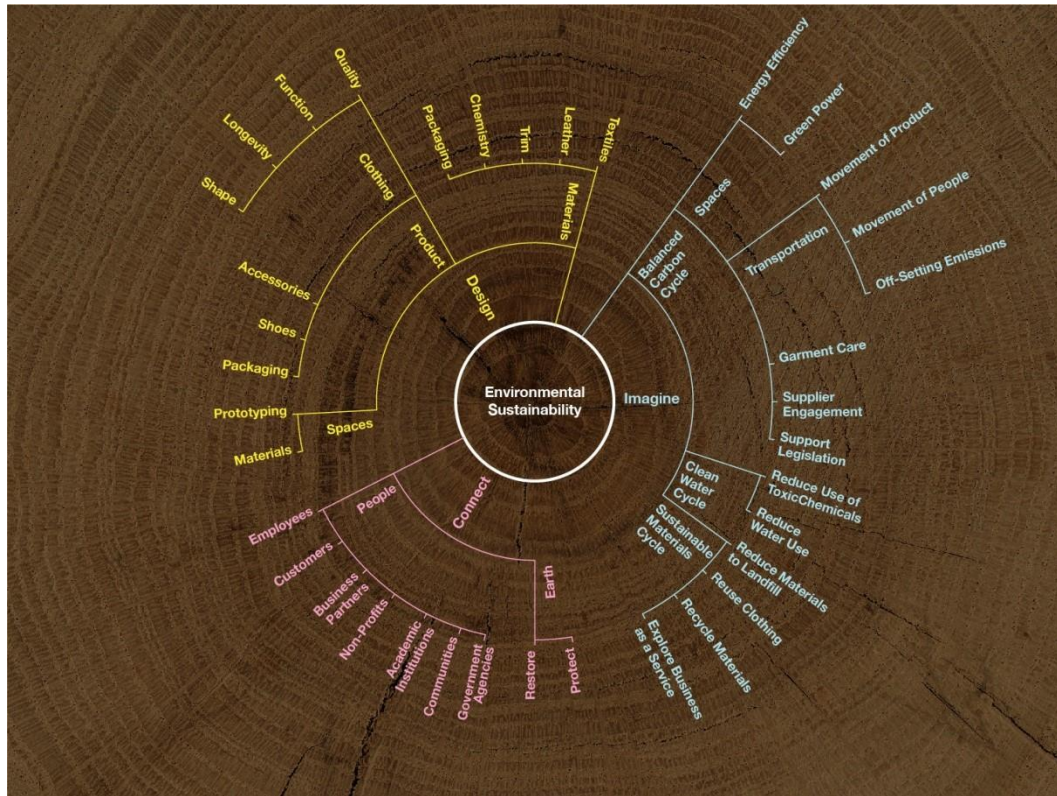


Figure 1. Vision Tree for Environmental Sustainability (reprinted with permission from Eileen Fisher)

Consistent with the company vision, EF’s workplace environment was designed to be a reflection of its purpose and practices. The headquarters and showroom facilities in New York utilized sustainable materials and energy-efficient systems to be socially responsible. The spaces incorporated open floor layouts to foster collaboration and creative teamwork; skylights, which endowed the spaces with copious amounts of natural light to provide an uplifting atmosphere; and a designated room for yoga & massages, to encourage the individual well-being of employees.

To determine the company’s sustainability objectives, EF leaders worked with consultants on lifecycle assessments. LCA’s enabled them to understand the

environmental impacts of EF's products including energy use, greenhouse gas emissions, water use, land use, waste, toxicity to humans and ecosystems, useful life of the product, and final disposal. Aware of the strain conventional apparel production and use put on the environment, but working within the realities of the fashion business, EF's practical strategy developed.

So at one point I was in a meeting and one of the leaders said, 'Well what is the best fiber to use?' Well, in the end, it really doesn't end up mattering too much because when you're in this world of clothing, you're going to use wool for one thing, cotton for another, thing. You're going to use nylon for another thing. So within that fiber or classification, how can you make it as green as possible? So that's kind of what we look at, is how to use the most sustainable supply chain or, 'what do we have to work out in that supply chain to make it the best,' and prioritize that. ..It's a continual journey or trying to tweak those most important elements. (Alicia)

As communicated on the products' hangtags EF's goal is for 20% of the product line to have ecologically sustainable components. The Peru Project fit the company's environmental and social objectives with its use of certified organic cotton and fair trade. Judy said, "We made a commitment to a sustainable product... We moved it through a period of it not really being what we consider a very Eileen Fisher product aesthetically; but we tried to hold on to it and grow it because of the political and social reasons, rather than strictly aesthetic reasons, and we are feeling some success now."

Identified Challenges for Sustainable Apparel Product Development

Interview questions (Appendix D) elicited stories and examples from the various participants' points of view. They described their experiences with the Peru sweater program including the successes, failures, and obstacles encountered. Participants were forthcoming about the products' demerits and assets based on EF's required disciplined scheduling, uncompromising standards, stakeholder responsibility, and business acumen.

Sweaters lacked perceived value. Maintaining DI's local Peruvian supply chain while creating an aesthetically beautiful and saleable product presented challenges to EF's design team. There were limitations to the available yarn choices in Peru. The ability to spin the yarn in Peru was not as sophisticated as in Italy where EF purchased yarns and then sent to be knit in Chinese factories. Bonnie, a member of the sales team, described the product at the beginning of the Peru Project as "very heavy and basic, and didn't have perceived value." Debra accorded, "It has taken us a while to get the product itself to where sales wants to leap in and buy it. The organic cotton, the styling, and usage [are] fairly minimal. It's not a sophisticated yarn." Miriam described the challenge of working with cotton yarn, "Cotton yarn has limitations; cotton doesn't have the hairy loft or [luxuriousness] that a mohair or alpaca does, so in that way it's sort of a design challenge to create product that is as compelling as a material that has more interest built in." A further limitation revolved around the capabilities of the machinery used by the Peruvian knitters. Judy described them as "somewhat rustic and not refined enough" compared to the capabilities of sophisticated knitting machines used in Chinese factories.

Styles dropped from line due to late arrival. EF designers were finding that getting samples was taking longer than their process could support. There was a point in EF's design process where the team reviewed all the prototype samples, in order to finalize which styles got placed in the line. The products from Peru, however, were not arriving in time for this juncture. As a result, those styles would fall out of contention for placement in the line because the design team would rather select, as one team member explained, "something we have, and that we see, and that we know is going to work," rather than rely on something that wasn't there to see. They found that even shipping to and from Peru took longer than what the design process was geared up for. "It's the

customs. Peru and South America are just not set up to import and export things as quickly as they are in, like, China,” said Miriam. “Their culture doesn’t work as fast and they just don’t have that mentality, which makes [working with them] a lovely experience, but it can be frustrating, as well.” EF leaders made allowances for the lateness in the beginning but recognized it had to change if they were to have a successful program of sweaters.

Product failed aesthetic and quality standards. The high quality of construction and the accurate sizing specifications that EF products were known for was not apparent in initial garments.

From the manufacturing and product development standpoints, there have been some challenges with [PP] getting the aesthetic and getting it right. When I say aesthetic, it is really about a finesse and execution that we are looking for. Eileen Fisher is known for simple luxury goods. Well, part of that are the finishing and the handling of the product, in a way that the execution is at a certain high quality level. (Judy)

Consequently, the styles PP submitted were not making it into the line due to their substandard make. “Although we are very interested in sustainability, we are also very demanding in terms of quality of our product,” declared Debra. Because all EF products had to be held to the same quality standards, whether they came from an artisan community or sophisticated factories, the designers found this a particularly tricky hurdle to jump.

Unused machine capacity jeopardized suppliers’ livelihoods. At the beginning of the Peru Project, as explained by the sales manager, a new style was created which was well received by the sales force and 20,000 units were booked for the season, a dramatic increase over the few thousand units previously contracted. PP scaled up for the increase in production by purchasing new equipment and training more knitters. The sweater,

however, did not sell; its failure was due to both its design and the execution. In addition, due to the seasonality of the cotton yarn fiber, EF did not buy as much product the next season and orders returned to previous levels of a few thousand units. The suppliers were left with unused machines and what appeared to be a shaky investment. The owner of DI complained to EF’s team leaders that PP’s artisans were left in the predicament of having built up their businesses to accommodate EF’s capacity needs only to see the orders drop off and leave them in a lurch.

Ordinary markups threatened sales. EF faced another challenge, because the cost of organic cotton runs considerably higher than conventional cotton but the fiber itself demonstrates no appreciable difference in value as perceived by the customer, explained Lauren. A higher material cost typically requires a higher selling price, which was a red flag for the sales team. Coupled with the product’s basic make and mediocre quality, the higher price negatively impacted sales. The design team recognized that in developing this sustainable sweater program, it needed to find a way to offer saleable garments, despite higher priced organic cotton yarns, so the Peru Project could compete successfully in the marketplace.

Solutions to Identified Challenges

This case study explains how Eileen Fisher overcame the stated challenges with the Peruvian cotton sweater product in its effort to establish a sustainably designed

Table 2. *Analysis of Challenges Encountered the by Design Team, Solutions, and Corresponding Effects*

CHALLENGE	ROOT CAUSE	COUNTERMEASURE	SOLUTION	EFFECT
<ul style="list-style-type: none"> • Sweaters lacked perceived value. 	<ul style="list-style-type: none"> • Limited yarn selection & machine capabilities 	<ul style="list-style-type: none"> • Developed more creative designs. • Developed new yarns and new ways to use existing yarns. 	<ul style="list-style-type: none"> • Exercised creativity & innovation in design 	<ul style="list-style-type: none"> • Sweaters are more saleable. • Win-win for EF and supply partners.

<ul style="list-style-type: none"> • Styles dropped from line due to late arrival. 	<ul style="list-style-type: none"> • Suppliers needed more time to submit samples. 	<ul style="list-style-type: none"> • Adjusted design process timeline by giving two additional weeks to suppliers. • Reduced breadth of samples requested. 	<ul style="list-style-type: none"> • Optimized timing & resources 	<ul style="list-style-type: none"> • Timely arrival of samples to be adopted into the line. • Supplier's & EF's business grows. • New timing calendar puts a temporary strain on the designer.
<ul style="list-style-type: none"> • Product failed aesthetic and quality standards. 	<ul style="list-style-type: none"> • Suppliers lacked the required craftsmanship and understanding of EF's standards. 	<ul style="list-style-type: none"> • Designers made seasonal trips to Peru to tutor artisans. 	<ul style="list-style-type: none"> • Engaged hands-on "upstream" 	<ul style="list-style-type: none"> • Quality is improved • Relationships are strengthened • Seasonal tutoring trips were no longer needed. • Product is more saleable. • Vendor becomes more desirable to other customers.
<ul style="list-style-type: none"> • Unused machine capacity jeopardized suppliers' livelihoods. 	<ul style="list-style-type: none"> • High variability of order quantities from season to season, typical of fashion business 	<ul style="list-style-type: none"> • Submitted orders to supplier for steady but conservative quantities. • Developed new products for alternate seasons to keep suppliers in year-round production. 	<ul style="list-style-type: none"> • Managed relationships responsibly & for the long term 	<ul style="list-style-type: none"> • Producers have steady workload and can anticipate business accordingly.
<ul style="list-style-type: none"> • Ordinary markups threatened sales. 	<ul style="list-style-type: none"> • Higher cotton cost for organic and fair trade and uncontrollable commodity pricing 	<ul style="list-style-type: none"> • EF absorbed some of the margin and found the savings elsewhere. 	<ul style="list-style-type: none"> • Made tradeoffs based on cost & values 	<ul style="list-style-type: none"> • Prices are competitive for better sales • Long term positioning for market share • Reliance on alternate programs to make up margins.

apparel program. The solutions to the five identified challenges were that team members (1) exercised creativity and innovation in design, (2) optimized timing and resources, (3) implemented hands-on involvement at the source of production, (4) managed relationships responsibly and for the long term, and (5) made trade-offs based on cost and company values. Table 2 elucidates the challenges encountered with the Peru Project, their root causes, countermeasures taken, solutions and resulting effects.

Exercised creativity and innovation in design. Data affirmed the importance of material choices in promoting sustainable design. “When we kick off the season, one of the first things we do is talk about materials,” said Melissa. The design team substituted, limited, and streamlined materials. Given that yarns and fabrics comprise the largest

portion of materials used in garment making, they drove EF's design process and influenced the product's aesthetics and sustainability.

I would say it's crucial for the fabric R&D team to be actively engaged in researching sustainability and sustainable practices in the textile industry... because it is what we bring to the table that gets reviewed and judged on the aesthetic merits of what it brings to Eileen Fisher. (Beverly)

The design team practiced visually tagging the design boards with an "e" logo to indicate what products had an ecological component which helped designers assess what portion of each new line addressed their sustainability goal. The fabric team often replaced conventional fabrics that designers liked, with refashioned eco-friendly versions having a suitable supply chain. Material substitutions occurred at the dye house level for the company's silk program. EF teams, together with the Chinese agent, the silk dye house, and an outside firm, worked to make the dye chemistry more environmentally friendly by replacing toxic chemicals with benign ones. For the Peru Project, dyeing and finishing were already performed in a non-toxic way, so it was not necessary for EF to substitute more eco-friendly materials. EF routinely employed third party companies such as Oeko-Tex, BlueSign, and GOTS to guide and certify the dye and fiber processes.

Designers worked with limited materials for the Peru Project that were comprised, initially, of just two sizes of organic cotton yarn because that was all that was grown, spun, and dyed locally. The basic yarn was a liability at first; however its limitations eventually spawned designer creativity. The sweater designer asserted that to overcome the limitations of the yarns, she regularly engaged in new development "like tuck stitches or mixing two of two different types of cottons to make something brand new from that." She also explored and manipulated sweater silhouettes by using "some sort of very modern, forward thinking shape that would bring the basic yarn into a new realm because

it's such a contemporary body." Eventually another cotton yarn was added and she began mixing the different yarns together in various stitches and gauges for more variety.

Streamlining was adopted in the design process to reduce the breadth of samples that were requested from DI, in order to limit waste of both materials and of manpower.

I am always looking to edit, limit, edit, limit, because the more work that we create out of our area, there's a ripple effect that affects everyone else who touches the product in every single way... If we are asking for eight colors and we know we never book more than three, there's that wastage as well. ... We don't want them to have to ramp-up for sampling if we can't realistically support that much bulk on the line. (Lauren)

Optimized timing and resources. Early order placements for organic cotton were required for product developers to hedge against the variable nature of commodity supply and demand. In addition, Melissa noted, "It's integral to the design process to commit early enough to both the materials and to the design, so that we can ship by sea instead of by air." So for the Peru Project, the design team adjusted their calendar in order to give the Peruvian supply chain enough time to operate at its own pace and still overcome the consistently late arrival of the product:

What we realized was that the timeline that worked great for our Asian suppliers was not supporting what the people in Peru needed in order to be successful. Where our tech sheets might go out a week later for the balance of the line and the things being produced in China, we back it up and give Peru an extra week to two weeks to make sure they have time that they need to get the protos, etc. to us on time." (Lauren)

When asked where those two weeks come from, Miriam accounted:

That means I have to work outside the calendar and work quicker and do Peru work first... So I have to work outside the conventional box and double-time it on my end... I kind of do put myself on overdrive and just focus on what we want ... I did it last weekend. I went home and worked from home and really just focused on cranking out twenty five ideas for Peru.

In addition, EF's design and product development teams planned and monitored their supply chain processes to keep the Peru suppliers on time. This was a change from what they were used to with their Chinese vendors:

Our China suppliers have more sophisticated production planning, production acumen than do our suppliers in Peru, so the designers come to rely on our China suppliers to know and do everything almost without thinking. In Peru we have to do a lot more checking in, and checking up, and pushing things along, and evaluating, than we normally do in China. (Debra)

Engaged “hands-on” and “upstream”. The design team discovered it needed one-on-one, hands-on time with the artisans to iron out major problems with first samples, so the team members went Peru to work directly with them. Rick, who acted as agent and supply chain manager, was asked to suspend his typical role of intermediary, in order to create space for direct relationships and knowledge sharing between the artisans and the design team. Miriam pointed out that taking the time to understand and respect the artisans' culture engaged her to determine what was needed to optimize product quality within the existing parameters.

I think I am more comfortable and understand what Peru's limitations are and wouldn't push them to a place they can't understand, or know what I am talking about, or be able to achieve...I have found different finishes that they are good at and that make a garment look very sophisticated versus rustic. I have found different constructions in terms of draping that they can do, versus what they can't do, building up that inventory and really focusing on what they can achieve. (Miriam)

Hands-on tutoring began to elevate product quality and achieve EF's expected aesthetic level. The design process and timing were adjusted for routine travel to Peru at the juncture between prototypes and samples until such trips were no longer needed. The sweater designer said, “I feel the face to face time just put us all on the same page.”

Managed relationships responsibly & for the long term. Designers recognized that success of the sweater program depended on honoring the artisan's timeframes, instead of forcing theirs on them.

The artisans are based anywhere from three to six hours away from the central city where suppliers are based. They are moms and they have kids coming home from school and then they stop. The next day they pick it up again; so [the production] is on their time frame. And we finally, after 4 or 5 years, find that we are okay with that. For a while it was like, 'you've got to speed it up!' But the beauty of working with a community like that is that you want to allow them their lives; so we have managed to understand that. (Joy)

Participants unanimously acknowledged that EF, DI and PP were committed to their relationship for the long term. When asked what made the process with Peru different than with conventional product, Lauren said, "There is a general sense in the studio that it's a relationship we want to nurture and initiative we want to support. So I think it's handled with a little extra TLC." EF designers worked directly with the artisans to improve their craftsmanship, so that not only EF would benefit, but so would the artisans, which created a spirit of generosity and guidance.

We were [all] working to change our processes to create the conditions under which a more flourishing relationship could happen... In the long run, our hope for them was also the more they could elevate their make, the more likely they would attract other vendors, because it's not sustainable for them either, to have one private party. (Melissa)

The EF team tutored the artisans to achieve EF's aesthetic standard and asked DI to monitor the quality. The team also developed new cotton yarns which, in turn, enabled the yarn supplier to increase its offering to other customers. EF's demand for high quality standards and wider yarn variety raised the level of craftsmanship for the Peru sweater production and became advantageous for members of the supply chain. Rick said:

"Eileen Fisher is impeccable as far as quality control standards. I think they have definitely helped to continue to raise the bar in that way... We're benefitting in a certain aspect of our supply chain and that's a good thing. It's like being held

accountable on a continual basis. That's a positive from a quality control standpoint."

Although Rick claimed that engaging with EF did not influence the way his company did business with other suppliers, he did say that "It has certainly made us feel great pride and confidence" particularly since the product is being sold in stores including Neiman Marcus and Bloomingdales. "The type of quality that it takes to get into those settings and sell well is exceptional, and via Eileen Fisher we are doing that."

EF, although unable to control the fluctuations in demand for the sweater product, determined to stabilize fluctuating order quantities that were the original cause of PP's over-production followed by unstable working conditions for the knitting community.

The lesson we learned was about the stability that a smaller social entrepreneur needs from a bigger company. You can't do that up and down thing like we do in the fashion industry. They need a steady workload. It doesn't have to be big; it just has to be steady because they're supporting people. (Alicia)

Leaders proceeded by providing a continuous level of business to supply chain partners to successfully support the sustainable model. Joy said, "Now there is an understanding. The quantities may be a little lower but they might be more steady. We are really making sure that the pieces that are being made are the ones that are going to sell." Nevertheless, the reality remained that there are fluctuations in styles and trends in the fashion business. So despite leaders' and team members' appreciation of supply chain partners' needs, they were still left with some questions.

If you are working with a vendor which has a certain capacity- how do you ask them to increase their capacity? To hire more people, plant more land, if you are not going to stay with them for the foreseeable future? That's what I meant by the challenges of a fashion brand. We have to be careful not to offer a certain false hope to some of the partners we work with and be very open about our processes, and at the same time be very responsible and work with them. (Beverly) Rick maintained that a company the size

of EF could be unwieldy when embarking on new initiatives. He said the beauty of DI's relationship with EF was the agility DI could offer.

We're the tugboat and they are the Titanic... We are extremely nimble. We don't have close to the same type of [product] volume or the same volume of employees [as Eileen Fisher]. Their ability to shift is a much bigger deal. When they decided to go into organic cotton, it was really tough for them to change the way that they did things.

So the benefits of strong supply chain relationships were not only bestowed by EF, but reaped by EF as well.

Made trade-offs based on cost & values. The design process priority included fulfilling the design vision first, "the design has to be compelling for the customer to buy it," but it also followed a parallel track to embed sustainability into its core business practices. Data revealed that "people want to be more sustainable but they feel they have to have the go-ahead from the company, because of the economics of it." EF's clear mission provided designers with the power to make decisions based on this mandate. This finding supports the literature correlating effective sustainable design and a firm's commitment and orientation toward sustainability (Rossi, et al., 2006).

The fabric leader regularly screened out materials choices which were least socially responsible due, for example, to fiber origin, dye and finishing processes, or company practices. Her mandate was to guide the designers towards vendors and products which were more ecological.

On the materials level our challenge is to deliver a certain level of excitement while giving the rest of the team a wealth of choices; and by the way, they're all sustainable... If I'm sourcing raincoat material, I will go to the mills that I know have, for example, signed up to support Blue Sign, like Teijin; mills that are known for that kind of work. I'd rather go to them, to give designers a selection of fabrics from those sources. I will consciously limit my choices because there is a wealth of choices within those. I have to make those kinds of decisions because otherwise, if you present everything equally, unless you have a mandate

to be sustainable, designers can just choose the other thing, and then what do you do? (Beverly)

The company mandate enabled leaders to make decisions on pricing strategy for the Peru product. For example, organic cotton cost EF about 25% more than conventional cotton, and labor costs were higher since workers received fair wages. However, because the Peru Project had the full support of the company, EF leaders determined to adjust margins to remain competitive:

We have organic cotton in a lot of our tops. It's about 75% of all of our cotton that is organic... and the way we have been able to manage that is to absorb some of the margin and make it more affordable for our customers. If we really passed the entire cost onto our customers, we wouldn't sell any of it. That's the truth. (Joy)

Principles for Effective Sustainable Design

The solutions to the challenges faced by EF are supported by fundamental Guiding Principles for Sustainability Solutions (Table 2) practiced by the company.

Company mandate. The strong company mandate for sustainability was a byproduct of the grass-roots endeavors of its company members, some of whom were very passionate about it. However, as a member of the design team declared, it is ultimately the mission of the company that enables things to happen.

One of the things I learned was that [an] individual holding a torch in a company is not sustainable. If you want to light a fire, you have to hand the torch from the individual to the company; the company has to hold the torch. (Melissa) Management based the decision to absorb some of the margin on a long-term view of the company mission rather than on short-term financial goals. They deduced that other areas of the line could offset the price difference. Rick suggested that despite taking less profit, EF was "still enjoying decent margins." Nevertheless, the decision to reduce margin was made possible by the strong underlying company mandate to develop sustainable

practices and products which, as Rick maintained, benefitted EF in the long run by making it “a leader in the business category.”

Table 3.
Guiding Principles for Sustainability Solutions

<i>GUIDING PRINCIPLES</i>
Strong company mandate
Match of core values within the supply chain
Gathering & diffusion of information.
Cross-functional organizational structure
Significance of the supply chain

Match of core values. Participants imparted that developing sustainable designs with a supply chain requires shared values within and across organizations. They acknowledged that EF assessed the general value system of its suppliers, agents, third party companies, and employees before enlisting them. EF aimed to do business with those engaged in socially responsible practices as a way to effect social change. This was also the sentiment of the owner of DI.

We have a certain amount of capacity and we’re looking for the right partners...One of the reasons that we have chosen to work with Eileen Fisher is because there is a core values match... Their company sees the value of what we are doing in our company, so that’s the common denominator. (Rick)

Because EF wanted to support the mission of DI, the relationship grew over time. Leaders were committed to the organic plus fair trade model and one leader stated that “We hope through our business [Rick] can sustain the kinds of social programs he has going on down there.” Design, manufacturing, and social consciousness teams

collaborated closely, as Beverly described, to guide yarn and fabric choices “toward mills and suppliers that we feel may be more empathetic or potentially more engaged in ecologic activities.” For other products besides sweaters, working with environmentally minded mills was reported to be added value for EF’s fabric team, making the process of supporting sustainable design much easier and more effective:

Not every mill is a good partner in this effort...the mills that have embraced [sustainability] and implemented these changes- it doesn’t have to be necessarily at the fabric level, it could be on the facilities level [like] solar panels for power or carbon offset-anything that they do that shows their commitment, is one more reason for us to work with them. (Beverly)

It was discovered that personal rewards were inherent in the process of working with suppliers who shared EF’s vision. In comparing the Peru Program to conventional design and product development, Miriam described it as a great experience with “a lot more depth to it” and explained the individual satisfaction she receives from working with supply chain partners for the Peru Project:

The things that I have success with in Peru don’t reflect the same mentality or our way into our products made in China. I don’t have the strong connections with the factories, I don’t follow the supply chain, I don’t do any of those things to the extent that I do in Peru. So if anything, the Peru project is more impactful to me as a designer maybe, than the more conventional work that I do; which is actually the bulk of my work, not to say there isn’t satisfaction in that; this is just a very unique situation. (Miriam)

After several teams made a visit to work hands-on with the artisans in the village, Miriam said “It really just made us all hold hands and set up this product to have success.” The commitment to the sweater program’s success may stem from the personal satisfaction derived from individuals’ experiences with the artisans, as well as from fulfilling personal and company objectives.

Gathering and diffusion of information. Once the company was on board to design and develop environmentally sustainable products, leaders found it necessary to

facilitate the flow of knowledge and information about sustainability and promote transparency of the supply chain. A sustainability leader, who was an expert on environmental issues as they related to the apparel industry, was hired to join EF. In addition, Eileen Fisher, the owner, attended a conference hosted by the Organic Exchange. As a result, new ideas arose for growing sustainable design practices. One of them was to commission a third party firm to perform a lifecycle assessment on the main fibers in the line. Beverly stated, “We reached out to our vendors with questionnaires... hoping for more transparency, and then that was analyzed.”

The assessment took about two years to create. The resulting LCA data reported that, in addition to garment maintenance (addressed by encouraging consumers wash clothes less frequently using cold water, to line dry, and avoid dry cleaning), other “hot spots were in the field and in the dye house.” As a result, an internal ranking schedule was formed to enable designers to score the sustainability of each product. The first component of the tool was fiber ranking. The second component of the tool, which was under construction, is a ranking system for processes such as dyeing and finishing. The cumulative score will inform designers on the sustainability of each product. Meeting objectives required investigating upstream suppliers.

What you do with something like this is take the information and get a general sense of how things are happening in your supply chain...It’s looking at the fiber and where the fiber is coming from and how it is dyed. (Alicia) Transparency on suppliers’ practices was also integral to ranking.

Recently there was this whole thing with Uzbekistan, the cotton there, and some of the issues with the labor. We don’t work with mills that [directly] use that cotton, but we just have to screen out mills to see if they’ve used that in their supply chain... We are working on how to structure our supply chain in a better way, for more transparency, for more information at the early level. (Beverly) EF took the lead on educating suppliers on

various issues that inform sustainability and social consciousness such as human trafficking and slavery, forced child labor, and irresponsible environmental practices. A strategy was devised to verify, audit, certify, train, and hold accountable its suppliers in the chain. A list of EF vendors was posted on the website in order to promote supply chain transparency.

Information sharing was routinely practiced between departments. The sustainability leader shared technical information on organic farming. Design team members provided “green talking points” about products to the sales team. Designers absorbed consumer feedback to analyze what made a style successful. Above all, “selling the story” was an important factor to support the Peru Project and to disseminate the information around fair trade and organic.

Basically, at Eileen Fisher, we sell our line, our fashion collection, a little different than any other company I have worked at in the past. We really sell the line not so much in looks, but in key fabrics and key stories. With eco being a great talking point and a lot of energy around that, it ends up being a great story in our line... We also take on the role of educating our personal sellers within these retailers... A lot of the education is around fabrics and hopefully our eco and sustainable portion of their assortment. (Bonnie)

Cross-functional organization. The cross-functional organizational model entitled the “Leadership System” is pictured in Figure 2 (Allwood, Laursen, Russell, & Malvido de Rodriguez, 2008). It grew out of the company’s collaborative culture and the way in which EF was already operating, but formally organized and codified it.

Crossfunctional teams engaged and empowered employees around issues that drive business.

We don’t dictate from the top down. Rather, we look for critical mass around issues and move into them that way. That is how our cross-functional teams support business initiatives and also engage people around issues that interest them. (Joy)



Figure 2. *Eco-Team as a Part of the Cross Functional Leadership System*

More than forty cross-functional teams were on-going, and teams arose and dissolved, depending on the needs of the company, supporting the research suggesting that sustainable design requires an integrative approach (Hong et al., 2009; White et al., 2008). Acknowledging EF’s complicated system and work flow Joy accounted, “This is just how we work. I’m not sure there is a way to fix it. It is always a work in progress. We use the phrase ‘we’re in the river.’”

EF’s organizational structure included primary job function teams as well as interdependent secondary teams that have specific functions. Interview data acknowledged the important role of the eco-team, a secondary team which emerged as a

result of launching the company's environmental initiative. The eco-team was an oversight group which acted as advocates for sustainable design initiatives. It was comprised of interested individuals from the areas of social responsibility, sales, manufacturing, design process, fabric, and design. Eco-team members were well-versed in sustainability and brought that knowledge to their primary teams. They convened quarterly, as per Bonnie, to "talk about strategies and ideas and global conversations that are happening in the world and how they can be translated into our company and into our environment." For instance, team members engaged with the Textile Exchange to determine the actual stakeholders for EF's organic cotton supply chain, enabling the EF brand to publicly link itself with a socially responsible and transparent supply chain. The eco-team also initiated the movement to convert the dyes and processes used in their Chinese supplier's silk factory to more sustainable ones.

The eco-team spawned sub teams, eco-product and eco-business, each of which had a specific focus. The eco-product team worked with designers and merchandisers to develop the Peru Project story and the eco-business team worked with sales to determine the Peru Project's marketing strategy. Eco-team members were frequently members of other teams, such as the core concept team, leadership forum, culture concept team, facilitating leader team, and creative forum, to mention a few. EF's Leadership System supported the cross-pollination of information between departments, facilitating sustainable practices throughout both the company and the design process.

Significance of supply chain. Participants accorded that local sourcing and a small supply chain were unique and key factors for sustainability of the sweater product and the program's success.

That's the beauty about Peru; there really is a good supply chain and it's all very local. Cotton is grown on certified organic farms right in the area where they are knitting and spinning the yarn...The yarn is then shipped to another local producer- a factory that is producing the sweaters. There really is not a huge supply chain...It's very unusual, especially in yarn [sourcing]. It's hard to find that kind of small supply chain anywhere else really." (Miriam)

Typically, fiber is not sourced in the same area in which it is spun. For example, EF has sourced organic cotton yarn in Peru, which was mixed with cashmere sourced in Mongolia. Both fibers were sent to China where they were spun and knit, requiring extensive transportation and logistics. The Peru supply chain, however, was more economical in terms of time and energy, and resulted in a smaller eco-footprint. In addition, the proximity of a supplier to its final market determines the amount of energy used for transportation; hence, South America was a more beneficial location for an American market than was China, for example.

EF leaders said they believe the Peru supply chain comes very close to meeting their vision of sustainability. "It is probably the most closed, clean loop that we actually have as far as its eco footprint," said Debra. The sustainability leader agreed but said there was still room for improvement. "Water use at the field level could be reduced through drip irrigation, but we have not invested in that yet." Buttons, zippers, and/or trim that may be used on the Peru sweaters are sourced locally when the quality is acceptable, but sometimes, they are sourced from Hong Kong, increasing the ecofootprint and reducing the sustainability of the product.

We do lots of pins on garments. The pins are our signature pins and they are made in Hong Kong. And if we do want offer them on a Peru product we can...we get them shipped from Hong Kong to our Secaucus warehouse, then they add the pins to the sweaters in the warehouse. We don't ask Peru to do that; it's too hard to count on them to do that. (Miriam)

CONCLUSIONS AND DISCUSSION

This study has shown that, despite the advantage of employing a local Peruvian supply chain for its eco-friendly attributes, EF faced and surmounted a number of hurdles for a viable program of sustainable sweaters. The effects of these measures were manifold: samples had a timely arrival for adoption into the line, although it did put a temporary strain on the sweater designer each season; the producers assumed a steady workload and could anticipate business accordingly; product quality improved, supply chain relationships were strengthened, the product became more saleable; and prices were adjusted to be competitive, for better sales. Furthermore, EF possessed a sustainable sweater marketing story which may serve to position the company for market advantage in the long term.

All of the solutions and principles which emerged from this research concur with product development considerations described by other disciplines which are reviewed in the earlier section of this paper, such as the importance of an organization's values, integrative product design, focus on materials, and the necessity of design innovation.

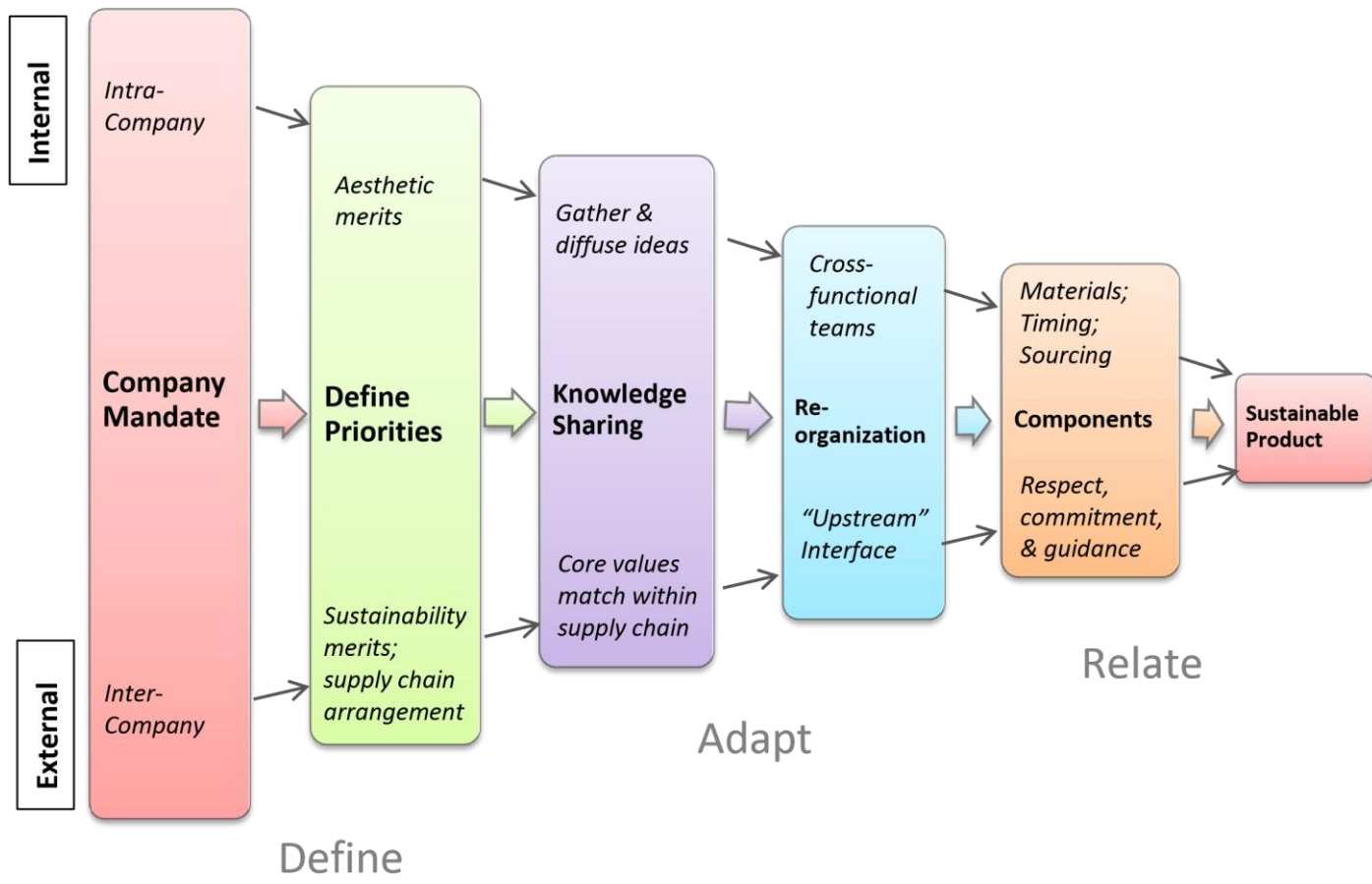


Figure 3. Sustainable Design Process Map: Principles behind Eileen Fisher's Peru Project with its Upstream Supply Chain (illustrated by the researcher)

The combination of solutions and principles from EF's Peru Project scenario is organized in a conceptual Sustainable Design Process Map in Figure 3. The company mandate is the underpinning to the process of overcoming problems and effecting successful sustainable outcomes. While other companies may have abandoned the Peru Project due to the challenges with quality and price, EF persevered because the program embodied those values in which the company and its employees believed. Defining of company priorities follows. EF defined its journey toward a sustainable product by the aesthetic merits of the product as well as its sustainability merits and the supply chain arrangement. Knowledge sharing occurred by gathering and diffusing ideas with colleagues, suppliers, and other stakeholders, and matching core values between EF and its supply chain partners. EF re-organized by creating the cross-functional eco-team and restructuring supply chain communication, both of which supported its sustainable product. Finally, skillful attention was paid to design components such as materials, timing, and sourcing; and to relationship components such as respect for, commitment to, and guidance of its suppliers for successful sustainable product outcomes. "Define", "Adapt", and "Relate" are overarching stages of the process.

EF's sustainable design strategy was not radical; it considered the existing systems and processes in the textile and apparel industry and worked within those parameters to shift practices. While EF nurtured its internal organizational structure, the design team zeroed in on the areas in the upstream supply chain where it could make the most difference in eliminating the environmental impacts of its product. EF approached the journey as one of continuous improvement, slowly shifting industry practices toward becoming more ecological. Implications of this study for EF are to keep organizational structure fluid so it may continue to support sustainability; to redefine priorities according to the particular sustainability objective or initiative; and to explore new ways of

knowledge sharing to develop and test additional sustainability models. Whether or not the same sustainable model of organic + fair trade is a viable one for other new programs remains to be seen. The implications for other apparel companies, from the lessons learned by EF, are that overcoming challenges of sustainable product development start with a clear mission, strong company mandate and liked-minded supply chain partners.

The sources of data collected for this case are limited to one apparel manufacturing company and some of its suppliers. As such, the case company and its upstream suppliers represent only a small sample of a supply network in the textile and apparel chain, and do not address the many other functions in the supply chain that shape sustainability of a product. As previously discussed, the review of literature and the observations of the case company indicate useful practices for nurturing sustainable new product development and supply chain relationships. The author believes that further examination of the connections between the two can shed additional light on apparel and textile sustainability. In the future, researchers should consider conducting cross case studies of various apparel companies' sustainable design and supply chain dynamics, in order to reveal and compare similar and/or different strategies throughout the upstream and downstream supply chain. In addition, only one of the present case company's sustainable initiatives was reported in this paper. Conducting further research on the other initiatives undertaken by the case company may offer a more comprehensive picture of how sustainable design practices in a single company compare and contrast.

Furthermore, researchers may wish to consider other forms of data collection as an alternative to the subjective nature of a qualitative study. Conducting surveys may be helpful for assessing common challenges and solutions facing a wide sample of apparel firms in developing sustainable product. Testing proposed solutions and quantifying the outcomes for evaluation may also be of practical and theoretical value.

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