

RE-FASHIONING THE FUTURE: ECO-FRIENDLY APPAREL DESIGN

A Thesis

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ABSTRACT

The main research question for this study was: **how can eco-friendly apparel design re-think, or “re-fashion,” consumer interactions with clothing in order to cause less environmental harm while also meeting or exceeding consumer wants and needs?** The objective of this research was to create collections of eco-friendly apparel designs that would meet the goals for consumer appeal and behavioral influence, and then to exhibit them so that consumers could react to and rate the success of these design collections’ concepts and executions in meeting those goals.

Experts in eco-friendly clothing design provided feedback about an initial set of design goals derived from the literature review. A finalized list of Eco-Friendly Apparel Design Goals was developed that along with the literature review inspired the development of a new eco-design framework for this study called the ERRor-Friendly Framework: *effective*, *resilient*, and *relational*. These goals and principles were conceptualized and executed into eco-friendly apparel design collections. Each design concept was inspired by a combination of research-derived information, expert feedback, and personal inspiration. A panel of design critics evaluated the designs in order to solve problems, improve designs, and select the most viable ideas. In the end, a total of five eco-friendly apparel collections were created: two *effective* designs, one *resilient* design, and two *relational* designs.

The Life Cycle Analysis (LCA) Label and T-shirts *effective* design provides consumers with environmental impact data on products so they can make informed choices and behaviors. The Green Clothing Care (GCC) Label and T-Shirts *effective* design encourages low-impact clothing care behaviors. The “Suit Yourself” *resilient* design transforms over time to reflect current fashion trends and the wearer’s changing sizes so that consumers are more satisfied with their clothes and consume fewer

clothes overall. The “No Sew” Projects *relational* design provides easy, do-it-yourself projects that allow people with no sewing skills to be creative and make worthwhile products. “The Dowry Dress” *relational* design re-thinks the life cycle of a wedding dress so that it becomes part of the entire life of the marriage.

The five design collections were evaluated during a two-week exhibit at an art gallery in downtown Ithaca, NY. During the exhibit’s duration, 52 people participated in the study by completing a short questionnaire assessing each design collection’s appeal, behavioral influence, and interest in design features. General consumer attitude and behavior responses were used to identify them as either green or conventional consumers. The questionnaire data were analyzed using descriptive statistics to provide a summary of results and chi square tests for significant relationships between participants’ consumer types and how they responded to the designs. The results showed that all of the designs possessed positive overall design appeal and the ability to influence behavioral change. Furthermore, analysis of consumer type with design assessment results showed no significant differences between how green and conventional consumers responded, except LCA Label influence.

Based on the questionnaire results for the design assessment and the green and conventional consumer analysis, each of the five design collections met the study’s two overall goals for appealing to all consumers, both green and conventional, and influencing them to change their behaviors. This high appeal and influence indicates that each design has potential for certain commercial applications, which will have the potential to reduce environmental impact. However, this study only tested behavioral intentions rather than actual behaviors. Future studies are needed to evaluate whether these designs would in fact inspire the intended behavioral changes in consumers and that those behaviors would indeed produce a net reduction in environmental impact.

BIOGRAPHICAL SKETCH

Kathleen Dombek-Keith, who always had a passion for expressing herself artistically in various ways, was first exposed to apparel design when making costumes for her Shakespeare literature classes at the Indiana Academy of Science, Mathematics, and Humanities, Muncie, IN. She went on to pursue multiple degrees at Indiana University, Bloomington, IN, including a Bachelors of Science Degree in Apparel Merchandising, a Liberal Arts Management Program (LAMP) honor's certification in business, and an Associate's Degree in Costume Construction Technology, her true interest. Yet, it was in an ecology class for a mandatory science credit during her last semester that exposed Dombek-Keith to the environmental crises we face as well as the work of William McDonough, one of the foremost leaders in eco-friendly design. It was McDonough's claim that designers have to be the ones that change the world that grabbed Dombek-Keith's attention. As the lone design student in a class full of science majors, her initial question of "Why me?" soon turned into "What can I do?" After completing her undergraduate degrees at Indiana University, Dombek-Keith came to Cornell University to study how apparel designers can make clothing that is better for the environment.

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TABLE OF CONTENTS

BIOGRAPHICAL SKETCH	iii
ACKNOWLEDGMENTS	iv
TABLE OF CONTENTS	vi
LIST OF FIGURES	x
LIST OF TABLES	xi
CHAPTER 1	1
INTRODUCTION	1
CHAPTER 2	4
LITERATURE REVIEW	4
2.1 Design and the Environment	4
2.1.1 Why is Design the Solution?	4
2.1.2 Degrees of Design Change: Re-pair, Re-fine, Re-design, and Re-think ...	4
2.1.3 Degrees of Design Approaches: Green, Ecodesign, Sustainable, and	
Resilience	5
2.1.4 Eco-Friendly Design.....	9
2.2 Environmental Concerns: Life Cycle Analysis (LCA) of Clothing	10
2.2.1 Product Design Criteria	12
2.2.2 Material Selection.....	14
2.2.2.1 Natural Fibers: Cellulose and Animal Protein.....	14
2.2.2.2 Manufactured Fibers: Regenerative and Synthetic.....	22
2.2.2.3 Other Materials	26
2.2.3 Production Processes	26
2.2.4 Distribution.....	30
2.2.5 Product Maintenance	31
2.2.6 End of Life.....	34
2.2.7 LCA-Informed Eco-Friendly Design Choices.....	36
2.3 Understanding Consumers and Their Clothing Concerns	37
2.3.1 The Green Consumer: Who is she and does she even matter?	38
2.3.2 The Green Product: What does the consumer want?.....	40
2.3.2.1 Consumer Compromises: Performance and Costs	40
2.3.2.2 Consumer Confidence: Environmental Claims	42
2.3.2.3 Peattie’s Green Purchase Perception Matrix (2001).....	43
2.3.2.4 Consumer Requirements for Eco-Friendly Apparel: Fit and	
Fashion	44
2.3.3 The Green Behavior: How will the consumer use it?.....	48
2.3.4 Consumer-Informed Eco-Friendly Design Choices	51
2.4 Innovative Eco-Friendly Design Approaches.....	51
2.4.1 Promoting Awareness Through Design.....	52
2.4.2 Nature as the Ultimate Design Model	53
2.4.3 Designing Engaging and Meaningful Relationships between People and	
Products	54

CHAPTER 3	56
DESIGN PROBLEM AND APPROACH	56
3.1 Design Problem	56
3.2 Design Approach	56
CHAPTER 4	59
PHASE 1 - DESIGN GOALS	59
4.1 Eco-Friendly Apparel Design Goals	59
4.2 Eco-Friendly Design Expert Feedback	61
4.2.1 Natalie Chanin- October 25, 2006	62
4.2.2 Otto von Busch- November 1, 2006	63
4.2.3 Bená Burda - November 3, 2006	64
4.2.4 Kate Fletcher- November 15, 2006	65
4.2.5 Janet Hethorn- January 2, 2007	67
4.2.6 Finalized List of Eco-Friendly Apparel Design Goals	68
4.3 The ERRor-Friendly Framework	69
4.3.1 Effective	70
4.3.2 Resilient	71
4.3.3 Relational	72
CHAPTER 5	73
PHASE 2 – DESIGN EXECUTION	73
5.1 Life Cycle Analysis (LCA) Label and T-Shirts	73
5.1.1 Concept	73
5.1.2 Purpose	74
5.1.3 Inspiration	75
5.1.4 Design Process	75
5.1.5 Final Design Description	79
5.2 Green Clothing Care (GCC) Label and T-Shirts	82
5.2.1 Concept	82
5.2.2 Purpose	83
5.2.3 Inspiration	84
5.2.4 Design Process	85
5.2.5 Final Design Description	86
5.3 “Suit Yourself”	89
5.3.1 Concept	89
5.3.2 Purpose	90
5.3.3 Inspiration	91
5.3.4 Design Process	92
5.3.5 Final Design Description	95
5.4 “No Sew” Projects	99
5.4.1 Concept	99
5.4.2 Purpose	99
5.4.3 Inspiration	100
5.4.4 Design Process	101
5.4.5 Final Design Description	103
5.5 “The Dowry Dress”	105

5.5.1 Concept.....	105
5.5.2 Purpose	106
5.5.3 Inspiration.....	107
5.5.4 Design Process.....	108
5.5.5 Final Design Description.....	110
CHAPTER 6.....	115
PHASE 3 – DESIGN EVALUATION.....	115
6.1 Final Design Exhibit.....	115
6.1.1 Exhibit Location and Time.....	115
6.1.2 Publicity.....	116
6.1.3 Exhibit Layout and Displays.....	116
6.1.4 Exhibit Events: Opening Night and Gallery Talk.....	119
6.1.5 General Exhibit Attendance	120
6.2 Questionnaire.....	121
6.3 Questionnaire Results.....	123
6.3.1 Demographic Description of Final Valid Participants	123
6.3.2 Design Assessment Results	124
6.3.3 Green Consumer Assessment.....	133
CHAPTER 7.....	137
DISCUSSION & CONCLUSIONS	137
7.1 Research Participation	137
7.1.1 Exhibit Location and Time.....	137
7.1.2 Publicity.....	137
7.1.3 Questionnaire.....	138
7.1.4 Socio-Demographics of Sample.....	139
7.2 Design Assessment.....	140
7.2.1 “The Dowry Dress”	141
7.2.2 “Suit Yourself”	142
7.2.3 GCC Label and T-Shirts.....	143
7.2.4 LCA Label and T-Shirts	145
7.2.5 “No Sew” Projects.....	146
7.3 Green and Conventional Consumer Impact	147
7.4 Limitations.....	148
CHAPTER 8.....	150
RECOMMENDATIONS & SUMMARY.....	150
8.1 Recommendations for Methodology	150
8.1.1 Design Goals	150
8.1.2 Design Execution.....	150
8.1.3 Design Evaluation	152
8.2 Recommendations for Designing.....	153
8.2.1 Applying the ERRor-Friendly Framework to Other Design Projects ...	153
8.2.2 Other Eco-Friendly Apparel Design Goals	154
8.3 Recommendations for Commercial Applications.....	155
8.3.1 Product Labeling that Informs Consumer Decisions and Promotes Behavior Change	155

8.3.2 Engaging Consumers in Eco-Friendly Lifestyles.....	157
8.3.3 Reducing Resource Use.....	158
8.3.4 Adding Meaning to the Product	159
8.4 Recommendations for Future Research.....	160
8.5 Summary of Study.....	161
APPENDIXES.....	169
REFERENCES.....	201

LIST OF FIGURES

Figure 1: "Four Step" Model (Charter & Chick, 1997).....	5
Figure 2: Peattie's Green Purchase Perception Matrix (2001).....	43
Figure 3: Life Cycle Analysis (LCA) Labels	74
Figure 4: LCA Labels for Conventional and Organic Cotton T-Shirts	80
Figure 5: "Red Dot" and "Green Dot" T-Shirts	82
Figure 6: Green Clothing Care (GCC) Label	83
Figure 7: Headline Shirts Care Label	84
Figure 8: Green Clothing Care (GCC) Label with Key	87
Figure 9: "Energy Hogs"	89
Figure 10: "Dry Green, it's FREE"	89
Figure 12: "Fill before you wash!"	89
Figure 14: "Wash only when..."	89
Figure 15: "Suit Yourself" Collection	90
Figure 16: Tuxedo Pant Sliding Buckle	94
Figure 17: Abby Suit Base Garments	96
Figure 18: Jane Suit Base Garments.....	97
Figure 19: Abby's Button Pins.....	98
Figure 20: "No Sew" Projects.....	99
Figure 21: The Knot	103
Figure 22: The "Faux" Knit.....	103
Figure 23: Knot Projects.....	104
Figure 24: Knit Projects.....	104
Figure 25: "The Dowry Dress"	106
Figure 26: Corset Design Solution for Reducing Waste	109
Figure 27: Decorative Mural Appliquéd on the Corset Lining	110
Figure 28: Corset Double Closure System	111
Figure 29: Styling the Skirt	112
Figure 30: Skirt Trained	113
Figure 31: Skirt Bustled.....	113
Figure 32: "The Dowry Dress" Keepsakes	114
Figure 31: LCA Display	117
Figure 33: GCC Display	117
Figure 35: "Suit Yourself" Display	117
Figure 37: "No Sew" Display	118
Figure 39: "The Dowry Dress" Display	119

LIST OF TABLES

Table 1: Descriptions of Environmental Design Approaches	9
Table 2: Patagonia's Definition of 'Ideal Garment' (Brown & Wilmanns, 1997).....	11
Table 3: Strategies for Promoting Resource Efficiency of Garment Archetypes (Fletcher & Tham, 2003).....	13
Table 4: Natural Fibers - Environmental Concerns and Benefits.....	21
Table 5: Manufactured Fibers - Environmental Concerns and Benefits	25
Table 6: Top Four USA Body Shapes	46
Table 7: Outline of Design Approach	57
Table 8: Initial List of Eco-Friendly Apparel Design Goals	60
Table 9: Finalized List of Eco-Friendly Apparel Design Goals.....	69
Table 10: The ERRor-Friendly Framework	70
Table 11: Green Consumer Attitude/Behavioral Assessment, 7-item Scale	122
Table 12: Exhibit Questionnaire Participant Demographics	124
Table 13: Overall Design Appeal and Influence (N=52)	125
Table 14: LCA Label & T-Shirts - Design Features (N=52).....	127
Table 15: GCC Label & T-Shirts - Design Features (N=52)	127
Table 16: "Suit Yourself" - Design Features (N=52)	128
Table 17: "No Sew" Projects - Design Features (N=52).....	129
Table 18: "The Dowry Dress" - Design Features (N=52)	129
Table 19: Overall Ranking of Designs (N=52)	130
Table 20: Common Response Themes for Most and Least Liked Designs	131
Table 21: Attitude/Behavioral Assessment Results - Green vs. Conventional Consumers (N=41)	134
Table 22: Consumer Type x Age, Education Level, Gender (N=41).....	135
Table 23: Consumer Type x Design Appeal and Influence (N=41).....	136
Table 24: Eco-Friendly Apparel Design Goals	163
Table 25: The ERRor-Friendly Framework	164

CHAPTER 1

INTRODUCTION

Designers have often aspired to radicalism; many times that radicalism has been solely related to aesthetics, or has not created a net improvement in the utility or social impact of the item designed. Radical design now has new outlets, as many solutions to environment and social problems will be unexpected and unconventional. Only by re-thinking some basic assumptions about function, tastes and lifestyle will we be able to move any significant way towards a more sustainable way of living. (Mackenzie, 1997, p. 168)

The main objective for all eco-friendly design is to develop a system of sustainable consumption. Consumption, by definition, implies the purchase and use of goods and services, in other words, consumer behavior. Agenda 21 at the UN 1992 Rio Earth Summit first brought up this notion of sustainable consumption when it called for “new concepts of wealth and prosperity which allow higher standards of living through changed lifestyles” (UN, 2004, chap. 4.11). Jackson and Michaelis (2003) go on to explain Agenda 21’s emphasis on consumer behavior: “it provided a potentially far-reaching mandate for examining, questioning and revising consumption patterns – and, by implication, consumer behaviours, choices, expectations and lifestyles” (p.13).

Unfortunately, many current sustainable design initiatives misunderstand this objective and instead focus their energies purely on “the production and sale of more sustainable products” (Jackson & Michaelis, 2003, p.4). “The consideration in ecodesign of consumption, human choices, and actions, has been overshadowed by an emphasis on pollution and resource use during production as the main object of environmental concern” (Fletcher & Goggin, 2001, p. 15). This is precisely the case

for many eco-fashion designers, who concentrate on making their clothing with more sustainable materials and production yet still want consumers to make numerous and impulsive purchases.

The role of the designer must expand dramatically in light of current environmental concerns with the contamination and destruction of the ecosystem. This increased importance of the designer stems from the great influence she has over how the developed world affects the environment, for the design stage is often where fundamental mistakes result in products or services that fail to meet the goals of the design. Reducing environmental and social harm is an incredibly complex design goal as it involves understanding how a product will interact with people and the environment throughout all the stages of its life. Today's designer must be well informed on a vast array of topics, from methods of production to governmental regulations to life cycle analysis. She must account for the environmental impacts of the materials she uses, the resulting waste from the forms she chooses, how products are produced and packaged, where they will be made and then sold causing energy use for transportation, and how consumers may use and dispose of the product.

In order to create designs that truly meet the goal for sustainable consumption, potentially problematic consumer behaviors must be addressed at the design stage. Some of the more environmentally responsible apparel designers and companies do consider some aspects of the consumer's role. They recognize the importance of reducing the energy consumers use to clean and care for their clothing (Fletcher & Goggin, 2001), as well as offering high-quality, appealing clothing designs that consumers will want to buy and wear (Donaldson, 2005). Yet many apparel designers and companies are still unaware of how people use and interact with their clothing and how those behaviors can have an enormous effect on the environment. Designers who

do not understand how their consumers use or misuse their products risk creating designs that fail to meet sustainable goals (Lilley, Lofthouse, & Bhamra, 2005).

In this research, design goals will focus on meeting the needs of both the consumer and the environment. As the Brundtland Commission noted in their 1987 report “Our Common Future,” people and their environment create a complete ecological system, in which one cannot be considered without the other. If environmental initiatives do not account for people’s needs, then consumers will not embrace them. Eco-friendly design addresses environmental concerns by making an effort to decrease overall material use while promoting production and consumption cycles that imitate closed natural cycles through innovative new materials and methods of fabrication. As for consumer concerns, eco-friendly design can add more satisfaction to people’s lives through improved performance while providing more fulfilling engagement with society and natural world. Eco-friendly design has the ability to nurture this dynamic relationship between people and their environment, bringing both renewed vitality and meaning. Eco-friendly design can only be effective if it accounts for both environmental concerns and consumers’ needs and behaviors; for it to be revolutionary, it must re-think, or “re-fashion,” how we interact with each other and the world in a way that provides a truly rewarding experience.

CHAPTER 2

LITERATURE REVIEW

2.1 Design and the Environment

2.1.1 Why is Design the Solution?

In order to solve the environmental crises we face today, experts say we need to decrease our resource and energy use by a factor of 4 to 10 (Charter & Chick, 1997; Hawken, Lovins, & Lovins, 1999; Schmidt-Bleck, 1993). It is estimated that 80% of a product's environmental impact and costs are determined in the design stage (Fletcher, 1998). The choices that designers make have far-reaching implications on the amount of energy and resources a product will need to be manufactured, used, and disposed. The question is: What changes should designers be making, and what are the potential environmental benefits?

2.1.2 Degrees of Design Change: Re-pair, Re-fine, Re-design, and Re-think

Charter and Chick (1997) proposed a "four step" model (Figure 1) arguing that change happens at four different levels with corresponding degrees of environmental benefits. The first step to change is "Re-pair," in which environmental impacts are cleaned up after they have occurred. Using a coat to illustrate these steps, the toxic wastewater from the dye-house used to color the coat's fabric would be reclaimed and cleaned. In step two, "Re-fine," changes start to happen at the source of the problem, the design stage. At this step, the coat's materials and production methods would be replaced with less environmentally harmful alternatives, such as recycled polyester and wind-powered sewing factories, while the coat's function and design largely remain the same. Many of the current design approaches are at the "Re-fine" level of design change.

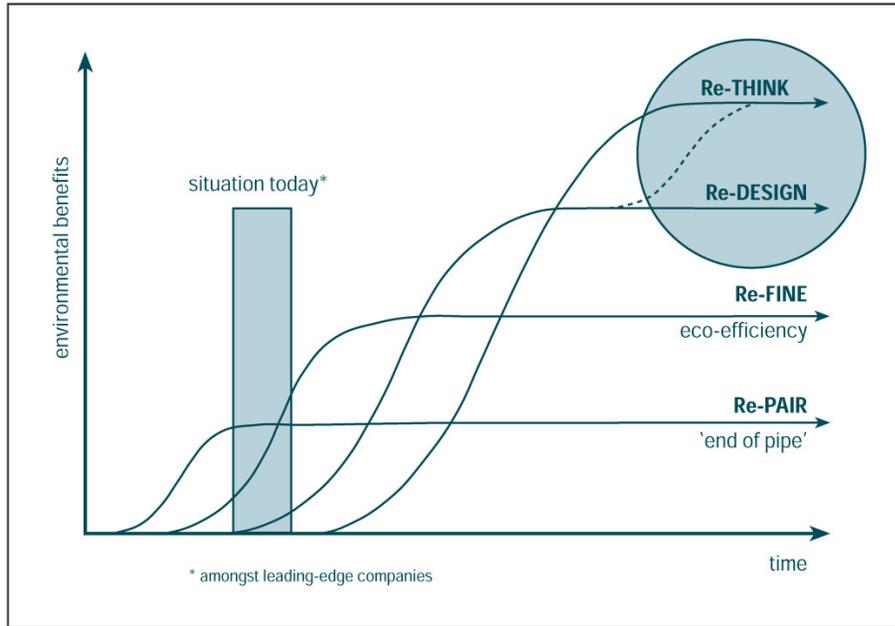


Figure 1: "Four Step" Model (Charter & Chick, 1997)

In step three, “Re-design,” the function of the product would remain largely the same but the design would change to offer more environmental and consumer benefits. The coat may be redesigned so that it would be a three-in-one vest, jacket, and coat so that consumers would need to purchase fewer outerwear garments. At the final stage, “Re-think,” the product would be reduced to its purpose, and a whole new product or even service could be created to better meet that purpose. In this case, the coat’s purpose is to keep people warm, so this purpose could be met by a solar powered undergarment that regulates body temperature in any weather, or maybe a geothermal outdoor heating service. More designers need to work on the “Re-design” and “Re-think” levels to truly change our lifestyles away from destructive consumption.

2.1.3 Degrees of Design Approaches: Green, Ecodesign, Sustainable, and Resilience

Design approaches for the environment have evolved in scope and depth, beginning with environmental awareness and leading to a complex understanding of

how society and the environment interact with and affect each other. Environmental design approaches started with *green* design, a term originally borrowed from the environmental “buzzword” of 1980’s politics (Madge, 1997). Green has been applied to a vast array of topics: product design, packaging design, building design, marketing, consumers, city planning, and many others. In each of these topics, green design took on meanings that were related to that topic’s attributes. The goal of green product design was a minimalist approach that removed the environmentally harmful aspects from production, to eliminate chemical additives and keep products in their “natural” state. Green apparel products were defined by such marketing slogans as “100% natural fiber,” “cotton grown without pesticides and artificial fertilizers,” and “without chemical dyes and additives” (Sewekow, 1996, p. 21). The excessive use of the term *green* in the past led to ambiguity about what it really meant. Yet *green* is still used today, often for marketing purposes, as a generic “catch-all” term for any topic that is environmentally aware or driven. In this study, the term *green* is used when describing consumer markets to denote environmental awareness and when discussing consumer-focused studies about green marketing and green products.

Ecodesign, the next major environmental design approach in the 1990’s, embraced the ideas of ecology and focused on understanding how design affects the environment. During this time, helpful environmental analysis tools were devised, including the Life Cycle Analysis (LCA) that charted the environmental impact of products throughout all the stages of their lives, from “cradle to grave” (Madge, 1997). Charter and Chick (1997) considered *ecodesign* the embodiment of the “Re-fine” design step: “moving towards the development of cleaner processes and the designing out of environmental problems at the sources” (p. 5). The *ecodesign* goal was to reduce environmental impact by replacing current materials and production methods with alternatives that were more efficient and caused less environmental harm, yet the

motivation was not to redesign or rethink the products themselves. Ecodesign remained “a product focus attempt to influence environmental impact by making existing products more efficient” (Fletcher & Goggin, 2001, p. 17).

Other common ecodesign terms include *environmentally responsible* or *eco-friendly* and *eco-efficient*. Environmentally responsible or eco-friendly design, just like ecodesign, focused on reducing the environmental impact of products.

Environmentally responsible apparel products are considered “fibers, fabrics, or apparel whose manufacturing, usage, maintenance and ultimate disposal have minimal negative impact on the environment” (Chen & Burns, 2006, p. 248). The goal of eco-efficient design was “doing more with less,” so eco-efficiency became the “strategy of choice for change” because it offered belief that possibilities for industrial growth were limitless if they were done in an eco-efficient manner (McDonough & Braungart, 1998). McDonough and Braungart, leaders in the design and environment movement, refer to eco-efficiency as a policy of “less bad” that is “no good” (2002a) as it only slows down the negative effects of intrinsically flawed systems of production to the point that we only become less aware of their negative effects. “Relying on eco-efficiency to save the environment will in fact achieve the opposite – it will let industry finish everything quietly, persistently, and completely” (McDonough & Braungart, 1998, p. 85).

Sustainable design, the current major design approach, broadened the focus of environmental design beyond resource use to encompass how societal issues affect the whole ecology of our world. “‘Sustainable Product Design’ (SPD) is the addition and balancing of social and ethical issues, alongside environmental and economic issues into the product design process” (Charter & Chick, 1997, p. 5). The 1987 Brundtland Commission’s landmark report “Our Common Future” provided one of the earliest definitions of sustainable development that highlighted the social impact of

environmental devastation: “to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (p. 8). Sustainable design urged the development of new systems of consumption that promoted “living within the regenerative capacity of the biosphere” (Wackernagel et. al., 2002, p. 9266), thereby putting a limit on the industrial growth but not societal improvement and development.

With sustainable design, designers began to re-design and even re-think the systems in which we live. One such re-thinking of consumption systems is McDonough and Braungart’s design philosophy “cradle to cradle” (2002a). They believed that man-made consumption cycles should mimic the regenerative cycles found in nature. They referred to the nature’s cycles as “eco-effective” (rather than eco-efficient) in which all “waste equals food” (1998, p. 86-88). The life cycles of products would not be “cradle to grave,” design to disposal, but “cradle to cradle,” in which the life cycle of each product would end with the creation of a new product.

Resiliency, a new and less frequently applied design approach, builds upon sustainability’s focus on the environment and society by striving to better understand the dynamic relationships of these “socio-natural’ systems” according to van der Leeuw & Aschan-Leygonie (2000), in order to handle the potential and possibly unforeseen environmental problems as they arise. The resilience approach is “dependent on the capacity of the human societies involved to process in the time available all the information necessary to deal effectively with the complex dynamics of the system as a whole” (p. 2). This approach utilizes tools, such as flow structures and system thinking, in order to understand how disturbances in complex systems cause reactions so that systems that are resilient to such disruptions can be designed. This concept of resilience seemed to epitomize a statement made by Ezio Manzini, a leading thinker and designer for sustainability, that the foremost aim of environmental

design must be “the search for ‘error friendly’ solutions that are able to coexist with the human tendency to make mistakes” (1992, p. 17). Table 1 summarizes these four major environmental design approaches.

Table 1: Descriptions of Environmental Design Approaches

Design Approach	Description	Related Design Approaches/Terms
Green	Generic term used to describe numerous environmentally aware/driven topics: politics, products, packaging, consumer markets, cities, etc.; leaving products in their natural state	<i>Natural</i>
Ecodesign	Inspiration from ecology; focus on reducing environmental impacts of current products - Life Cycle Analysis (LCA); belief that growth could continue without limits if done efficiently	<i>Environmentally Responsible Eco-Friendly Eco-Efficient</i>
Sustainable	Broadened focus to environment and society; living within natural cycles means limits to growth; creating cyclical systems of consumption - cradle to cradle	<i>Eco-Effective Cradle-to-Cradle Eco-Friendly*</i>
Resilience	Understanding dynamic socio-natural systems to solve environmental problems that arise; systems thinking approach	<i>Error-Friendly</i>

** this study's interpretation of design approach*

2.1.4 Eco-Friendly Design

Eco-friendly (short for ecologically-friendly), the design approach for this study, was informed by all four of these design approaches. Initially, my thinking was largely influenced by sustainable design’s focus on solving the problems of both the environment and society, as they create the complete ecology of the world in which one cannot be considered without the other (Brundtland, 1987). McDonough and Braungart’s “cradle to cradle” design philosophy (2002a) also influenced me to truly re-think, or “re-fashion,” the system of apparel design and consumption in ways that would meet the needs of both consumers and the environment, rather than just refining current apparel design to make it “less bad” for the environment. Implementing these

eco-friendly design goals first demands an understanding of how product production and consumption affects the environment. Therefore the LCA tool developed for ecodesign was used to analyze the environmental impacts of the clothing industry and its products. Eco-friendly design also heavily involves understanding the clothing consumer's wants, needs, and behaviors that was informed by green consumer market research. Yet this design goal's main purpose is to re-fashion how consumers interact with their clothing in ways that both appeal to consumers and influence them to behave in a more eco-friendly way. This process requires inspiration from innovative eco-friendly design approaches. One such innovative approach, Manzini's "error-friendly" concept (1992), much like the concept of resiliency, inspired this study's design framework the ERRor-Friendly Framework: *effective, resilient, and relational*. Therefore, in order to inform eco-friendly design goals of this study and the ERRor-Friendly Framework, the following topics had to first be investigated: environmental concerns of clothing, clothing consumer needs and behaviors, and innovative eco-friendly design approaches.

2.2 Environmental Concerns: Life Cycle Analysis (LCA) of Clothing

The first step in forming the eco-friendly design goals for this study was to analyze how the apparel industry and its products affect the environment. An increasingly common practice has been to conduct a Life Cycle Analysis (LCA), which examines the environmental impacts of a given item over its entire lifespan, from design goals through disposal. In general, environmental concerns for these stages involve energy consumption, use of toxic chemicals, and ethics and sustainability of resource consumption. Patagonia, a pioneering company in eco-friendly apparel innovations and environmentally responsible business practices, was one of the first apparel companies to incorporate LCA in their design development.

Patagonia described what they considered their “ideal garment” (Brown & Wilmanns, 1997), adhering to their mission of “‘maximum attention to product quality’ while ‘striving to do no harm’ to the environment” (Chouinard & Brown, 1997, p. 118).

Patagonia’s LCA outline (Table 2) is used to organize the major environmental concerns of the clothing life cycle according to these six life stages.

Table 2: Patagonia's Definition of 'Ideal Garment' (Brown & Wilmanns, 1997)

Product design criteria

- meets specified performance criteria
- product lifespan – minimum 10 years
- ease of repair, component reuse and composting/recycling
- product requires minimum care

Materials selection

- natural fibres produced in sustainable manner
- biopolymers
- recycled content
- all inputs to material production identified and toxicity characterized
- toxics: if used, they should be produced, consumed and detoxified on-site/the final products should not be toxic

Production processes

- efficiency of material use analysed and optimized
- energy and water use analysed and optimized
- energy from solar-based sources
- quality standards specified and production defects meet three sigma level (97% of products defect free)
- wastes are eliminated and there is no disposal from production

Distribution

- packaging manufactured from renewable resources and finally recycled or composted
- transportation is optimised for energy efficiency
- energy from solar-based sources.

Product maintenance

- consumer care is minimized
- product only requires cleaning with cold water and mild soap, then line dried/no ironing or dry cleaning required
- quick and cost effective repair service offered

End of life

- consumers urged to keep and use product if it is still useful
- compostable products come with composting instructions for the consumer
- product can be returned to Patagonia if the consumer does not want to dispose of it
- where feasible, systems in place for disassembling non-compostable products for component reuse, material recycling and remanufacture

2.2.1 Product Design Criteria

Patagonia's principal design criteria were to increase a product's utility through improved performance and longevity, easy care and repair, and future uses through valuable reuse and recycling (Brown & Wilmanns, 1997). Of these, a long lifespan seems in direct contradiction to the apparel industry, due to the focus on ever-changing fashion. Today, the apparel industry is disseminating vast quantities of disposable "fast-fashion" products at an ever-increasing rate (Allwood, Laursen, Rodriguez, & Bocken, 2006). Environmental groups have long criticized the apparel industry for propagating planned obsolescence as fashion's principal design objective. Frequently changing designs are blamed for increasing clothing consumption and disposal, creating wardrobes full of unused, still wearable clothes.

Van Nes and Cramer (2005) offer one of the few studies exploring why people replace their still-useful products. In their study, they reveal a conflict between the intentions of the designer and the actions of the user in that "product lifetime is a result of a user's decision, and not a predetermined design criterion" (p. 287). They identified four main reasons that consumers replace their products: wear and tear (the most important), improved utility, improved expression, and new desires. They applied these reasons to develop five design strategies for increasing a product's lifespan. Two of these correspond with Patagonia's design criteria: "design for reliability and robustness" and "design for repair and maintenance," while they also suggest "design for upgradeability, design for product attachment, and design for variability" (p. 295). Product attachment refers to the emotional relationship the consumer has for a product, which influences people to take better care of products and keep them for longer.

Rather than applying product longevity to all types of clothing, Fletcher and Tham (2003) argue that a garment's lifespan and durability should match its function.

They categorize the range of clothing functions into three main archetypes of classic, basic, and fashion depending on how long and frequently the consumer uses the garment. They suggest appropriate design strategies for reducing the environmental impacts of each archetype based on how the consumer will use the product. According to Table 3, only classic garments should be designed for durability, repair, and strong emotional attachment as they are the most likely to be used for a long period of time and will cease to be useful if the garment is damaged, no longer fits, or becomes trite. Basic designs are worn the most frequently, therefore they should be designed using materials and construction that allows for easy, low-impact cleaning and care, as the maintenance life stage demands the most energy of all the stages mainly due to machine drying. Fashion-oriented garments have fleeting lives due to their short shelf-life style; some may only be worn once for a night on the town. So rather than making fashion items more durable, it is better to construct such garments from materials and with structures that are easy to deconstruct for reusing or recycling into new products.

Table 3: Strategies for Promoting Resource Efficiency of Garment Archetypes (Fletcher & Tham, 2003)

Archetype	Characteristics	Strategy
Classic	<ul style="list-style-type: none"> • expensive • high quality • durable • timeless design • used frequently over a long period 	<ul style="list-style-type: none"> • specify virgin materials • materials, dyes and finishes that age 'gracefully' • re-fitting, mending service from outlet • instructions for low impact care and wear • information about garment's history to increase user-garment 'bonding'
Basic	<ul style="list-style-type: none"> • cheap • functional • 'easy' design • used frequently for a short period* 	<ul style="list-style-type: none"> • equal standard of material and making • instructions for low impact wear and care • take back scheme <p>[* <i>matter of a few years, use ends once product is worn-out</i>]</p>
Fashion	<ul style="list-style-type: none"> • affordable • fashionable • rich in status, identity, etc. • used infrequently for a short time 	<ul style="list-style-type: none"> • recycled materials components are easy to both disassemble and dispose of • instructions for low impact care • take back scheme • rental option

2.2.2 Material Selection

Of all the life stages, the apparel industry has concentrated its environmentally responsible innovation on developing eco-friendly materials, for some understandable reasons. Material choices incorporate the environmental impacts of the production of those materials into the apparel product's life cycle and affect how the garment can be processed, cared for, and disposed. The environmental concerns for materials include energy consumption, use of toxic chemicals, and ethics and sustainability of resource consumption. In order to address these material environmental concerns, eco-friendly apparel designers must strive to minimize non-renewable resource and energy use, as well as waste, while utilizing materials that are nontoxic and ethically produced. These materials should also provide a valuable characteristic to the consumer, require low impact care, and be effectively disposed through reuse, recycling, energy reclamation, or composting.

The apparel designer's primary material is, of course, fabric that can be composed of various fiber types that have unique properties and production. The two principal fiber types are natural fibers, from plant cellulose and animal proteins, and manufactured fibers, derived from natural and synthetic polymers. Fibers are either cultivated, manufactured, or a combination of both. Each fiber source and production method comes with its own set of environmental concerns, yet all can be improved to various degrees of reduced environmental harm by either employing better practices in current systems, implementing new, more effective technologies, or replacing current materials and practices with eco-friendly alternatives.

2.2.2.1 Natural Fibers: Cellulose and Animal Protein

Natural fibers are often viewed as the most environmentally responsible as they come from renewable sources and use less energy to produce than manufactured fibers. In actuality, modern conventional production of natural fibers can demand large

amounts of water and land as well as utilize numerous hazardous chemicals and biotechnology in order to manipulate and combat the forces of nature, all of which disrupt ecosystems and pose potential health risks. Yet there are alternative, eco-friendly fibers and production methods that demand fewer natural resources and use the forces of nature to their benefit.

Cotton, a plant seed fiber, is by far the largest single fiber used in apparel production today, commanding a growing world market share of 60% (Textiles Intelligence, 2007). Cotton's appeal is driven by consumer preference for cotton's wear comfort and easy care, and recently, increasing oil prices have made synthetic fibers production more expensive than natural fiber production. From a different perspective, textile historian Mary Schoeser (2003) considered cotton to be the first product with planned obsolescence due to its propensity to wear out compared to linen. Cotton is the most important non-food crop in the world, doubling its production in the last 30 years (EJF, 2007), and thereby increasing the significance of its negative environmental impacts. Conventional cotton production demands heavy water irrigation, utilizes large amounts of pesticides and synthetic fertilizers, and employs biotechnology, all of which cause severe environmental and social damage.

Cotton is a water intensive crop requiring up to 20 inches of rainfall per year and is grown in more than 80 countries all over the world (Kadolph & Langford, 2002). Depending on the region of the world, cotton crops use up to 29,000 liters of irrigated water per kg of raw cotton to make up for lack of rainfall (Allwood et. al., 2006). This high demand for irrigation can cause desertification in the cotton producing areas. The Aral Sea, once the fourth largest lake in the world, is now a quarter of its original size due to heavy irrigation for Uzbekistan's cotton fields and is predicted to dry up in only 15 years if significant actions are not taken (Allwood et. al., 2006). Heavy water irrigation has other damaging side effects such as chemical

runoff that contaminates vital freshwater supplies and, when combined with wind, soil erosion threatening future prosperity.

Conventional cotton production can use up to a third of a kg of agrochemicals per kg of raw cotton, with synthetic fertilizers comprising the vast majority.

Denmark's EPA conducted a LCA of a cotton t-shirt and determined the following figures for a worst-case scenario of chemical use: nitrogen .14 kg, phosphorus .08 kg, and potassium .08 kg for a kg of raw cotton (Laursen et. al., 2007). Of these, nitrogen is considered the most detrimental to the environment, causing leaching and runoff that pollutes freshwater supplies and causes algae blooms, thereby disrupting local ecosystems. Nitrogen fertilizers are also a major contributor to increased N₂O emissions, which are 300 times more potent than CO₂ as greenhouse gas (Kramer, Reganold, Glover, Bohannan, & Mooney, 2006). This is ominous for global warming considering that overall crop nitrogen fertilizer use is forecasted to increase roughly 2.7 times by mid-century (Tilman et. al., 2001).

The remaining agrochemicals used in conventional cotton production consist of a variety of pesticides including insecticides, herbicides, fungicides, growth enhancers, and defoliating agents. The same LCA report puts the total application of these other chemicals at 18 g per kg of raw cotton (Laursen et. al., 2007). Although this amount seems minor in comparison to fertilizers, cotton is one of the most pesticide-ridden crops. When many types of pesticides, including the notorious and now banned DDT, are introduced into the environment, they produce dioxins, a family of organochlorines that are the most toxic of all chemicals (Hawken, 1993). According to Harrison (2001), dioxins do not degrade and are not water-soluble, so they gather in animal fat cells, like breast tissue, and bioaccumulate up the food chain. Human infants, who are at the very top of the food chain, can ingest breast milk containing up to 35 times the dioxins that an American adult intakes daily, which is 6,000 times

greater than the EPA's acceptable daily level of exposure to dioxins. These chemicals are thought to cause cancer, disrupt reproductive and immunology systems, and affect growth development.

The Environmental Justice Foundation (EJF, 2007) labels cotton as the "dirtiest crop in the world" as it leads all other crops in insecticide use, consuming 16% of the total insecticides produced even though it covers only 2.5% of the world's cropland. Insecticides are the most hazardous of the agrochemicals since they are engineered to affect the biological systems of many organisms. Typical health effects cover a wide range of acute and chronic conditions, among which are nervous and reproductive disorders, increased risk of cancer, and death. According to EJF, three of the most extremely hazardous insecticides to human health, as determined by the World Health Organization (WHO), rank in the top 10 most commonly used in cotton production. Aldicarb, the second best selling insecticide used on cotton and the most acutely toxic pesticide produced, can kill a man with just one drop absorbed through the skin, yet it is still used in 25 countries and the US, where 16 states have reported it in their groundwater.

Pesticide use has decreased significantly in areas like the US and China where conventional cotton producers have turned to biotechnology (Bt), the fastest adopted yet most controversial technology in agricultural history (Cantrell, 2006). Chaudhry (2007) points out that after only 11 years on the market, Bt cotton now comprises 34% of total cotton cropland and 45% of world cotton production. In the last 30 years, cotton yields have increased 29% due to insecticides and recently, better pest control technology in Bt seeds. While the benefit and sustainability of Bt is fiercely debated, many agree that pest immunity is a major problem. Unlike insecticides, Bt seeds better target specific insect populations, yet the toxic protein they produce is always present so insects develop immunity in only a few seasons. This could have a range of effects

from short-term increases in secondary pest populations during the growing season that will need to be controlled with pesticides to long-term creation of super-pests (Chaudhry, 2007). Cotton Inc. claims Bt cotton can be sustainable but only when used in conjunction with integrated pest management practices, like crop rotation and cover crops (Cantrell, 2006). Yet, many environmental organizations believe Bt crops are too risky due to concerns of unknown long-term environmental impact of ecosystems and potential human health side effects, such as food allergies (Chaudhry, 2007).

Unlike conventional farming, organic growing methods work with nature to achieve an ecological balance without the use of chemical controls and biotechnology in order to protect the health of humans, animals, and the environment. Organic farmers use natural predators and intercropping to control pests, and special machinery and fire control to handle weeds. Organic farming uses natural fertilizers like compost and animal manures that recycle the nitrogen already in the soil rather than adding more, which can reduce both pollution and N₂O emissions. These natural fertilizers plus crop rotation keep the soil healthy so it needs less water and erodes less; this also translates into energy savings for irrigated fields (Walsh & Brown, 1995).

Currently, organically grown cotton comprises less than 1% of total cotton production, but it has increased five-fold in just the last four years due to growing consumer demand (EJF, 2007). Cotton growing must meet established standards and be certified by a third-party in order to be labeled “organic,” which promotes consumer confidence. Patagonia was the first conventional apparel company that switched all its cotton products to 100% organically grown cotton in 1994 (Chouinard & Brown, 1997). Nike followed in 1998 by committing to blend organic cotton into its cotton apparel with a goal of 5% organic cotton by 2010 (Speer, 2005). In addition, many small apparel start-ups have used organically grown cotton as part of their mission and market, such as Maggie’s Functional Organics founded in 1992. Recently,

organically grown cotton has entered into more mainstream markets, even reaching the shelves of mega-retailer Wal-Mart.

Hemp is often advocated as a sustainable alternative to cotton as it requires little to no pesticides, fertilizers, and water and has a shorter growing season with 250% more fiber yield than cotton (Kadolph & Langford, 2002). Hemp is almost always grown organically (Broudy, 2005a), but it still needs certification to be legally labeled “organic.” Hemp is most renowned for its superior strength utilized in ropes, but it also has valuable consumer benefits of comfort, caused by good absorbency, as well as UV resistance and anti-mold properties. For most of human history, linen made from flax and hemp fibers dominated clothing and textiles, valued for its fine luster, appearance retention, and durability. But the Industrial Revolution produced numerous technological advances for reducing the time and energy requiring for yarn spinning, weaving, bleaching, and printing, all of which were significantly more effective on cotton (Schoeser, 2003). Today, most hemp is grown in China, while hemp farming is banned in some countries due to its connection with marijuana, including the US (Kadolph & Langford, 2002).

Hemp is a bast fiber that comes from the stiff plant stem, so it must go through a great deal of processing in order to create a softer fiber. This process, known as retting, can demand large amounts of time and energy, which can result in an environmental impact comparable to cotton’s (Turunen & van der Werf, 2006). More efficient retting technologies and renewable energy sources could reduce this impact. Bamboo, another bast fiber, can be processed either in its natural fiber state by retting like hemp or manufactured into a fiber like rayon, so it is discussed in both fiber type sections. Just like hemp, bamboo also requires no pesticides and irrigation to grow, has a very short growing season with large fiber yield, and offers antimicrobial properties, and can be certified organic (Broudy, 2005a).

Wool and silk, both natural protein fibers, hold a small yet consistent place in apparel history (Schoeser, 2003). All protein fibers offer a unique hydroscopic property that absorbs water without feeling wet providing comfort while reducing temperature fluctuations (Kadolph & Langford, 2002). Wool has long offered its comfort and warmth to many people, while silk has always been considered a luxury prized for its fine luster and distinctive dry hand. Both are harvested from animals that have been bred for centuries for the sole purpose of fiber production. Although animals do not require the direct use of agrochemicals, sheep are often treated with some pesticides to protect against parasites, and agrochemicals and biotechnology can be used to grow their food. Sheep are usually kept on marginal land that cannot be used for food cultivation. Their manure can return valuable nutrients to the land, but it can also end up in runoff contaminating local waterways if done to excess. Wool-producing animals can also cause soil erosion by overgrazing. Currently, increasing numbers of goats are taking over northern China in order to meet growing consumer demand for cashmere. These goats eat all the vegetation causing devastating dust bowls that are affecting the air quality across the Pacific to North America (Osno, 2007). Conventional sheep husbandry methods also concern animal rights advocates, namely the cutting of hind skin in order to create scar tissue that prevents the animal from potential deadly blowfly infestation (Broudy, 2005a). Wool can be certified organic if chemical pesticides are not applied to the sheep or grazing land and if the sheep are fed organic food and not subjected to painful procedures. Wool fibers contain grease and other impurities that must be washed out, requiring large amounts of water, energy and alkaline soaps (Chen & Burns, 2006).

Silk is made from moth cocoons that are either cultivated in farms, known as sericulture, or gathered from the wild. It is the only natural fiber that can be produced in filament form as opposed to shorter staple fibers that must be spun together to

create yarn. However, in order to produce silk as a filament, the moths must be boiled to death before they exit the cocoon and break the fibers. Unwinding the cocoons also requires large amounts of very cheap hand labor from rural families including children (Kadolph & Langford, 2002). Staple silk can be produced from broken cocoons or silk waste, but it is less durable and lower quality than filament silk. No organic standard currently exists for silk production, but staple silk made from the cocoons of moths that are allowed to live, referred to as either tussah or “peace” silk, is considered the ethical alternative. Silk, like wool, requires intensive cleaning to remove sericin, using large amounts of water, energy and chemical soaps. Based on these sources, Table 4 summarizes the environmental concerns and benefits of the discussed natural fibers.

Table 4: Natural Fibers - Environmental Concerns and Benefits

Natural Fibers	Environmental Concerns	Environmental Benefits	Eco-Friendly Alternatives
Conventional Cotton	High water demand - energy for irrigation, desertification, runoff, erosion Synthetic fertilizer use - leaching & runoff that results in algae blooms, N ₂ O emissions Pesticide use - production of dioxins, acute to chronic health effects Biotechnology - production of super-pests, unknown long-term effects to ecosystem, potential health effects (food allergies)	Renewable resource	<i>Organic Cotton</i> <i>Hemp</i>
Organic Cotton	Water demand - energy for irrigation	Renewable resource No chemical use or biotechnology Natural fertilizers do not pollute and prevent N ₂ O emissions	<i>Hemp</i>
Hemp, Bamboo	Energy demand for fiber retting	Renewable resource Little water demand Naturally pest resistant	<i>Organic Hemp</i> <i>Organic</i>
Wool	Manure runoff and overgrazing Pesticide use - production of dioxins, acute to chronic health effects Biotechnology (food) Animal rights Cleaning requiring energy, water and alkaline soap use	Renewable resource Use of marginal land	<i>Organic Wool</i>
Silk	Exploitation of cheap labor Animal rights Cleaning requiring energy, water and chemical soap use	Renewable resource	<i>Tussah or "Peace" Silk</i>

2.2.2.2 Manufactured Fibers: Regenerative and Synthetic

Manufactured fibers are made from thick viscose solutions, either from natural or synthetic polymers, pushed through tiny holes in a spinneret, a process inspired by how silk moths turn saliva into a long fiber. This production process allows for complete control over the fiber's size, shape, length, and chemical composition, all of which affect the fiber's final properties. Unlike natural fibers, manufactured fibers can be produced anytime of the year, have better uniformity, and can be engineered to meet consumer needs for aesthetics and performance. On the other hand, they require significantly more energy to produce, 160 MJ per kg of nylon versus 50 MJ per kg of cotton (Allwood et. al., 2006). Energy requirements can be improved with more efficient technologies and switching to renewable and clean energy sources. Environmental concerns vary based on the raw materials used to create the viscose solutions and the type of spinning method that creates the fiber.

Manufactured regenerated fibers are created from natural, often cellulose polymers, so they possess the same chemical properties as their natural source, like biodegradability. Viscose, more commonly known as rayon, was the first man-made fiber developed, prompted by cotton shortages in the later part of the 19th century (Schoeser, 2003). Rayon's base solution is made from wood pulp or waste cotton fibers. Using discarded cotton fibers puts to use an otherwise wasted product, though cotton production's harmful effects are still present. Wood pulp, rayon's most common raw material, requires little water and no pesticides to produce, and is currently not genetically-modified. Wood sources can vary widely from responsibly harvested tree farms that are grown on marginal cropland unfit for food to mature forests that have been clear-cut destroying animal habitats and causing soil erosion (Kadolph & Langford, 2002). Yet rayon's major environmental concern is its wet spinning process that uses toxic chemicals to dissolve the raw materials into solution

and bathe the fiber as it spins. In fact, cuprammonium rayon, which uses a copper and ammonium, was so polluting that it is no longer legal to manufacture in the US (Kadolph & Langford, 2002), and production has moved to developing nations. These solution chemicals plus those needed to clean the fiber after spinning are disposed of in large amounts of wastewater, which could be recycled but is often discarded into local waterways due to expense.

In the early 1990's, lyocell was developed in order to address rayon's environmental impacts by changing the fiber production process to solvent spinning that uses less toxic chemicals and reclaims and reuses the solvent numerous times (Kadolph & Langford, 2002). Lyocell is made from wood pulp specifically farmed for fiber production, and different woods produce different varieties of lyocell, like Tencel® made from eucalyptus and Modal® made from beech wood (Collins, 2006). Lenzing, an Austrian lyocell producer, is working toward a closed-loop production system; they source wood pulp from Forest Stewardship Council (FSC) certified forestry, recycle 99.6% of its solvent, are 90% energy self-sufficient, and purify all wastewater onsite in their biological waste treatment plant. Lenzing's Modal® also produces a by-product that is processed into a sweetener for breath mints manufactured at the factory next door. Moreover, its solvent process produces a fiber closer to the feel of cotton than rayon. In fact, the touch of Tencel® fabric on skin was shown to stimulate relaxing brainwaves according to a Japanese Theta Wave study (Collins, 2006).

A variety of new regenerative fibers that use novel natural sources including bamboo, soy, and corn have recently been introduced to the apparel market, so LCA information is limited. These fibers are being marketed as eco-friendly since they come from renewable resources as opposed to oil, yet how these fibers are grown and processed is still of concern. Bamboo requires no pesticides and irrigation to grow, has

a very short growing season with large fiber yield, and offers antimicrobial properties (Broudy, 2005a). While the growing of bamboo is sustainable, the fiber processing can be far from eco-friendly. The majority of bamboo, as well as soy, are most likely chemically processed like rayon using wet spinning. Crop production of soy and corn (fiber name Ingeo™), requires agrochemicals and sometimes utilizes genetically modified (GMO) seed varieties, which many consumers are opposed to especially in Europe. In response, Cargill Dow, makers of the polylactic acid (PLA) base material for corn plastics and Ingeo™, offers a non-GMO PLA variety.

Synthetic fibers, like polyester and nylon, are made from chemical polymers derived from natural gas and oil, non-renewable resources. Because of this, they are typically viewed as the worst for the environment, along with being associated with the oil industry's environmental catastrophes. On the other hand, fiber production uses a tiny amount of by-product from oil refining that was once considered waste. In fact, synthetic fiber processing requires fewer chemicals and less subsequent wastewater than natural and naturally derived fibers. This is because synthetic fibers do not need to be washed to remove any debris that occurs in harvested natural fibers, and they can be chemically engineered for special end uses negating the need for chemical finishes (Kadolph & Langford, 2002). They are manufactured by either melt spinning, which does not use a chemical solvent, or dry spinning, in which the solvent is recovered, and both methods do not require washing after fiber production. However, the production of synthetic fibers does release harmful chemicals. Nylon production releases nitrous oxide, an ozone-depleting chemical (Chen & Burns, 2006). Polyester production uses a carcinogenic chemical called antimony, which leaches into the wastewater during the dyeing process and is released when the polyester is burned during the recycling process (McDonough & Braungart, 2002b).

More synthetic fibers are recycled and produced from recycled resources than any other fiber, which can significantly reduce energy consumption and divert waste from landfills (Kadolph & Langford, 2002). In the early 1990s, Patagonia worked with Wellman, a fiber producer, and Dyersburg, a fabric manufacturer, to develop EcoSpun™ made from recycled plastic bottles; however, its quality was limited due to impurities inherent in the recycling processes, so it was only suitable for making into fleece material, such as Patagonia’s Synchronia® fleece line (Broudy, 2005b). Patagonia then collaborated with Teijin, a Japanese textile manufacturer, to develop a perpetually recyclable fiber-to-fiber polyester known as ECOCIRCLE™ that Patagonia used in its Capilene® baselayers. In 2005, Patagonia launched its “Common Threads Recycling Program” to take back its Capilene® apparel items in order to make sure its products were recycled and to save on its production costs. Patagonia estimated that creating fibers from recycled versus virgin sources saves 76% in energy and reduces CO₂ emissions by 71% (“Patagonia announces revolutionary...”, 2005). Table 5 summarizes the environmental concerns and benefits of these manufactured fibers.

Table 5: Manufactured Fibers - Environmental Concerns and Benefits

Manufactured Fibers	Environmental Concerns	Environmental Benefits	Eco-Friendly Alternatives
Rayon	Energy demand for manufacturing fiber Forest harvesting methods Toxic chemical solvents for processing	Renewable resource	<i>Lyocell</i> <i>Tencel®</i> <i>Modal®</i>
Lyocell, Tencel®, Modal®	Energy demand for manufacturing fiber	Renewable resource Sustainable forestry Less toxic, reclaimed	<i>Tencel®</i> <i>Modal®</i>
Bamboo, Soy, Corn (Ingeo™)	Energy demand for manufacturing fiber Bamboo and Soy - Toxic chemical solvents for processing Soy and corn - Biotechnology, pesticide and fertilizer use	Renewable resource Bamboo - no pesticide use Corn - non-BT PLA varieties	<i>Tencel®</i> <i>Modal®</i>
Polyester, Nylon	Non-renewable resource High energy demand for manufacturing fiber Toxic chemical release during production and recycling	Extensively recycled Use waste product Needs less water and chemicals to process and finish	<i>EcoSpun™</i> <i>ECOCIRCLE™</i>

2.2.2.3 Other Materials

Apparel also uses other types of non-fiber fabrics, like leather and fur, and other materials, such as buttons and zippers. In general, environmental concerns for these materials involve energy consumption, use of toxic chemicals, and ethics and sustainability of resource consumption. A few eco-friendly alternative materials are worth noting. The tagua or corozo nut is gathered from palm trees in South American countries, providing local people with a profit-driven alternative to clear-cutting the rainforest for cocaine cultivation and preserving the virgin endangered palm trees and decreasing crime (MacKenzie, 2006). Often referred to as vegetable ivory, this nut can be carved and dyed to create beautiful buttons. Other innovative eco-friendly button materials include coconut, bamboo, and recycled glass and other found objects.

The main concerns for using animal skins and furs are the ethical treatment of animals and the preservation of species, especially those that are endangered. Fake furs are an alternative to real furs, and fish skin can be used as a substitute for snakeskin (Mackenzie, 1997). Leather in the US often comes from animals processed for their meat and, in the case of sheep, meat and fiber (Kadolph & Langford, 2002). Chemical use in leather tanning, like the carcinogenic hexavalent chromium, is the main environmental concern of leather production. It can be replaced with vegetable tanning, although with more expense.

2.2.3 Production Processes

While fiber production is typically considered the main environmental concern, the large amounts of chemicals, energy, and water used to produce a finished apparel product post-fiber are often overlooked. Clothing production is a multi-step procedure that often includes spinning, weaving or knitting, pre-treating, dyeing and/or printing, finishing, and make-up (cut-sew-trim). During these stages, the

apparel product is subject to various chemical treatments, many of which have been highly toxic and non-degrading but now are sometimes replaced by more nontoxic and biodegradable counterparts (Kadolph & Langford, 2002). Some fiber processing standards exist that prohibit the use of hazardous chemicals, including the Organic Trade Association's (OTA) American Organic Standards for Fiber Processing (Murray & Coody, 2003) and the Global Organic Textile Standard (GOTS) (2005), both of which are intended for only natural, preferably organic, fibers. Each production stage demands energy and often water to apply treatments, which then require more energy to dry the product after treatment. And lastly, the working conditions at each stage can pose health and safety risks due to exposure to toxic chemicals and air and noise pollution. Workers may also be forced to work long and tedious hours with little pay. Eco-friendly apparel production uses resources and energy efficiently, only uses nontoxic cleaners and applications, and provides a safe and fair working environment.

Yarn spinning causes noise and air pollution from the high-speed machinery that produces a deafening sound and fiber dust. Cotton dust can lodge in the lungs and cause "brown lung", which can be fatal. Creating spun yarns from natural staple fibers causes significant waste, 15% when carded and 30% when combed, due to inconsistency in fiber size and organic debris from the field (Laursen et. al., 2007). This waste can be recycled into lower quality fabrics and manufactured regenerative fibers. After the yarn is produced, it is either woven or knitted into fabric. Dust is much less of a problem at this stage, but knitting machines can transfer some of their mineral machine oils on the fabric, which are eventually washed out in wastewater (Laursen et. al., 2007).

Water is used during many fabric production stages for cleaning and application of dyes and finishes, resulting in large amounts of problematic wastewater. This wastewater can contain washed away dirt and wax from natural fibers, cleaning

chemicals, and up to 15% of dyeing and finishing applications (Laursen et. al., 2007). Wastewater has high biological oxygen demand (BOD), needed for decomposing organic material, and high chemical oxygen demand (COD), needed for organic chemical function, which interferes with the aquatic ecosystems (Kadolph & Langford, 2002). Most wastewater is dumped rather than treated due to the expense, causing disruptions in the local environment and contaminating the freshwater supply.

Dyeing can be done at almost any stage, from the fiber to the constructed product, and may require whitening pre-treatment. Cotton is often bleached before it is dyed and finished. Chlorine, often used in bleaches, weakens the fibers and readily combines with organic elements in nature to form organochlorines, which do not degrade and are carcinogenic. For white clothes, optical brighteners are often used to add a blue tint that makes the product appear whiter than white. These brighteners are made of fluorescent chemicals that pollute wastewater and do not degrade. Hydrogen peroxide is the eco-friendly whitening alternative recommend by the OTA's fiber processing standards (Murray & Coody, 2003).

Dyes and printing inks require a pigment and a fixative, or mordant, both of which can utilize toxic chemicals and heavy metals. Azo group chemicals, which release carcinogenic arylamines, were once widely used in synthetic dyes and pigments, but these chemicals and heavy metals are being phased out (Laursen et. al., 2007). Dyes are difficult to remove from wastewater and leave it colored, preventing wastewater from supporting plant life by inhibiting aquatic plants' ability to photosynthesize. New jet-dyeing machines can reduce water to fiber ratios from 10:1 to no more than 6:1, resulting in significantly less wastewater (Kadolph & Langford, 2002). Screen printing inks may use chlorine-containing polyvinylchloride (PVC). Eco-friendly alternative color options include low-impact and natural dyes that use

nontoxic mordants, water-based inks, and colorgrown cotton and wool fibers, although the colorgrown palates are often muted and limited.

Finishing occurs after the fabric is made and often implies the application of chemicals to the fabric to give it enhanced properties, either aesthetic or functional. This process often requires water for the application and to wash out the excess finish. Thirty years ago, a large finishing factory could use as much as 2 million gallons of water a day (Kadolph & Langford, 2002). Many finishing processes have been redesigned to use less water or foam substitute, although they still need to be improved to reduce water use and increase wastewater processing. Toxic chemical finishes pose human health risks while their wastewater disrupts ecosystems, yet more finishes are being replaced with less toxic, biodegradable alternatives. Sizing agents add BOD to wastewater, and chlorine compounds affect COD. Formaldehyde, a known carcinogen, is used in permanent press finishes, leather finishing, and some dyes (Kadolph & Langford, 2002), yet citric acid is an alternative eco-friendly durable press finish (Chen & Burns, 2006). Certain finishes can also require the garment to be “dry-clean only,” which uses cleaning solvents with toxic chlorine chemicals. Conversely, finishes can make traditionally dry-clean only fibers, like wool and silk, washable. Some such washable finishes are toxic chemicals while others use environmentally safe natural enzymes (Chen & Burns, 2006).

Make-up, also known as cut-make-trim, involves cutting the garment pattern out of fabric, sewing it together, and then adding any trim or embellishments. Waste from cutting can vary between 6% and 25% depending on the complexity of the pattern, although this cutting waste is often recycled into low-quality textile products (Laursen et. al., 2007). The apparel industry still relies heavily on human labor as no machinery has been able to reproduce the agility and intricacy of a human producer. This high labor demand often makes apparel production the first industry to take root

in developing countries, as labor prices are cheap and the skills are easy to learn. Because apparel production is often found in developing regions that lack laws or law enforcement, one main concern is the propensity of sweatshops that exploit young women and sometimes children with hazardous working conditions, pay below living wage, and inability to prosecute unjust employers for late payment and refusal of employee benefits due to lack of a legal employment contract (Allwood et. al., 2006).

Inherent in the production life stage is the design of the product and the decision to produce it. Product planning determines what types of products to offer, where they will be produced, and how many products to produce. Poor decision making during the product planning stage can result in unsaleable products either by producing more products than are needed to meet demand, producing the wrong size or style of garments, or bringing in a product type too late in the season. When apparel companies over produce or produce unwanted products, those products may enter secondhand discount stores or the waste stream.

2.2.4 Distribution

Since the various life cycle stages of apparel can occur in different regions all over the world, a great deal of transportation is required that raises concerns over greenhouse emissions. E-commerce might seem even more energy intensive due to increased transportation costs, yet it often results in a net reduction of energy use due to the energy required to maintain a brick-and-mortar retail store location and the consumer's own transportation to and from the store (Collins & Aumônier, 2002). All this transportation also requires packing to protect the product in transit as well as the packaging for displaying the merchandise at retail. Apparel packaging includes everything from polybags covering fabric tubes to the hangtags on garments. Decreasing packaging saves waste from landfills and money by using less material

and labor for assembly and reduced shipping costs due to less weight from packaging. Efforts to reuse and recycle as much packaging in-house as possible result in reduced environmental impact. For example, Coats American recycles returned thread packages into new cones and tubes for packaging thread (Kadolph & Langford, 2002). Packaging made from recycled or sustainably produced renewable sources can also help reduce environmental impact but only if the materials can be either recycled profitably or composted easily by an infrastructure that is already in place. Packaging made from either one material or a few materials that easily separate from each other further aids recycling. Packaging can also be designed to be part of the product or have its own unique use, such as a set of bed sheets packaged in a reusable cloth bag.

2.2.5 Product Maintenance

Consumer clothing cleaning uses significantly more energy than any other life cycle stage, as much as 70-80% (Collins & Aumônier, 2002). Factors that contribute to this energy use include washing frequency, load size, water temperature, heat used in tumble-drying, and ironing. Fortunately, vast improvements can be made by simple behavioral modifications. Washing clothing 50% less frequently could reduce the overall energy consumption of the garment by 15-30% (Allwood et. al., 2006). Increasing the amount of clothes washed in a single load from 3 kg to 3.5 kg can reduce washing energy by 14% and overall energy use by 5%. Just changing the washing temperature from 50°C (122°F) to 40°C (104°F) can decrease overall energy consumption of the garment by 10% (Collins & Aumônier, 2002). Washing machines also are available in front-loading and energy efficient models, such as Energy Star certified products in the US, which require up to 50% less energy and water compared to a top-loading washer (McNary, personal communication, April 10, 2007).

Tumble-drying consumes the largest amount of energy, up to 60% of this maintenance life stage (Allwood et. al., 2006). Complete abandonment of tumble-drying would result in a 25% reduction of energy consumption over the life of a garment (Collins & Aumônier, 2002). Project Laundry List (2007), advocates for simple lifestyle changes to reduce energy use and consequent environmental impact and promotes the benefits of air-drying other than just energy savings, such as longer-lasting clothes and the natural bleaching and disinfecting effects of sunlight. Air-drying may be a reasonable supplement to tumble drying but not an outright replacement due to weather conditions and space and time constraints. Currently, a truly energy efficient dryer is not available; yet future research may discover more efficient drying options, such as using microwaves to produce heat (Kadolph & Langford, 2002).

It should be noted that these energy figures make assumptions about many things including garment lifespan, frequency of washing and drying, load size, and most significantly, garment washing according to its individual washing and drying specifications. In many studies, the amount of energy for garment care changes significantly with type of fiber and finish (Allwood et. al., 2006), yet often consumers wash different fiber types at the same time so their actual behavior is different from assumptions. Therefore, the studies that claim some materials or garments are better or worse for the environment based on the garment's recommended care instructions may be inaccurate due to unpredictable consumer cleaning behaviors.

Cleaning clothing also calls for cleaning agents, some of which have conventionally used harmful and toxic chemicals. Many detergents have switched to biodegradable solutions, and some are even concentrated, which translates into less packaging and lower weight to be transported. Chlorinated chemicals are used in household bleaches and dry-cleaning solvents and can produce organochlorines. Wet-

cleaning, eco-friendly alternative to dry-cleaning since it does not use toxic solvents, is an advanced washing system that uses heat, steam, and natural soaps to clean typically dry-clean only garments, but wet-cleaning does demand a great deal more heat and water, though less electricity, compared to dry-cleaning (Kadolph & Langford, 2002).

Another possibility to reduce the environmental impact of clothing cleaning is to reduce the need to clean clothes. The burgeoning field of nanotechnology has offered a new stain-resistant finish that mimics the surface structure of a lotus leaf in order to repel water and dirt (Clark & O'Mahony, 2005), keeping clothes from being ruined due to permanent stains and hopefully decreasing the rate of cleaning. In the future, nanotechnology may offer more ways to self-clean and self-repair clothing, which would eliminate the energy needed to clean and repair clothing and increase product life spans.

In addition to cleaning, clothing maintenance also encompasses repair. In the past, clothing required a large investment, of either money or time and effort, so people had more incentive to repair their clothing. Mass production decreased new clothing costs while clothing repair costs increased in time or money if hired out. It is now often less expensive to replace a damaged garment with a new one, creating a disposable culture. An innovative design solution to clothing wear and tear could be to make clothing with replaceable parts and also allow for a "fashion upgrade," by making clothes useful for longer (Allwood et. al., 2006, p. 39). On the other hand, clothes could be rented out through novel lending programs. These clothes would be used more often and would ideally reduce overall consumption. This option would be especially useful for types of clothing that are worn less frequently, such as formal wear, wedding dresses, costumes, uniforms, and even business suits as lifestyles become more casual.

The “Strategies towards the Sustainable Household” (SusHouse) Project (Bras-Klapwijk & Knot, 2001) studied the potential benefits for reducing the environmental impact of clothing through four innovative clothing use and cleaning scenarios, referred to as “design orienting scenarios” (DOSs). The four DOSs compared the benefits of outsourcing clothing cleaning and repair as well as a variety of consumer clothing wardrobes, including (1) owning fewer yet high quality clothes, (2) sharing a pool of clothing within a neighborhood, (3) leasing clothes from a service, and (4) purchasing new or secondhand clothing from the internet. All four DOSs resulted in decreased amounts of consumed clothing, producing the largest reduction in environmental impact due to “higher quality materials and clothes, reparation and less washing, which led to a longer use life, and through limited and flexible wardrobes, sharing clothes, which led to a higher use intensity” (p. 116).

2.2.6 End of Life

The end of a garment’s life is a very subjective term that can encompass anything from when the consumer disposes of it to where it finally ends up. According to a study by Koch and Domina (1999), over 99% of participants took advantage of some form of clothing recycling. Of the possible recycling methods, participants were most likely to donate unwanted clothing to charitable organizations, like Salvation Army, pass them down to family or friends, or make them into rags, while they were less likely to sell clothing at yard sales or to secondhand shops or modify them into something new.

Garments reused in the secondhand clothing market may enter another cycle of distribution, use, and disposal. Secondhand clothing markets use 1.7 kilowatt-hour (kWh) per kg for processing and distribution yet it does not need any new energy to produce the product, translating into energy savings from 65 kWh per kg for a cotton

garment to 90 kWh per kg for a polyester garment when compared to the life cycle of a new garment (Collins & Aumônier, 2002). However, the switch to low-quality, cheap clothing has resulted in a 71% drop in recycling value over 15 years so that it costs more to collect and sort secondhand clothing than its resale values (Morley, Slater, Russel, Tipper, & Ward, 2006). This has forced secondhand clothing shops to carry products other than clothing in order to stay in business according to Garth Ward (2006), National Recycling Coordinator for The Salvation Army UK.

Compared to reselling secondhand usable clothing, actual recycling of unusable clothing waste into fibers, referred to as “shoddy,” is not as prevalent because fabric is very difficult to recycle by current recycling methods, which have changed little in the last century. Fabric has a tendency to jam up shredding machines and special finishes, such as new nanotech stain-resistance finishes, melt and gum up the machinery (Ward, 2006). The proliferation of fiber blending in fabric production decreases the scrap quality, making it useful for only low-quality products. Many clothing donation centers either refuse to accept or charge a handling fee for damaged and soiled clothing. On the other hand, Patagonia’s use of the ECOCIRCLE™, a fiber-to-fiber recyclable polyester, in its Capilene® baselayers allows for easy and valuable fiber recycling. In 2005, Patagonia was one of the first global apparel companies to accept its used clothing back for recycling, as part of its “Common Threads Recycling Program” (“Patagonia announces revolutionary...”, 2005). In 2007, Patagonia extended its program to accept any Polartec-brand fleece clothing and cotton tees for fiber recycling, making Patagonia the first global apparel company to accept competitors’ products for recycling (“Patagonia announces major...”, 2007).

While overall textile fiber recycling is on the increase, the value of shoddy covers only 10% of the costs for collecting secondhand textiles (Morley et. al., 2006). Product Ecology (PRé) Consultants (2007) consider recycling clothing to be too

troublesome and unprofitable to be worth the effort and instead recommend burning it to reclaim energy. Currently, only a small percentage of clothing is incinerated to produce energy, and those textiles that are biodegradable are rarely composted due to lack of infrastructure (Kadolph & Langford, 2002).

In the end, clothing textiles account for 3.34% (8.43 million tons) of total municipal waste generated in the US, of which only 17% (1.13 millions tons) is recovered by recycling (U.S. EPA, 2006 November). The remaining 7.3 million tons end up in landfills, where even natural fiber textiles do not decompose. In order for clothing disposal to become more sustainable, innovative recycling methods must be developed that are both profitable and supported by a readily available infrastructure. Clothing designers can contribute to recycling efforts by limiting the diversity of materials in a garment and/or designing it for easy disassembly of the different materials (Allwood et. al., 2006). Designers can also create clothing that has multiple lives or uses built into the original design, such as Connie Chen's "Five Lives" apparel design that began as a piece of clothing and then became a sewn garment, a re-fashioned garment, an accessory, and was finally reprocessed into materials for a new apparel product (Chen & Lewis, 2006).

2.2.7 LCA-Informed Eco-Friendly Design Choices

In the end, to ensure the lowest environmental impact of a garment during its entire life cycle, the following eco-friendly choices must be made in the design stage:

- Product criteria for durability reflect how the consumer will use the product, so that classic garments do not wear out too soon and fashion garments do not outlast their appeal.

- Material choices minimize both waste and the use of non-renewable resources and energy, are nontoxic and safely produced, and provide a benefit to the consumer.
- Production choices do not use toxic chemicals for whitening, dyeing, and finishing and minimize material waste by efficiently designing patterns.
- Transportation needs decrease by sourcing materials and production in places that are close to each other and the point of sale.
- Products are designed to need as little packaging as possible and can be valuably reused or recycled.
- Products are designed from materials, finishes, and constructions that require low-impact cleaning and easy repair.
- Products are designed so they can be effectively disposed through reuse, recycling, energy reclamation, or composting.

2.3 Understanding Consumers and Their Clothing Concerns

The next step in forming the eco-friendly design goals of this study was to analyze consumer needs and behaviors in order to ensure that eco-friendly apparel designs will be appealing to consumers and actually meet goals for reduced environmental impact when consumers use them. The analysis begins with the consumer, then the product, and finally combines the two by considering how consumers use products. This section refers to environmentally-driven consumers and products as *green* in order to be consistent with the referenced literature on green consumer, products, and marketing. The term *eco-friendly* is used when describing design goals and products that directly relate to the goals of this study, i.e. both reduced environmental impact and increased consumer appeal.

2.3.1 The Green Consumer: Who is she and does she even matter?

Before we embark on a hunt for the green consumer, the hunting party needs to ask itself some fundamental questions about whether their quarry is a real or mythical creature; what they would do with one if they caught it; and whether the hunt has a real purpose or whether it follows a strong hunting tradition of symbolic rituals. (Peattie, 2001, p. 187)

Since the 1970's, polls have charted consumers' growing concern about the impacts society has on the natural world (Roberts, 1995). With these findings came promises of an increasingly viable market for environmentally friendly goods. A "hunt for the green consumer" (Peattie, 2001, p. 187) was initiated to search for the special combination of variables that would reliably predict which consumers would purchase products based on their environmental concern. Traditional marketing strategies tried to apply socio-demographics, but, unfortunately, there was no consistent set of characteristics to create a predictable green consumer profile. Study after study failed to find any statistically sound relationships between demographics and green consumption; most found limited, inconsistent, overly complex, or often contradictory interactions, in part due to incompatible definitions of behavior and methods of measurement (Berger & Corbin, 1992; Butler & Francis, 1997; Diamantopoulos, Schlegelmilch, Sinkovics, & Bohlen, 2003; Minton & Rose, 1997; Roberts, 1995).

Evidence for a stronger and simpler predictor of environmentally conscious consumer behavior (ECCB) was found in consumer attitudes rather than demographics, with environmental concern (EC) and perceived consumer effectiveness (PCE) showing significant relationships with actual consumer behaviors (Berger & Corbin, 1992; Roberts, 1995). PCE, defined as the degree to which people think they can create a positive change through consumer choices, was once considered a part of EC but demonstrated strong support as an independent moderator

between EC and ECCB in that EC had a greater effect on ECCB when PCE was high (Berger & Corbin, 1992). In other words, people who are very concerned about the degradation of the environment (high EC) but think that they are helpless to affect it (low PCE) will be less likely to make green purchases (ECCB). The realization of EC and PCE as two separate yet closely related consumer attitude variables seemed to explain the inconsistent findings of previous studies. This relationship between EC and PCE on ECCB has been supported by other studies (Minton & Rose, 1997; Roberts, 1995; Staughan & Roberts, 1999), making them appropriate indicators for identifying a consumer's predisposition toward green consumption.

A study by Minton and Rose (1997) brought two other factors into the environmental concern (EC) and perceived consumer effectiveness (PCE) equation: personal and social norms. Their research addressed environmentally conscious consumer behavior (ECCB) by differentiating between behavioral intentions and actual behaviors. Their findings showed that behavioral intentions were most influenced by EC, then by social norms, and finally, personal norms. Personal norms (defined as personal obligation to do something and possibly another way of testing for PCE) were the most effective at predicting actual behaviors, followed by social norms (what others think I should do), and lastly EC (p. 44). In other terms:

- Behavioral Intentions: Environmental Concern (EC) > Social Norms > Personal Norms/Perceived Consumer Effectiveness (PCE)
- Predicting Actual Behaviors: Personal Norms/ Perceived Consumer Effectiveness (PCE) > Social Norms > Environmental Concern (EC)

Peattie (2001) wondered if researchers were approaching this issue from the wrong direction. He posed the rather startling question: Do green consumers even really exist? (p. 191). He noted a key argument made by Kardash in 1974 during the early years of the green consumer hunt:

All consumers (barring a few who enjoy contrariness for its own sake) [are] ‘green consumers’ in that, faced with a choice between two products that are identical in all respects except that one is superior in terms of its eco-performance, they would differentiate in terms of the environmentally superior product. (Peattie, 2001, p. 192)

According to Kardash, green marketers should focus more on improving their green products rather than obsessing over finding the green consumer market. Furthermore, having a green product market that caters only to those considered green consumers would probably make a lot of money but do little to make a real environmental improvement, as the conventional consumers who are more responsible for causing environmental degradations would be left to continue their bad habits (Paavola, 2001). Therefore, the goal should be to attract as many consumers as possible, especially those who do not identify themselves as green.

2.3.2 The Green Product: What does the consumer want?

2.3.2.1 Consumer Compromises: Performance and Costs

Most green marketing literature is strongly based on the assumption that a consumer’s environmental awareness is a pre-condition for green purchasing. While following such a ‘behaviouristic’ green marketing both scholars and companies seem to have neglected that green products are bought only if consumers perceive the products as superior to competitors’ offerings. (Meyer, 2001, p. 317)

When promoting green products, marketers have often relied heavily on environmental claims to sell green products only to see them fail to meet general product expectations in the marketplace (Meyer, 2001; Peattie, 2001). Marketers seemed to forget that even the most dedicated environmentalist buys dish soap in order

to clean dishes and not just to save the environment, although she would really love for it to do both. This focus on designing green products to lower environmental impact with less concern about how well they worked resulted in green products with poor performance (Peattie, 2001; Meyer, 2001). By developing products that failed to meet even the most basic consumer needs for quality and function, green companies were in essence creating waste by designing useless products that would be discarded.

Concentrating on the aspects of the purchase itself, one aspect of the green purchase leaps to center stage: the price. When consumers are asked if they are willing to pay a premium for green products, their answer is usually “No” (Ottman, 1999). On the other hand, Peattie (2001) thought that market researchers were framing the question wrong: instead of asking if consumers were willing to pay more for a product if it helped the environment, ask them if they were willing to pay less for a product if it hurt the environment. The necessity of price premiums is debated since many green products have fewer inputs, require less energy, and possess other cost saving attributes. Some evidence for apparel products indicates a 33.8% premium for organic apparel due to higher prices for raw materials and smaller manufacturing runs that are less cost efficient (Nimon & Beghin, 1999). Many predict that organic apparel, as well as many other green products, will decrease in cost as increasing demand spurs production levels into economies of scale.

Meyer (2001) demonstrated that green consumers incur many costs other than the sticker price. Green products hold a small yet growing market share, yet they are still difficult to find. In order to find a green product, most consumers have to invest a great deal of time and energy, resulting in a “search cost.” In addition, consumers who truly want to find the best product for them and the environment have to compare functionality and double-check the environmental claims of products, resulting in

“information cost.” If the green product is innovative, consumers may have to learn a new way of behavior in order to correctly use it, incurring a “cost of change.”

2.3.2.2 Consumer Confidence: Environmental Claims

The high prices of green products can make many consumers become suspicious of companies’ true motivations and the validity of their claims (Peattie, 2001). Little official regulation existed for any green products before the middle 1990’s, causing many consumers, green and otherwise, to speculate that these green marketing claims were exaggerated or fabricated in order to charge high prices. In all fairness, many of these companies’ intentions were probably driven by high levels of environmental concern (EC) and perceived consumer effectiveness (PCE), but unfortunately they were lumped together with those companies driven by profits.

Some consumers may still have an ingrained distrust of green products from the previous poor-quality and unfounded environmental claims (Peattie, 2001). Official legal regulations and third-party organizations are now in place, such as the USDA’s organic certification standards, to better analyze and validate environmental claims on consumer products. In a Tang, Fryxell, and Chow (2004) study, environmental labels with explanations and endorsed symbols were shown to aid in green product purchasing, demonstrating that such labels increase consumer confidence. A 2003 YouGov poll in the United Kingdom indicated a strong consumer demand for even better and clearer labeling on the part of companies about their products’ environmental impacts (Berry & McEachern, 2005). In 2007, Timberland started placing labels on the packaging on some of its shoe lines indicating “the energy used in making the shoes, the portion that is renewable, and the factory’s labor record,” with a goal of labeling all their shoes and clothing by 2009 (Cortese, 2007).

2.3.2.3 Peattie's Green Purchase Perception Matrix (2001)

Peattie (2001) attempted to explain why so many green products failed to achieve consumer support by analyzing consumer reactions to all of the attributes of the products. Peattie theorized four possible categories of green purchases (Figure 2) to be functions of the consumer's perceived degree of (1) confidence in the product (brand name, environmental effectiveness, etc.) and (2) compromise (product quality, product cost, search cost, information cost, cost of change, etc.) (p. 192). Confidence in green purchases has been a problem for consumers who mistrust marketers' claims and motivations (Peattie, 2001; Meyer, 2001), and many consumers have been unwilling to compromise product quality for reduced environmental impact. The best "win-win" green purchase scenario occurs when the consumer has a low degree of compromise in terms of cost and quality and high degree of confidence in the green product's environmental benefits. For example, energy efficient home design saves the consumer money by reducing or eliminating utility expenses, which translates into reduced greenhouse gas emissions.

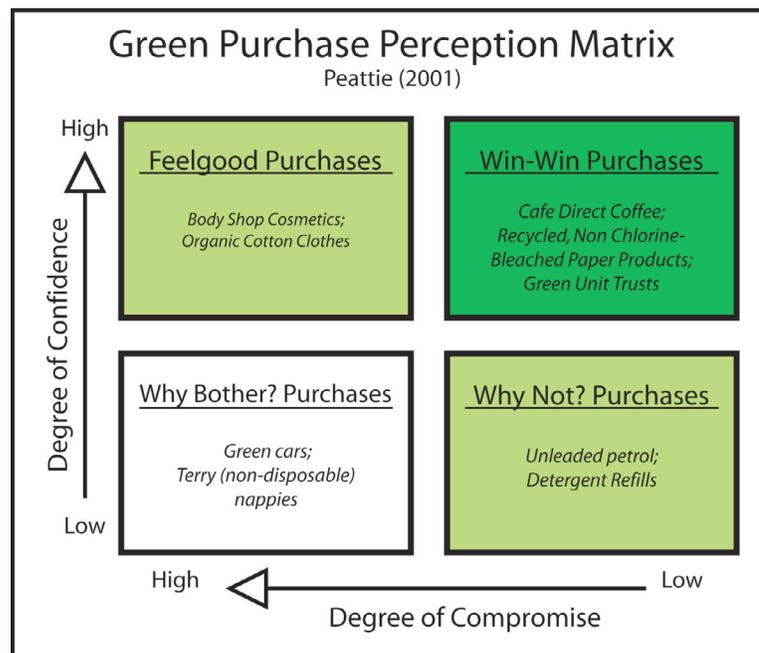


Figure 2: Peattie's Green Purchase Perception Matrix (2001)

Other researchers support Peattie's claim that green products must perform at least similar to their conventional counterparts, if not better, if they are to be embraced by consumers, regardless of a person's environmental concern. A study by Dickson (2001) showed that consumers were more likely to purchase a product based on its traditional product traits, i.e. cost and quality, than on their personal attitudes toward social responsibility. The research findings of green product researcher Robin Roy (1997) further supports Peattie's claims:

Any successful greener product must balance environmental performance against the many other design attributes – performance, reliability, appearance, etc. – wanted by the market. ...products had to be competitive in terms of performance, quality, and value for money before environmental factors entered the list of consumer requirements. (p. 41)

Therefore, when marketing green products, the needs and desires of consumers must be addressed first and foremost while the product attributes that benefit the environment and other social issues should be presented as an added plus (Donaldson, 2005; Ottman, 1999). Manzini (1992) considers green consumerism to be part of “a demand for a new quality” (p. 8). Today, more green companies focus on offering superior performance, competitive prices, and transparency about environmental claims (Donaldson, 2005). By striving to achieve superior performance and consumer appeal, eco-friendly design can set the standard for production and consumption rather than be viewed as a mere alternative to conventional design.

2.3.2.4 Consumer Requirements for Eco-Friendly Apparel: Fit and Fashion

In order to set the standard for clothing, eco-friendly apparel design must meet all of the essential consumer requirements. It is important to consider both the reasons why consumers buy clothing and why they cease to use the clothing they have. It is estimated that millions of dollars worth of potential sales are lost due to ill-fitting

clothing designs (“AlvaProducts...”, 2005), and one in three catalogue clothing purchases are returned because of poor fit (Gardyn, 2003). In addition, Koch and Domina’s (1997) study found that participants (mostly college students) were most likely to get rid of clothing when they no longer fit, while they were least likely to dispose of clothing because it is out of style or they were tired or bored with them. Koch and Domina note that this finding of the importance of fit over fashion may be due to the lower incomes of their sample. This study did not specify why the fit was bad: was it always bad, did the person’s body change, or did the size of the clothing change? Regardless of the reason, the life of most clothing may end not when it is unfashionable or unusable but when it no longer fits.

The fit problem is a result of how sizing systems are developed in the current apparel industry. Apparel designers create clothing to fit an idealized body size and shape as realized by a single “fit model;” in women’s wear, this fit model is usually a size 8 with an hourglass figure (Campbell & Chase, 2004; Gardyn, 2003; Reda, 2006). The fit model’s pattern is scaled up and down using a grading system in order to make the other sizes, assuming that all women are proportionally smaller and bigger versions of one another. The SizeUSA sizing survey revealed the major inaccuracies of the assumption that one shape can fit all, especially the hourglass shape women’s fashion has chosen. According to the SizeUSA findings (Table 6), only 8% of women in the US have an hourglass shape, while the majority of women have a rectangular shape (46%), then spoon or pear shape (21%), and third, an inverted triangular shape (14%) (Istook, 2005). Furthermore, the larger size a woman is, the less likely she will be an hourglass shape. Since the majority of retailers use a fit model and grading system that caters solely to this shape, most women above size 12 are unable to find clothes that fit properly (“AlvaProducts...”, 2005).

Table 6: Top Four USA Body Shapes

Table based on the SizeUSA findings from “AlvaProducts...” (2005)

Body Shape	Measurements	% of USA
Rectangular	Bust and hips similar, waist less than 9” smaller than bust	46.12%
Spoon/Pear	Hips 2” or more larger than the bust, waist less than 9.25” than the bust	20.92%
Inverted Triangle	Bust 3.6” or more larger than the hips, waist is less than 9” smaller than the bust	13.83%
Hourglass	Bust and hips similar, waist 9” or more smaller than the bust	8.40%

Designing clothing that fits better is essential to meeting the clothing needs of consumers. Sizing systems must reflect the diversity of human body shapes. Some shapes have more variations than others, which will affect how many sizes need to be produced (Istook, 2005). Istook recommended developing sizing systems for the top four body shapes that encompass 89% of the population, starting with the rectangular shape of the majority. The challenge is to produce enough sizes to meet the needs of each shape without making retailers carry inventory in too many different sizes. Steps are already underway to add 3” to hip measurements on missy sizes (Istook, 2005) since current larger sizes are least likely to fit their intended markets. Retailers, like JC Penney’s that contributed to the SizeUSA survey, have adjusted their sizes and fit based on the SizeUSA fit data for their target markets (Reda, 2006).

While fit is an issue for all clothing designs, fashion, in particular, has been problematic for eco-friendly apparel design, which began by offering clothing with bland colors and sack-like fit. Many environmentalists are quick to condemn fashion for its obvious wasteful negatives, yet its invaluable positives are often forgotten, such as establishing personal identities and forming communities (Fletcher & Tham, 2003). While people must wear clothing to meet physiological needs, it is the fashion of clothing that satisfies the psychosocial needs of the individual and society. Because of these diverse drives, our closets contain everything from a sweater so comfortable it

has become threadbare in places to an old college football t-shirt worn to show school solidarity at every home game. According to Fletcher (2005), the role of fashion cannot be removed from the function of clothing, so fashion must be adapted to meet the needs of both consumer and the environment:

Fashion clothing plays a leading role in contemporary culture and its presence cannot be ignored... [yet] the way it exists today is hostile to ecological thinking. This means that a 'real world' ecology of clothing has to, by force, include fashion, but a reconceived notion of what fashion is – one that is reformulated in light of ecological values. This would mean moving away from the needy, destructive relationship that typifies many people's experience of fashion clothes today, to a more healthy, therapeutic one which champions expressiveness, difference and sharing. (p. 68)

Consumers are unwilling to compromise fashion and fit for lower environmental impact and for a good reason: they simply will not wear these clothes. Therefore, the most important design objective for eco-friendly apparel must be making clothing that consumers will want to wear, which implies that clothing has to fit their body shapes and sense of style. Designing and producing apparel that does not meet these needs for fit and fashion will not be embraced by consumers, and therefore will only add to the waste stream.

Bená Burda, co-founder and CEO of Maggie's Organics, contends that more environmentally and socially responsible clothing companies and producers need to realize that consumers' needs must be met if they are going to stay in business and make a difference (personal communication, November 3, 2006). She illustrated with a story about a woman who helped run the sewing cooperative in Nicaragua that made Maggie's clothes. During a trade show, this woman was explaining to a potential customer who was trying on a top about the wonderful social aspects of how that shirt

was made, when all the customer wanted to know was if the shirt made her look fat. Burda said that this experience helped her manufacturers understand what matters most to consumers; that they must produce a good product, not just a good story.

2.3.3 The Green Behavior: How will the consumer use it?

Instead of considering the object, the *garment*, as the focus of your design activity, visualize someone wearing and moving and enjoying her or his life in the garment that you design. Move your focus away from the object to the *person*. In that way, the shift toward sustainability can begin. (Hethorn & Ulasewicz, in press)

Many accepted principles of eco-friendly design can have a dramatically negative impact in the hands of consumers. For instance, eco-efficient light bulbs require less energy to use yet people tend to keep them on longer using more energy than they previously did (van de Velden, 2003). Eco-friendly design goals advocate shifting from selling products to selling services, yet in cases where a product is necessary for providing that service, this actually increases product consumption, such as cell phones that are constantly replaced with the latest upgraded models. In general, most efficiently-produced products result in cheaper prices because they require less energy and materials to make, but “leaner products tend to become throwaway goods and, for this reason, to proliferate” (Manzini, 2001, p. 4).

This is known as the “rebound effect” (Lilley et. al., 2005; Manzini, 2001; van de Velden, 2003) when a consumer uses or often misuses a product or service in a way that was unintended by the designer resulting in an unexpected, often negative, effect on the environment and/or society. Many apparel designers and companies are still unaware of how people use and interact with their clothing and how those behaviors can have an enormous effect on the environment. But some of the more

environmentally responsible apparel designers and companies do consider some aspects of the consumer's role. They recognize the importance of reducing the energy consumers use to clean and care for their clothing (Fletcher & Goggin, 2001), as well as offering high-quality, appealing clothing designs that consumers will want to purchase and wear.

In order to prevent the “rebound effect”, designers must consider what Jelsma and Knot (2002) term “use(r) logic”:

To increase chances for intended outcomes, such normative (re-)design efforts have to start with careful mapping of the interactions between users and their material surroundings in the reference situation, especially with respect to underlying values and logic... A design logic that aims to inscribe eco-efficiency in products and services while being insensitive to use(r) logic makes little chance to enroll users in new ways. (p. 124)

Designers must be aware of and, better yet, know how to influence use(r) logic if they want to achieve sustainable clothing consumption. For example, if eco-friendly clothing were designed to offer better, adjustable fit, the desired outcome would be that consumers would buy less clothing over time. Yet this may go against use(r) logic. As previously mentioned, poor fit often limits what people will buy, so if it were easier for people to find clothes that fit them, they may buy more clothes than they previously did.

In the UK during the last 10 years, new clothing sales volume has increased 60% (Morley et. al., 2006) while the price of women's clothing has decreased 34% (Beckett, 2006), suggesting that consumers are buying more cheap clothing. Very rarely, and never as continuously, have prices gone down so dramatically as consumer demand has increased, yet this trend is expected to continue indefinitely (Beckett, 2006). Whether this dramatic increase in clothing consumption is mainly due to the

lower prices that allow consumers to purchase more for the same amount or to the lower quality of cheap clothing that need to be replaced more often is unclear, but it is probably a combination with both reasons reinforcing each other. *The Guardian*, a UK newspaper, interviewed a woman leaving a value retail shop who had purchased the same cheap handbag in nine different colors; when asked why, the woman replied “You never know when a bag is going to come in handy when they’re £3 a time” (Beckett, 2006), demonstrating a “more for less” mentality. Yet a UK consumer pool showed that over 60% of participants noticed that in the last three years, clothing lifetimes had decreased and clothing was becoming lighter, showing that current clothing has a decreased usefulness and lower quality (Morley et. al., 2006).

Ironically, in making products more efficiently and from fewer resources, steps that should have helped the environment only made products cheaper so that consumers could buy even more. Consumers either bought more of the same products or spent the extra money on other, more environmentally-unfriendly expenditures, such as long-distance travel, that resulted in no net environmental improvement (van de Velden, 2003). In order to achieve social and environmental fairness, Western countries need to decrease overall consumption levels and share environmental resources with the rest of the world. Some may argue that it is impossible to change human behavior, but appealing to some deeper value and logic can influence people to change their ways in order to better reflect those inner values.

Reducing consumption in the apparel industry may be helped by higher prices as a result of making better fitting, better quality products. Better fitting more consumers would likely require a greater number of sizes, which would mean lower production levels per size or even custom production. Better quality may use more resources and labor but still could be environmentally and socially responsible. Paying a fair price for environmental resources and sewing labor will most likely require a

higher price. Phil Patterson, representative of the socially responsible UK retailer Marks & Spencer, argued that the future of retail should be higher prices for better products, since lower prices did not help anyone as greater volumes of cheaper products only made consumers buy and waste more (personal communication, November 16, 2006).

2.3.4 Consumer-Informed Eco-Friendly Design Choices

Eco-friendly apparel designers put the needs of the clothing consumer first in the product criteria, and then find ways to meet those needs that reduce net environmental impact with special attention to how the consumer will actually use the product. Eco-friendly clothing supplies similar, or hopefully superior, quality and performance compared to conventional clothing in terms of fit, durability, and style, which, according to Kardash in Peattie (2001), ensures that any consumer, green and conventional, will be interested in purchasing them. The eco-friendly objective of better meeting consumers' clothing needs encourages consumers to actually purchase less clothing overall because improved eco-friendly clothing will fit them and last longer. In order to accomplish this, consumers must realize the personal benefit of investing in fewer, high-quality clothing items that will better meet their needs rather than wasting money on cheap clothes that do not fit or last, which in turn benefits the environment through reduced overall resource consumption.

2.4 Innovative Eco-Friendly Design Approaches

Research of new and innovative eco-friendly design approaches was the final step that informed and inspired the goals of this study. These design approaches provide a way of using the information from the LCA and consumer analyses to achieve new, eco-friendly consumer-product interactions. These new interactions can

inform us about our environmental impact, how to adapt to our current needs in ways that offer both the sustainability of the environment and the advancement of society, and how to engage us in more creative and meaningful relationships. This section discusses three innovative approaches that can be applied to eco-friendly designs.

2.4.1 Promoting Awareness Through Design

Users are able to make thought through decisions if they are aware of the situation they are in, the situation they would like to be in and the way they can get there. Just as it does for other behaviours, people just need to link action with consequence to feel the effect of their actions and make an association. They need to be aware of the consequence. (van de Velden, 2003, p. 7)

In order to reign in the consumer “rebound effect,” van de Velden’s paper on “Using Awareness in Product Design to Influence Sustainable Behaviour” (2003) recommended designing mechanisms into products that alert consumers to the effects of their behaviors, such as when they are using too much energy or water. Design examples of this strategy include lamps that melt when left on for too long or t-shirts with screen-printed logos that change color in harmful UV light. In order to best implement this strategy, van de Velden concluded that we must “inform consumers in a transparent way and through that offer them an honest choice” (p. 7). This means putting consumers in control of understanding and changing their own behaviors by using a positive approach to product design and marketing. In order to achieve this, he concluded that design must enable behavior changes rather than enforce them, inform all consumers, and be transparent without lying or becoming confusing. Promoting awareness by design ensures that when consumers use eco-friendly products, their behaviors actually help reduce environmental impact rather than enhance it. This eco-

friendly design approach requires the understanding gained from the entire LCA on clothing, with special attention to the consumer use stage.

2.4.2 Nature as the Ultimate Design Model

Nature – highly industrious, astonishingly productive and creative, even “wasteful” – is not efficient but *effective*. Consider the cherry tree. It makes thousands of blossoms just so that another tree might germinate, take root, and grow. Who would notice piles of cherry blossoms littering the ground in the spring and think, “How inefficient and wasteful”? The tree’s abundance is useful and safe. After falling to the ground, the blossoms return to the soil and become nutrients for the surrounding environment. Every last particle contributes in some way to the health of a thriving ecosystem. “Waste equals food” – the first principle of the Next Industrial Revolution. (McDonough & Braungart, 1998, p. 86 & 88)

“Waste equals food” is the definition of cyclical consumption, and it is the way nature has always worked. Unfortunately, humankind has been less effective with its systems of consumption by focusing only on creating and using yet ignoring dismantling and disposal impacts. Some companies are beginning to look at the end of the consumption cycle, such as Patagonia’s “Common Threads” program that achieves a fully cyclical production process from fibers back into fibers, made possible with an innovative polyester fiber and consumer take-back initiatives (“Patagonia announces revolutionary...”, 2005). Yet nature is doing more than just reusing its waste, it is constantly improving to meet current demands. In order for systems of production and consumption to be truly sustainable, they must be able to adapt to new situations and offer continuous yet balanced improvement, to evolve just like nature.

Manzini (1992) stated that the foremost aim of eco-friendly design must be “the search for ‘error friendly’ solutions that are able to coexist with the human tendency to make mistakes” (p. 17). Errors are an inevitable fact of both human’s and nature’s endeavors, as we must react to life’s perpetual change and variation. Anticipating errors may seem like an unrealistic task requiring designers to foresee the future, but we only have to look at nature, the greatest designer of all, for a working model for finding solutions and handling errors. From the elements it uses to the relationships it forms, nature creates a resilient system that sustains itself while providing limitless opportunities for growth and innovation. Eco-friendly designs can mimic nature’s ability to react and adapt to ensure, at best, our continuing prosperity and, at least, our continuing existence. Nature as a model for eco-friendly design relies heavily on the LCA and consumer analyses to inform the design choices that will produce the most resilience over time and in the future by determining how a product’s production waste and disposal can feed other products and how the consumer’s needs will change over time.

2.4.3 Designing Engaging and Meaningful Relationships between People and Products

The environmental problematic can generate a new sensuous horizon for design and can be the source of a vast series of cultural transformations and contemporary societal practices... a system of consumer production more favorable to the environment but also to propose new values and deeper conceptions of quality. (Manzini, 1992, p. 5)

Improved user-experience has begun to surpass style as the ultimate design goal. Manzini argues that we are living in “a throw-away world that requires no effort but, at the same time, produces no real quality” (1992, p. 20). Industrial designer Uday

Gajendar (2004) calls for designers to subscribe to a model of beauty that centers on user-experiences. One way he defines this beauty is through the words of John Dewey, American pragmatist philosopher. Dewey coined the term “experiential beauty- a harmonious balance of the maker’s intent and the perceiver’s expectation towards a meaningful consummation of movement of emotion from inception, carried through development, and ending with an artifact that lives in experience” (p. 4).

By using experiential beauty as a design goal, designers have the opportunity to create products and services that not only improve user-experiences but also promote eco-friendly consumer behaviors. Design examples of this strategy include the iPod that has transformed music purchases to digital rather than physical and eBay that provide a virtual platform for people to purchase unique and often used goods instead brand new products at traditional retail stores. These enhanced user-experiences help form both personal identities and social communities, added values that are appreciated by many consumers regardless of their personal environmental concern. Eco-friendly design for enhanced user-experiences can create a strong and meaningful connection between the product and consumer so that the consumer will take better care of that product, keep it longer, and hopefully need or want fewer products overall. Executing this design approach requires an understanding of what consumers want from their products.

CHAPTER 3

DESIGN PROBLEM AND APPROACH

3.1 Design Problem

The basic assumption of this research is that people will continue to use clothes in the foreseeable future as a means of protection and personal identity. A Life Cycle Analysis (LCA) of clothing showed that the largest environmental impacts are a direct result of consumer behaviors, such as cleaning and length of useful lifespan. These behaviors are influenced by the choices made by the apparel designer, from the materials used to the sizing of the clothing to the consumer's relationship with the clothing. In order to truly produce a net environmental improvement, apparel designers must understand and consider both what consumers want from their clothing and how they will use their clothing. It is vital that eco-friendly designs appeal to all consumers, not only green consumers, as conventional consumers are probably more likely to behave in ways that cause environmental harm. The main research question for this study was: **how can eco-friendly apparel design re-think, or “re-fashion,” consumer interactions with clothing in order to cause less environmental harm while also meeting or exceeding consumer wants and needs?**

3.2 Design Approach

The purpose of this study was to create a collection of innovative eco-friendly apparel designs and then evaluate the effectiveness of those designs. This involved a three-phase design approach (Table 7): generate design goals, create design concepts, and evaluate design collections.

Table 7: Outline of Design Approach

PHASE 1: Generate Design Goals

- 1- Develop an initial list of Eco-Friendly Apparel Design Goals based on the literature review
- 2- Solicit eco-friendly design experts to evaluate design goals resulting in a finalized list of Eco-Friendly Apparel Design Goals
- 3- Develop a new eco-friendly design framework: The ERRor-Friendly Framework, and relate it to Eco-Friendly Apparel Design Goals

PHASE 2: Create Design Concepts

- 1- Develop design concepts based on design goals
- 2- Design an apparel collection to embody each design concept
- 3- Evaluate each design collection during design critiques

PHASE 3: Evaluate Design Collections

- 1- Exhibit the five resulting design collections at a local venue
- 2- Collect data on success of design collections by questionnaire
- 3- Analyze questionnaire results using descriptive statistics to summarize results as well as chi square analysis and Fischer's Exact Test to determine any significant relationships

During the first phase, design goals were established that would guide the development of the design collections. The main motivations for these design goals were to provide improved products that would better serve consumers and increase environmentally responsible consumer behaviors. An initial set of design goals was derived from the literature review. Then, eco-friendly design experts were interviewed to provide qualitative feedback about these goals. These experts were identified based on their work researching and designing eco-friendly initiatives in the industry. With their feedback, a finalized list of Eco-Friendly Apparel Design Goals was produced. The expert feedback, design goals, and literature inspired the development of a new eco-design framework for this study called the ERRor-Friendly Framework: *effective*, *resilient*, and *relational*. The overall objective of this study evolved to demonstrate the principles of the ERRor-Friendly Framework related to the specific Eco-Friendly Apparel Design Goals.

During the second phase, innovative design concepts were developed that addressed the Eco-Friendly Apparel Design Goals and embodied at least one of the three principles of the Error-Friendly Framework. Each design concept was executed into a collection of apparel products through a process of researching current fashion trends, developing a series of sketches and mock-ups, and creating the finished products. The designs were evaluated during two scheduled design critiques by a panel of three to four design critics for creativity, feasibility, and eco-friendly initiatives. A total of five design concepts were generated, evaluated, refined, and executed into five eco-friendly apparel design collections including two *effective* designs, one *resilient* design, and two *relational* designs.

The success of the five eco-friendly apparel design collections was evaluated in the third phase. The final design collections were exhibited for two weeks at an art gallery in downtown Ithaca, NY. During the exhibit's opening night event and the duration of its mounting, exhibit-goers were asked to evaluate the designs by completing a questionnaire. The questionnaire gathered feedback about which designs were the most successful in terms of consumer appeal and the potential to influence eco-friendly consumer behaviors. The questionnaire data were analyzed using descriptive statistics to provide a summary of the design assessment results. Chi square and Fischer's Exact Test were conducted to test for any significant relationships between the participants' consumer types, either green or conventional, and how they responded to the design assessment.

CHAPTER 4

PHASE 1 - DESIGN GOALS

In order to determine the most essential and appropriate design goals for this study, an initial set of Eco-Friendly Apparel Design Goals was developed based on the literature review about environmental concerns and consumer needs. Five eco-friendly design experts were interviewed to gather feedback about these goals as well as to inspire ideas for eco-friendly apparel designs, resulting in a finalized list of Eco-Friendly Apparel Design Goals. From this process an environmental design framework was developed: the ERRor-Friendly Framework. The design objective for this study was to illustrate the principles of the ERRor-Friendly Framework while addressing the specific Eco-Friendly Apparel Design Goals.

4.1 Eco-Friendly Apparel Design Goals

Eco-friendly design goals for apparel were developed to promote the reduction or adjustment of the consumer clothing behaviors that cause environmental harm and to design clothing that better meets consumer needs. An initial set of goals was developed based on the literature review: a Life Cycle Analysis (LCA) of clothing; research on green consumerism, green products, and clothing consumers; and innovative eco-friendly design approaches. The result was a list of seven Eco-Friendly Apparel Design Goals (Table 8) that spanned the life cycle of a garment, from materials to disposal. At the center of these goals were the materials and product designs, the two choices designers have the most control over. Material choices influence Eco-Friendly Materials, Reduced Care, and Effective End, while product design choices can achieve Transformable Forms, Improved Fit, New Life, Re-Thought Life Cycle, and Effective End.

Table 8: Initial List of Eco-Friendly Apparel Design Goals

- **Eco-Friendly Materials:** low-impact materials that provide added value to the consumer
- **Transformable Forms:** clothing that has updatable/transformable forms, multiple uses that possibly go beyond apparel
- **Improved Fit:** clothing that fits better, perhaps adjustable fit; new method of defining or assigning fit (body shape in addition to body size)
- **Reduced Care:** clothing that requires low-impact care or less care
- **New Life:** refashioning old clothing to give new form and useful purpose
- **Re-Thought Life Cycle:** addressing the entire life cycle of a garment during the design conception to achieve a new and enhanced consumer experience compared to a conventional garment
- **Effective End:** using materials that can be perpetually recycled (fiber-to-fiber) or composted, designing for easy recycling

The Eco-Friendly Materials goal addressed the need for eco-friendly materials not only to have a low environmental impact during production but also to offer valuable features appealing to consumers, such as comfort, durability, and style. The Transformable Forms goal aimed to increase the usefulness and lifespan of clothing by designing clothing that transforms in style or changes into other types of products. The Improved Fit goal created clothing that provides better fit with the ultimate goal of providing a system of adjustable fit so that consumers can continue to use the same clothing as their bodies change over time. The Reduced Care goal worked to reduce resource use for cleaning clothes by designing clothing that can be effectively cleaned using low-impact methods, such as cold water and hang drying, or that needs to be cleaned less often due to durable designs that prevent spoilage. The New Life goal prevented old clothing from becoming waste by finding creative ways to refashion them into new and useful products. The Re-Thought Life Cycle goal re-thought the entire life cycle of a garment during the design conception in a way that better meets the needs of consumers and allows for a long, useful, and meaningful life. The Effective End goal ensured that clothing waste could become food for other products

by using materials that decompose or can be recycled, and designing clothing that can be easily disassembled for effective recycling.

4.2 Eco-Friendly Design Expert Feedback

Five eco-friendly design experts were interviewed to evaluate and improve upon the Eco-Friendly Apparel Design Goals and design concepts. These five experts were chosen based on their credentials of design work and research in the field of eco-friendly apparel design. They were contacted with a cover letter or e-mail requesting their participation in my research (Appendix A) and an outline of the interview questions with the list of Eco-Friendly Apparel Design Goals (Appendix B). The experts agreed to participate in short interviews that were audio recorded either in person or over the phone. The interviews began with two questions focused on the experts' own work. The first question asked how their own eco-friendly design work benefits consumers, and the second question inquired how they thought their designs might promote eco-friendly consumer behaviors. The interview ended with three questions focused on Eco-Friendly Apparel Design Goals. First the experts were asked to identify which of my design goals they thought would most likely promote eco-friendly consumer behaviors and why. The last two questions asked the experts to suggest other design goals to include and if they had any ideas for design concepts that could meet my goals. The recorded interviews were later transcribed for analysis. Their answers to the first two questions about their work were used to describe the experts' unique interpretations of eco-friendly apparel design. Their responses to the last three questions about my research were used to refine the final design goals for this study and inspire apparel design concepts that could meet those goals.

4.2.1 Natalie Chanin- October 25, 2006

Fashion designer Natalie Chanin co-founded the socially and environmentally responsible fashion business Project Alabama and was currently starting a new business called Alabama Chanin with similar principles. Her work with Project Alabama and her new line promoted the preservation and revitalization of what she calls the “living arts,” skills such as hand-sewing, cooking, and gardening. Chanin believed these “life-giving skills” are a necessity if we want to achieve true sustainability:

We can build all the sustainable communities that we want and put all the sustainable products into a room, but if you do not have people to carry on the traditions and bring that community to life, it is not a sustainable community.
(personal communication, October 25, 2006)

I considered Chanin’s work as an embodiment of my New Life goal, as she transformed used t-shirts into beautiful, high fashion garments. She agreed that all my goals helped to make apparel products better for people and the environment, especially prolonging usefulness, reducing energy from care, and creating compostable clothing that could go back to the earth. Yet her design focus was always on sustaining people not just products. She felt strongly that eco-friendly design should empower people to be self-sustaining; she does this is by teaching time-honored traditions of gardening, cooking, and sewing. With sewing in particular, most people have lost once-necessary sewing skills, making them uneasy about cutting into a garment in order to refashion it or even to make simple alternations. Chanin noted that high fashion is so intimidating that people do not really feel they are allowed to change their own clothing to meet their needs. She suggested that I could be responsible for teaching people to honor, engage, and master their clothing.

4.2.2 Otto von Busch- November 1, 2006

Otto von Busch was a PhD candidate in the fashion design program at Göteborg University, Sweden when I interviewed him. His current work focused on developing ways for everyone, from manufacturers to consumers, to become “hackers” of the fashion design system so they all can be included in the clothing design process. In order to accomplish this, he argued that designers should be guides who inspire rather than dictators who instruct. His current project was creating “cookbooks” called ReFashion Manuals that teach people the skills to remake their clothes. Von Busch proposed that this re-fashioning promoted not only extended use of resources but also a deeper personal connection with clothing, making the process “up-cycling” rather than just recycling:

I make cookbooks, small manuals for how to change clothes to something else. ... Another thing that happens then is hopefully people choose the clothes they already have some kind of connection to, a kind of a “teddy bear” factor, and they want to make them live longer. What might be the biggest investment that they actually do is invest the time in these garments. ... What is fascinating when you dissect the garments is that you also get another understanding of how garments are reversed engineered and what this second skin actually is. Perhaps you touch them and feel the quality again, and you are reminded of what a nice garment this was. Or maybe once you started doing this you do not like it anymore, and it can fail actually. I think that is also just like cooking; sometimes you fail but that actually makes you a better cook. (personal communication, November 1, 2006)

Von Busch considered my Reduced Care goal to be closest to his method of eco-design; as people get to know their garments better through refashioning them, they are more inclined to better care for them because of the added time and emotional

investments. But he suggested that Reduced Care should encompass more than just product maintenance; it should consider how we connect with our clothing. He recommended that I change people's relationships with their clothing. For example, one of the design kits he sold or traded included the materials needed to embroider over a clothing stain, inspired by his personal experience with a stain he received during a dinner event that he wanted to remember:

While embroidering, it manifested a memory onto this garment, which picked it out of the fashion cycle. Now the colors are wrong, everything is wrong with the shirt because it is a few years old. What happened is that moment has totally lifted it up [out of the fashion cycle] and now I only value [the shirt] for the stain, or the memory of the [dinner event that produced the] stain. (personal communication, November 1, 2006)

Von Busch also saw great potential with the Transformable Forms and Improved Fit goals working together to offer people ways to update their cherished clothing to fit their bodies and tastes as they change over time. He mused at the possibilities for the future of fashion, "What if Chanel's next line was a manual of how to refashion last year's clothes?" (personal communication, November 1, 2006).

4.2.3 Bená Burda - November 3, 2006

Bená Burda was the co-founder and owner of Maggie's Organics, a socially and environmentally responsible apparel basics and accessories company. Maggie's roots were in using environmentally responsible materials but the business later expanded its goals to include fair trade production. It was the longest surviving organic clothing company at the time of interview and Burda attributed that longevity to its ability to design itself out of mistakes and knowing its customers. Maggie's target market was the LOHAS (Lifestyles of Health and Sustainability) consumer. As

Burda explained, LOHAS consumers wanted to be intimately connected to what they consumed, and they did this by investigating the stories of how products were made, by whom, and from what. At the same time, LOHAS consumers despised product hype and distrusted advertising, especially ads that verged on lies. Instead, they depended on advice from their friends when deciding which products to consume.

Burda considered my research objectives on the cutting edge because they rethought the entire life cycle of apparel rather than merely replacing bad components with better ones. Of the specific design goals, she was most intrigued by the Transformable Forms and Improves Fit goals because of their emphasis on meeting consumer needs, which she believed is the first and most important step of developing a successful eco-friendly design:

We try to improve our consumers' satisfaction with their clothing, and I think the first step in that is a successful design that makes consumers feel good about themselves. . . . I think that it starts there, and then the consumer knows that it is sewn by a group of women in Nicaragua who built their own building that it is made from organic fabric, and that it is going to last a long time, and all that is just an extension. (personal communication, November 3, 2006)

4.2.4 Kate Fletcher- November 15, 2006

Kate Fletcher earned her PhD from Chelsea College of Art and Design, UK, on the topic of eco-fashion design in the textile industry. Since then, she has worked on many projects and published numerous journal articles and a new book on this topic. She has been a researcher and teacher of sustainable fashion design and has also worked as a consultant for apparel companies interested in greening their clothing designs and production. Fletcher disagreed with current environmentalist rhetoric attacking fashion and its myopic focus on materials:

One thing that I really hate is the idea that fashion isn't important. Lots of what you see written on eco-textiles and fashion generally talks about [it as] something you mustn't engage with and that is moralizing clothing. It's bad, implicitly. ... I came to that view from understanding a little bit more about human need. We have a whole rash of human needs, and some of them are materially based and some of them are things like creativity. And in order to meet the needs of creativity, we have to start engaging in things. Actually, true sustainability can be reached by just giving people things that encourage creativity as well as opportunities to interact and have leisure. True sustainability needs all of these aspects to be met and not just a material efficiency, which is very much where most of the conversation lies now. (personal communication, November 15, 2006)

Fletcher's positions on these topics inspired her current design focus: to create "user-makers, trying to engage people with their garments and make them active citizens" (personal communication, November 15, 2006). These "user-makers" create their own unique fashions that reflect and define their local environment and personal identity rather than buying into the monocultures of seasonal fashion trends. Rather than designing physically durable clothing, Fletcher focused on promoting emotionally durable and eco-friendly disposable clothing that meets people's ever-changing emotional needs. Much like von Busch and Chanin, Fletcher recommended developing consumer-engaging designs that were simple and enjoyable in order to overcome people's fears of inadequacy and empower them to be their own designers.

Of all my goals, Fletcher believed that Reduced Care would result in the greatest environmental improvement. She was an advocate for designing clothing with low-impact care requirements. She proposed that designers should educate consumers about what the product actually is so they know how to better care for it, citing studies

that show people are ignorant of material types and how to care for them accordingly. She also recommended reevaluating our society's demanding definition of cleanliness as a part of proper hygiene. Her "No Wash" design in her "5 Ways" project (Earley & Fletcher, 2003) pushed the boundaries of common decency a bit too far, she admitted, but hopefully some people realized that their standards for cleanliness were just as ridiculously extreme. Overall, Fletcher argued that the current role of eco-friendly fashion designers should be to "create images of *what might be*," to provide a "mass of answers" (personal communication, November 16, 2007).

4.2.5 Janet Hethorn- January 2, 2007

Janet Hethorn was a professor of Fashion and Apparel Studies at the University of Delaware. Her research focused on clothing fit and the body, gang and subcultural uses and meanings of clothing, and sustainable fashion. In general, she contended that good design leads to sustainable products that meet the needs of people and, as an extension, the environment, while bad design only leads to waste. Hethorn advocated that good design is tailored to meet a specific person's needs:

If we are to sustain people, we need to look more closely at individuals—who they are, what they want to wear, what they need. By thinking about people as a group, the opportunities for sustainable design narrow. In fact, I would argue that a goal for hitting the center of a target market breeds waste. It means that there are many people on the fringes whose needs are not met, perpetuating many fashion items that are unacceptable, flawed, or left for discounted secondary choices. (Hethorn & Ulasewicz, in press)

In the case of clothing, Hethorn considered good design to specifically relate to the use of quality materials and ensuring proper fit. She considered that most current mass-produced apparel designs create waste because of their cheap materials that wear

out quickly with no possible afterlife uses and their poor fit of the population's diversity of body sizes and shapes. Hethorn saw Improved Fit as a necessity for eco-friendly clothing design, as well-fitting clothes are loved and cherished by people. Improved Fit not only ensures a long useful life for the garment, but more importantly, helps individuals feel personally uplifted by wearing garments that fit well, producing a society of empowered people.

4.2.6 Finalized List of Eco-Friendly Apparel Design Goals

Based on the feedback from the eco-friendly design experts, the list of Eco-Friendly Apparel Design Goals (Table 9) was finalized to include only the most effective and achievable. Eco-Friendly Materials was refined as using a variety of eco-friendly materials that provide a diversity of eco-friendly options to choose from, inspired by Fletcher's comments on the fashion industry's current focus on eco-friendly materials. In addition, those materials have to be high-quality so that clothing designs can be used and reused for a long time, inspired by Hethorn's comments about cheap clothing being designed waste. Transformable Forms focused on offering updatable or transformable features so that consumers could mix and match their clothing styles, inspired by von Busch's comments of how interacting with clothing inspires better understanding and stronger appreciation. Improved Fit maintained its intention for providing adjustable fit and styles that flatter multiple body shapes, influenced by Burda's comments about women's fluctuating sizes and that good design starts with meeting the needs of the consumer. Reduce Care became Informed care as it now promoted eco-friendly clothing cleaning behaviors as well as encouraged people to maintain their clothing through repair and reuse, inspired by Fletcher's comments that designers should educate consumers about reducing clothing care impact to have the most directly positive effect on the environment.

Table 9: Finalized List of Eco-Friendly Apparel Design Goals

- **Eco-Friendly Materials:** promoting a diversity of low-impact materials that provide added values of high quality, durability, and easy care
- **Transformable Forms:** clothing that has updatable/transformable forms
- **Improved Fit:** clothing that flatters body shapes and provides adjustable fit
- **Informed Care:** educating consumers about the environmental impacts of the clothing life cycle and how to reduce the impact of their clothing care, encouraging them to become more involved in the upkeep of their clothing
- **New Life:** giving old clothing a new and improved life by empowering them to interact with their clothing in a creative way
- **Re-Thought Life Cycle:** addressing the entire life cycle of a garment during the design conception to achieve a new and enhanced consumer experience compared to a conventional garment
- **Effective End:** clothing that can be easily disassembled for recycling

The New Life goal focused on reuse by providing creative ways for people to engage with their old clothing and give it a new, useful life, inspired by Chanin, von Busch, and Fletcher's comments about people needing engaging and creative relationships with their clothing. Re-Thought Life Cycle maintained its objective of taking a current garment type and redesigning its entire life in order to better meet the original meaning of that garment's use. Effective End proved to be the hardest goal to achieve due to the unavailability of fully compostable or recyclable materials. It was restated to focus on improved facilitation of current recycling methods by constructing garments from one uniform material or from different materials that can be easily disassembled.

4.3 The Error-Friendly Framework

At this point, the inspiration gained from the expert interviews and three innovative eco-friendly design approaches (promoting awareness through design, nature as ultimate design model, and designing engaging and meaningful relationships) formed a central eco-friendly design framework: the Error-Friendly

Framework. It is proposed as a guide to eco-friendly design that could apply to all types of design, not just apparel. The title and central theme of this framework were directly inspired by Manzini's (1992) statement that the foremost aim of eco-friendly design must be "the search for 'error friendly' solutions that are able to coexist with the human tendency to make mistakes" (p. 17).

The basic argument of the ERRor-Friendly Framework is that systems of production and consumption must be able to adapt to new situations and offer better solutions, to continuously evolve just as nature does, in order to be truly sustainable. In addition, errors are seen as inevitable in design as the result of life's perpetual change and variation. Nature's ability to react and adapt can be our working model as we apply its three main principles: *effective*, *resilient*, and *relational* (Table 10). The overall objective of this study was to apply these three principles of the ERRor-Friendly Framework in the specific Eco-Friendly Apparel Design Goals.

Table 10: The ERRor-Friendly Framework

E- *Effective*: form cyclical systems of consumption

R- *Resilient*: support and foster diversity

R- *Relational*: develop cooperative and meaningful relationships

4.3.1 *Effective*

Nature disposes errors through an effectively designed system of perpetual cyclical consumption in which everything consumes and is consumed. This natural process is the basis for McDonough and Braungart's sustainable design concept "cradle to cradle" (2002a). Their solution to the problems of our current industrial society is the elimination of unusable waste by designing and implementing materials and processes that allow all waste to become food for another process. In an effectively designed system, the errors become food for new solutions. The *effective* principle can be realized in apparel design through the goals for Eco-Friendly

Materials, Informed Care, and Effective End that create a cycle of production and consumption that reduces resource use and enables product waste to become food for other products.

4.3.2 Resilient

Nature develops its ceaseless ecological solutions through the process of evolution. Evolution relies on the continual pursuit of diversity in the hope that some of the variations will be more apt, or fit, to survive given the demands of the current environment. As Paul Hawken, author of the provocative book “The Ecology of Commerce” (1993), asserts that “nature depends on diversity, thrives on differences, and perishes in the imbalance of uniformity. Healthy systems are highly varied and specific to time and place. Nature is not mass-produced” (p. 12). Diversity allows life to constantly adapt to its dynamic environment, making life resilient to whatever changes may happen. Resiliently designed systems support and foster diversity in order to produce solutions for a variety of potential problems, and thus, be prepared for whatever the future may hold. For example, if a super pest emerges and destroys all the organic cotton crops in a region, another eco-friendly fiber must be available to take its place, such as Tencel® made from sustainably harvested wood. Resilient, in essence, means error-friendly; it is the ability to recover, in this case, from design errors. The *resilient* principle can be realized in apparel design through the goals for Eco-Friendly Materials, Transformable Forms, Improved Fit, and New Life that support diversity in both production and consumption, and allow designs to adapt to changes over time.

4.3.3 *Relational*

Nature maintains effectiveness and builds diversity by establishing relationships among all things. Western society has been slow to realize the great influence its actions have on the entire world's ecosystem, environments and people. Ignorance and lack of empathy has allowed us to exploit both the environment and people to our own eventual detriment. We also need to reconnect with the fruits of our labor. When resources are taken for granted and products are devalued, it is easier for people to abuse and waste them. Meaningful relationships between people and their goods and the environment can break this cycle. The *relational* goal can be realized in apparel design through the goals for New Life and Re-Thought Life Cycle that encourage meaningful relationships between consumers and their clothing by engaging them in creative refashioning activities or designing garments. Eco-friendly apparel design can work to better reflect the meanings people ascribe to garments and enhance consumers' experiences with their clothing.

CHAPTER 5

PHASE 2 – DESIGN EXECUTION

The next phase of this study was the execution of five different design collections, from concepts to final products. The purpose of these design collections was to illustrate the three principles of the ERRor-Friendly Framework, *effective*, *resilient*, and *relational*, through the Eco-Friendly Apparel Design Goals. Each design collection had a unique design process and was evaluated in one or two design critiques conducted with a panel of three to four designers, except “The Dowry Dress,” which was completed before the critiques.

5.1 Life Cycle Analysis (LCA) Label and T-Shirts

5.1.1 Concept

The Life Cycle Analysis (LCA) Label (Figure 3) details the various environmental impacts of a consumer product during four main stages in its life cycle: Production, Packaging & Distribution, Consumer Use, and Disposal. Each category is evaluated on criteria relevant to the nature of the given life cycle stage, such as energy use and the consequent CO₂ emissions and various external environmental costs associated with production. The LCA Label functions much like the Nutritional Facts label for food. It is attached to the product at point of purchase in order to inform consumers about the impacts of their purchasing decisions as well as influence how they care and dispose of their possessions. LCA Labels can be created for almost any type of consumer product. For this design, two LCA T-Shirts, one made from conventional cotton and the other organic cotton, were analyzed to develop their own LCA Labels and embellished with logos that provoke consumers to consider the way they care for their clothes.

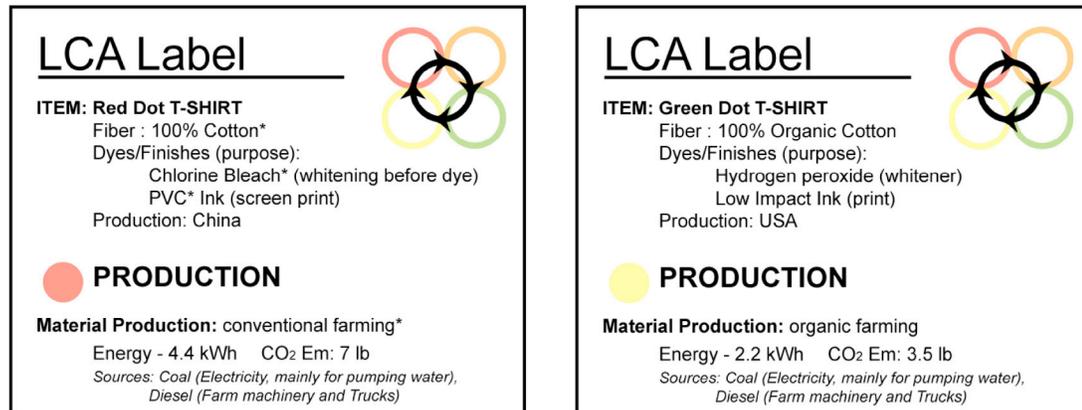


Figure 3: Life Cycle Analysis (LCA) Labels

5.1.2 Purpose

The aim of the LCA Label is to promote consumer awareness of the environmental effects of the products as they are purchased, in this case clothing. The objective is to enable informed decision making rather than simply endorsing a product as eco-friendly. By providing consumers with relevant facts and related information, they are allowed to choose which products best adhere to their needs and values. The information on these labels could also function as an intriguing starting point for consumers to conduct a more thorough investigation. The expectation is that this label will empower people to become more savvy shoppers as well as encourage them to consider the environmental effects of their other consumption behaviors. The t-shirt logos further the LCA Label's goal of consumer awareness by highlighting consumer use, which typically causes a significantly larger impact than all the rest of clothing's life cycle stages.

The LCA Label and T-Shirts represent an *effective* design by proclaiming the degree to which products achieve cyclical consumption. This design embodies my design goals for Informed Care and underlying aspects of Eco-Friendly Materials in that it provides information about their reduced resource benefits, both for the

consumer and the environment. Therefore, the consumer may be inclined to buy eco-friendly products and alter their clothing care behaviors.

5.1.3 Inspiration

The overall impetus for this design to promote consumer awareness came from van de Velden's paper on "Using Awareness in Product Design to Influence Sustainable Behaviour" (2003), in which he argued that "users are able to make thought through decisions if they are aware of the situation they are in, the situation they would like to be in and the way they can get there" (p. 7). The idea for a product label as the means for achieving this goal was supported by Berry and McEachern (2005), who cite UK consumers' increasing demand for "improved labeling... enabling the public to choose between 'good' and 'bad' companies or products" (p.71). Berry and McEachern referred to the Energy Star label as a prime example of a label that has brought major environmental improvement in product design. As more consumers began valuing energy-efficiency, this persuaded retailers to carry more Energy Star products, which in turn drove companies to make products that met the label's requirements. Based on this outcome, it is reasonable to speculate that a LCA Label could also encourage companies to reduce their environmental impacts in order to look better on the label and, as a result, more eco-friendly products would become available in more stores.

5.1.4 Design Process

The initial design step was to determine an item of clothing to label and research the environmental impacts from its life cycle. A classic t-shirt was chosen since it is one of the most common garments people wear and thus often extensively researched in clothing environmental studies. In addition, creating logos for t-shirts

provided another design opportunity that could help explain the LCA Label and possibly further its goal of consumer awareness. A general outline of a t-shirt's life cycle was compiled along with important factors that influence the environmental impacts of each stage and an inventory of potential criteria to evaluate those factors (Appendix C). A list of possible t-shirt production properties was also developed, with the objective that two or more LCA Labels would be made for t-shirts with differing environmental impacts so that consumers could compare and contrast during the final design evaluation (Appendix D).

A variety of ethical and environmental product labels were examined and applied as a foundation for the overall label design and organization, important topics to address, and methods for evaluating those topics. Two of these labels were instrumental in influencing the final label design. The "Carbon Facts" (Cascio, 2007) label supplied not only energy values but also explanations for the energy use and the resulting CO₂ emissions. The format of the "Ethical Consumer Company Rating Table" (Berry & McEachern, 2005, p. 79) offered a method for qualitative analysis that used a code of different sized and colored dots to provide a way of quantifying and comparing a variety of differing factors. These two label ideas inspired the creation of two preliminary label design formats, Appendix E a and b.

Collections of ethical and environmental t-shirt logo designs including Headline Shirts, Drapeta, and Clothing of the American Mind were reviewed and inspired a variety of design themes and styles for the LCA T-Shirt logos. The first logo theme concept had a consumer activist motivation with designs that emphasized highly toxic environmental impacts that harm the environment and our own bodies, especially women's breast milk (Appendix F a). The second logo theme had a more subdued yet thought-provoking approach of having four t-shirts create a mural that illustrated a relevant quote by McDonough and Braungart (1998) about the importance

of effectiveness over efficiency (Appendix F b). A third logo theme served to equate clothing with food, and by extension the LCA Label with a Nutritional Facts label (Appendix F c). The t-shirt logos depicted foods that were equivalent to the t-shirts' properties in order to show the "healthy" and "unhealthy" product choices.

These preliminary LCA Label designs and LCA T-Shirt logo themes underwent the first of two design critiques. The objective for this first critique was guidance from the design critics on what topics to include on the label, how to make the most effective label design, and which t-shirt logo themes were the most appealing. The critics recommended concentrating on topics that consumers are concerned about and most directly affected by, such as increasing energy costs. They stressed the importance of consumers being able to determine what is good and bad, possibly through comparison to some standard. The critics thought the two preliminary labels had too much information and were difficult to understand. In order to retain the complexity of the consumer use section, they suggested creating an interactive program that consumers could input their clothing cleaning habits and receive the resulting costs and environmental impacts of their care behaviors. The critics had mixed reactions to the t-shirt logo themes. A short brainstorming period about other possible logo and label concepts resulted in an idea of colored dots, red for high environmental impact and green for low environmental impact, that could be placed on the label or even on the outside of the garment, like a brand.

A new LCA Label design was developed, mixing the techniques of the previous two label designs while reducing the number of variables and amount of information. Quantitative analysis covered energy use, CO₂ emissions, and water, with explanations of sources. The critics' concept of color-coded dots that indicated the degree of environmental impact, red for high and green for low, provided a common scale that could be applied to many different factors, allowing them to be easily

compared with one another. These dots became the icon for the LCA Label and the theme for two new t-shirt logos, using the Consumer Use stage dots. The Consumer Use stage was chosen to highlight with the LCA T-shirts since it has a significantly greater environmental impact than all the other life cycle stages combined. Inspired by one of the critic's preference for logos with just text, the dots were inscribed with narrative descriptions of the types of clothing care behaviors that reflected the dot's color, one green (low impact) and one red (high impact). This new LCA Label and the dot logos for the LCA T-Shirts were presented at the second design critique. The critics loved the impact of the narratives on the dot logos; they thought the design was especially strong because it brought to life the quantitative analysis of the label and helped define the color-coded dot concept.

After the label design was approved, t-shirt properties were chosen to best show comparison between the labels and verify the data figures for those properties. This decision was largely influenced by available data from two prominent environmental analysis case studies, "Well Dressed" (Allwood et. al., 2006) and "Pricing the Environmental Impacts: A Tale of Two T-shirts" (Walsh & Brown, 1995). "Well Dressed" provided an energy life cycle assessment for a conventional cotton t-shirt. "A Tale of Two T-shirts" compared the energy inputs and a variety of environmental impacts between conventional and organic cotton production. Two LCA Labels for the two LCA T-Shirts were created: a conventional cotton t-shirt for the "Red Dot" logo and an organic cotton t-shirt for the "Green Dot" logo.

The life cycle of a cotton t-shirt was organized into four main stages: Production, Packaging & Distribution, Consumer Use, and Disposal. Available data were applied to assess these stages on total energy consumption and CO₂ emissions. Since the method of material production was agricultural, water consumption values were also included as well as a variety of environmental effects associated with

farming. Environmental impact figures for the conventional cotton t-shirt label were determined first and then appropriately adjusted for the organic cotton t-shirt label. Energy figures from “Well Dressed” (Allwood et. al., 2006) served as the basis for the conventional cotton label. To determine the CO₂ emissions, these energy figures were multiplied by a CO₂ emissions rate for coal electricity of 1.58 pounds per kilowatt (kWh) (U.S. EPA, 2006), even though some stages were a mixture of diesel and coal electricity, the most common source of electricity. Water consumption can be highly variable due to location so conservative estimates were chosen. Statistics from “A Tale of Two T-shirts” (Walsh & Brown, 1995) were used to adjust the energy and water figures for organic cotton and to provide information about the environmental impacts of conventional verses organic cotton farming methods.

CaféPress.com, an online custom printing company, was chosen to supply the actual printed t-shirts, as they offered an organic cotton t-shirt option in addition to many conventional cotton t-shirt styles. CaféPress.com also allowed designers to set up individual stores to sell their designs imprinted on merchandise from their own webpage at CaféPress.com. A store for the LCA and GCC T-Shirts was created at the following web address: <http://www.cafepress.com/refashionfuture> (Appendix G). CaféPress.com provided convenience with the ability to quickly produce more t-shirts if there was a demand for them, yet it limited design possibilities in terms of print locations (e.g. the black conventional cotton t-shirt could not have a logo on the back).

5.1.5 Final Design Description

The LCA Label provides information about the realized and potential environmental impacts a product will cause throughout its lifespan. LCA Labels are placed on products at point of purchase, such as hangtags on clothing. The clothing products analyzed here are a conventional cotton t-shirt and an organic cotton t-shirt.

The information included on these two LCA Labels (Figure 4) are prototypes based on available data and informed assumptions. Unfortunately, data were not available to reflect the actual LCA T-Shirts exhibited. At the top of the LCA Label, the clothing item is identified and described in terms of the fiber type(s), dyes and finishes with their purpose explained, and primary location of the garment's production.

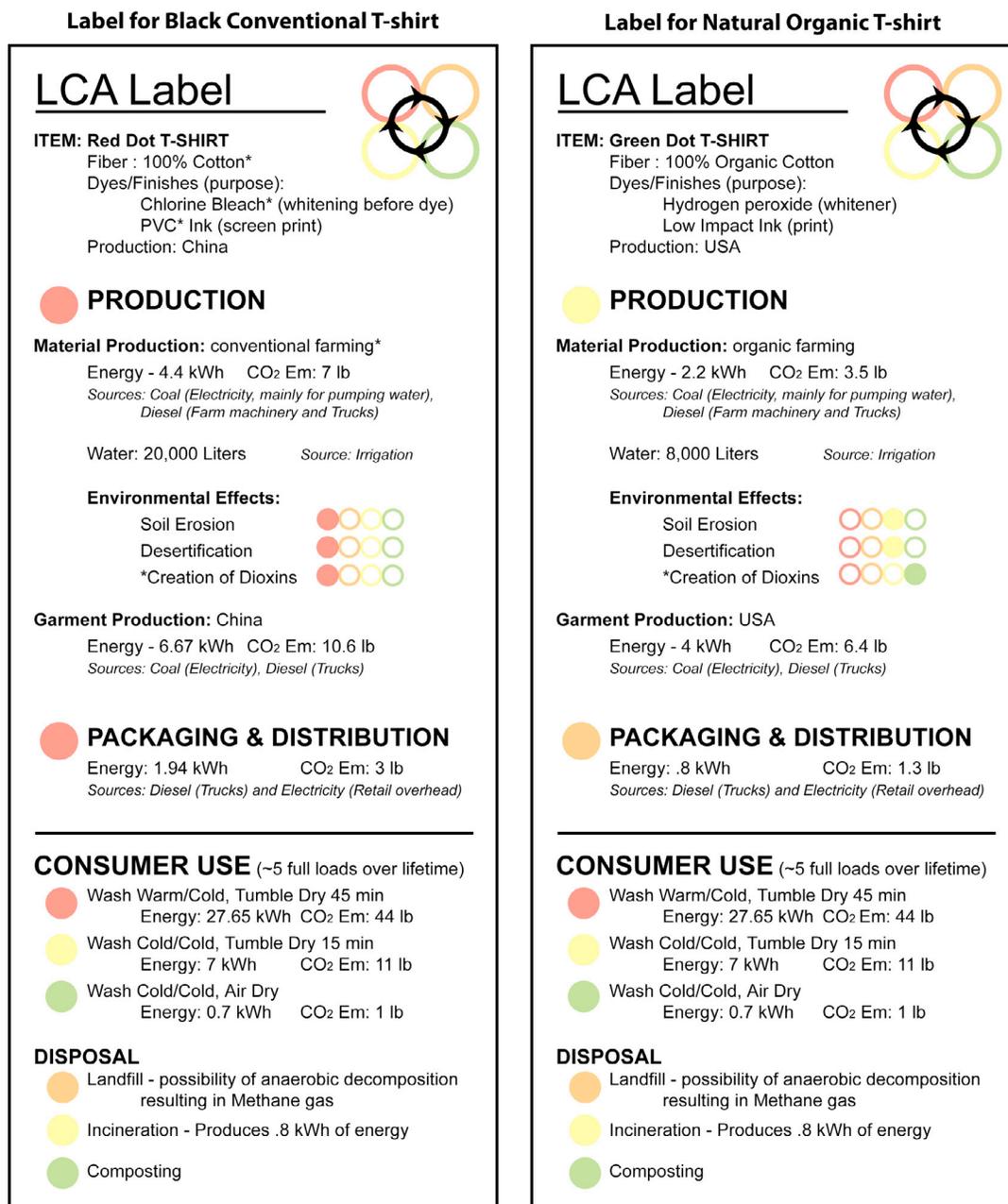


Figure 4: LCA Labels for Conventional and Organic Cotton T-Shirts

The remainder of the LCA Label outlines the four main life cycle stages: Production, Packaging & Distribution, Consumer Use, and Disposal. The production stage is broken down into fiber production and garment assembly. Each of these categories is evaluated on various criteria relevant to the nature of each life cycle stage. Quantitative values for energy consumption, kilowatts (kWh) per product, and consequent CO₂ emissions, pounds per product, are provided for all categories except disposal. For non-quantifiable items, a qualitative color-coded dot system indicates the degree of environmental impact. The color levels are red, orange, yellow, and green, with green representing a low-to-no environmental impact and red representing a highly negative environmental impact. These color-coded dots evaluate the following environmental issues associated with farming production: soil erosion, desertification, and creation of dioxins. A single colored dot summarizes the overall environmental impact of each of the stages already completed, Production and Packaging & Distribution, while a range of colored dot options is given for the future stages, Consumer Use and Disposal.

These colored dots also are the theme for the two logos on the LCA T-Shirts (Figure 5) created to highlight the most significant impact of the clothing life cycle: cleaning. The green and red dot behavioral options from the Consumer Use section of the LCA Label are translated into personal narratives describing how and why a person may behave in a green or red way. People can compare these narratives to their own personal clothing care behaviors to see which one they are most like. The “Red Dot” is featured on a t-shirt that is dyed black and made from conventional cotton, both of which use toxic chemicals reflecting the toxic nature of the red dot behaviors. In contrast, the “Green Dot” is on a natural-colored organic cotton t-shirt in accord with the eco-friendly aspects of the green dot behaviors.



Figure 5: "Red Dot" and "Green Dot" T-Shirts

5.2 Green Clothing Care (GCC) Label and T-Shirts

5.2.1 Concept

The Green Clothing Care (GCC) Label (Figure 6) is a best-practice guide for reducing the environmental impact of the consumer use life cycle stage of clothing. This label both complements and expands current clothing care labels by selecting existing care symbols internationally accepted by the Federal Trade Commission (FTC) (www.ftc.gov), developing two new care symbols that promote low-impact washing, and extending the idea of care to repairing, reusing, and recycling. The GCC Label conveys a general outline of desirable behaviors that could be placed on clothing tags in addition to current clothing care instructions or adjusted to reflect the

specific care requirements for a given garment. In conjunction with the GCC Label, a series of four GCC T-Shirts with logos were designed using the care symbols in combination with catchy slogans to explain the meaning of the GCC Label while promoting awareness of high- and low-impact clothing care behaviors.



Figure 6: Green Clothing Care (GCC) Label

5.2.2 Purpose

The GCC Label and T-Shirts are in essence a green marketing campaign for changing the way people care for their clothes. Once clothing items reach consumers, their behaviors and choices largely dictate the environmental impacts for the remainder of the garment's life, from how they wash it through where they decide to dispose it. Consumer use has been shown to demand significantly more resources than any other life cycle stage (Collins & Aumônier, 2002). Yet it is within the consumer's power to substantially reduce that impact through simple behavioral changes, such as washing in cold water or air-drying. Consumers can also choose to effectively utilize their clothing by means of repairing, reusing, and recycling.

The GCC Label and T-Shirts are another *effective* design extending from the design goals of the LCA Label with primary focus on encouraging Informed Care behaviors in consumers. In the LCA Label, only washing and drying behaviors are included since they are easily measurable and cause the most direct impact. The GCC Label and T-Shirts provide consumers with other care behavior tips that could also significantly reduce resource use but are not so easily quantifiable, such as reducing the number of loads by only washing clothes that are dirty or stinky and waiting to

wash until the loads are full. The symbols represent general green clothing care behaviors rather than providing exact care requirements for a specific garment, since the GCC Label's purpose is to inspire behavior changes.

5.2.3 Inspiration

During the design research for the LCA T-Shirt logos, an interesting care label was discovered (Figure 7). The Headline Shirts company included not only the standard care symbols on their tagless care labels but it also incorporated symbols that fit the company's culture and philosophy as well as provided a shock-value to consumers reading it. This design demonstrated both the legal ability to have poetic license with the care requirements as well as the impact such a break from the norm could have on consumers. This inspired designing the new care symbols to not only educate but also incite an immediate reaction from consumers, in hopes that the label becomes ingrained in their memory, resulting in behavioral change.



Figure 7: Headline Shirts Care Label (Image: www.headlineshirts.net)

5.2.4 Design Process

All of the standard FTC garment care symbols were reviewed in order to choose which to include on the GCC Label. The following four current care symbols were selected: “Wash Cold,” “Non-Chlorine Bleach,” “Hang Dry,” and “Do Not Dry Clean,” all of which covered cleaning behaviors. “Hang Dry” was used instead of the symbol for “Do Not Tumble Dry” to avoid implying that one should never tumble dry, since hang drying can cause stiffness which can be alleviated by a few minutes in the dryer with a wet towel. Next, two new care symbols were designed to address pre-cleaning behaviors, “Wash Only When Dirty or Stinky” and “Full Loads.” At this point, the GCC Label still resembled current clothing care labels with their emphasis on only cleaning behaviors. But just as the Headline Shirts care label included icons that depicted their company’s philosophy, it seemed fitting to incorporate the classic green behavioral mantras of repairing, reusing, and recycling. The “Repair” and “Reuse” symbols were created to reflect how these activities would apply to clothing, while the generic “Recycle” symbol was used to conclude the label.

Four t-shirt logos were designed to work in combination with the GCC Label, featuring some of the care symbols chosen and designed for the GCC Label. The “Energy Hogs” logo was the only design not to use any of the GCC Label care symbols. Instead, “Energy Hogs” used the FTC care symbols for “Wash Warm” and “Tumble Dry Medium” to show the energy consumption contrast to the GCC Label symbols “Wash Cold” and “Hang Dry.” The “Hang Dry” symbol also inspired the “Dry Green, It’s *FREE*” logo design, which shows that green behaviors are both beneficial to the environment and the consumer. The two new pre-cleaning symbols “Wash Only When Dirty or Stinky” and “Full loads” were the basis of the two other t-shirt logo designs: “Wash only when...” and “Fill before you wash.” Finally, a logo

of the completed GCC Label along with a key describing what each care symbol meant was designed for the backsides of the GCC T-Shirts.

The GCC Label and four GCC T-Shirt logos were evaluated in the second design critique. The design critics believed that the GCC concept was strong enough on its own to be a separate design from the LCA design, and that both provided unique and important design arguments. They also agreed that the GCC T-Shirt logos were very marketable and people at the final exhibit may want to purchase them. This issue had already been planned for with the creation of the online store at CaféPress.com for both the LCA and GCC T-Shirts.

5.2.5 Final Design Description

The GCC Label (Figure 8) consists of nine symbols that guide eco-friendly clothing care behaviors. The first two symbols were newly designed to portray desirable pre-cleaning behaviors. “Wash Only When Dirty or Stinky” encourages only washing clothes that really need to be cleaned rather than washing any clothing worn even for a short amount of time. The symbol depicts a t-shirt with a stain on the front and odor lines emanating from the armpit areas, providing a shocking yet humorous beginning to the label that entices people to read on. The second symbol, “Full Loads,” advocates waiting until there are enough dirty clothes to fill the washer before cleaning. It shows a laundry basket with three horizontal lines indicating a high level of fullness. Both of these pre-cleaning behaviors decrease the overall number of loads washed, resulting in significant energy savings.

GREEN CLOTHING CARE



Figure 8: Green Clothing Care (GCC) Label with Key

The next four symbols address environmentally conscious cleaning behaviors using current care symbols. “Wash Cold” and “Hang Dry” suggest energy saving cleaning practices. “Wash Cold” offers perhaps the most reasonable opportunity to achieve the greatest potential decrease in energy use by eliminating the need for heated water. The “Hang Dry” symbol suggests a practical supplement to tumble drying but realistically not an outright replacement. The other two symbols address some of the more toxic effects of cleaning clothes. Both “Non-Chlorine Bleach” and “Do Not Dry Clean” symbols recommend avoiding the use of toxic chlorinated chemicals found in chlorine bleach and dry cleaning solvents. The last three symbols “Repair,” “Reuse,” and “Recycle” cover other ways of clothing care that people may fail to recognize as opportunities to be eco-friendly. “Repair” shows a darning technique for repairing holes, while the “Reuse” symbol shows scissors cutting up a garment in order to make rags or possibly something more creative. The iconic “Recycle” symbol completes the GCC Label, encouraging reflection on how the garment’s life should end as well as cementing the environmental focus of the label in

the mind of the consumer. This GCC Label with key (Figure 8) is featured on the backside of each GCC T-Shirt.

The logos on the front of the four GCC T-Shirts further describe and promote the GCC Label. The “Energy Hogs” logo (Figure 9) was the first and only logo not to use symbols from the GCC Label, but its negative message serves as an argument for washing in cold water and reducing the amount of tumble-drying. The logo itself uses the FTC care symbols for “Wash Warm” and “Tumble Dry Medium,” respectively shown in gray. Both of these care symbols have two dots in the center that indicate the temperature level and double as a pig snout. The word “Energy” and these dots are shown in red, since higher temperatures require more energy to produce. Each symbol has been given a pink pig’s tail, and the word “Hogs” is shown in the same color to help associate the curvy lines as pig’s tails. This logo is placed on a white ringer t-shirt with red trim to emphasize the red of the energy and to contrast its negative message from the other three positive logos on plain white t-shirts.

The other three GCC T-Shirt logos clarify some of the symbols from the GCC Label through their designs. The “Dry Green, It’s *FREE*” (Figure 10) logo has an image of a sheet blowing in the wind on the “Hang Dry” symbol to help define this FTC care symbol, which is not familiar to all consumers. The word “*FREE*” is both italicized and fully capitalized in order to emphasize a highly desirable consumer benefit of this behavior. The “Fill before you wash!” (Figure 11) logo features three progressively fuller laundry baskets, explaining the newly created care symbol for “Full Loads.” The horizontal lines on the laundry baskets indicate the level of fullness. Finally, the “Wash only when...” t-shirt logo (Figure 12) is basically a life-size version of the newly designed “Wash Only When Dirty or Stinky” symbol but without the odor lines. All of these logos are featured on various styles of plain white t-shirts.

Both the “Dry Green, It’s *FREE*” and “Fill before you wash!” logos are presented on women’s style t-shirts, while “Wash only when...” is printed on a male cut t-shirt.



Figure 9: "Energy Hogs"



Figure 10: "Dry Green, it's FREE"



Figure 11: "Fill before you wash!"



Figure 12: "Wash only when..."

5.3 “Suit Yourself”

5.3.1 Concept

“Suit Yourself” (Figure 13) is a dynamic system of modular clothing, in which the garment bases, such as the body of a jacket or the waistband and top yoke of a bottom, can be matched with a variety of collars, cuffs, and bottoms (both pants and

skirts) to create a wide assortment of looks. In addition to transformable looks, these garments offer adjustable fit, mainly around the waistline. These garments are crafted using high-quality, eco-friendly fabrics to promote sustainable materials and product durability. All these features allow the garment to adapt as the wearer and fashion styles change, resulting in a long and useful lifespan.



Figure 13: "Suit Yourself" Collection

5.3.2 Purpose

“Suit Yourself” is a collection of apparel designed to stand the test of time. Many eco-friendly apparel designs stress materials and durability of form while offering little selection in the way of style and fit. “Suit Yourself” promotes a new interpretation of durability with an emphasis on clothing adapting to the consumer’s changing needs in order to ensure long-lasting use. These garments can alter in style and fit with either fashion trends or as the wearer’s body changes and are well crafted from high-quality, eco-friendly fabrics to provide durability and apply sustainable production practices. In addition, consumers can become more engaged with their clothing as they alter its look and fit, fostering a deeper sense of connection that encourages the consumer to care for their garments better and longer.

“Suit Yourself” is a *resilient* design supporting and fostering diversity through my design goals of Eco-Friendly Materials, Transformable Forms, Improved Fit, and Effective End. These clothes can adapt to meet consumers’ changing needs for both fit and fashion, so they can get more use out of fewer resources promoting lower consumption over time. Using a variety of eco-friendly materials also illustrates that no one material will be able to solve all our environmental problems. As the climate rapidly warms and human populations continue to surge, a diversity of fibers and innovative ways of producing fabrics will be needed to react and adapt to an ever-changing environment while working to maintain sustainability. While a variety of materials were used, many of the individual components were constructed using materials that all had the same fiber type to facilitate textile recycling at end of use.

5.3.3 *Inspiration*

Inspiration for offering transformability as a valued design feature in eco-friendly apparel came from the “Well Dressed” report on textile sustainability (Allwood et al., 2006), in which the authors propose “replacing certain panels within a dress might allow a sufficient ‘fashion upgrade’ to give new value to otherwise outdated styles” (p. 39). Style is not the only thing that varies over time; the consumer herself changes, as well. Physically, her body will most likely alter in size and shape over the years, which may result in her favorite clothing becoming unusable due to fault of fit rather than lack of fashion. Therefore, adjustable fit complements the goals of transformability. The impetus for including adjustable fit as another valued design feature came from Bená Burda, owner of Maggie’s Organics, who considers adjustable fit to be a major asset to mature women whose sizes may oscillate on a regular basis (personal communication, November 3, 2006).

High-quality materials were used to promote durability of the design in order to reduce overall clothing consumption and increase clothing life spans. The SusHouse Project showed that limited wardrobes of high-quality clothing greatly reduced overall environmental impact due to lower consumption levels and the longer useful life of the clothing (Bras-Klapwijk & Knot, 2001). In addition, the consumer will be engaged with these “Suit Yourself” garments when she changes the looks and adjusts the fit, so she will have an intimate knowledge of the construction of each part. She will have the opportunity to appreciate the attention to detail in the construction, both inside and out, which the average consumer may not notice in normal clothing. According to Otto von Busch, this increased attention to their clothes may cause people to better appreciate and value their clothing (personal communication, November 1, 2006). High-quality materials and construction as well as a deeper connection with their garments also provides a greater incentive for consumers to repair or reform the garment when wear and tear renders the initial design unwearable (Hethorn, communication, January 2, 2007), thereby ensuring the garment a long life and possible future lives through reuse or recycling.

5.3.4 Design Process

The first part of the “Suit Yourself” design process was to develop methods for incorporating transformability and adjustable fit into current clothing styles, with the expectation that people would be more willing to try something new if it was also partly familiar. Suits were chosen as the garment type to illustrate the “Suit Yourself” design concept because they are investment wardrobe pieces that would benefit from ensuring a long, useful lifespan. In addition, coordinating suit jackets and bottoms could effectively demonstrate how changing just a few parts of a garment can result in a whole new style, such as a collar on a jacket or making a skirt into a pair of pants.

A variety of transformable apparel designs and adjustable fitting techniques were researched. Most of these transformable clothing styles were artistic and avant-garde, but provided no practical solutions for offering transformability in everyday clothing. Yet some retail clothing items, such as cargo pants that become shorts and outdoor jackets with removable linings, offered transformable features through use of separating zippers. This zipper system both successfully integrated into current clothing styles and had proven mass consumer acceptance, making it an ideal method to improve upon. A variety of novel zipper placements were diagrammed for suit jackets (Appendix H) as well as an assortment of style changes resulting from two of those placements (Appendix I).

Adjustable fitting techniques addressed changing waistlines that occur due to regular weight gain and loss, such as water retention. Two promising fit techniques identified through research were tuxedo pant sliding buckles and 18th century drop front breeches. The adjustable tuxedo pant system, often used on rented tuxedos, consists of two buckles on the waistband at either front side pocket that slide along plastic guides and lock into place (Figure 14). The drop front breeches were laced up the back to fit and had a flap on the front for easy access. The tuxedo buckle system was suitable to incorporate into modern clothing, yet the drop front breeches system needed a few design alterations. Moving the lacings to the front under the flap provided better access and flattened the tummy while hiding the lacings. Another closure system could be placed in the back for taking the garment on and off so that the lacings would only function for size adjustment.

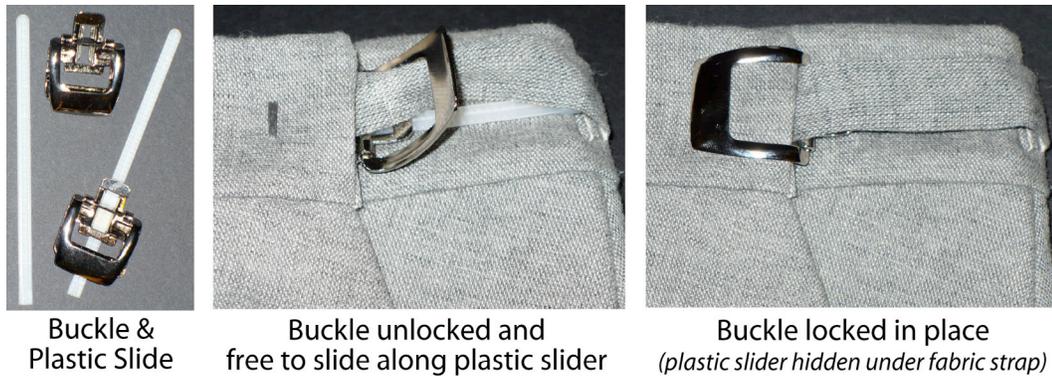


Figure 14: Tuxedo Pant Sliding Buckle

These fit techniques and the zipper placements and styles were presented at the first design critique. The goal was to determine the best zipper placement that would offer a high degree of variability in style but require a minimal amount of new materials needed for the components. The design critics analyzed the various zipper placements according to these requirements as well as feasibility of construction. They suggested avoiding too many curved lines due to the difficulty in placing zippers in curves. They were impressed by the placements that allowed the suit jackets to change from single to double-breasted. It was agreed that placement “C” (Appendix H) would best meet all the design goals of style options, minimal new resource use, and functionality. Other areas for zipper placements, such as sleeve cuffs and hiplines on bottoms, were discussed for further design development. Both fitting techniques were deemed inventive and viable solutions for providing a fit range over three pant sizes.

The major zipper placement in the jacket and the fit techniques were incorporated into a collection of suit jackets and coordinating bottoms. In order to show a variety of design possibilities, two differently styled suit ensembles were created, each with at least two transformable looks. Two mannequins were purchased with different body types, one pear shaped and the other inverted-triangle, with the objective of creating clothing styles that would flatter these body shapes. For pear shaped bodies that are small on top, more structured clothing is preferable, such as

shoulder pads, while inverted triangle-shaped women need softer garments to deemphasize their broad shoulders. Sloper patterns for a jacket and a skirt were made for each mannequin using a combination of flat-pattern drafting and draping, and then fabric mock-ups were constructed to check fit and garment ease.

Before the base patterns could be altered into unique clothing styles, an inventory of eco-friendly fabric swatches and notions, like buttons and trimmings, was acquired from online retailers, since the limited availability of fabrications and colors would likely restrict design options. Two sets of swatches and notions, one for each suit ensemble, were compiled based on similar color palette and ensuring a diverse selection of high quality, easy to care for materials. Once the materials were chosen, current fashion styles were researched and incorporated into design sketches that both reflected recent trends and flattered the two consumer body types. These sketches were reviewed during the second design critique, in which the design critics judged the most successful design styles and material choices. The selected designs were developed into paper patterns, fabric mock-ups, and then final garments.

5.3.5 Final Design Description

The basic components of the “Suit Yourself” collection are base pieces, including jacket bodies and the waistband yoke of the bottoms, and a selection of changeable components, from jacket collars and cuffs to skirts and pants. These changeable components attach and detach using a system of separating zippers and snaps to secure the zipper ends. Jacket bases have zippers around the neckline facing seam, which encompasses the entire center front placket and collar around the back of the neck, and around each sleeve hem. The base waistband has a zipper around the hipline that can be attached to either skirt or pants components. The waistband also offers a method of adjustable fit across a range of three pant sizes. Extra-long lining

zippers were appropriately shortened to accommodate all the various lengths and circumferences necessary for each garment location. The zipper pulls were located on the changeable components; in case they do break off, it will only render the changeable component (temporarily) useless and not affect the base garment.

For this “Suit Yourself” collection, two suit ensembles were created for two different target consumers, named “Abby” and “Jane.” Abby (Figure 15) has a pear shaped figure with narrow, sloping shoulders and wide hips. The Abby Suit’s base jacket is short and fitted with light shoulder padding to give definition to the upper body. Two welt pockets were set in-between the fitting darts and side seams, slightly standing away from the body. The base waistband has tuxedo pant slide buckles on the waistband above at the pocket edges, allowing for up to six inches of adjustable fit, and a front fly zipper for ease of dressing. The center back seam of the waistband can be easily let out or taken in for more permanent size adjustment.

Abby Suit

Abby has a pear shaped figure (narrow, sloping shoulders and wide at the hip)



Figure 15: Abby Suit Base Garments

Jane (Figure 16) has an inverted triangular shaped body with broad shoulders, full chest, and narrow hips. The Jane Suit’s base jacket is long and semi-fitted with

three-quarter length raglan sleeves to deemphasize broad shoulders, creating a soft and flowing overall look. The Jane Suit’s jacket offers an extra zipper placement along the jacket hem to add length. The bottom base has a lacing down the center front, which can be covered up or exposed depending on the style of the attached changeable bottom. The lacing offers approximately three inches of ease and primarily ensures proper fit, while an invisible zipper down the center back makes donning and doffing easy. Snaps on the inside of the waistband allow for waistband covers to be added.

Jane Suit

Jane has an inverted triangle figure (broad shoulders, large bust, and narrow hips)



Figure 16: Jane Suit Base Garments

The Abby and Jane Suits each have two sets of changeable components in order to achieve two very different looks (Appendix J). The Abby Suit’s first set of components features a black contrasting dropped semi-shawl collar with six buttons that can be worn by itself or styled with a double-breasted, eight button front panel. The short sleeve options are plain or with attachable buttoned cuffs with optional snap-on cuff extensions. The suit look is finished with cuffed black trousers. The second look of the Abby Suit is comprised of a reverse collar with matching tie belt and a skirt with side belts and pleats. Both of these jacket looks utilize buttons glued to tie

tacks that can be easily and securely attached anywhere on a garment (Figure 17). The Jane Suit's first look offers a narrow turned-back collar with covered snap closures and decorative leaf buttons with a matching belt and jacket extension. A bias plaid skirt with asymmetrical waistbands covers and visible front lacings finishes the look. The other Jane Suit jacket look has a zip-up collar with detachable hood and side-zippered cuffs. The bottom is a pair of capri length pants with a front flap that covers the lacings, decorative side buttons and an adjustable buckle at the back.

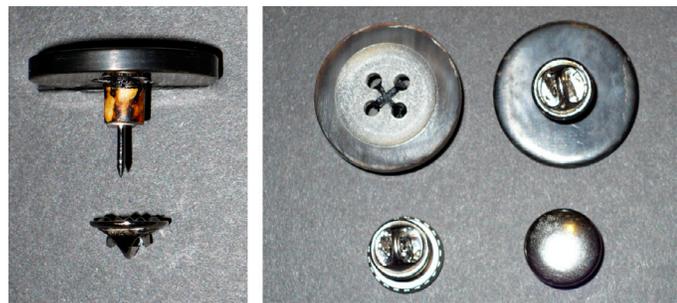


Figure 17: Abby's Button Pins

Both of these collections incorporate a variety of high-quality, eco-friendly fabrics and materials. Materials were judged on their quality, ease of care (all machine washable except wool), and eco-friendly production methods, with a realization that none are currently produced without some degree of harm to the environment. The Abby Suit base garments were fashioned from a gray hemp and yak blend and underlined in natural organic hemp muslin. The Abby Suit changeable components were made of hemp blends and Tencel fabrics with horn and corozo, or tagua nut, buttons. The Jane Suit's main fabric was a heavy tussah silk made from wild-gathered silk cocoons and underlined in light tussah pongee, both undyed. The Jane Suit components consisted of hemp/silk and hemp/Tencel blends, organic cottons and organic wool. For a complete list of these materials and the suit parts where they were used, see Appendix K for the Abby Suit and Appendix L a and b for the Jane Suit.

5.4 “No Sew” Projects

5.4.1 Concept

The “No Sew” Projects (Figure 18) present ways to refashion worn-out t-shirts that combine simple techniques with trendy styles, resulting in an activity that is both easily accessible and worthwhile for the consumer and environmentally effective. These projects are designed to ensure durability in construction as well as a stylish accessory item that no longer resembles a t-shirt, i.e. its second life. They are named “No Sew” because they do not require a needle and thread to make. In fact, the only tools needed are a pair of scissors and possibly a safety pin, both commonplace items in most households. Two main techniques were developed: the knot and the “faux” knit. The knot technique used double square knots, while the “faux” knit combined the simple techniques of crocheting and coiled basket making. While these two simple techniques offer endless design possibilities, five “No Sew” Projects were chosen to represent the techniques and show their enormous potential.



Figure 18: "No Sew" Projects

5.4.2 Purpose

The “No Sew” Projects are a *relational* design that realizes my design goals for New Life and Informed Care by empowering people to be creative and transform their clothing. These projects not only extend but also enhance the useful life of clothing. Old, unwanted t-shirts are reborn as unique fashion accessories, possibly more durable

and stylish than they were in their previous life. This makes them not only recycled but “up-cycled.” In addition, the creator develops an intimate relationship with the project, adding more meaning and relational significance to the clothing item and further “up-cycling” it. These techniques are simple yet they require time to create; projects take anywhere from an hour to two days to complete. The consumer becomes the producer, investing in the design with time and effort.

The rationale for these “No Sew” Projects was to increase accessibility to creative activities for people with little or no sewing experience and supplies. The projects require a few easy steps rather than many skilled sewing processes. The techniques allow mistakes to be easily fixed and not obvious. By keeping the projects simple and foolproof, those who have fears or inhibitions about refashioning their clothing may have the courage to make that first scissor cut.

5.4.3 Inspiration

Otto von Busch’s ReFashion Manuals were the direct inspiration for these projects. His main goal was to inspire rather than instruct, for he considered instruction to be constrictive while inspiration to be emancipatory (personal communication, November 1, 2006). For this reason, the focus of this design is on the two main techniques rather than the individual project designs, hoping that people will be inspired to use the techniques to create their own designs rather than simply replicate these projects. Von Busch also believed that such re-fashion projects are “up-cycled” since the personal connections to these items, both from memories of the previous garments and the investment in recreating them, encourage people to care for these items better and longer.

Otto von Busch, Natalie Chanin, and Kate Fletcher all professed the desire for sustainable design to empower people to be more creative and self-sufficient. Yet they

cautioned that people are often afraid to cut up their clothing. For this reason, these projects were made from unwanted thrift store t-shirts, which lacked personal connection and could already be considered waste. This lowered the level of risk since mistakes could be discarded without much regret or cost, except for time invested, making them ideal first projects. A favorite old t-shirt could be re-fashioned once confidence in the techniques was built.

5.4.4 Design Process

The first decision was selecting t-shirts as the starting garments because their standardized shape and construction offered a common starting point but with incredible potential for a wide variety of ending designs. T-shirts are popular yet highly disposable resulting in an overabundant supply in both people's closets and secondhand stores. Most people have old, worthless t-shirts they would be willing to try to re-fashion into something new without too much fear of destroying the t-shirt's usefulness if the project did not turn out as well as expected. A variety of t-shirts were acquired from the local thrift store, with attention to purchasing undesirable items that were either stained or damaged. T-shirts were chosen based on minimal decoration, color appeal, and tubular knit construction with no side seams. Tubular knit t-shirts were easy to find since they are cheaper to manufacture than those with side seams making them the most common t-shirt style.

The popular book "99 Ways to Cut, Sew, Trim, & Tie Your T-Shirt Into Something Special" (Blakeney, Blakeney, Livakovic, & Schultz, 2006) was reviewed to prompt design ideas by analyzing what types of projects were already available. Many of the styles looked like "street fashion," i.e. cut-up t-shirts that many people would find immodest or inappropriate to wear. The designs often lacked functionality and durability, resulting in products with limited usefulness. One design that appeared

especially flawed was a bag with the bottom edge sewn along the hem of the t-shirt. Basic hand sewing lacks both the strength and security required for the bottom of a bag. Yet, some of the other designs utilized a promising construction technique of knotted fringed edges. The value of this technique compared to hand sewing was immediately evident in both ease and strength of construction. The ill-conceived bag design inspired the creation of a more effective bag that also no longer resembled a t-shirt. This first project featured the knotted fringed construction and a braided strap. This entire project required only a pair of scissors to create, inspiring the “No Sew” concept for all the projects. Another “No Sew” technique was developed based on coiled basket making and crocheting that resembled a knitted article. The second project used this “faux” knit technique to create a simple cap style hat. While the concept of “No Sew” may have limited design options initially, the two resulting techniques were superior to hand or even straight-stitch machine sewing in producing a stronger construction and more finished look with the t-shirt material.

These two projects, the fringed bag and cap, were evaluated during the second design critique. Each demonstrated their respective “No Sew” techniques. Both projects and the overall consumer involvement concept received enthusiastic responses from the design critics; they especially liked that the projects required minimal skill yet produced a totally transformed item that was durable, fashionable, and required an investment of time to create. For the final exhibit display, they suggested showing the projects in progressive stages and providing instructions for how to make the items. They encouraged making a few more design examples, so three more projects were designed and produced, a knotted scarf and a “faux” knit hat and purse set. These last three projects were more complex in order to show the extensive design range of these basic “No Sew” techniques.

5.4.5 Final Design Description

The “No Sew” Projects utilized two construction techniques, the knot and the “faux” knit, to create a variety of apparel accessories from old t-shirts. The knot technique (Figure 19) cuts a fringed edge through two or more layers of fabric and double knots overlapping pairs of fringes in order to seam or finish an edge. This method produces two different finished looks on either side; the side on which the knots were tied has a fringed finish, while the underside shows a line of knots. To show only the knots, the item can be turned inside out.



Figure 19: The Knot



Figure 20: The "Faux" Knit

The “faux” knit (Figure 20) is a more involved procedure (Appendix M) and can only be made from tubular knit t-shirts. The body of the t-shirt is spiral cut into a long continuous ribbon about one inch wide and pulled from either end to form a rounded rope. This rope is then turned into a braided cord using a crocheting technique of making a continuous line of interconnected loops that is secured at the end by pulling the remaining rope through the last loop. The braided cord is coiled into the desired shape and secured by lacing a strip of fabric cut from the t-shirt’s back shoulder between the coils, using a safety pin placed at the fabric strip’s tip as a guiding “sewing” needle for the “thread” fabric strip. When a fabric strip runs out, another piece is tied to the end of the previous strip and the “sewing” continues. Once the project’s design reaches the desired size and shape, the remaining unused braided

cord is shortened by pulling out the extra braids and then re-securing the last loop. The ends of the braided cord and the strips are tied together and ends trimmed off.

Five “No Sew” Projects were created, two using the knot technique (Figure 21) and three using the “faux” knit (Figure 22). All the projects were made from tubular knit t-shirts and mainly used the body of the shirt below the sleeves. The knot projects used the t-shirt body as a solid piece to form the items, while the knit projects peeled the body into a long strip: the bigger the t-shirt, the longer the strip. The fabric leftovers from the t-shirts can be used to create decorative details for the projects.



Fringed Bag



Green and Yellow Double-Sided Scarf

Figure 21: Knot Projects



Green Cap



Striped Clutch Purse



White Bucket Hat

Figure 22: Knit Projects

The fringed bag (Figure 21) was made from a rectangular section of a tubular t-shirt's body folded over with the fold along the bottom of the purse. This design makes the purse double layered and has no seam at the bottom for durability. The side seams were secured and finished with fringed knots, and a braided strap offers strength with style. The other knot project was a double-sided scarf (Figure 21) made from the bodies of two t-shirts cut into two long rectangles. The long sides were fringed and knotted, and then the scarf was turned inside out to show only the knots along the edges. The ends of the scarf were cut into fringes and knotted.

The first "faux" knit project was a green cap (Figure 22) made from the body of a single t-shirt. The second was a white and navy striped clutch purse (Figure 22) made by coiling two colors of braided t-shirts at the same time. The clutch handles were made from cardboard circles that were taped for strength and then covered with the t-shirt collar bands. The hems from the two t-shirts were used to attach the handles to the bag and also form a knot and loop closure. The final "faux" knit project was a white bucket hat (Figure 22) with navy band and flower embellishment made from two white t-shirts and navy scraps from the previous project.

5.5 "The Dowry Dress"

5.5.1 Concept

"The Dowry Dress" (Figure 23) is a wedding dress that represents the bride and shares in the life of the marriage. The corset is the heirloom that commemorates the life of the bride and her wedding day while the skirt is re-fashioned into other keepsakes that celebrate the many milestones in the life of the marriage, such as the birth of a child or a special anniversary. In addition to reusing the wedding dress skirt, the other parts of the dress can be worn again by incorporating reversibility into the corset and designing the accessories that serve additional purposes. Recycling

cherished worn garments and fabric scraps reduces new resource use and waste while further adding personal significance to the design.



Figure 23: "The Dowry Dress"

5.5.2 Purpose

The “The Dowry Dress” is a *relational* design that realizes the Re-Thought Life Cycle goal by re-thinking the life path of a wedding dress in a way that enhances its purpose and extends its usefulness beyond the wedding day. “The Dowry Dress” maintains the significance of the wedding dress by reflecting both the life of the bride and the marriage, and gives the dress a new purpose. Instead of the wedding dress being worn one day then stashed away with little chance of being worn again, its life is just beginning on the wedding day. It will change in form and meaning just as the newly joined lives grow and flourish. This dowry is not a price that the bride must pay but a gift that she gives to herself and her future family. As she walks down the aisle, she brings with her material and spiritual resources she will use in the years ahead. The act of the wedding ceremony in essence sanctifies the cloth of the skirt, instilling the keepsakes with memories of the special day that began this new life stage.

“The Dowry Dress” incorporates three main processes: recycling of special garments, creating reusable components that can be worn again on special occasions, and refashioning the skirt of the dress into keepsakes that mark milestones of the marriage. All of these features deliver an environmental benefit by reducing the need for new resources and giving other garments the goal of New Life, but more importantly, instilling the design with personal meaning and significance. Optimizing keepsake layouts and creating embellishments from the fabric scraps minimize waste. The main new material, a soft draping hemp/silk charmeuse is an eco-friendly and elegant fabric. Hemp has a low environmental impact because of its fast growing cycle that requires little water and no pesticides to cultivate. On the other hand, silk cultivation is a very labor-intensive process and raises ethical concerns over killing of the silk moths.

5.5.3 Inspiration

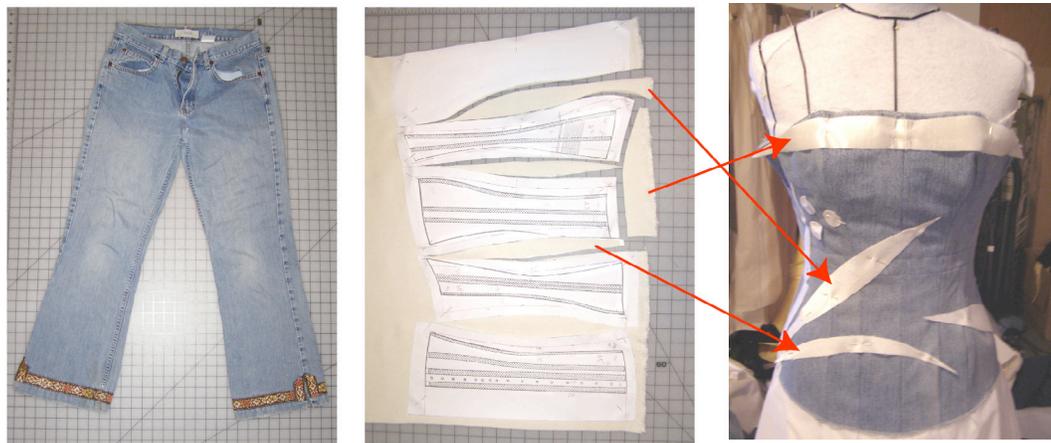
The formation of this design concept was motivated by my own upcoming wedding. The realization that the wedding dress is probably the most expensive and elaborate garment a woman will ever invest in yet is worn for one day seemed at the least absurd and at most wasteful. I saw a great opportunity to improve upon this tradition in a way that benefited both the bride and the environment. The idea of giving the wedding dress a new life in the form of family keepsakes came from the Christmas tree skirt my mother made from the fabric scraps and extra lace of her wedding dress. The pioneer “friendship” quilt was another model of resourcefulness that creatively reused old textiles and fabric straps while adding sentiment through embroidered or printed names of the friends who created it. This inspired reusing a cherished piece of my old wardrobe, in this case an old pair of jeans, and adding my name on the inside of the corset.

5.5.4 Design Process

“The Dowry Dress” design process began by determining the most flattering dress silhouette. A local wedding dress shop was visited to try on a variety of dress styles. A corset top was selected for creating a pleasing silhouette, and it was matched with an A-line skirt. The challenge was to develop a skirt design that required the minimum amount of construction and waste while at the same time provided appealing style and formality. A vintage petticoat was purchased in order to achieve the desired skirt silhouette. A series of skirt designs were draped in muslin over the petticoat. It was during the draping of the skirt using the fashion fabric, a supple hemp/silk charmeuse, that the ideal design was formed. The final skirt design required a single length of cloth wrapped around the body with one center back seam and an attached waistband section. The ends of the cloth that formed the back train were rounded in order to create a more appealing style when trained and bustled. The scraps from cutting were eventually made into bias strips for finishing the corset’s edges. Instead of a head veil, a long silk chiffon scarf lay along the back of the skirt when trained and then was tied around the bride’s wrists when bustled. This scarf could be worn again after the wedding on special occasions.

The corset was created with expert advice from Ithaca, NY, corset maker Judith Johnson. Her recommendation was to start with a vintage corset pattern and then alter it for fit and style. An 1880’s corset pattern was chosen from the costumer’s resource “Corsets and Crinolines” (Waugh, 1954/2000). Body measurements were taken and the pattern appropriately scaled to fit. A functional mockup was constructed from a heavyweight twill fabric, reusable grommet inserts, and plastic sewn-on and steel fabric-encased boning. The mockup was fitted, adjusted, and fitted again to ensure the final pattern was accurate.

One drawback of the corset pattern was the fabric waste left behind from cutting out the corset pieces. Creating a corset by tucking and gathering a single, solid piece of fabric was attempted, but the result was too complicated to construct and lacked the necessary strength. This waste issue also affected the selection of the appropriate eco-friendly fabric for the corset lining, which had to be shaped by seaming and be very sturdy. An inventive solution for reducing waste by giving a new life to old garments (Figure 24) led to a reversible corset that also added meaning and utility to the design. Inspired by some of Johnson's recycled denim corsets, an old pair of my worn-out jeans was used for the corset lining, reducing waste by preventing their disposal in a landfill. Cutting scraps from the fashion corset pieces were used to create an appliquéd design on the jean lining that reflected my name and birth identity as well as my love of nature. Since the lining was so beautifully decorated, the corset was made reversible so that it could be worn after the wedding.



Worn-out pair of jeans + Scraps from fashion fabric = Reversible corset lining

Figure 24: Corset Design Solution for Reducing Waste

The final stage of the design process was creating keepsakes from the main cloth piece of the skirt, which measured 208" in length and 56" in width. Taking into account the curved ends, this dimension established the usable area for segmenting into the keepsake patterns (Appendix N). All the patterns of the keepsakes were made

rectangular in order to reduce waste, except a Christmas tree skirt that utilized the rounded ends of the cloth. In addition to the skirt fabric, a variety of eco-friendly materials were used to embellish the keepsakes, including tussah “peace” silk yarn embroidery, silk chiffon scraps, eco-wool, and vintage lace and buttons.

5.5.5 Final Design Description

The corset of “The Dowry Dress” links me to my past and embodies my family’s future. The lining of the corset (Figure 25) is a mural representing my unique identity. The base material is a refashioned pair of old, worn-out jeans that I kept for sentimental reasons, which infused the corset with cherished memories of my youth. Fabric scraps leftover from cutting out the fashion fabric corset pieces created an appliquéd design on the corset lining. The three Chinese characters embroidered down the front side of the jean lining symbolized my personal traits. The first two characters stand for “purity,” the meaning of my name, and the last means “water,” my element sign by birth. Under the characters is an appliquéd red dot made from the prom dress I made. The corset is designed to be reversible so I can wear my corset after the wedding, showing the beautifully decorated lining. Yet regardless of whether I wear the corset again, having such an extraordinary and individualized lining embracing me on my wedding day provided a secret source of personal empowerment.



Figure 25: Decorative Mural Appliquéd on the Corset Lining

Reversibility was achieved by a unique double closure system (Figure 26), one for each side of the corset. On the jean lining, the grommets for the lacing act as the primary closure and are essential for creating the desired fit. On the fashion side of the corset, a continuous column of twenty-eight silk-covered functional buttons acts as a decorative detail that hides the lacings underneath and only needs to be used when wearing the fashion side out. These buttons are applied after the grommet closure has been constructed in order to accurately determine their positions while the lacing is tightened. If a future bride wearing this corset is a different size, the back buttons can either be repositioned or removed totally and replaced by a decorative lacing.

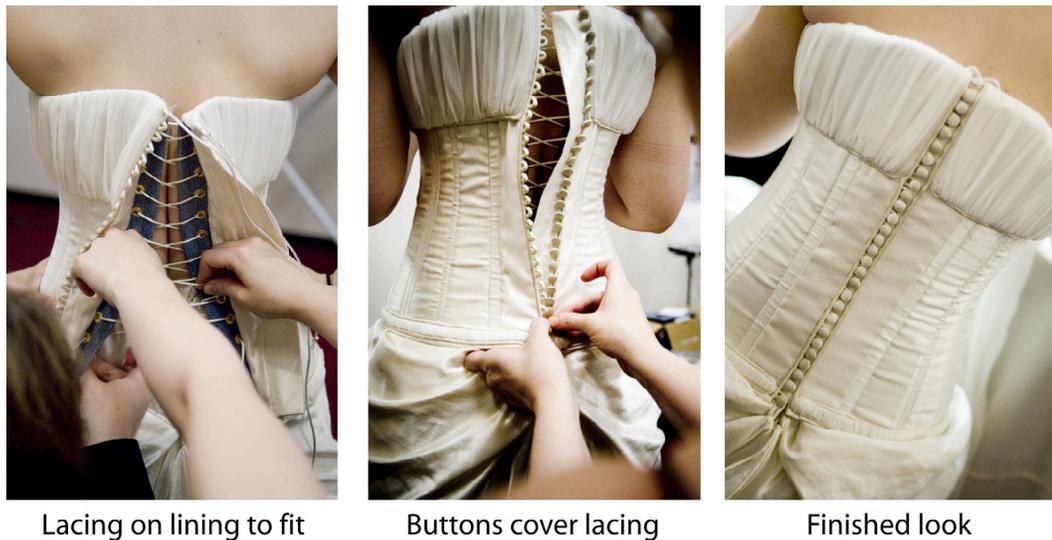


Figure 26: Corset Double Closure System

Unlike the lining, the fashion side of the corset is made plain and then any embellishments are hand-basted in place. This corset's embellishments feature an empire bodice and bottom trim made of gathered silk chiffon and edged with silk charmeuse piping. These pieces can easily be removed and new decorations added, if another bride should wear the corset in the future and want her own look. She could also embroider her name's meaning and her elemental birth sign onto the lining, thereby adding her mark to the corset.

The skirt of “The Dowry Dress” is an unfashioned length of cloth that is skillfully draped to create the skirt’s silhouette. The main cloth wraps around the body and its ends create the train in the back. A vintage petticoat worn underneath supports the A-line silhouette. Additional fabric was used to create an elastic waistband that is attached along the top edge of the skirt, and in that seam, two deep pleats in the skirt are created at the center back. Large hooks line the inside of the elastic waistband and secure to their corresponding eyes along the waistband of the vintage petticoat, so that the skirt stays in place. The front of the skirt is styled by gathering portions and safety pinning them in place to an underskirt made from muslin (Figure 27). This pinning allowed for quick style adjustments and the ability to length or shorten the skirt.



Hooking skirt to petticoat
(Skirt unstyled in mirror)

Pinning to create style

Finished look

Figure 27: Styling the Skirt

The train of the skirt is seamed at the center back along the top and bottom edges of the two fabric ends. This creates a tube that is finished with a circular hem for the end of the train. The two center back seams are sewn on top of each other to create a solid, double-sided train. A cord filled with curtain weights placed along the hem edge helps to further define and retain the train’s shape. The train is bustled using a cord loop in the middle of the back seam, hooked to a button where the skirt’s back

pleats meet at the waistband seam. A long and narrow silk chiffon scarf edged with silk charmeuse piping is also attached to this button at the scarf's midpoint. At the ends of the scarf are encased cords that have loops at either end and extend beyond the casing. When trained (Figure 28), the two sides of the scarf lay next to each other along the train where they are secured to buttons using the cord loops. When bustled (Figure 29), the scarf ends are tied to the hands using the cords, giving the bride "wings." This scarf replaces the typical head veil and can be worn again as a scarf on special occasions such as anniversaries.



Figure 28: Skirt Trained



Figure 29: Skirt Bustled

After the wedding, the skirt can be deconstructed back into a flat piece of cloth. Then it is ready to section off into the appropriate parts to create the different desired keepsakes. Special attention should be made to cut efficiently so that there is as little waste as possible (Appendix N). This is a sacred cloth so every part must be used. This skirt had enough area to produce a baby crib blanket, a christening dress, a

Christmas tree skirt, and four photo album covers and embroidery canvases that commemorate the wedding, the birth of a child, or special anniversaries (Figure 30).



Figure 30: "The Dowry Dress" Keepsakes

Other eco-friendly materials can be used for embellishing the keepsakes. Tussah "peace" silk yarn was used to create subtle tone-on-tone embroidery on the wedding album and birthday embroidery and beautiful smocking on the christening dress that forms the fitted bodice section of the dress without cutting or seaming. Using vintage rather than new lace and buttons required no new resources and added novelty. Scraps from the silk chiffon corset decorations formed a unique focal piece on the wedding album cover. Eco-wool, free of harsh processing chemicals, provided a warm, healthy filling for the baby's blanket.

CHAPTER 6

PHASE 3 – DESIGN EVALUTION

The last phase of this study was the evaluation of the five design collections during a final design exhibit. The time and location of the exhibit were coordinated and publicized. Displays showcasing and explaining the design collections were created. Two events, an opening night and a gallery talk, were held to encourage attendance. A questionnaire was administered during the exhibit to collect data on who attended and their reactions to the design collections. The questionnaires were analyzed to determine the success of the designs' concepts and executions.

6.1 Final Design Exhibit

6.1.1 Exhibit Location and Time

The final design exhibit was held at the main gallery of the Community School of Music and Arts (CSMA) in downtown Ithaca, NY, May 1-13, 2007. The criteria for selecting the exhibit location were to achieve high attendance by a general, community-based audience. The CSMA gallery was chosen because its off-campus location was likely to encourage exhibit-goers with a broad range of ages, education levels, and income levels. CSMA also offered high foot traffic from people attending classes and meetings, which brought people to the gallery who may not have gone out of their way to visit this exhibit. The main gallery was on the street level, well lit, and open late during the week, which brought in passersby. But the most important attendance draw was scheduling the opening night of the exhibit on May 4th to coincide with Gallery Night of Ithaca. This is a recurring event for which Ithaca art galleries stay open late on a Friday night showcasing special exhibits and artists as well as providing food and live music, thus drawing large crowds of people. In

addition to the opening night, a gallery talk was planned for Sunday afternoon, May 6th, to provide an alternate event for those who could not attend the opening night or were especially interested in the exhibit.

6.1.2 Publicity

The exhibit title “Re-Fashioning the Future: Eco-Friendly Apparel Design” and one-line summary were developed for the CSMA events calendar and Ithaca Gallery Night flyer (Appendix O). Wendy Skinner, local eco-fashion journalist, wrote a press release detailing the important dates and times of the exhibit as well as intriguing descriptions of some of the designs and background information (Appendix P). The press release was sent to over 100 e-mail addresses for press offices all over Central New York and was featured in the Arts and Cultural Events calendars in several newspapers, radio stations, and on the Cornell website. The Ithaca Journal requested an interview and published an article about the exhibit. A camera crew from TV News Channel 36 in Elmira, NY, came to the opening and filmed a segment that was shown on the local news that night. In addition to traditional forms of press, an informational postcard (Appendix Q) was designed and produced. Stacks of postcards were distributed on campus and at key areas downtown such as cafés, galleries, libraries, and downtown shops and placed at the exhibit as a takeaway.

6.1.3 Exhibit Layout and Displays

The five main design collection displays were grouped in the gallery by similar Error-Friendly principles: first both of the *effective* designs, then the *resilient* design, and finally the two *relational* designs (Appendix R). The *effective* LCA (Figure 31) and GCC (Figure 32) Label designs were displayed adjacently on one wall. Next to each of the label designs hung their respective LCA and GCC T-Shirt designs.



Figure 31: LCA Display



Figure 32: GCC Display

The *resilient* “Suit Yourself” design (Figure 33) was presented with one each of the Abby and Jane Suit looks on two mannequins standing on a platform. On the wall to the sides of the mannequins were life-sized photographs of the other two suit looks to illustrate how the suits could change. Hung next to the photos were the actual garment pieces that created those alternative looks, presented on maroon banners that framed the display. In front of the display were two boards (Appendix S) that pictured photos of each of the Abby and Jane Suits’ coordinates. These boards also provided tangible samples and descriptive labels of all the eco-friendly materials used to make the suite so that people could feel the materials and learn more about them.



Figure 33: "Suit Yourself" Display

The *relational* “No Sew” Projects display (Figure 34) also featured two boards, one for the knot technique and the other for the “faux” knit, that illustrated the steps for transforming a t-shirt into a project. The “faux” knit board demonstrated how to start the green cap, while the knot board showed how to create the fringed bag. The fringed bag project was featured on the knot display board while the four other projects were placed under a Plexiglas box on top of a table below the boards.



Figure 34: "No Sew" Display

The final *relational* display for “The Dowry Dress” (Figure 35) was presented in the front foyer of the gallery. The dress itself was positioned in the window next to the doorway so that people could view its elaborate backside as they entered the gallery. The dress was placed on the left side of a platform, and on the right side was a showcase containing a similarly lined corset that was designed for the wedding’s maid of honor. Behind the showcase in the gallery corner was a curved panorama showing all four sides of the bride’s corset lining. The keepsakes were stationed along the wall with a diagram of how the skirt was segmented into the keepsakes’ patterns hanging

above them. On the adjacent wall was a poster explaining the three main stages of “The Dowry Dress” life cycle. Similar posters were created and displayed with all of the design collections in order to educate the exhibit viewers about the important design features so they could successfully complete the questionnaires. Each poster stated the design’s goals and results and explained the key features of the design. To view all the five design posters, see Appendix T through Appendix X.



Figure 35: "The Dowry Dress" Display

6.1.4 Exhibit Events: Opening Night and Gallery Talk

The opening for the exhibit was attended by 80 to 100 people who were both Gallery Night of Ithaca show-goers and those who had come especially for this exhibit. Many participants devoted much time and effort to investigating the displays and considering their responses. In particular, a father explained each of the designs to his daughter as he filled in her responses to the questions. Although her questionnaire could not be included in final data analysis due to her young age, her vested interest in the topic gave hope that the next generation will make eco-friendly initiatives top priority. During the opening night, several people commented that the exhibit was beautifully designed and very innovative. Of those who shared their comments, the men were drawn to the t-shirt designs while the women enjoyed “The Dowry Dress”

and “Suit Yourself.” In fact, a few of these women remarked, “I wish I had thought of that” about these two design collections. Some people also mentioned that they felt vindicated by the GCC Label, which they thought gave them permission to continue wearing their clothes more times between washings.

About 20 people attended the gallery talk, with some having also attended the opening night. The purpose of the gallery talk was to provide those interested with further insight about how the designs were created and functioned, especially the designs that were not clearly observable, such as adjusting the fit in the “Suit Yourself” waistbands and creating the “No Sew” Projects. The inspirations for the designs were also shared; in particular, the Christmas tree skirt my mother made from wedding dress scraps that inspired “The Dowry Dress” concept. Another motive for the talk was to encourage more research participation. Almost everyone who attended and had not previously filled out a questionnaire did so after the gallery talk.

6.1.5 General Exhibit Attendance

The exhibit was open to the public for a full week after the gallery talk from 10 a.m. to 8 p.m. on weekdays and during the day on the weekend. Many people walked through the main gallery as they went to their classes and meetings, so some participants were recruited by circumstance. A CSMA staff member relayed a story about an art teacher who was heading to class but stopped in amazement at the exhibit. She readily filled out the questionnaire as well as gave questionnaires to all of her students, although it is unclear whether any of them actually completed it. The CSMA staff members were amazed at the amount of traffic the exhibit received by people who normally would not come to this gallery, a demonstration that the publicity was effective as well as those people’s willingness to spend the time responding to the questionnaire. One viewer was so moved by the exhibit that she wrote a postcard to

me expressing how the LCA T-Shirts influenced her to change the way she cared for her clothes (Appendix Y). At the closing, 70 completed and partially completed questionnaires had been submitted.

6.2 Questionnaire

The questionnaire was a single page printed on both sides (Appendix Z a and b). Each questionnaire was numbered to preserve anonymity of participants; the numbers were pre-printed by hand on the top right. The questionnaire was divided into three sections: socio-demographics, Design Assessment, and Attitude/Behavioral Assessment. The socio-demographics section asked the participants to indicate their ages and zip codes and to circle their gender, income level, and completed education level. These were used to describe the sample and compare Attitude/Behavioral Assessment responses for possible significant demographic influences with consumer type: green versus conventional consumers.

The Design Assessment formed the main portion of the questionnaire. Participants evaluated each design in three categories: design appeal, potential behavioral influence, and reactions to some of the main design features. They were asked to rate each of these items on an individual basis using a 5-point Likert scale. These scales were formatted two different ways in order to conserve space; participants were asked to either write in the appropriate number or circle the appropriate word answer. In addition, participants were asked to write in the names of their favorite eco-friendly materials and suit look for the “Suit Yourself” design assessment. The final part of the Design Assessment was an overall evaluation of all the designs in which participants had to rank order the five design collections (1 = most liked design and 5 = least liked design). Participants were then asked to explain the reasons why they chose their highest and lowest ranked design collections.

The last section was the Attitude/Behavioral Assessment that determined if the participant was a “green consumer” or not. The assessment consisted of seven statements (Table 11) to which participants indicated their level of agreement on a 5-point Likert scale. The exhibit questionnaire’s 7-item scale was adapted from a 17-item scale previously developed for a Research Methods class project (Appendix AA). For the Research Methods project scale, the construct of “green consumption” was operationalized as a function of both consumer behavior and attitudes toward consumption. Based on relevant research concerning environmentally conscious consumers (Berger & Corbin, 1992; Minton & Rose, 1997; Roberts, 1995) and sustainable consumers (Autio & Heinonen, 2004; Nyberg & Stø, 2001), the construct was divided into four main categories: Environmental/Social Concern, Perceived Consumer Effectiveness, Sustainable Consumer Behaviors and Attitudes.

Table 11: Green Consumer Attitude/Behavioral Assessment, 7-item Scale

Scale Item (-/+)	Construct	Source
1 - If I had more money I would definitely buy more and more things. (-)	Sustainable Consumer Attitude	Developed in Focus Group
2 - When I go shopping, I usually plan out what I'm going to buy beforehand and I usually end up buying only what I planned. (+)	Sustainable Consumer Behavior	Developed in Focus Group
3 - I don't feel I have enough knowledge to make well-informed decision on environmental. (-)	Perceived Consumer Effectiveness	Scale Item from Berger & Corbin, 1992
4 - I buy fewer things than the average person my age. (+)	Sustainable Consumer Behavior	Based on info in UNESCO/UNEP, 2001
5 - My local environment would really have to deteriorate before I would consider altering the way I consume. (-)	Perceived Consumer Effectiveness	Adapted Scale Item from Berger & Corbin, 1992
6 - I read and compare labels to look for environmentally safe ingredients/practices. (+)	Sustainable Consumer Behavior	Adapted Scale Item from Minton & Rose, 1997
7 - I consider myself a “green” consumer. (+)	Sustainable Consumer Attitude	Developed for this scale

The Research Methods project scale items were developed for each of these four categories by rewording or borrowing the exact items from previously tested scales, developing scale items from research findings, and brainstorming scale items in a focus group. An initial set of 50 scale items was administered to a group of 13 scale

judges. The items that most differentiated the top and bottom 25% of the judges were kept, resulting in a 17-item scale. This 17-item scale was tested by a sample group of 28 participants for reliability and received a test-retest score of .96 and a Cronbach Alpha score of .82, both indicating high reliability.

For this study's questionnaire, a shorter yet still reliable scale was needed to identify green consumers that took participants less time to complete. In order to determine which items from the Research Methods project scale to include in this study's exhibit questionnaire, the results of the top and bottom 25% judges from the project scale development were reviewed to establish which items produced the greatest differentiation between the two groups. An additional pilot study using the Research Methods project scale was conducted, and those results were reviewed to see which items produced the greatest variation. Items were also chosen to have a balance between negative and positive items. Only the last of the seven final items was newly developed for this study's scale in order to address an overall attitude based on the participant's self-identification with green consumption.

6.3 Questionnaire Results

6.3.1 Demographic Description of Final Valid Participants

A total of 70 questionnaires were completed during the exhibit. All submitted questionnaires were recorded into a data set with discontinuous participant numbers since they were pre-numbered, from 1 to 100. Eighteen questionnaires were deemed unacceptable to include in the final data analysis. Seven questionnaires were eliminated because they were blank on the back side. Six others were discarded because 20 or more questions were left blank. Two participants were younger than the 18-year age requirement to participate in this study, while two others had obviously misunderstood the questionnaire directions based on their response patterns, making

four more questionnaires unusable. Finally, the questionnaire of one participant, who rated everything with the highest score possible and failed to rank the designs because she liked them all, was eliminated as an obvious outlier. The end result was that 52 (74%) of the original 70 questionnaires were applicable for data analysis.

The demographics of the 52 participants (Table 12) were analyzed to describe the sample. Their ages ranged from 18 to 69, with an average age of 40. The gender was unbalanced, with 72% (36) female and only 28% (14) male participants. A majority of those who attended were local from either Ithaca or Lansing, NY, while the other 23% (12) came from nearby towns or other states. This participant sample was highly educated, with almost 80% (41) holding a Bachelor's Degree or higher and none with only a high school education. The "Income" question caused some confusion about whether it was asking for personal or household income, making those results unreliable.

Table 12: Exhibit Questionnaire Participant Demographics

Age	#	% Total	Gender	#	% Total
29 and Under	15	28.8%	Male	14	28%
30 - 39	10	19.2%	Female	36	72%
40 - 49	13	25.0%	Valid	50	100%
50 - 59	7	13.5%	# Missing	2	
60 and up	7	13.5%	Total	52	
Total	52	100%			
Mean	40				
Min	18				
Max	69				
Location	#	% Total	Education	#	% Total
Local	40	77%	High School	0	0%
Out-of-town	12	23%	Some College	11	21%
Total	52	100%	Bachelor's Degree	17	33%
			Master's Degree	17	33%
			Doctorate	7	13%
			Total	52	100%

6.3.2 Design Assessment Results

The Design Assessment results were analyzed using response rates and totals, primarily combining the two positive responses "Yes" and "Somewhat." Response rates were discussed rather than means since the data were not normally distributed

and were categorical, meaning the distance between two points on the Likert scale cannot be assumed to be the same distance as between two other points.

The Design Assessment responses covered each design collection’s overall appeal and influence, interest in specific design features, and placement in the rankings for most liked design. Due to the design of the questionnaire, there were two exceptions. Overall design appeal was not requested for the GCC Label and T-Shirt; rather individual appeal scores were measured for each of the four new care symbols and four t-shirt logos. Overall design influence was not requested for the LCA T-Shirt; rather participants were asked to identify themselves with one of the logos.

According to the available overall design appeal and influence results (Table 12), over 80% of participants responded either “Yes” or “Somewhat” to design appeal, a very positive evaluation, except for the LCA T-Shirt appeal with combined-positive responses at 57% (24). In addition, “Yes” was the most frequent response in each overall appeal question. The most appealing design to the participants was “The Dowry Dress,” with 80% (41) “Yes” responses and 94% (48) for “Yes” and “Somewhat,” followed by the LCA Label’s appeal at 89% (38) combined positives.

Table 13: Overall Design Appeal and Influence (N=52)

OVERALL DESIGN APPEAL & INFLUENCE	Yes		Somewhat		Neutral		Not much		No		TOTAL *	# Missing	MEAN *	ST DEV *
LCA Label - Appeal	49%	21	40%	17	9%	4	2%	1	0%	0	43	9	1.65	0.75
LCA Label - Influence	47%	21	38%	17	4%	2	7%	3	4%	2	45	7	1.84	1.09
LCA T-Shirt - Appeal	40%	17	17%	7	24%	10	14%	6	5%	2	42	10	2.26	1.27
GCC Label - Influence	19%	6	63%	20	3%	1	9%	3	6%	2	32	9	2.22	1.07
OR, I already care for my clothing this way										34%	11		11	from item 6
GCC T-Shirt - Influence	25%	9	56%	20	6%	2	8%	3	6%	2	36	10	2.14	1.07
OR, I already care for my clothing this way										17%	6		6	from item 6
Suit Yourself - Appeal	51%	25	35%	17	4%	2	8%	4	2%	1	49	3	1.76	1.01
Suit Yourself - Influence	37%	19	27%	14	14%	7	8%	4	14%	7	51	1	2.33	1.41
No Sew - Appeal	57%	28	24%	12	4%	2	4%	2	10%	5	49	3	1.86	1.31
No Sew - Influence	35%	17	31%	15	10%	5	8%	4	15%	7	48	4	2.35	1.42
Dowry Dress - Appeal	80%	41	14%	7	4%	2	2%	1	0%	0	51	1	1.27	0.63
Dowry Dress - Influence	43%	22	25%	13	20%	10	2%	1	10%	5	51	1	2.10	1.27

* 6th item not included in count or calculations

For overall design influence, the label-related designs, including the LCA Label, GCC Label, and GCC T-Shirt, received responses over 80% for “Yes” and “Somewhat,” with the LCA Label receiving the highest combined-positive responses at 89% (38). On the other hand, the garment-related designs, including “Suit Yourself,” “No Sew” Projects, and “The Dowry Dress,” received 64% (33), 66% (32), and 68% (35) respectively. “Yes” was the most frequent response for all the overall design influence questions, except for the GCC Label and GCC T-Shirt, where “Somewhat” was the most frequent at 63% (20) and 56% (20) respectively. However, there was a slight difference in the response options for the GCC Label and GCC T-Shirt with a sixth item: “I already care for my clothing this way,” which received response rates of 34% (11) and 17% (6) respectively. This response option is what reduced the sample size for the GCC Label and T-Shirt influence questions analyses.

Design features of the all five design collections had combined-positive responses ranging from 50% to 86%, with “Yes” being the most frequent of all the responses, except two of the “No Sew” Projects with combined-positive responses under 50%. For the LCA Label and T-Shirts design (Table 14), the label’s most interesting design feature was “Energy Consumption,” with a combined-positive response rate of 80% (34). “Energy Consumption” and “Consumer Use” both had the highest “Yes” response rates of the four label features at 50% (22). “Consumer Use” and “CO₂ Emissions” both had combined-positive response rates of 70% (31), followed by “Environmental Issues” at 65% (29) and “Disposal” at 57% (25). The LCA T-Shirts were measured according to the participant’s level of self-identification with the narrative logos, with 45% (19) of the participants identifying with the “Green Dot” logo and 48% (20) “In-Between” the green and red logos.

Table 14: LCA Label & T-Shirts - Design Features (N=52)

<i>LCA Label Features</i>	<i>Very Interested</i>	<i>Somewhat Interested</i>	<i>Neutral</i>	<i>Somewhat Uninterested</i>	<i>Not at all Interested</i>	<i>TOTAL</i>	<i># Missing</i>	<i>MEAN</i>	<i>ST DEV</i>
Energy Consumption	50% 22	30% 13	11% 5	2% 1	7% 3	44	8	1.86	1.15
CO ₂ Emissions	36% 16	34% 15	20% 9	0% 0	9% 4	44	8	2.11	1.19
Environment Issues	45% 20	20% 9	25% 11	2% 1	7% 3	44	8	2.05	1.20
Consumer Use	50% 22	20% 9	18% 8	2% 1	9% 4	44	8	2.00	1.28
Disposal	30% 13	27% 12	27% 12	2% 1	14% 6	44	8	2.43	1.32
LCA T-Shirt Logos									
<i>Which "Dot" narrative is you?</i>	Green 45% 19	Red 7% 3	In-Between 48% 20					*	*
						42	10	2.02	0.98

The GCC Label and T-Shirts design features (Table 15) provide insight into this design's appeal. The "Full Loads," "Repair," and "Reuse" new care symbols were rated between 60-70% in the combined-positive responses, with "Full Loads" receiving the highest "Liked a lot" response rate of the four care symbols at 59% (29). The "Stinky" care symbol did receive a majority of positive responses with 53% (26), yet it also received the second highest response rate for "Didn't like" of all the design features in this study, with 22% (11). For the GCC T-Shirts, the "Dry Green, It's Free" was the most liked of the four logos with a 65% (33) response rate for "Yes," making a combined-positive response rate of 73% (37).

Table 15: GCC Label & T-Shirts - Design Features (N=52)

<i>GCC Label - New Care Symbols</i>	<i>Liked a lot</i>	<i>Somewhat liked</i>	<i>Neutral</i>	<i>Somewhat didn't like</i>	<i>Didn't like</i>	<i>TOTAL</i>	<i># Missing</i>	<i>MEAN</i>	<i>ST DEV</i>
Stinky	45% 22	8% 4	14% 7	10% 5	22% 11	49	3	2.57	1.66
Full loads	59% 29	10% 5	18% 9	2% 1	10% 5	49	3	1.94	1.34
Repair	43% 21	18% 9	20% 10	6% 3	12% 6	49	3	2.27	1.40
Reuse	51% 25	16% 8	14% 7	6% 3	12% 6	49	3	2.12	1.42
GCC T-Shirt Logos									
Wash only when...	47% 24	16% 8	20% 10	6% 3	12% 6	51	1	2.20	1.40
Fill before you wash	45% 23	24% 12	18% 9	4% 2	10% 5	51	1	2.10	1.30
Energy Hogs	43% 22	12% 6	27% 14	4% 2	14% 7	51	1	2.33	1.42
Dry Green, It's FREE	65% 33	8% 4	16% 8	6% 3	6% 3	51	1	1.80	1.25

“Eco-Friendly Materials,” a “Suit Yourself” design feature (Table 16), was the most popular of all the design features in this study with 62% (31) “Yes” responses and 86% combined-positive responses (43). Moreover, none of the participants responded negatively to this design feature. “Transformable” and “Adjustable Fit,” the other two “Suit Yourself” design features, were rated much lower, 50% and 64% combined-positive responses respectively. The total 36 written-in preferences for favorite eco-friendly material produced broad results for all fabric types, both fashion and underlining fabrics, with no clear favorites and balanced between the materials used in the Jane Suit totaling 53% (19) and the Abby Suit totaling 47% (17). One participant noted, "The most eco-friendly fabric is Salvation Army clothes. New fabric uses resources in production and transportation." Of 41 total responses choosing one of the two suit designs as their favorite, the Jane Suit received 59% (24) of the vote and the Abby Suit 41% (17).

Table 16: "Suit Yourself" - Design Features (N=52)

<i>Suit Yourself Features</i>	<i>Very Interested</i>	<i>Somewhat Interested</i>	<i>Neutral</i>	<i>Somewhat Uninterested</i>	<i>Not at all Interested</i>	<i>TOTAL</i>	<i>#Missing</i>	<i>MEAN</i>	<i>ST DEV</i>
Transformable	40% 20	10% 5	32% 16	10% 5	8% 4	50	2	2.36	1.32
Adjustable Fit	38% 19	26% 13	22% 11	0% 0	14% 7	50	2	2.26	1.35
Eco-Friendly Materials	62% 31	24% 12	14% 7	0% 0	0% 0	50	2	1.52	0.74
<i>Which suit was your favorite?</i>	Abby 41% 17	Jane 59% 24				41	11	*	*

* 2 Point Scale

For the “No Sew” Projects (Table 17), the three “faux” knit projects, including the “White Striped Purse,” “White Hat with Flower,” and “Green Cap,” were well liked, receiving combined-positive response rates of 74% (35), 72% (34), and 67% (30) respectively. The two knot projects, including the “Fringed Bag” and the “Green and Yellow Scarf” received lower combined-positive responses at 36% (17) and 44% (19) respectively. These were the only two design features not to receive higher than

50% of combined-positive responses. The “Fringed Bag” received the highest negative response rate for “Didn’t like” of all the design features in this study at 23% (11).

Table 17: "No Sew" Projects - Design Features (N=52)

<i>No Sew Projects</i>	Liked a lot	Somewhat liked	Neutral	Somewhat didn't like	Didn't like	TOTAL	# Missing	MEAN	ST DEV
White Striped Purse	55% 26	19% 9	17% 8	6% 3	2% 1	47	5	1.81	1.08
White Hat with Flower	51% 24	21% 10	23% 11	2% 1	2% 1	47	5	1.83	1.01
Fringed Bag	13% 6	23% 11	26% 12	15% 7	23% 11	47	5	3.13	1.36
Green and Yellow Scarf	22% 10	20% 9	33% 15	7% 3	18% 8	45	7	2.78	1.36
Green Cap	40% 18	27% 12	20% 9	4% 2	9% 4	45	7	2.16	1.26

“The Dowry Dress” (Table 18) had the highest overall positive responses for “Yes” in all of its three design features, including “Recycled Garments” at 60% (29), “Reusable Components” at 63% (31), and “Refashioning Keepsakes” at 59% (29). “Reusable Components” had the second highest combined-positive responses of all the design features at 85% (42).

Table 18: "The Dowry Dress" - Design Features (N=52)

<i>Dowry Dress Features</i>	Very Interested	Somewhat Interested	Neutral	Uninterested	Somewhat Not at all Interested	TOTAL	# Missing	MEAN	ST DEV
Recycled Garments	60% 29	15% 7	13% 6	6% 3	6% 3	48	4	1.83	1.24
Reusable Components	63% 31	22% 11	10% 5	0% 0	4% 2	49	3	1.59	0.98
Refashioning Keepsakes	59% 29	10% 5	22% 11	2% 1	6% 3	49	3	1.86	1.21

In the overall design ranking (Table 19), participants had to rank-order the five designs from most liked (1) to least liked (5). “The Dowry Dress” was the clear favorite with 61% (28) of participants ranking it as their most liked design, consistent with its high scores for appeal, influence, and interest in design features. “Suit Yourself” received the most second highest rankings with 28% (13), consistent with its high ratings for appeal and having the most popular design feature “Eco-Friendly Materials.” The GCC Label and T-Shirts were most frequently ranked third at 41% (19), followed by the LCA Label and T-Shirts with the most frequent fourth ranking at

35% (16). The “No Sew” Projects design was most frequently ranked as the least liked with 35% (16), consistent with low appeal responses for the two knot project designs.

Table 19: Overall Ranking of Designs (N=52)

OVERALL RANKING OF DESIGNS	Highest Ranked		Second Highest Ranked		Middle Ranked		Second Lowest Ranked		Lowest Ranked		TOTAL # Missing		MEAN	ST DEV
LCA Label & T-shirt's	11%	5	9%	4	17%	8	35%	16	28%	13	46	6	3.61	1.29
GCC Label & T-shirt's	2%	1	22%	10	41%	19	17%	8	17%	8	46	6	3.26	1.06
"Suit Yourself"	13%	6	28%	13	22%	10	22%	10	15%	7	46	6	2.98	1.29
"No Sew" Projects	13%	6	17%	8	13%	6	22%	10	35%	16	46	6	3.48	1.46
"The Dowry Dress"	61%	28	24%	11	7%	3	4%	2	4%	2	46	6	1.08	1.08

High participation in the last two short-answer questions, in which participants wrote their reasons for ranking their most favorite (71% response rate n = 37) and least favorite (60% response rate n = 31) designs, provided further information about participants’ responses to the design sets. Five main themes were found in their comments: related to self, either by involvement in design or commitment to design and its meaning; personal meaning; too complicated, hard to understand; would not change behavior; and beautiful or dowdy. Table 20 displays sample participant responses illustrating each. For all participants’ written responses to most and least liked designs, see Appendix BB.

Table 20: Common Response Themes for Most and Least Liked Designs

Common Response Themes	Design	Ranking	Comment
1 (a) Related to self - <i>involvement in design</i>	Dowry Dress	Highest	"It's something I could do with things I own for my children and grandchildren" (P# 17)*
	No Sew	Highest	"I could see myself doing this at home" (P# 41)
(b) Related to self - <i>commitment to design or its meaning</i>	LCA	Lowest	"Not interested in wearing that info though I like to be aware and use the info" (P# 10)
	Dowry Dress	Highest	"I loved the idea of making keepsakes out of the dress" (P# 19)
2 Personal meaning (Dowry Dress mostly)	Dowry Dress	Highest	"Lovely and has nostalgic appeal; family heirloom" (P# 3)
	Dowry Dress	Highest	"Sanctifying the material" (P# 100)
3 Too complicated, hard to understand (LCA mostly)	LCA	Lowest	"A lot of information, maybe too much" (P# 8)
	LCA	Lowest	"The dots are too wordy and complicated, I like the label idea" (P#41)
4 Would NOT change behavior	GCC	Lowest	"I don't think people would be very affected by it; I don't think they'd bother to look at the symbols. They'll think about it but not do anything about it - we're too much and convenience" (P# 64)
	LCA	Lowest	"Just wouldn't wear t-shirts with messages on them" (P# 44)
5 Beautiful or dowdy/craft	No Sew	Lowest	"Look like 'hippie' projects which I can't wear to work, except scarf" (P# 15)
	Suit Yourself	Highest	"I think the idea is the most novel and would catch on well, and they're beautifully executed" (P# 21)

*P# stands for participant number

Considering these open-ended responses by design collection, those who chose “The Dowry Dress” as their most liked design noted the design’s beauty, innovation, and personal meaning. Participant 62 wrote that “I really liked all of [the designs], but especially the wedding dress because it was beautifully designed and constructed as were all the keepsakes; something I could do and would do.” Those participants who

chose the “The Dowry Dress” also specifically discussed the personal meaning of refashioning the skirt into keepsakes. Participant 51 wrote: “I really liked the skirt reuse plan, carrying a cherished garment into other cherished moments.” However, participant 9 said she was “not convinced I’d cut up my wedding dress up into other items, [that she] considered it an heirloom.”

Participants who chose the “Suit Yourself” as their most liked design noted its style, craftsmanship, and versatility. Participant 21 wrote “I think the idea is the most novel and would catch on well, and they're beautifully executed,” while participant 47 wrote “good design, better idea.” Participant 15 wrote “very useful for lots of occasions.” Participants who choose the “Suit Yourself” design as their least liked design said that it was not their style. Participant 30 wrote that the suits were “dowdy, clunky, not very flexible or sexy!”

The participants who ranked either the GCC or LCA Labels and T-Shirts as their least liked design said that they liked the labels but either did not like the t-shirt logos or just did not wear logo t-shirts. Participant 64 said that they did not like GCC Label: “I do not think people would be very affected by it ... [or] bother to look at the symbols. They’ll think about it but not do anything about it (we’re too much about convenience).” Some participants indicated that the LCA Label and T-Shirt logos had too much information or were too wordy. Participant 10 wrote about the LCA design collection: “Seems better in an article or brochure than in clothing I would wear.” Participant 19 said about the GCC T-Shirts: “not interested in wearing t-shirts with logos or slogans.” Two participants did rate the LCA and GCC design as their most liked design. Participant 9 considered the LCA design as an “effective way to convey information to influence consumer buying decisions,” while participant 74 said that the GCC design was the “most applicable” to himself.

The participants who liked the “No Sew” Projects said that they looked fun and easy to make. Participant 70 said that “these projects are easy to understand, practical, and inexpensive.” Participant 68 noted liking the “No Sew” aspect of the design: “did not require sewing (I do not know how to sew).” The participants who ranked these projects as their least liked said that they either doubted their ability to create them or considered them primarily youth projects. Participant 18 wrote, “Although I like the projects, I probably would not do them,” while participant 15 said that they “look like ‘hippie projects, which I cannot wear to work, except the scarf.’”

6.3.3 Green Consumer Assessment

The seven Attitude/Behavioral Assessment items were combined into a scale and tested for reliability. The scale earned a .73 Cronbach Alpha for internal reliability, above the .70 deemed acceptable for use in social research. The participants were divided into “green consumers” and “conventional consumers” according to the total sum of their scores. The middle 10% of the participants were eliminated to sufficiently differentiate the two groups, leaving N=41. Participants with total scores ranging 7 to 15 were included in the green consumers group (n=22), while those with total scores 20 to 27 were included in the conventional consumers group (n=19). The scale items that best divided the green and conventional consumer groups were 1, 3, 6, and 7: “I consider myself a ‘green’ consumer,” according to the mean responses that showed opposing positive and negative reactions by the two groups (Table 21).

Table 21: Attitude/Behavioral Assessment Results - Green vs. Conventional Consumers (N=41)

ATTITUDE/ BEHAVIORAL ASSESSMENT	Consumer Type	Response					TOTAL	MEAN	ST DEV
		Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree			
Item 1 - more money, buy more (-)	Green	5% 1	9% 2	18% 4	23% 5	45% 10	22	3.95	1.21
	Conv	47% 9	32% 6	21% 4	0% 0	0% 0	19	1.74	0.81
Item 2 - planned out shopping (+)	Green	43% 9	38% 8	14% 3	5% 1	0% 0	21	1.91	0.97
	Conv	16% 3	37% 7	21% 4	26% 5	0% 0	19	2.58	1.07
Item 3 - don't have enough info (-)	Green	0% 0	23% 5	9% 2	45% 10	23% 5	22	3.68	1.09
	Conv	21% 4	42% 8	11% 2	21% 4	5% 1	19	2.47	1.22
Item 4 - buy fewer things than others (+)	Green	77% 17	23% 5	0% 0	0% 0	0% 0	22	1.23	0.43
	Conv	32% 6	16% 3	16% 3	26% 5	11% 2	19	2.68	1.45
Item 5 - local environ deteriorate (-)	Green	0% 0	0% 0	0% 0	5% 1	95% 21	22	4.95	0.21
	Conv	16% 3	11% 2	11% 2	37% 7	26% 5	19	3.47	1.43
Item 6 - read and compare labels (+)	Green	23% 5	45% 10	32% 7	0% 0	0% 0	22	2.09	0.75
	Conv	0% 0	11% 2	21% 4	26% 5	42% 8	19	4.00	1.05
Item 7 - "green" consumer (+)	Green	27% 6	55% 12	14% 3	5% 1	0% 0	22	1.95	0.79
	Conv	0% 0	0% 0	32% 6	53% 10	16% 3	19	3.84	0.69

Cronbach Alpha = .73

The two consumer types were compared based on age, gender, and education levels to see if there were any significant correlations. Each demographic was divided with the goal of splitting the sample into two balanced groups: age, “below 40” and “40 and above;” gender, male and female; and education level, “Bachelor’s degree and below” and “Master’s degree and above.” Crosstab analysis using the Fisher’s Exact Test chi-square calculation was used to determine significant relationships ($p \leq .05$) between demographics and consumer type. In Table 22, age and education level were found to have significant correlations in this sample, with Fischer’s Exact Test scores of .002 and .025 respectively. This meant that the older and more educated participants were more likely to be green consumers. There was no significant difference between the two groups based on gender, but this may have been due to the unbalanced sample with 72% (36) female.

Table 22: Consumer Type x Age, Education Level, Gender (N=41)

Consumer Type X AGE	Below 40	40 & Above	TOTAL
Green Consumers (n=22)	22.73% 5	77.27% 17	22
Conventional Consumers (n=19)	73.68% 14	26.32% 5	19

Pearson Chi-Square = 10.646

Asymp Sig. (2-sided) = 0.001

Fischer's Exact Test = 0.002*

Consumer Type X EDUCATION LEVEL	Bachelor's Degree &	Master's Degree &	TOTAL
Green Consumers (n=22)	40.91% 9	59.09% 13	22
Conventional Consumers (n=19)	78.95% 15	21.05% 4	19

Pearson Chi-Square = 6.078

Asymp Sig. (2-sided) = 0.014

Fischer's Exact Test = 0.025*

Consumer Type X GENDER	Male	Female	TOTAL
Green Consumers (n=22)	28.57% 6	71.43% 15	21
Conventional Consumers (n=18)	22.22% 4	77.78% 14	18

Pearson Chi-Square = 0.205

Asymp Sig. (2-sided) = 0.651

Fischer's Exact Test = 0.468

* $p \leq .05$

The main aim for creating these two consumer groups was to determine whether there was a relationship between participant consumer type and his or her responses to the Design Assessment. Since the data were not normally distributed, Pearson's Chi-Square analyses were conducted to determine which design responses had the potential for significant relationships with consumer type. For Pearson's Chi-Square scores that were significant or borderline significant ($p \leq .05$), the statistical software StatXact v.4 was used to calculate Fisher's Exact Test scores to conclusively determine significant relationships between consumer types and design response.

Table 23: Consumer Type x Design Appeal and Influence (N=41)

Consumer Type		Design Assessment								TOTAL	# Missing	MEAN		Pearson Chi-Square		Aysmp. Sig (2-sided)		Fischer's Exact Test			
		Yes	Somewhat	Neutral	Not much	No	"I already care..." Not included in totals	ST DEV													
LCA Label - Appeal (n=33)	Green	47%	9	37%	7	11%	2	5%	1	0%	0		19	3	1.74	0.87	1.203	0.752			
	Conv	43%	6	50%	7	7%	1	0%	0	0%	0		14	5	1.64	0.63					
LCA Label - Influence (n=34)	Green	60%	12	30%	6	0%	0	5%	1	5%	1		20	2	1.65	1.09	7.872	0.096	0.0493*		
	Conv	21%	3	57%	8	14%	2	0%	0	7%	1		14	5	2.14	1.03					
LCA T-Shirt - Appeal (n=32)	Green	37%	7	16%	3	26%	5	21%	4	0%	0		19	3	2.32	1.20	3.276	0.513			
	Conv	54%	7	15%	2	15%	2	8%	1	8%	1		13	6	2.00	1.35					
GCC Label - Influence (n=23)	Green	9%	1	73%	8	0%	0	9%	1	1%	1	45%	5	11	11	3.50	1.97	1.730	0.785		
	Conv	25%	3	50%	6	0%	0	17%	2	8%	1	33%	4	12	7	3.25	1.98				
GCC T-Shirt - Influence (n=27)	Green	31%	4	46%	6	8%	1	8%	1	8%	1	31%	4	13	9	3.06	1.98	1.066	0.957		
	Conv	21%	3	57%	8	7%	1	7%	1	7%	1	14%	2	14	5	2.69	1.66				
Suit Yourself - Appeal (n=39)	Green	50%	10	25%	5	5%	1	15%	3	5%	1		20	2	2.00	1.30	2.158	0.707			
	Conv	63%	12	26%	5	5%	1	5%	1	0%	0		19	0	1.53	0.84					
Suit Yourself - Influence (n=40)	Green	33%	7	24%	5	29%	6	10%	2	5%	1		21	1	2.29	1.19	6.265	0.180			
	Conv	37%	7	21%	4	5%	1	11%	2	26%	5		19	0	2.68	1.70					
No Sew - Appeal (n=39)	Green	59%	13	18%	4	9%	2	5%	1	9%	2		22	0	1.86	1.32	2.568	0.633			
	Conv	65%	11	24%	4	0%	0	0%	0	12%	2		17	2	1.71	1.31					
No Sew - Influence (n=38)	Green	24%	5	43%	9	14%	3	5%	1	14%	3		21	1	2.43	1.33	4.977	0.290			
	Conv	53%	9	18%	3	12%	2	0%	0	18%	3		17	2	2.12	1.54					
Dowry Dress - Appeal (n=40)	Green	81%	17	10%	2	5%	1	5%	1	0%	0		21	1	1.33	0.80	1.228	0.746			
	Conv	79%	15	16%	3	5%	1	0%	0	0%	0		19	0	1.26	0.56					
Dowry Dress - Influence (n=40)	Green	33%	7	29%	6	29%	6	0%	0	10%	2		21	1	2.24	1.22	3.839	0.428			
	Conv	53%	10	21%	4	11%	2	5%	1	11%	2		19	0	2.00	1.37					

* $p \leq .05$

All of the appeal and influence Design Assessment questions (Table 23) were analyzed for possible influences by consumer type. No significant relationships were found between the participants' consumer types and how they responded to the design appeal and influence questions, except for LCA Label influence. The LCA Label influence question was borderline significant with a Fischer's Exact score of .0493.

CHAPTER 7

DISCUSSION & CONCLUSIONS

7.1 Research Participation

7.1.1 Exhibit Location and Time

The Community School of Music and Arts (CSMA), Ithaca, NY, exhibit location yielded high exhibit attendance and questionnaire participation by a diverse, yet highly educated segment of the community population. The exhibit opening on May 4th coincided with the Gallery Night of Ithaca event resulting in strong attendance by a diverse group of people, both those participating in the Gallery Night event and those who came specifically to see my exhibit. The gallery talk two days later drew an audience of people interested in knowing more about the designs, some who were unable to attend the opening night. The CSMA building's late open hours and high traffic of staff, teachers, and students guaranteed steady exhibit attendance and provided participation in the design evaluation questionnaire beyond the two exhibit events. If the exhibit had been mounted for longer, attendance might have remained steady with additional questionnaire participation.

7.1.2 Publicity

Press coverage, especially the TV interview, indicated a general interest in eco-friendly design initiatives and those specific to clothing fashion. On the other hand, many of the stacks of exhibit postcards distributed around town were hardly touched, so they seemed better as a take-away to remind exhibit-goers of what they saw rather than persuading people to attend. If the postcards had been mailed to interested parties, they may have been more effective at encouraging attendance, yet that attendance may have been biased by the mailing list composition. Posters, rather than postcards,

placed around town and on campus may have drawn a larger general attendance, as a large poster placed on a wall is more eye-catching than stacks of postcards on a table.

7.1.3 Questionnaire

The objective of the questionnaire format was to collect consumer reactions to the designs without taking too much of the participant's time and energy. In order to balance minimum time and maximum information, the questionnaire was designed to fit on a single, double-sided piece of paper. As anticipated, some participants (7 of the original 70 questionnaires collected) did not fill-out the back side. A written reminder to fill out the back side was placed on clipboards at the exhibit, but not all participants used the clipboards when completing their questionnaires. After the first 42 questionnaires had been submitted, arrows were physically drawn on the bottom right-hand corners of the front pages of all the remaining questionnaires, and after that, no one who completed the front page of the questionnaire left the back side blank. If the original questionnaire design had included such an arrow or reminder to go the next page, fewer questionnaires would have been completed only on one side.

The Design Assessment section was the longest of the three sections and had the most questions left blank on completed questionnaires. Of the original 70 questionnaires collected, 6 participants ended the Design Assessment section prematurely, plus 7 participants left the entire back side blank. Of those 6, 4 actually went on to complete the Attitude/Behavioral Assessment, indicating that for some participants, the Design Assessment was too long. On the other hand, 34 participants left two or fewer questions blank in the Design Assessment, not including the last two short answer questions. As far as the response rate for the two short-answer questions, 47 of the total 70 questionnaires submitted had responses for both questions. The Attitude/Behavioral Assessment section consisted of a 7-item scale to determine

whether a participant was a green or conventional consumer. Only 2 of the original 70 questionnaires collected had missing data in this section, not including 7 participants who left the entire back side blank. Therefore, the length was short enough that the majority of people were willing to complete the section. The questionnaire results analysis showed that this scale had high reliability even with only seven items.

The questionnaire may have been too long for some to even start filling it out as well as for some who started and left it incomplete. Almost half of the participants responded to all but two of the questions in the Design Assessment, and more than half of participants responded to the short answer questions in the Design Assessment and the 7-item Attitude/Behavioral Assessment. This indicates either that the questionnaire was a reasonable length or that these participants were so interested in this exhibit that they were willing to spend extra time completing the questionnaire, as observed by some members of the CSMA staff. This may also indicate that only people who were interested in the designs took time to participate in the study and might also partially explain the overwhelmingly positive results in the Design Assessment. Therefore, a shorter questionnaire may have resulted in higher research participation and perhaps a broader range of reactions to the designs.

7.1.4 Socio-Demographics of Sample

This participant sample offered a balanced age range, balanced yet overall high education levels, and over twice as many females than males. A female bias was expected given that women are often more interested or more comfortable showing interest, in clothing and fashion than men. Unfortunately, due to the vague wording of the “Income” question, participants were unclear about whether to indicate their personal or household income level so the income levels were unreliable and not analyzed. The intention was to ask for household income level, as this is the best

gauge of spending power in the case of participants who are still dependents to their families and both single and dual income households. This problem could be easily corrected in the future by using the term “Household Income.”

While the education levels were balanced between those having completed a bachelor’s degree and below, and those with a master’s degree and above, all participants had completed some higher education beyond high school. Since Ithaca, NY is home to both Cornell University and Ithaca College, it was expected that the participant sample would be biased toward people with higher education levels than the general population. This is evident when comparing the education levels of local and non-local participants. Of the 23% (12) of total participants who were not from the local Ithaca and Lansing, NY area, only 16% (2) had a master’s degree or above. Yet of the 73% (40) of total participants who were local participants, 55% (22) had a master’s degree or above. If the exhibit had been in a non-college town, a more generalizable sample population in terms of education level might have been achieved.

7.2 Design Assessment

All of the appeal and influence questions about design concepts and features received a majority of combined-positive responses, over 80% for appeal (except for LCA T-shirt Appeal with 57%) and over 60% for influence. In addition, each design’s features received 50% or higher combined-positive responses (except the “Fringed Bag” at 36% and the “Green and Yellow Scarf” at 44%). However, some of the participants were personal acquaintances who were already very familiar with the designs and supportive of my project, so they may have rated the designs positively. The positive appeal and interest in each design’s concept and features indicate that consumers may be willing to either purchase or use them, the first step toward ensuring the success of the design. Each design collection also showed the potential to

influence consumers to change their behaviors in ways that might result in reduced net environmental impact.

7.2.1 *“The Dowry Dress”*

Of all the design collections, “The Dowry Dress” was significantly higher in the overall rankings, with 61% (28) of participants ranking it as their most liked design, consistent with its high positive responses in appeal, influence, and design feature interest. This suggested that the design was well developed and executed, and that the exhibit layout and display poster were effective at portraying the design’s meaning and concept to exhibit-goers. Participants that ranked this design as their most liked noted in their short answer responses that they liked how personally meaningful the design was, especially the refashioning of the keepsakes, confirming the significant consumer appeal for Gajendar’s “experiential beauty” (2004, p. 4).

“The Dowry Dress” design’s very positive results may be partially biased due to it being the featured design in the publicity and a focal point of the exhibit; those drawn to the exhibit by the publicity or by seeing this design prominently displayed in the front window might have been predisposed to be quite interested in it. Some of the participants were personal acquaintances who were already very familiar with this particular design since it had been developed over the longest amount of time; therefore, they may have been predisposed to better understand it and find it more appealing. Yet the general attendance on the opening night coupled with this design’s unusually strong appeal and interest ratings in its three design features suggested some success based on the design’s concept and execution. This design was the most developed of the five design collections; it was the first concept envisioned and was created over the longest period of time, about nine months.

7.2.2 “Suit Yourself”

The “Suit Yourself” design was most frequently ranked second in the overall rankings, consistent with its “Eco-Friendly Materials” receiving the highest positive responses of all the design features. This design’s two other features, “Transformable Looks” and “Adjustable Fit,” were rated much lower yet still received 50% or higher combined-positive responses. Since materials are the main, and often myopic, focus in current eco-fashion news and marketing, participants might have been previously exposed to some eco-friendly materials and consequently, were very interested in discovering more about them. In addition, this exhibit offered a much broader range of eco-friendly materials, such as “peace silk” and Tencel®, as compared to more prevalent materials eco-friendly apparel, like organic cotton and bamboo, which may have surprised the participants and positively affected the scores on this design. Participants’ choices for their favorite eco-friendly material used in the suits ranged widely and included both fashion and underlining fabrics. This suggested that the favorite fabrics may have been influenced by the display boards with the fabric samples and extra information as well as the suit designs, yet it is unclear how much each part contributed to participants’ responses.

Along with the general interest in materials, the size and placement of the material display boards could explain why “Eco-Friendly Materials” rated so much higher than the two suit design features, “Transformable Looks” and “Adjustable Fit,” which were featured on a much smaller poster mounted on the wall to the side of the design. While the displays of the other suit components and pictures of the other two suit looks did show that the suit could transform, they did not show exactly how the transformation worked, e.g. intricately placed separating zippers. Moreover, the adjustable fit features on the waistbands were completely hidden from sight; participants only had written descriptions on the poster to understand how the

adjustable fit would work. If participants could have seen how the suits transformed and adjusted in fit, perhaps in a video displayed with the designs, they may have found these two design features much more interesting.

Suits were chosen as the garment type to illustrate the “Suit Yourself” design concept because they are investment wardrobe pieces that would benefit from ensuring a long, useful lifespan and their styles can be updated by changing design components like collars and bottoms. Rather than just showing a particular type of garment, a few different types of garments could have been designed and displayed, e.g. children’s wear. The benefits of the “Transformable Looks” and “Adjustable Fit” design features could have been further demonstrated by showing how they could be applied in other types of garments. With this approach, participants might focus on the common design features of the different garment types, in this case the transformability and adjustability, rather than the specific styles of those garments. Participants might better understand the “Transformable Looks” and “Adjustable Fit” design features and rate them higher in interest and influence.

7.2.3 GCC Label and T-Shirts

The GCC Label and T-Shirts design was the most frequent third place response in the overall rankings, consistent with its moderate yet positive ratings of interest in design features. Some of the participants who chose this design as their least favorite noted they did find the design appealing but were not interested in wearing t-shirts with slogans. The t-shirt logo “Dry Green, It’s FREE” was the most popular of these designs, supporting Peattie’s (2001) theory that viable green products are created by combining environmental benefits with clear consumer gains. On the other hand, the “Energy Hogs” logo, which combined environmental harm with consumer costs, was the least popular of the designs. The “Energy Hogs” logo was based on the current

care symbols for “Wash Warm” and “Tumble Dry Warm,” but these were not included nor explained on the GCC Label like the other logos, so participants may not have recognized these care symbols or understood their meanings. The addition of these two labels’ names to the logo design may have made it less confusing.

The “Stinky” design was the least popular care symbol and received the second highest negative responses of all the design features in the exhibit. This could be due to either participants misunderstanding the logo or the strong culture of cleanliness that underpins our society. The taboo of being perceived as dirty was alluded to in the comments of some people at the opening, who felt that this symbol finally gave them permission to wear what others would consider “dirty” clothes. The “Wash only when...” t-shirt that brought to life the “Stinky” care symbol was also the only t-shirt to be purchased from the website store and by a person who did not attend the exhibit, indicating that its logo design has at least some commercial appeal.

The GCC Label and T-Shirt overall influence questions included a sixth item (“I already care for my clothing this way”) in order to account for participants who may not be influenced to change their clothing care behaviors because they already reflect the ones suggested by the GCC design. More participants chose this sixth response item for the GCC T-Shirts influence, as those logo designs focused only on clothing cleaning behaviors, than for the GCC Label influence, which extends clothing care beyond cleaning behaviors. These findings suggest that while some consumers may already be implementing low-impact clothing cleaning behaviors, more consumers need to learn about the other eco-friendly ways to care for their clothing, including repairing, reusing, and recycling.

7.2.4 LCA Label and T-Shirts

The LCA Label and T-Shirts design was the most frequently ranked fourth of the five design collections, notably inconsistent with the label's very positive appeal and influence responses. Some of the participants noted that either or both of the LCA Label and T-Shirts were too complicated to understand or find appealing. The design of the LCA Label had a great deal of new information that participants may have found hard to process. This design could benefit greatly by consumer focus group reactions during its development in which consumers would discuss how they understood the label. This could have helped determine if the information or how it was presented was confusing or misleading and if it was effective at influencing behaviors. The label design could then be refined and even pilot tested in order to see if participants effectively understood the label and if their consumer behaviors were influenced by it. Additional explanations on the LCA Label display board may have helped participants better understand the information.

Yet most of the participants who ranked this design their least liked said that they did like the label idea just not wearing all that information on a t-shirt. Participant 41 commented that the dot logos were "too wordy," and participant 79 said "seems better in an article or brochure than in clothing I would wear." These dot logos may not have been realistic for t-shirts that people would actually wear, according to some of the written responses and the postcard sent by an exhibit-goer, but rather their message was effective as an exhibit installation. These logos could be used as statement pieces to make people consider their own cleaning behaviors rather than designs that consumers would actually purchase and wear, more pictorial logos that illustrated the behaviors, perhaps in a comic strip fashion, might have been more appealing than the written narratives, while just as thought-provoking.

7.2.5 “No Sew” Projects

The “No Sew” Projects were most frequently ranked the least liked of the five design collections, consistent with receiving the most negative responses to the two knot projects. The “faux” knitting projects, namely the matching hat and purse set, were ranked much more appealing than the two knotted projects, possibly because the knot projects looked less polished than the knits. One participant mentioned that the “No Sew” projects looked too “hippie,” so she may have been referring to the fringe on the knot projects, a typical feature of hippie style clothing. If so, the knot projects may have been more appealing to participants if they had been constructed to show only the knots and not the fringe. In addition, the faux “knit” technique could have been more novel and interesting to the participants because they may have never seen it before. The contrasting color palette and fashionable style of the white and navy hat and purse set may have overwhelmed the knot projects’ dull colors and basic styles.

The “No Sew” Projects may have also been the least liked design because they required the most involvement on the part of the consumer, i.e. the consumer would have to do more than just read a label or purchase a garment. A few participants said that they liked the look of them, but that they did not think they would actually do craft projects. They may also have thought themselves incapable of executing the projects well or were simply scared to cut up a t-shirt for fear of ruining it, consistent with Chanin and Fletcher’s comments that many people are afraid to cut up clothing in order to redesign it. If the “No Sew” Projects had actually been made by people with varying degrees of craft skills and interest, this may have been more influential at convincing those who do not consider themselves crafty that these projects would be enjoyable to them. Step-by-step instruction sheets for how to make the “No Sew” Projects could have been provided as take-aways, so that exhibit-goers would be even more inclined to give the projects a try. A “No Sew” Projects station could have been

set-up with donated old t-shirts and supplies so that people could try the projects perhaps as they waited for their CSMA classes to start. Or, a workshop event could have been advertised at the display and held at the end of the exhibit to teach people the skills. These interactive experiences would have provided the opportunity to explore and understand the potential of these “No Sew” design techniques and consumer involvement in general.

7.3 Green and Conventional Consumer Impact

The Attitude/Behavioral Assessment produced a balanced sample of green consumers (scores ranging 7 to 15) and conventional consumers (scores ranging 20 to 27). Strong correlations between green and conventional consumer groups with age and education level further demonstrated inconsistencies in other research about whether or not green consumers can be defined by their socio-demographic characteristics (Berger & Corbin, 1992; Diamantopoulos et al., 2003; Minton & Rose, 1997; Roberts, 1995). An alternative explanation is that the study’s sample size was too small, too unique to this university town, too highly educated, or that the people interested in visiting this exhibit did not accurately capture the broader range of green and conventional consumers in the larger population.

The lack of significant correlations between consumer type and the Design Assessment showed that the success of these eco-friendly apparel designs was not dependent on a green consumer market as intended. This is in accordance with Peattie’s argument about the “Myth of the Green Consumer” (2001) that all consumers decide to purchase a product based on degrees of confidence and compromise. Since these designs were rated high in appeal and influence, this could mean that the designs inspired confidence in consumers about their environmentally friendliness and/or consumers had to compromise little in terms of quality, function, and style.

One exception was the influence of the LCA Label, in which green consumers said they would be more influenced by the LCA Label than conventional consumers. This significant relationship between consumer type and the LCA Label influence might have been affected by the attitude/behavioral scale, which included label reading as a way of differentiating between the green and conventional consumer groups. In addition, this pool of green consumers was also highly educated, which suggests a desire for knowledge that may be the reason they were more interested in an informative label than the conventional and less educated consumer group. Therefore, this particular group of green consumers may have found the LCA Label more influential because they were highly educated and based their consumer decisions on labels and not because they were green.

7.4 Limitations

This research was limited by the time and resources available for a master's thesis and graduate student. These included number and extent of development of design collections, sample selection, methods for evaluating design collections, and the measurement of behavioral intentions rather than actual behavior.

More time and resources would allow each design concept to be developed more completely into apparel collections, with multiple prototypes and critiques to improve its aesthetic, functional, and influential features. Likewise, the displays for the exhibit might have benefited from additional display options in interactive media appropriate to the design concept. These could have helped clarify some of the more complex design concepts, such as the adjustable fit and transformable looks of the "Suit Yourself" design, and reduce the likelihood of participants rating these designs lower because they could not easily understand them.

In addition, although the eco-friendly design experts and design critics helped in the design process, the questionnaire with limited open-ended questions was the single method for evaluation of the designs upon their completion. Using a multiple method approach that increases the qualitative data collection may result in richer responses that could be used to improve these designs as well as provide inspiration for additional designs. For example, combining the Likert scale questions with focus groups that discuss each design collection separately would enhance the understanding of the high positive ratings and individual features. Conducting a workshop or interactive exhibit where participants actually tried out the “No Sew” techniques and discussed their experiences and outputs might provide more insights about the potential for this approach for connecting consumers with their eco-friendly products.

The design assessment questions only tested for behavioral intentions, yet the objective of these design projects was to influence changes in behaviors that would be less harmful to the environment than current behaviors. Further studies using methodology that evaluates actual consumer behaviors, such as self-reporting of wear tests or participant observations of activity-based designs, could verify whether these designs would result in the intended consumer behavioral changes.

The findings of the design assessment were limited by a self-selection bias in the sample by participants who were interested in the topic and friends and acquaintances attending to support my research. This may have contributed to the highly positive results of the design assessment. A larger and more diverse sample with fewer personal acquaintances may change the results of the study and provide more reliable and meaningful assessment of the design collections’ appeal and influence. Such findings could help inform changes needed to improve and extend the design collections’ executions or concepts.

CHAPTER 8

RECOMMENDATIONS & SUMMARY

8.1 Recommendations for Methodology

8.1.1 Design Goals

The design goals for this study were presented to experts from the field of eco-friendly design for their feedback. The five eco-friendly design experts who were interviewed provided a good balance of viewpoints between industry (Chanin and Burda) and academia (von Busch, Fletcher, and Hethorn). The methodology of one-on-one interviews was a qualitatively rich experience that inspired new ideas about my goals rather than evaluating the effectiveness of those design goals. For future studies, additional designers as well as non-designer expert viewpoints could be helpful to better understand how changes in apparel design would affect the other stages of the clothing life cycle, including those involved in materials, apparel production, and textiles recycling. In addition to personal interviews, a questionnaire could be administered to larger groups of experts that would ask them to rank the design goals in terms of effectiveness and provide comments for improvement in all stages of the clothing life cycle. This would provide more and diverse qualitative and quantitative input to add to, revise, or polish the goals.

8.1.2 Design Execution

Initial designs were critiqued by a panel of experts in design education, so their comments were informed by design experience as well as research literature related to effective design approaches and how consumers have responded to other design features in related studies. Another approach would be to have consumer involvement in the design development. Green and conventional consumers could be organized into

focus groups to provide input on developing designs. This method of consumer design critique could inform the development of designs that expose consumers to information they may have had no frame of reference for understanding and interpreting, such as the LCA Label. Focus groups would also be useful for design concepts that were dependent on consumer involvement, such as the “No Sew” Projects. Observational or experimental studies that tested prototypes with consumers could determine the effectiveness of the designs at producing desirable behaviors with low environmental harm.

Industry partnerships may help future eco-friendly design projects acquire the most innovative eco-friendly fabrics and technologies in exchange for results or media attention. The materials used in “Suit Yourself” and “The Dowry Dress” designs were limited to what were commercially available, mainly on the Internet, generally narrow color selections and types of fabrications. An industry partner could provide access to innovative yet hard to source eco-friendly fabrics, such as Ingeo™, bamboo, soy, and Modal®, in exchange for creation of unique designs showcasing the material and other eco-friendly design strategies. Industry involvement might also help develop more innovative and less complicated materials and products for attaching the components and achieving transformability and adjustability that are less labor intensive. For example, biodegradable corn PLA could be made into sliders instead of zippers that simply snap on the edge of the garment for transforming and then could be composted when the garment’s life was over. Likewise, applications of nanotechnology could produce other design ideas for meeting eco-friendly goals, such as Improved Care with clothing that did not need to be washed. Future advances in nanotechnology may also provide such eco-friendly features as self-repair functions and the ability to change color to extend wearing options.

The design execution of labels like the LCA Label would greatly benefit from the resources of an apparel company's research and development department to accurately present environmental impacts specific to the production of a particular garment. In this project, research results from several sources about a generic t-shirt were combined to create a label that served only as a fairly accurate representation of the impact of the LCA T-Shirts. With an apparel company's involvement, environmental data for products other than t-shirts could be developed and the information on the labels could be accurate to those specific garments.

8.1.3 Design Evaluation

This study was only exhibited in one location for a short period of time. This biased the results toward people from a single, narrow demographic location, those with interest in visiting the exhibit, and personal acquaintances who wanted to support my research. Exhibiting in multiple locations and for longer periods may provide additional information about the same design collections.

Another option would be to create a website based on the exhibit, develop a web-based survey with the same questionnaire, purchase a consumer sample, and administer the questionnaire. This could result in increased research participation by a generalizable sample that was not personally biased toward my research and may provide more insights on the designs. Greater research participation could produce results that are normally distributed and enough responses to allow for more in-depth data analysis. In addition, the focused step-by-step process of a web-based questionnaire could ensure that participants are exposed to all the important information about each design. An engaging and interactive web design could explain the design features and concepts more clearly than a mounted exhibit, for example, the suit transformations could be shown in short QuickTime videos.

8.2 Recommendations for Designing

8.2.1 Applying the ERRor-Friendly Framework to Other Design Projects

The ERRor-Friendly Framework deconstructs the various environmental design approaches into three basic common principles: *effective*, *resilient*, and *relational*, that can inspire a wide variety of eco-friendly designs. These three principles were the foundation of this study in guiding the formation of eco-friendly designs from the overall design objective to its final execution. This study provides some examples of how the ERRor-Friendly principles can be interpreted into overall objectives for future design studies and how specific design goals can be developed that meet those overall objectives. For example, in this study, the *effective* principle was realized through design goals that focused on the overall objective for reduction of resource consumption during the product's life cycle. Eco-Friendly Materials that were effectively produced used renewable resources and practices. Informed Care reduced resource use for cleaning clothes. New Life, Transformable Forms, and Improved Fit extended the lives of garments so that new resources were not needed to replace them. The ERRor-Friendly Framework principles can be applied in different ways by other designers, with each new design project providing additional possibilities for these and other design goals to achieve unique eco-friendly design concepts and executions.

The five eco-friendly apparel designs of this study highlighted the three principles of the ERRor-Friendly Framework. Yet, a truly eco-friendly design should possess all three principles. To be *effective*, the eco-friendly garment's life cycle uses resources effectively through closed-loop cycles in which all waste becomes food for another cycle. To be *resilient*, the garment adapts over time to the needs of the wearer, which could imply fit, style, and function. To be *relational*, the consumer engages in a meaningful relationship with the garment, through either contributing to its conception

or participating in its resilient adaptations. Future design projects could incorporate all three in one design concept. For example, a service for customizable clothing applying body scan fit technology satisfies the *effective* principle by preventing wasteful production of ill-fitting clothes, the *resilient* principle by providing a fitting system that supports diversity and adapts to current needs, and the *relational* principle by allowing consumers to customize clothing to meet their style and functional needs. As more people use the ERROR-Friendly Framework in guiding their design projects, it can be expanded and refined as a framework for eco-friendly design.

8.2.2 Other Eco-Friendly Apparel Design Goals

The seven Eco-Friendly Apparel Goals were initially formed using a life cycle focus on environmental impacts, yet other goals could be developed and applied as well. For example, after the eco-friendly design expert interviews, this study's purpose evolved to include the relationship between consumers and their clothing. This consumer focus became part of the Informed Care goal in addition to the Re-Thought Life Cycle goal, but it really deserves a goal of its own reflecting the importance of clothing to fulfill consumer needs for things like identity, community, meaning, empowerment, and creativity. In synch with Von Busch and Chanin's ideas, a Deeper Connection goal could call for extensive consumer involvement with clothing to increase satisfaction and connection with their clothing. According to Hethorn, an Enhanced Self-Image goal for eco-friendly clothing designs could empower people to be happier with who they are rather than degrading them by, for example, not offering the clothing styles they like in their size. A Local Fashion goal could focus on a diversity of locally emerging styles rather than globally established monolithic trends, as proposed by Fletcher's call for a new definition of fashion that "would be

reformulated to favour promoting dynamic relationships in society rather than its current drivers of competition and exclusivity” (2005, p. 68).

While this study’s objective was to create eco-friendly apparel designs that met consumers’ clothing needs, eco-friendly products other than apparel could also be designed to meet consumer needs that are not directly related to clothing. Extending the transformable concept beyond clothing could produce multiple-use products, such as transforming a dress into a chair or a solar energy collecting shirt to power a cell phone. Or, what if clothing was continuously useful? Imagine a clothing wardrobe doubling as insulation for a house or drapes for windows.

8.3 Recommendations for Commercial Applications

8.3.1 Product Labeling that Informs Consumer Decisions and Promotes Behavior Change

Labeling products could promote consumer awareness about a product’s environmental impacts in ways that would enable consumers to make informed changes to their behavior. Packaging label concepts like the LCA Label that provide consumers with basic information about the environmental impacts of an apparel product’s life cycle at point of purchase could educate consumers about important environmental issues and use this information to decide which products to purchase and how to use them. Widespread adoption of a standard environmental label without a government mandate might have to be a consumer-led initiative rather than industry-led, as only companies with eco-friendly products would initially want to rate the environmental impact of their products on a label. Consumers could create a market demand for the label by purchasing only products with environmental impact labels and telling retailers that they wanted the label on more products. Retailers would react to the consumer demands by carrying products with environmental impact labels. This

could then push manufacturers to provide labels so that their products would be carried and to improve production practices so that their products were rated favorably on the environmental impact label. To ensure that consumers would want to use an environmental impact label, it would have to provide reliable and useful information, and consumers would have to be able to effectively understand and interrupt that information. A third party might need to standardize and regulate its data and format, like the Nutritional Facts label, so that all products would use the same standard label. Consumers would then only need to understand one standard label design, and they would be able to effectively compare products.

The products themselves could also be permanently labeled, even visibly as part of the product, so that consumers would always have a reminder about the environmental impacts of their purchase and use of those products. For example, the color-coded dots used in the LCA Label design could be placed on a product in a prominent location indicating environmental impact of that product's production, distribution, and recommended care and disposal. In the case of a t-shirt, it may receive a "red" dot for production because it was made from conventional cotton, which required a great deal of energy and toxic chemicals to make, but a "green" dot for clothing care as it recommends washing in cold and hang drying. For garments and other products, these dots could become as influential as a brand label, acting as a statement of the wearer's environmental concern. The intended outcome would be for the "green" dots to become the trend rather than the "red" dots. In addition, a label indicating eco-friendly clothing care behaviors like the GCC Label could serve as a garment's official care label if it incorporates the standardized international care symbols to provide basic cleaning information as required by the Federal Trade Commission (FTC).

Marketing campaigns could also actively promote eco-friendly clothing behaviors by provoking consumers to think about the environmental harm caused by their behaviors and providing them incentives for changing those behaviors, such as reduced energy costs. Organizations that promote low-impact cleaning for clothing could use the LCA T-Shirt logos and GCC Label and T-Shirt logos as marketing tools on apparel or other products. The LCA T-Shirt narrative dot logo concept, “Which dot are you?” might provoke consumers to think about how they clean their clothes. The GCC T-Shirt “Dry Green, It’s FREE” slogan could provide people with an incentive for air-drying their clothing. These slogans and logos could be used in a variety of marketing methods other than t-shirts and apparel such as websites, commercials, and billboards to effectively communicate the message about how to reduce the amount of environmental resources used or wasted.

8.3.2 Engaging Consumers in Eco-Friendly Lifestyles

Informational resources could teach consumers about eco-friendly clothing care behaviors and skills so that they could take steps toward an engaging and self-satisfying eco-friendly lifestyle. Pamphlets, do-it-yourself books, or websites could inform consumers about the environmental impacts of cleaning clothing, present easy and creative ways to repair and reuse clothing, such as the “No Sew” Projects, and recommend ways to recycle clothing. By providing the initial education and inspirations for eco-friendly clothing behaviors, consumers will begin to figure out what ideas work for them and possibly develop new and better methods. Consumers could use or initiate online communities or blogs to share their own eco-friendly clothing experiences and changed behaviors, such as tips about the most effective air-drying methods or new techniques for re-fashioning old clothes into new products.

This would not only promote more effective eco-friendly behaviors but also community involvement and creativity.

For example, the “No Sew” projects could be featured on an interactive website that would both teach the techniques as well as showcase the creations of consumer-producers. How-to instructions for techniques would be most effective if they included images when describing each important step and videos might be even better. Sample projects that featured different applications of techniques and embellishments would be a useful starting place for many would-be producers; after creating several sample projects, they may be more confident in their skills and inspired to create their own designs. With an interactive website, consumers could even post instructions for new techniques that they developed and other readily available garments that they recycled or reused such as weaving strips of jeans into belts or molding felted wool sweaters into hats.

8.3.3 Reducing Resource Use

Fewer resources might be needed if eco-friendly products were designed to meet the needs of the consumer, provide long or many useful lives, and utilize materials that were sustainability produced or recycled. The clothing industry should make every effort to only produce stylish and well-fitting clothing items that consumers will want to purchase; clothing that is not wanted is “designed waste.” Various new technologies could aid in this goal, such as body scanning that provides actual size and shape for the garment’s target market and product configurators for consumers to choose design features.

Designing adjustable clothing that changes style and fit over time would reduce resources and overall clothing consumption as consumers would wear garments longer. The extent of resource reduction would depend on the methods

providing transformability and adjustable fit. For example, children's clothing would be an ideal application as children grow very quickly, requiring larger sizes and longer garment lengths.

Products made from recycled materials would require few additional new resources and potentially give products several useful lives. Products made from recycled resources could also provide opportunities for a variety of community-based industries. Cottage industries could utilize readily available waste supplies from community businesses and residences as well as techniques based on local culture for fashioning products. Challenge industries that provide employment for people with limited abilities could enable an economical business plan for eco-friendly production through lower or subsidized labor costs while providing valuable employment for an underserved segment of the population. Such challenge industries would be ideal for utilizing simple production techniques like those created for the "No Sew" Projects.

8.3.4 Adding Meaning to the Product

Services that allow consumers to be involved in the designing of the product could help ensure that the product meets consumers' needs. Design involvement could provide consumers with a deeper connection that may encourage them to care for these products better and keep them longer, i.e. a longer useful life. Involving consumers in the design process empowers them to be their own designer and provides an outlet for expressing creativity. For example, "The Dowry Dress" was envisioned as a co-designed effort between the consumer and the designer in order to give new life to cherished old garments and to instill personal meaning into the design.

Refashioning services could be offered for any type of meaningful garment, whether a special garment worn once or twice or an old favorite garment that was worn so much it was no longer useable. These services could include custom design

work co-designed by consumers, classes that taught consumers techniques for refashioning garments, or downloadable project instructions and patterns for the consumers to construct themselves. Likewise, web-based technologies, such as product configurators that enable consumers to customize their clothing, could provide more co-design opportunities for involving consumers that produce meaningful and deeper connections with their clothing.

8.4 Recommendations for Future Research

Future eco-friendly design research should focus on evaluating actual consumer behaviors, which could be applied at various stages of the study's methodology. Anthropological observations could help inform the research, such as watching people clean their clothes and noticing whether they follow the care label instructions. Consumers could wear test design prototypes, evaluating aesthetic, functional, and eco-friendly features and make suggestions to refine a design before its final evaluation. Final designs could be evaluated using methods that would allow for consumer behavioral assessment. For example, the environmental impact labels could be tested in real or experimental retail environments with green and conventional consumers to determine the influence of environmental impact labels on garments of varying prices and qualities to determine how consumers weigh these three variables when purchasing a product and whether green and conventional consumers behave differently. Design studies that evaluate actual consumer behaviors could examine the product in the context of its entire life cycle in order to determine whether it produces adverse "rebound effects" of unanticipated consumer actions that would negate any potential environmental benefit. For instance, the objective of the "Suit Yourself" design was to reduce overall clothing consumption, therefore the method for providing that transformability should require few new materials and encourage consumers to

buy less clothing overall. Yet the particular method developed for the “Suit Yourself” design of detachable components may in fact cause more consumption if fashion-hungry consumers continue to purchase the same number of suits in addition to all of the suits’ matching components.

Future research could provide additional content and approaches to improve the ERRor-Friendly Framework. The ERRor-Friendly Framework needs to be applied to a variety of design initiatives in order to determine whether its three principles are universally inspiring to any eco-friendly design, from products to services. Different or additional principles for eco-friendly design initiatives other than product design also need to be considered for expansion or refinement of the ERRor-Friendly Framework. This design research could be set up similarly to the current study. Another option would be a larger data collection conducted via email or a research web site with a random sample and an extensive set of design collections presented by representative images rather than completed apparel. Or, a group of designers could be convened in person or electronically (virtually) to discuss the current three principles, consider new ones, and brainstorm how the principles could be translated into apparel design goals and final design concepts. This could be a month-long or year-long process that allows reflection time while benefiting from continuous interaction among designers with eco-friendly consciousness and objectives.

8.5 Summary of Study

The purpose of this study was to re-think, or “re-fashion,” eco-friendly apparel design in a way that would appeal to the wants and needs of both green and conventional consumers, and that would influence them to change their behaviors in order to produce less environmental harm. These objectives were based on the literature review that showed consumer behaviors, including cleaning and buying

volume, caused the most environmental impact of the entire clothing life cycle. Due to the importance of consumer behaviors, it is vital that eco-friendly designs are appealing not only to green consumers, but also to conventional consumers whose behaviors are most likely responsible for environmental harm (Paavola, 2001). Yet regardless of a consumer's concern for the environment, eco-friendly products must meet the same needs for quality and performance that all products must meet if any consumer is going to purchase them. Moreover, Kardash contends that if eco-friendly products do in fact equal their conventional counterparts in product attributes, then all consumers will choose the products that are better for the environment (Peattie, 2001).

Fletcher believes that the current role of eco-friendly apparel designers should be to "create images of *what might be*," to provide a "mass of answers" for the environmental problems we face (personal communication, November 16, 2006). Therefore, the objective of this research was to create collections of apparel designs that addressed various eco-friendly design goals for re-thinking the ways consumers interact with their clothing. These collections were exhibited so that consumers could respond to and rate the success of the design collections' concepts and executions in terms of consumer appeal and behavioral influence.

Design goals were developed to meet the needs and wants of clothing consumers, and to change key behaviors that have been shown to cause environmental harm. An initial set of seven goals was developed based on the literature review and focused on the specific needs of apparel design, such as materials, fit, and care. Five eco-friendly design experts were interviewed to provide feedback about my initial design goals and concepts. The purpose of these interviews was to determine which goals were the most promising and how to best refine them. The designers were asked to describe the focus of their own eco-friendly designs in addition to commenting on my list of design goals. All designers asserted the need for a stronger consumer focus

in sustainable or eco-friendly design initiatives. They affirmed the important role of the designer as the connection between the industry's practices and the consumer's needs. These experts argued that my role as a designer should be to educate and empower consumers while demonstrating to both consumers and the industry what is possible in the field of eco-friendly apparel design. Their recommendations were incorporated into the finalized list of Eco-Friendly Apparel Design Goals (Table 24).

Table 24: Eco-Friendly Apparel Design Goals

- **Eco-Friendly Materials:** promoting a diversity of low-impact materials that provide added values of high quality, durability, and easy care
- **Transformable Forms:** clothing that has updatable/transformable forms
- **Improved Fit:** clothing that flatters body shapes and provides adjustable fit
- **Informed Care:** educating consumers about the environmental impacts of the clothing life cycle and how to reduce the impact of their clothing care, encouraging them to become more involved in the upkeep of their clothing
- **New Life:** giving old clothing a new and improved life by empowering them to interact with their clothing in a creative way
- **Re-Thought Life Cycle:** addressing the entire life cycle of a garment during the design conception to achieve a new and enhanced consumer experience compared to a conventional garment
- **Effective End:** clothing that can be easily disassembled for recycling

The expert interviews and the writings of Manzini (1992), Hawken (1993), and McDonough and Braungart (1998; 2002a) led to the development of the Eco-Friendly Framework: *effective*, *resilient*, and *relational*, environmental principles that could be applied to all forms of design (Table 25). These three principles served as the foundation for the development of the design collections, while the seven Eco-Friendly Apparel Design Goals provide the means for realizing those principles. The term *eco-friendly* was used as the exhibit and study titles as a recognizable term that would encourage people to attend the exhibit and read my research.

Table 25: The ERRor-Friendly Framework

E- *Effective*: form cyclical systems of consumption

R- *Resilient*: support and foster diversity

R- *Relational*: develop cooperative and meaningful relationships

Design concepts based on the seven Eco-friendly Apparel Design Goals and the three ERRor-Friendly Framework principles were developed into prototypes and twice critiqued by a panel of design critics, resulting in five eco-friendly apparel design collections: two *effective*, one *resilient*, and two *relational*. The Life Cycle Analysis (LCA) Label and T-Shirts, an *effective* design, informs people about the environmental impacts of clothing to encourage them to they change their consumer behaviors. The LCA Label provides consumers with the information they need about the products they consume, much like a Nutritional Facts label on food, so they can make informed choices on their own rather than a label telling them that a product is good for the environment or not. The two LCA T-Shirts were designed to represent two LCA Labels for a conventional cotton and an organic cotton t-shirt. More importantly, the LCA T-Shirts translate the labels' environmental impact data into human terms using logos with narrative descriptions of "green" and "red" clothing care behaviors. The LCA Label and T-shirts design meets the goals of Informed Care by educating consumers about the environmental impacts of the clothing life cycle and underlying aspects of Eco-Friendly Materials by promoting the benefits of their use.

The GCC Label and T-Shirts, the other *effective* design, informed consumers about the impact of their clothing care behavior using current and newly-designed clothing care symbols that expand the concept of clothing care beyond just cleaning. The Green Clothing Care (GCC) Label and T-Shirts encourages low-impact clothing care behaviors. The GCC design's primary goal is to instill Informed Care behaviors focused not only on clothing cleaning but also on maintenance, reuse, and disposal.

The “Suit Yourself,” the *resilient* design, transforms over time to reflect current fashion trends and the changing size of the wearer so that consumers are more satisfied with their clothes and consume fewer clothes over time. This design also showcases the quality and diversity of eco-friendly materials currently available so that consumers can see they are not limited to organic cotton or hemp. “Suit Yourself” encompasses many goals, including Eco-Friendly Materials, Transformable Forms, Improved Fit, and Effective End, by designing garments that facilitate recycling.

The “No-Sew” Projects, a *relational* design, provide easy, do-it-yourself projects that allow people with no sewing skills to be creative and make worthwhile products. As the title implies, these projects do not require sewing skills to encourage people to give them a try, especially those who believe they cannot learn to sew. The mission of the “No Sew” Projects was to empower people to be their own designers by teaching them simple skills that produce stylish and functional creations with the added benefit of endowing new and useful lives to old t-shirts. Therefore, the “No Sew” Projects embody the goals of New Life for old clothing and Informed Care by encouraging consumers to be creative with their clothing reuse.

Finally, “The Dowry Dress,” a *relational* design, realizes the goal for Re-Thought Life Cycle by re-thinking the life of a wedding dress so that it becomes part of the entire life of the marriage. This was the very first design envisioned and the true catalyst to the underlying purpose of this study: to re-think, or “re-fashion,” the way we relate to our clothing in order to better meet the needs of people and the environment. Inspired by the Christmas tree skirt that my mother made from her wedding dress scraps and my own upcoming wedding, I designed my wedding dress so that it would have a purpose beyond my wedding day, to be a part of my new family life. Yet I still wanted to incorporate something to potentially pass on to my daughter or granddaughter to wear on her wedding day. The design created for “The

"Dowry Dress" enabled both of these goals: the skirt provides material to be refashioned into memorable keepsakes that mark the milestones of the marriage while the corset is the cherished heirloom that can be passed from bride to bride.

These five design collections were exhibited at the Community School of Music and Arts, Ithaca, NY from May 1-13, including an opening night celebration on May 4th that coincided with a local event called the "Gallery Night of Ithaca" and a gallery talk on May 6th. A questionnaire was available at the exhibit during the entire time it was open in order to collect evaluations from consumers about each design collection's appeal and influence to change consumer behavior. A total of 70 completed questionnaires were collected, of which 52 (74%) were acceptable for data analysis. This sample of participants provided a balanced range of ages, a balanced although overall high range of education levels, and unbalanced genders favoring women. The attitude/behavioral scale divided the sample into two groups of 22 green consumers and 19 conventional consumers for analysis of possible significant relationships between participants' consumer types and how they responded in the design assessment.

The results of the design assessment were overwhelmingly positive, with all the overall design appeal questions receiving over 80% combined-positive responses ("Yes" and "Somewhat" on a 5-point Likert scale) and the overall design influence receiving over 60% combined-positive responses. Furthermore, interest in the specific features of each design was also positive, with all design features receiving 50% or more combined-positive responses, except the "Fringed Bag" and "Green and Yellow Scarf" for the "No Sew" Projects design collection. In the overall rankings of the five design collections, "The Dowry Dress" was the clear favorite, with 61% (28) of participants ranking it as their most liked design, consistent with its high positive responses in appeal, influence, and design feature interest. The participants who

ranked this design the highest noted its beautiful design and the personal meaning of refashioning the keepsakes. The “Suit Yourself” design was most frequently ranked second, reflecting its positive evaluations and the strong participant interest in “Eco-Friendly Materials.” Participants who ranked this design as their most liked design said it was well-made and the idea was “very surprising.” The GCC and LCA Label and T-Shirt designs were most frequently ranked third and fourth highest, respectively. Those who ranked these designs their least liked said that they were too complicated (mostly LCA) or that they just did not wear logo t-shirts. The “No Sew” Projects design was the lowest ranked design, reflecting the disinterest in the two knot projects. Those who ranked this design their least liked said they were not interested in doing crafts. Analysis of consumer type with the results of the design assessment showed no significant difference between the way green and conventional consumers responded. The one exception was LCA Label influence, but the composition of the attitude/behavioral scale differentiated green and conventional consumer groups based on their label reading behavior might also explain this significant relationship.

Based on the questionnaire results for the Design Assessment and the green and conventional consumer analysis, each of the five design collections met the study’s two overall goals for appealing to both green and conventional consumers and influencing all consumers to change their behaviors. This positive appeal and interest in each design’s concept and feature suggests that consumers would be willing to either purchase or use them, the first step to ensuring the success of the designs. Each design collection influenced consumer behavioral intentions that might result in reduced net environmental harm.

This high appeal and influence suggests that the design concepts have potential for certain commercial applications. However, the results of this study may have been biased by a sample that included many participants who were very interested in the

topic and some those who were personal acquaintances. Different methods for evaluating the design, such as purchasing a generalization participant sample for the questionnaire, could result in a broader range of responses and help alleviate this bias by producing more reliable results that could inform further design improvements. This study only tested behavioral intentions rather than actual behaviors. Future studies are needed to evaluate whether these designs would in fact inspire the intended behavioral changes in consumers and that those behaviors would result in a net reduction in environmental harm.

More work must to be done in order to achieve eco-friendly and sustainable clothing consumption. More apparel designers need to become aware of the important role they play in addressing the environmental impact of the clothing life cycle and learn of the specific ways they can change their design choices to reduce environmental harm. Likewise, consumers must also be educated about how their clothing consuming behaviors contribute to increased environmental harm, from the types and amounts of clothing they consume to their clothing care and disposal behaviors. This study has provided valuable eco-friendly design methods and tools as well as examples of eco-friendly apparel designs. Others need to continue the effort by implementing and further developing these approaches to produce the “mass of answers” needed to solve the environmental problems we face (Fletcher, personal communication, November 16, 2006).

APPENDIX A: Eco-Friendly Design Expert Cover Letter

Eco-Friendly Apparel Design: *Expert Feedback*

Interaction designer Uday Gajendar calls for a design model of beauty that centers on user-experiences. One way he defines this beauty is through the words of John Dewey, American pragmatist philosopher. Dewey used the term “*experiential beauty- a harmonious balance of the maker’s intent and the perceiver’s expectation towards a meaningful consummation of movement of emotion from inception, carried through development, and ending with an artifact that lives in experience*” (Gajendar. 2004).

Dear Design Expert,

Thank you for agreeing to participate as an “Expert Consultant” for my master’s degree thesis research. The working title for my thesis is **Eco-Friendly Apparel Design: Altering Users’ Experiences with their Clothing to Promote Eco-friendly Behaviors**. I am using ecological principles to inspire new design ideas that promote eco-friendly user behavior as well as meet the varying user needs associated with their clothing. Currently, I am in the brainstorming phase and I need your help. I have categorized the different ways people experience their clothing and developed eco-friendly design goals that apply to each experience. These will inspire workable design concepts that can be made into a line and displayed in a final show for clothing users to critique.

I want you to react to these design goals either positively or with suggestions for changes and to offer some ideas for design concepts that could achieve the goals. In this way, I will gather inspiration from you in order to develop new and better design concepts for clothing. During our interview, I would like to explore design possibilities that will energize us both. Please concentrate on the aspects of this topic that strike you as interesting and have the most potential for promoting eco-friendly behaviors.

The interview will be audio recorded. I have included the general outline for our interview so that you can start your creative thinking process. Please concentrate on the topics you find intriguing. Thank you for your time and cooperation. I am eagerly looking forward to our talk!

Sincerely,

Kathleen Dombek-Keith

APPENDIX B: Eco-Friendly Design Expert Interview Outline

Expert Interview

The goal of this research is to develop innovative apparel designs that alter how people experience their clothing in ways that provide added values for users as well as promote them to take on eco-friendly behaviors.

Expert Interview:

1. Knowing your commitment to “transform our relationships with materials and our experience of the world,” what added values would your clothing designs ideas offer to the people that would use them?
2. Do you think your design ideas would promote eco-friendly behaviors in the people that would use them, and how?

A List of My Design Goals:

I plan to create a collection of innovative designs that each address one or more of these goals.

- **Eco-Friendly Materials:** low-impact materials that provide added values to the consumer
 - **Transformable Forms:** clothing that has updatable/transformable forms, multiple-uses that possibly go beyond apparel
 - **Improved Fit:** clothing that fits better, perhaps adjustable fit; new method of defining or assigning fit (body shape in addition to body size)
 - **Reduced Care:** clothing that requires low-impact care or less care
 - **New Life:** refashioning old clothing to give new form and useful purpose
 - **Re-Thought Life Cycle:** addressing the entire life cycle of a garment during the design conception to achieve a new and enhanced consumer experience compared to a conventional garment
 - **Effective End:** using materials that can be perpetually recycled (fiber-to-fiber) or composted, designing for easy recycling
3. Which of my goals do you think are especially likely to achieve eco-friendly behaviors in users?
 4. Can you suggest any other design goals that I should include?
 5. Can you suggest any design concepts that could meet these goals?

APPENDIX C: Life Cycle Analysis of a Cotton T-shirt

Factors that affect the life cycle stages and ways of evaluating

Factors at each stage:

Evaluate on:

Preliminary Production

1. Fiber Growing/Processing
2. Dye & Finish making
3. Yarn Spinning
4. Knitting

1. Energy consumption (CO² Emissions)
2. Water Consumption
3. Water Pollution
4. Air Pollution
5. Noise Pollution
6. Toxicity/Dioxins
7. Effects on Ecosystem
8. Social Equality

Production

1. Cutting
2. Sewing
3. Finish Application
4. Screen-printing

Distribution & Packing

1. Locations of production and retail
2. Packaging

Use

1. # of washings
2. Size of laundry load
3. Efficiency of Washing Machine
4. Washing Temperature
5. Machine vs. Air Drying
6. Detergent
7. Dryer Sheets

Disposal

1. Fiber Type (Blends)
2. Finish
3. Dye

APPENDIX D: List of Potential T-Shirt Properties for Comparison

1. Fiber Growing/Processing

- Conventional vs. Organic Cotton (pesticide and fertilizer use)
- Polyester vs. recycled polyester
 - Recycled polyester energy savings of 76% and a CO₂ emissions reduction of 71%, versus creating that fiber from new raw material
- Cotton vs. Hemp
 - Hemp requires little to no pesticide, fertilizer, or water to produce and has a shorter, more productive growing season
- Waste- % of useable fiber from harvest (cotton 60% waste)

2. Water Consumption

- Irrigation vs. rain water
 - 1 kg of raw cotton can take 20,000; 40,000; up to 100,000 liters of water, causing ground erosion and salting
 - 1 kg of cotton fabric can take 150 to 175 liters of wastewater

3. Fiber Content

- 100% vs. Blends (blends harder to recycle)

4. Dyes & Finishes

- Water-based ink vs. PVC based ink
- Chlorine Bleach vs. hydrogen peroxide
- Nanotech (Lotus) finish: stain resistant finish
 - Supposed to decrease washing but washing is often done to freshen not remove stains
 - Difficult to recycle (melts)
- Silver coating: antimicrobial (reduces need to wash in order to freshen)
 - Heavy metals are a major groundwater pollutant
 - Heavy metals are not safe for human ingestion
 - Bacteria can build resistance to silver
- Gladiodor: antimicrobial (reduces need to wash in order to freshen)
 - Natural odor control comprises naturally derived amino acid chains
 - Kills odor-causing bacteria Nonpolluting and safe for humans
 - Natural odor control is durable

5. Locations of Production

- China vs. USA

6. Washing Behavior

- Small vs. Large Load size
- Hot vs. Cold Water
- Tumble dry vs. Air Dry
- Coal vs. Natural Gas (fewer emissions)
- Ironing
- Conventional vs. biodegradable detergent
- Conventional vs. chemical-free dryer sheet
- Typical vs. energy star washing machine (save 30% energy)
- Top vs. front loading washing machine (save 37.5%-50% water)

APPENDIX E a: Preliminary LCA Label Design – 1 of 2

LCA Label

Indirect Consumption:	MJ	CO ₂ (g)	Kyoto	Science
Material	16	4,223	0.042%	0.10%
Production	24	6,335	0.064%	0.15%
Transport	7	1,688	0.017%	0.04%
Disposal	-3	530	0.005%	0.01%

KEY

WH= Washing Hot
 WC= Washing Cold
 TD= Tumble Dry
 SL= Small Load
 LL= Large Load

Direct Consumption:		Coal-fired Elec			Nat Gas Elec		
	MJ	CO ₂ (g)	Kyoto	Science	CO ₂ (g)	Kyoto	Science
Washing (25 washes/yr)							
WH, TD, & SL (up 1/8)	73.1	19,302	0.39%	0.90%	12106	0.24%	0.57%
WH, TD, & LL (base)	65.0	17,158	0.34%	0.80%	10761	0.22%	0.50%
WC, TD, & SL (down 10%)	65.8	17,372	0.35%	0.81%	10896	0.22%	0.51%
WC, TD, & LL (down 10%)	58.5	17,158	0.34%	0.80%	10761	0.22%	0.50%
WH & SL (down 1/2)	36.6	9,651	0.19%	0.45%	6053	0.12%	0.28%
WH & LL (down 1/2)	32.5	8,579	0.17%	0.40%	5381	0.11%	0.25%
WC & SL (down 10%)	32.9	8,686	0.17%	0.41%	5448	0.11%	0.25%
WC & LL (down 10%)	29.3	7,721	0.16%	0.36%	4843	0.10%	0.23%

CO₂ Emission Standard

1990 US CO ₂ Em	4,833 million tons
Kyoto - 7% Drop	4,495 million tons
Scientists - 60% Drop	1,933 million tons
Total US Pop 1/07	301 million people

CO₂ Emission Allowance

Direct	Indirect
Kyoto 4.9779	9.9557
Science 2.1409	4.2817
tons/per person/yr	

Inspired by: Carbon Facts Label (Casco, 2007)

Carbon Facts	
Product Size 1 Cheeseburger (130g)	
<hr/>	
Amount Per Serving	
Kilograms CO₂ Equivalent 3.08	
Kilograms CO ₂	.243
Kilograms CH ₄	.123
<hr/>	
Total C: Energy Sources	243g
<i>Transportation</i>	
Fossil Fuel (Diesel)	120g
Fossil Fuel (Gasoline)	48g
<i>Electricity Production</i>	
Fossil Fuel (Natural Gas)	75g
Fossil Fuel (Coal)	0g
<i>Other</i>	
<hr/>	
Total C: Non-Energy Sources	2840gCO₂E
Enteric Fermentation	81.0g (1864gCO ₂ E)
Manure	25.8g (856gCO ₂ E)
Other	5.2g (120gCO ₂ E)
<hr/>	
Carbon/Product Ratio	23.7
<hr/>	
Localism Rating	C+
Sustainable Production Rating	D+
<hr/>	
overall carbon code: orange	

APPENDIX E b: Preliminary LCA Label Design – 2 of 2

Life stages:	Energy - CO ₂ Em	Water	Air	Dioxins*
Materials: Cotton Fiber Production, USA (subsidized) Dioxins Sources: Pesticides, Fertilizer, Scouring	●	●		●
Production: yarn spinning, weaving, dyeing, finishing	●	●		●
Transportation: production in China to retail store	●		●	●
Use**: Expected life span – 25 wearings				
Machine washing warm and drying, after each wearing, conventional detergent, dryer sheets	●	●		●
Machine washing cold and drying, after 2-3 wearings, eco-friendly detergents and dryer sheets	●	●		
Machine washing warm, air drying	●	●		
Ironing	■			
Disposal				
Landfill- anaerobic decomposition in 100yrs resulting in methane gas		●		
Incineration	●			●
Waste By-products: Cotton seed (60% of harvest) Dioxin: Pesticide residue Used in feminine hygiene products and oil in food products				●

WARNING: Dioxins are known cancer causer at center levels, and are reasoned to possess potentially hazardous effects to bodily functions regulate by hormones at very small levels of exposure.

* Use of chemicals that become toxic dioxins when they enter the environment. They are incredibly stable and are stored in the body. There is no acceptable level of consumption for dioxins

** Values for every 25 wearings

Inspired by: Ethical Consumer company rating table (Berry & McEachern, 2005)

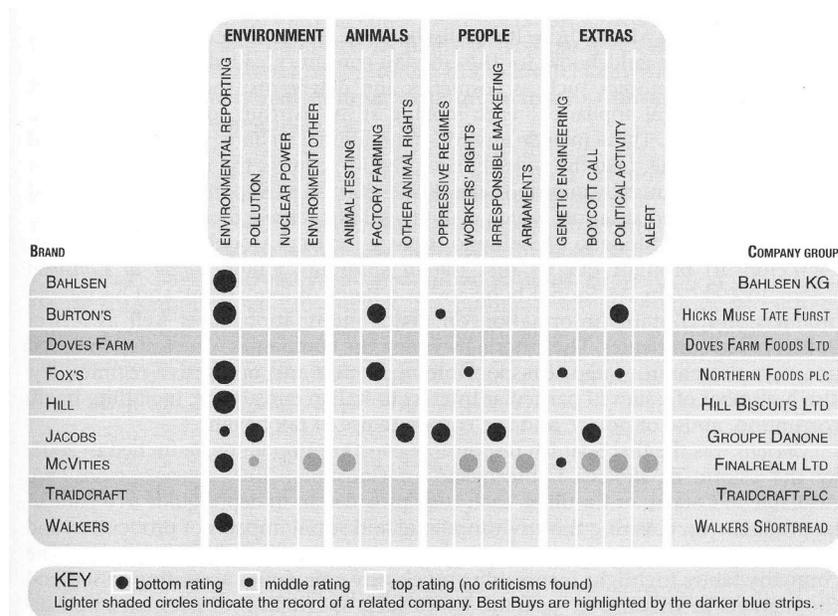


Figure 5.1 Ethical Consumer company rating table

APPENDIX F a: Preliminary LCA T-Shirt Design Themes – 1 of 3

T-Shirt Design 1 : Emphasis on Environmental Effects



APPENDIX F b: Preliminary LCA T-Shirt Design Themes – 2 and 3 of 3
T-Shirt Design 2 : Emphasis on the importance of Effectiveness (vs. Efficiency)



“Consider the cherry tress. It makes thousands of blossoms just so that another tree might germinate take root, and grow.”

‘Who would notice piles of cherry blossoms littering the ground in the spring and think, ‘How inefficient and wasteful?’

“The tree’s abundance is useful and safe. After falling to the ground, the blossoms return to the soil and become nutrients for the surrounding environment.”

“Every last particle contributes in some way to the health of a thriving ecosystem. ‘Waste equals food’ – the first principle of the Next Industrial Revolution.”

- William McDonough



Rough Sketch of Main Image



Style Inspiration: Silk Oaks Screenprinting - Ithaca, NY



T-Shirt Design 3 : Emphasis on the Clothing as Consumables



APPENDIX G: CaféPress.com Online Store for LCA and GCC T-Shirts


 Shop, sell or create what's on your mind.
 [Your Account](#) | [Sign In](#) | [Cart: 0 items](#) | [Help](#)

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Re-Fashioning the Future: Eco-Friendly Apparel Design

By Katie Dombek-Keith

Cornell University
Master's Thesis

Apparel

[Back to Top](#)



MORE COLORS AVAILABLE

[Energy Hogs \(Ringer T\)](#)
\$20.00



[Green Consumer \(Organic Cotton Tee\)](#)
\$20.00



[Green Clothing Care \(Value T-shirt\)](#)
\$12.00



[Fill before you Wash \(Women's V-Neck T-Shirt\)](#)
\$20.00



MORE COLORS AVAILABLE

[Red Consumer \(Dark T-Shirt\)](#)
\$20.00



[Stained \(Fitted T-Shirt\)](#)
\$20.00



MORE COLORS AVAILABLE

[Green Clothing Care \(Jr. Baby Doll T-Shirt\)](#)
\$22.00



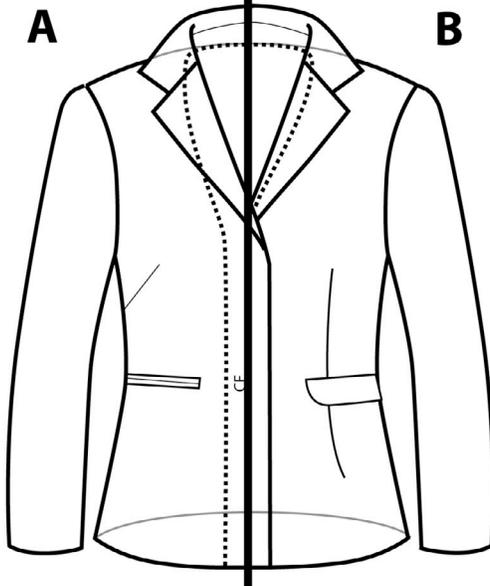
[Dry Green](#)
\$20.00

APPENDIX H: Zipper Placement Options for “Suit Yourself” Jackets

Zipper Placement

Small Area - Good Change
Front Fit Options
Zipper hidden under collar

A

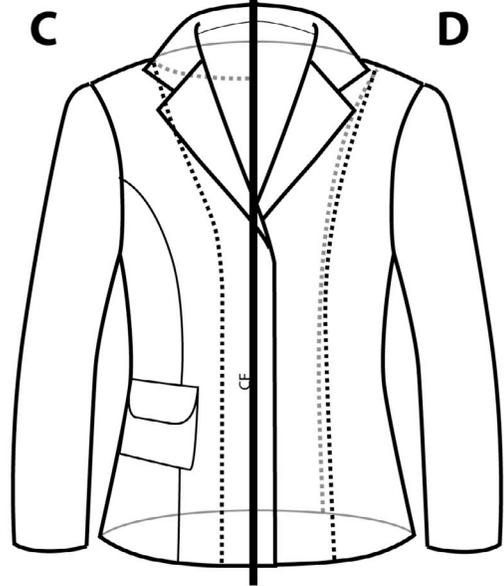


Tiny Area - Little Change
No Fit Options

B

Small Area - Good Change
Front Fit Options
Zipper follows facing lines

C

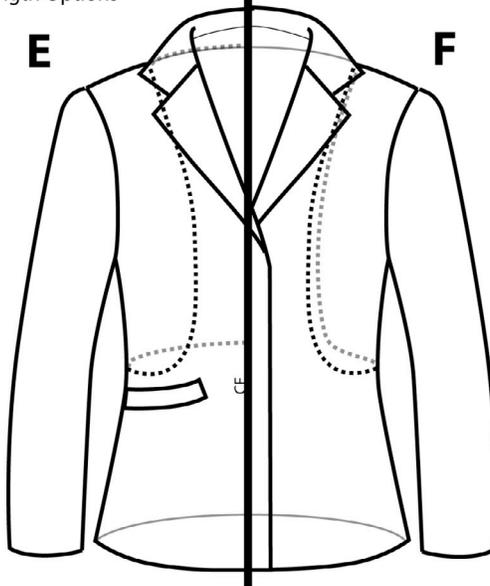


Med Area - Good Change
Front & Back Fit Options
Zipper follows princess seams

D

Big Area - Great Change
Front Fit Options
Zipper hidden under collar
Length Options

E

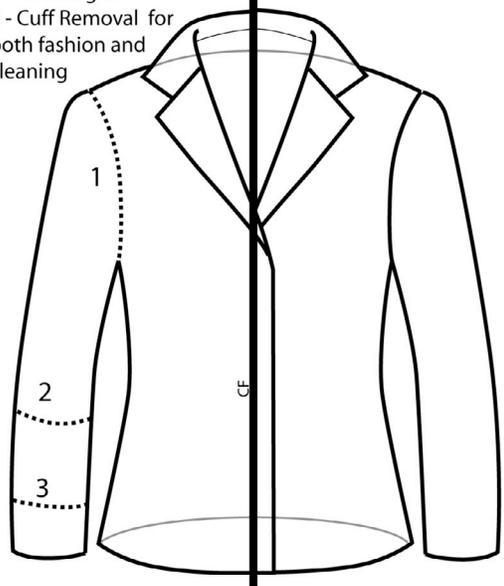


Big Area - Great Change
Front & Back Fit Options
Length Options

F

1- Sleeve removal for fashion (use with small area collars)
2 - 3/4 length
3 - Cuff Removal for both fashion and cleaning

Other Ideas:



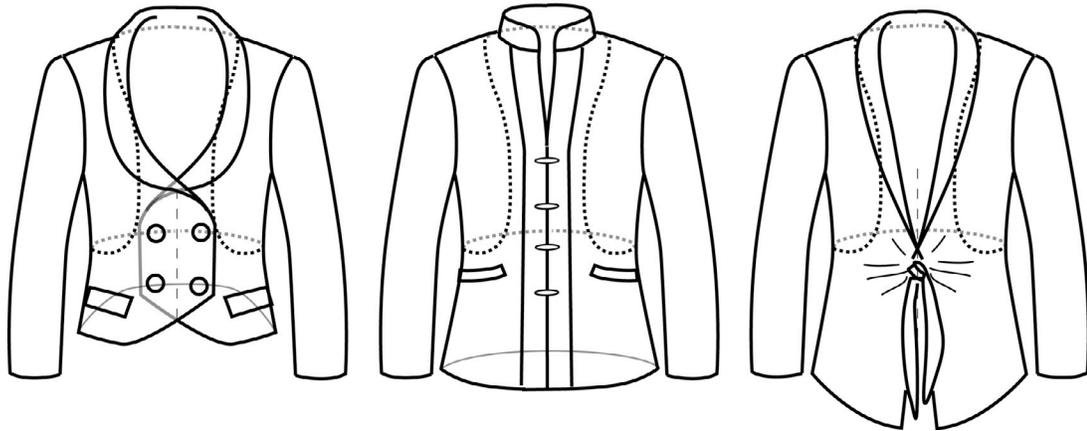
APPENDIX I: Preliminary "Suit Yourself" Jacket Styles

For zipper placement identification, refer to APPENDIX H

Zipper Placement A- 3 Style Options



Zipper Placement E - 3 Style Options



APPENDIX J: Abby and Jane Suit Components

Abby Suit Looks



Jane Suit Looks



APPENDIX K: Abby Suit Materials List

For garment identification, refer to APPENDIX J



Gray Hemp/Yak

Fiber Content: 85% Hemp, 15% Yak

Used for: Fashion Fabric for Jacket Body, Adjustable Waistband, Cuffs, Button Cover, and both Collars

Source: www.nearseanaturals.com



"Fine Fawn" Organic Hemp

Fiber Content: 100% Organic Hemp - certified & imported from Eastern Europe

Used for: Underlining/Interfacing Jacket Body, Adjustable Waistband, and Revere Collar

Source: www.aurorasilk.com



Charcoal Wool Blend

Fiber Content: 45% Hemp, 40% Wool, 15% Tencel

Used for: Black Collar, Cuffs, Button Cover, and Pants

Source: www.pickhemp.com



Black Hemp/Tencel Plain Weave

Fiber Content: 55% Hemp, 45% Tencel

Used for: Interfacing Black Collar, Cuffs, and Button Cover

Source: www.nearseanaturals.com



Mauve Tencel Herringbone

Fiber Content: 100% Tencel (Lyocell)

Used for: Facing for Revere Collar, Pleated Skirt, Skirt Belts

Source: www.fashionfabricsclub.com



Horn Button

Size (#): 7/8" (2) & 1 1/8" (8)

Used for: Cuffs and Button Cover

Source: Homespun
Ithaca, NY



Metal Button

Size (#): 1/2" (6)

Used for: Revere Collar and Skirt Belts

Source: JoAnn Fabrics
Ithaca, NY



Carved Corozo Button

Size (#): 3/4" (6)

Used for: Black Collar

Source:
www.nearseanaturals.com

APPENDIX L a: Jane Suit Materials List

For garment identification, refer to APPENDIX J



Heavy Tussah Silk

Fiber Content: 100% Tussah Silk

Used for: Fashion Fabric for Jacket Body, Jacket Extension, Hooded Collar, and Cuffs

Source: www.aurorasilk.com



Light Cream Pongee Wild Silk

Fiber Content: 100% Tussah Silk

Used for: Underlining and Bias Finishing on Jacket Body, Jacket Extension, Hooded Collar, and Cuffs

Source: www.aurorasilk.com



Natural Hemp/Silk Charmeuse

Fiber Content: 60% Hemp, 40% Silk

Used for: Leaf Button Collar and Belt

Source: www.pickhemp.com



Sage Light and Bright Tussah Silk

Fiber Content: 100% Tussah Silk - village woven in rural India and naturally hand dyed

Used for: Piping and Snap Covers on Leaf Button Collar and Belt

Source: www.aurorasilk.com



Sand Hemp/Silk Charmeuse

Fiber Content: 60% Hemp, 40% Silk

Used for: Fashion Fabric for Adjustable Waistband, Skirt Waistband Covers

Source: www.nearseanaturals.com



Natural Herringbone

Fiber Content: 100% Organic Cotton

Used for: Lining Adjustable Waistband

Source: www.nearseanaturals.com



O-Wool Melton

Fiber Content: 100% Organic Merino Wool

Used for: Hooded Collar and Cuffs

Source: Donated by O-Wool, Vermont Organic Fiber Co.

APPENDIX L b: Jane Suit Materials List cont...

For garment identification, refer to APPENDIX J



Plaid Textured Crepe

Fiber Content: 100% Organic Cotton

Used for: Skirt and Skirt Waistband Covers

Source: www.nearseanaturals.com



Eri "Peace" Silk

Fiber Content: 100% Eri "Peace" Silk - wild silk found in India and gathered after cocoons broken

Used for: Lining Skirt and Skirt Piping

Source: www.aurasilk.com



Olive Hemp/Tencel Twill Weave

Fiber Content: 55% Hemp, 45% Tencel - naturally grown hemp and dyed with low-impact dyes, workers given fair wage and voice

Used for: Capris

Source: www.nearseanaturals.com



Leaf Corozo Button

Size (#): 3/4" (1) and 1/2" (5)

Used for: Leaf Button Collar and Belt

Source: www.nearseanaturals.com



Jewel Lace, 5/8"

Fiber Content: 100% Organic Cotton

Used for: Hem Decoration on Skirt

Source: www.nearseanaturals.com



Bamboo Button

Size (#): 1 1/8" (4)

Used for: Capris

Source: www.nearseanaturals.com



Twill Tape, 1 1/4"

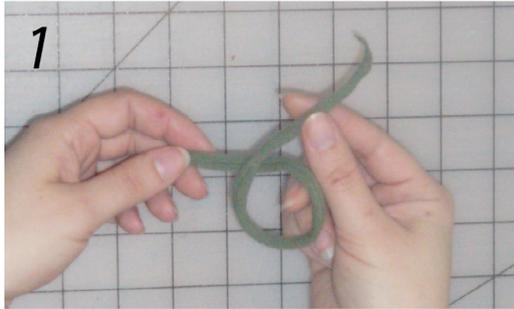
Fiber Content: 100% Organic Cotton

Used for: Strengthening Waistband in Adjustable Waistband

Source: www.nearseanaturals.com

APPENDIX M: “Faux” Knit Instructions

How to make the “Faux” Knit



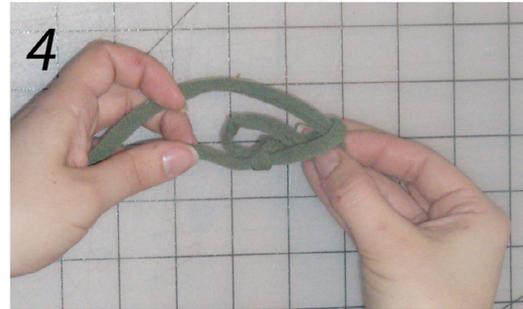
1
Loop the end like you are starting to make a knot



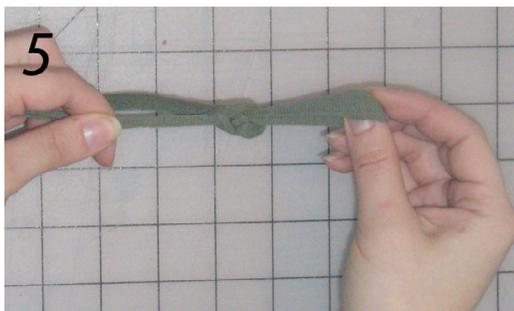
2
Push the end of the strip partially through the loop



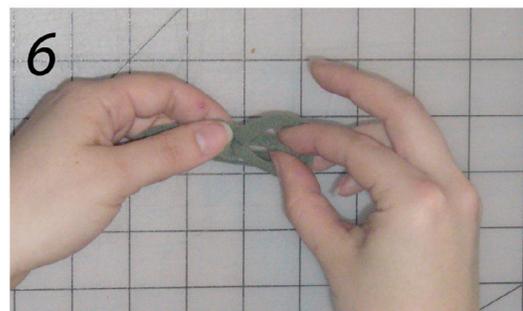
3
Tighten but don't pull the end all the way through - this will make another loop at the top



4
Now take up some of the strip through the new loop

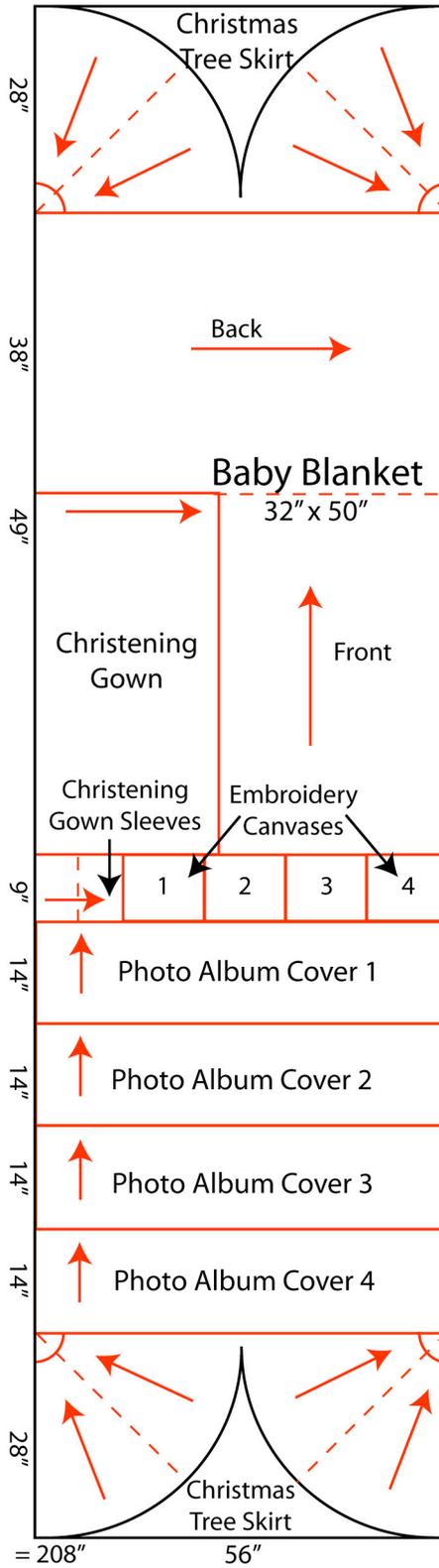


5
Pull to tighten



6
Repeat pulling the strip through each new loop

APPENDIX N: Skirt Diagram for Creating Keepsakes



APPENDIX O: Ithaca Gallery Night Flyer

May 4, 2007 Exhibits

Gallery Night

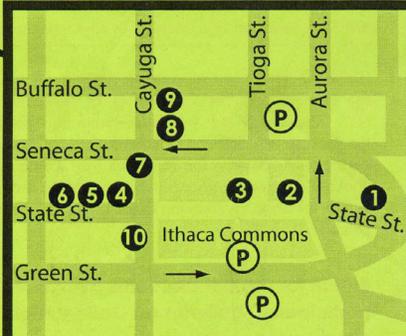
"Purchase art for a lifetime of enjoyment."



**10 Galleries
all open 1 Night
in downtown Ithaca**

May 4, 5 - 8pm

- 1 CSMA** 330 E. State Street
Refashioning the Future: Eco-Friendly Apparel Design AND Ah Leon and Friends
An exhibit by Cornell masters student Katie Dombek-Keith illustrating how we can change our relationship to clothing and its impact on the earth. In the lower gallery, Ah Leon and Friends: Ceramic Art in the Yixing tradition of Taiwan, by world-renowned artist Ah Leon and his students.
272-1474; Mon-Fri, 10 to 8.
- 2 Titus Gallery** 222 The Commons
Antique Etchings of European Views
Hand printed and signed etchings from several European countries.
277-2649; Mon-Wed 10:30 to 6, Thu, Fri 10:30 to 7, Sat 10 to 6, Sun 12 to 4
- 3 Shangri La** 156 The Commons
Naturally Chinese
This is a stunning collection of Asian brush painting watercolor pieces of Chinese nature, encompassing an assortment of birds, fish, and other animals. The works are done on traditional rice paper.
272-6156; Tue-Sat 11:30 to 6
- 4 Handwork Gallery** 102 West State Street
Handwork Artists Group Show
Handwork will feature Fernando Llosa's new oil paintings and assemblage and Kim Schrag's whole new set of oils on plaster.
273-9400; Mon-Wed, Sat 10 to 6, Thu, Fri 10 to 9, Sun 12 to 5



Front Side

2007

Gallery Night

- 5 Ink Shop Printmaking Center**
102 West State Street (above Handwork Gallery)
Floating World and Kiwi Bird Soup
Two exhibits/ Two printmakers from The Ink Shop: Neil Berger's show of lyrical black/white monotypes and Jenny's Pope's fanciful color reduction woodcuts.
277-3884; Tue-Fri 12 to 6, Sat 12 to 4
- 6 State of the Art Gallery** 120 West State Street
Members Show
This is a group exhibition by the 24 members of State of the Art. Paintings, drawings, prints, photographs, Giclee prints, collage, mixed media and sculpture will be shown.
272-1626; Wed-Fri 12 to 6, Sat, Sun 12 to 5
- 7 Clinton House ArtSpace** 116 North Cayuga St.
Greater Ithaca Art Trail Group Show
This gallery show is a new initiative for the Greater Ithaca Art Trail and represents the beginning of year-round Art Trail events for the public.
273-5072; Mon-Fri 10 to 5:30, Sat, Sun 12 to 4
- 8 Sola Gallery** 215 North Cayuga St.
1st floor of DeWitt Mall
The Magic of Ten: Japanese Printmakers
This show features works of Yasushi Noguchi, who creates truly magical creations of paint and gold leaf. Nine other artists are represented, including Hamanishi, Kuroda, Tamekane, Rome and Tanaka.
272-6552; Mon-Sat 10:30 to 5:30
- 9 Upstairs Gallery** 215 North Cayuga Street
2nd floor of DeWitt Mall
Transformation
This is a unique two-person show with Syau-Cheng Lai and Ann Johnston Miller.
272-8614; Tue-Sat 11 to 3
- 10 Patrick O'Connor Gallery**
114 South Cayuga Street
Spring
Patrick J. O'Connor will be exhibiting stunning floral watercolors. The gallery will also be featuring handmade jewelry by Dolce Designs.
379-3184; Sat, Sun 10-6, Mon-Fri by appointment

Gallery Night is made possible with public funds from the Community Arts Partnership of Tompkins County/ NYS Council on the Arts Decentralization Program and the Constance Saltonstall Foundation for the Arts, with additional funds from the Tompkins Trust Company and the Ithaca Downtown Partnership. Gallery Night is coordinated by The Ink Shop Printmaking Center. For more information, call 607-277-3884.

Watch for special discounts available at participating galleries on Gallery Night!!

"Purchase art for a lifetime of enjoyment."



Back Side

APPENDIX P: Press Release

For Immediate Release

To: Arts, Feature, and Calendar Editors

Contact: Katie Dombek-Keith, 607-244-4073, kmd54@cornell.edu

Sustainable Fashion Exhibit Opens at CSMA

When you think about eco-friendly fashion, your first thought probably is organic cotton and hemp. A broader vision of eco-friendly fashion will be presented in an exhibit by Cornell graduate student Katie Dombek-Keith at the Community School of Music and Arts, May 1 through May 13. Dombek-Keith's designs show how clothing can last longer and be more versatile, while still being attractive and fashionable. Her showpiece creation is a finely stitched wedding gown designed to be disassembled and reused in various ways throughout married and family life. Other designs include jackets, skirts, and pants that can be easily adjusted for size changes and that convert from casual to dressy looks so that fewer articles of clothing are necessary. Another design is a care label promoting extending the lifetime of clothes through repair, reuse, and low-impact washing.

Dombek-Keith is completing a master's degree in Apparel Design. Toward the end of her undergraduate days at Indiana University, she realized that design can lead the way to a more sustainable future. She feels strongly that fashion designers have a responsibility to reduce the clothing industry's use of resources and the impact that making, transporting, and maintaining clothing has on the earth. "My goal is to show how we can change our relationship with clothing," Dombek-Keith said.

The public is invited to the exhibit's opening reception, 5 - 8 pm, during Gallery Night of Ithaca, May 4, and Dombek-Keith is giving a gallery talk at 3 pm on May 6. For more information, contact CSMA, 330 East State Street, Ithaca, 607-272-1474.

PHOTOS

DowryDress.jpg

Caption: "The Dowry Dress" is designed for reuse during the marriage

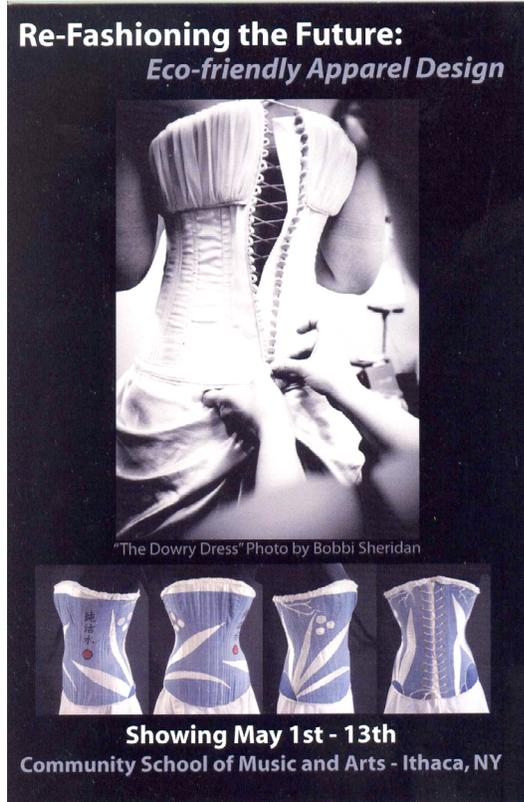
Dowry Dress 2.jpg

Caption: "The Dowry Dress" Photo by Bobbi Sheridan

Inside Corset.jpg

Caption: Inside of wedding corset allows reversibility

APPENDIX Q: Exhibit Postcard

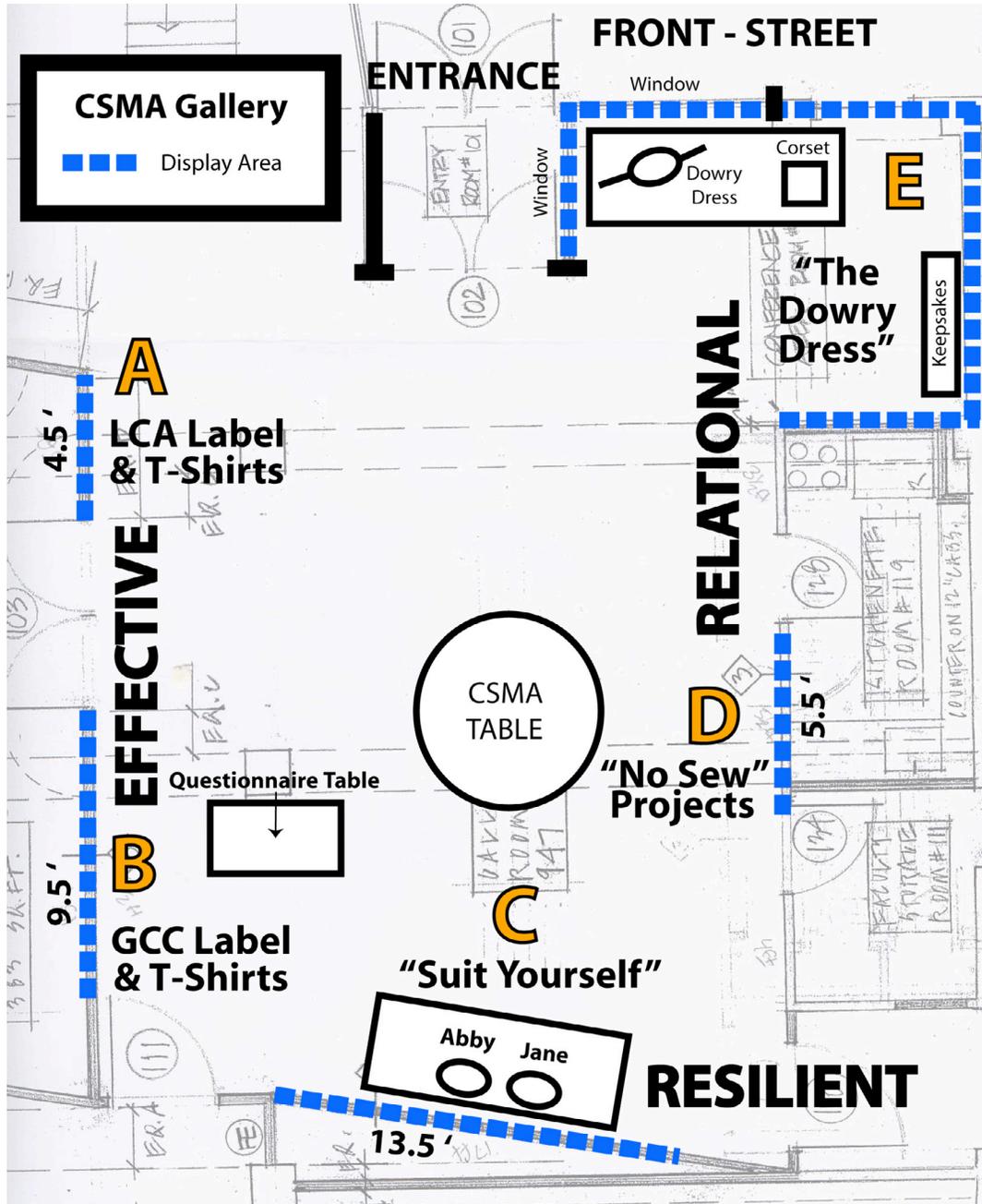


Front Side



Back Side

APPENDIX R: CSMA Gallery Layout of Displays



APPENDIX S: "Suit Yourself" Materials

Abby's Suit: Looks and Fabrics

<p>Gray Hemp/Yak Fiber Content: 85% Hemp/ 15% Yak Used for: Fashion Fabric for Jacket Body, Adjustable Waistband, Cuffs, Button Cover, and both Collars Source: www.nearneaturals.com (Item no longer available)</p>	<p>"Fine Fawn" Organic Hemp Fiber Content: 100% Organic Hemp (Certified Imported from Austria, Europe) Used for: Underlining/Interfacing, Jacket Body, Adjustable Waistband, and Revers Collar Source: www.suntrack.com</p>	<p>Marine Tencel Herringbone Fiber Content: 100% Tencel (Lycell) Lycell is a cellulose fiber made from eucalyptus. The production process is environmentally friendly. The yarn and is obtained from trees, which is a sustainable resource. The fabric is made from 100% eucalyptus wood pulp. It is biodegradable, renewable, and has low water consumption. It is also known for its moisture-wicking properties. It is a natural fiber and is known for its soft touch and drapability. It is also known for its moisture-wicking properties. The fiber is known for its soft touch and drapability. Used for: Facing for Revers Collar, Pleated Skirt Source: www.fabrics4u.com</p>
<p>Charcoal Wool Blend Fiber Content: 40% Hemp/ 40% Wool/ 15% Tencel Used for: Black Collar, Cuffs, Button Cover, and Pocket Source: www.jakihemp.com</p>	<p>Black Hemp/Tencel Plain Weave Fiber Content: 55% Hemp/ 45% Tencel Used for: Interfacing Black Collar, Cuffs, and Button Cover Source: www.nearneaturals.com</p>	<p>Horn Button Used for: Cuffs and Collar Cover Source: Home Depot, Westco, NY</p>

Handle Carefully

Abby Suit Materials

Jane's Suit: Looks and Fabrics

<p>Heavy Tussock Silk Fiber Content: 100% Tussock Silk Tussock silk is wild silk that is typically produced in the hills of China. It is a natural fiber and is known for its soft touch and drapability. It is also known for its moisture-wicking properties. The fiber is known for its soft touch and drapability. Used for: Fashion Fabric for Jacket Body, Jacket Extension, Hooded Collar, and Cuffs Source: www.suntrack.com</p>	<p>Light Cream Pongee Wild Silk Fiber Content: 100% Tussock Silk Used for: Underlining and Black Finishing on Jacket Body, Jacket Extension, Hooded Collar, and Cuffs Source: www.suntrack.com</p>	<p>Natural Hemp/Silk Charmeuse Fiber Content: 60% Hemp/ 40% Silk Used for: Leaf Collar and Belt Source: www.parkhemp.com</p>	
<p>Sand Hemp/Silk Charmeuse Fiber Content: 60% Hemp/ 40% Silk Naturally grown hemp is used as a sustainable crop in the hills of China. It is a natural fiber and is known for its soft touch and drapability. It is also known for its moisture-wicking properties. The fiber is known for its soft touch and drapability. Used for: Fashion Fabric for Adjustable Waistband, Skirt Waistband Source: www.nearneaturals.com</p>	<p>Natural Herringbone Fiber Content: 100% Organic Cotton Used for: Lining Adjustable Waistband Source: www.nearneaturals.com</p>	<p>Plaid Textured Crepe Fiber Content: 100% Organic Cotton Used for: Skirt and Skirt Waistbands Source: www.nearneaturals.com</p>	
<p>Corozo GreenLeaf Used for: Decoration on Leaf Collar and Belt The nut of a melting palm tree, known to also known as Corozo or Corozo nut. It is a natural fiber and is known for its soft touch and drapability. It is also known for its moisture-wicking properties. The fiber is known for its soft touch and drapability. Source: www.nearneaturals.com</p>	<p>Burnt Bamboo Button Used for: Decoration on Capris Source: www.nearneaturals.com</p>	<p>Twill Tape Fiber Content: 100% Organic Cotton Used for: Strengthening Waistband in Adjustable Waistband Source: www.nearneaturals.com</p>	
		<p>Jewel Lace Fiber Content: 100% Organic Cotton Used for: Hem Decoration on Skirt Source: www.nearneaturals.com</p>	<p>O-Wool Melton Fiber Content: 100% Organic Merino Wool Used for: Hooded Collar and Cuffs Source: Distributed by Cotton, Vermont Organic Fiber co., Thank you!</p>

Handle Carefully

Jane Suit Materials

APPENDIX T: Life Cycle Analysis (LCA) Exhibit Poster

Design: Life Cycle Analysis (LCA) Label

Design Goals: to promote consumer awareness of environmental issues related to the clothing life cycle

Design Results: a label that enables people to make informed decisions on how they consume their clothing, from purchase through disposal

Label for Black Conventional T-Shirt

LCA Label



ITEM: Red Dot T-SHIRT
 Fiber : 100% Cotton*
 Dyes/Finishes (purpose):
 Chlorine Bleach* (whitening before dye)
 PVC* Ink (screen print)
 Production: China

PRODUCTION

Material Production: conventional farming*
 Energy - 4.4 kWh CO₂ Em: 7 lb
Sources: Coal (Electricity, mainly for pumping water), Diesel (Farm machinery and Trucks)

Water: 20,000 Liters *Source: Irrigation*

Environmental Effects:

Soil Erosion	● ● ● ●
Desertification	● ● ● ●
*Creation of Dioxins	● ● ● ●

Garment Production: China
 Energy - 6.67 kWh CO₂ Em: 10.6 lb
Sources: Coal (Electricity), Diesel (Trucks)

PACKAGING & DISTRIBUTION
 Energy: 1.94 kWh CO₂ Em: 3 lb
Sources: Diesel (Trucks) and Electricity (Retail overhead)

CONSUMER USE (~5 full loads over lifetime)

● Wash Warm/Cold, Tumble Dry 45 min Energy: 27.65 kWh CO ₂ Em: 44 lb
● Wash Cold/Cold, Tumble Dry 15 min Energy: 7 kWh CO ₂ Em: 11 lb
● Wash Cold/Cold, Air Dry Energy: 0.7 kWh CO ₂ Em: 1 lb

DISPOSAL

● Landfill - possibility of anaerobic decomposition resulting in Methane gas
● Incineration - Produces .8 kWh of energy
● Composting

Label for Natural Organic T-Shirt

LCA Label



ITEM: Green Dot T-SHIRT
 Fiber : 100% Organic Cotton
 Dyes/Finishes (purpose):
 Hydrogen peroxide (whitener)
 Low Impact Ink (print)
 Production: USA

PRODUCTION

Material Production: organic farming
 Energy - 2.2 kWh CO₂ Em: 3.5 lb
Sources: Coal (Electricity, mainly for pumping water), Diesel (Farm machinery and Trucks)

Water: 8,000 Liters *Source: Irrigation*

Environmental Effects:

Soil Erosion	● ● ● ●
Desertification	● ● ● ●
*Creation of Dioxins	● ● ● ●

Garment Production: USA
 Energy - 4 kWh CO₂ Em: 6.4 lb
Sources: Coal (Electricity), Diesel (Trucks)

PACKAGING & DISTRIBUTION
 Energy: .8 kWh CO₂ Em: 1.3 lb
Sources: Diesel (Trucks) and Electricity (Retail overhead)

CONSUMER USE (~5 full loads over lifetime)

● Wash Warm/Cold, Tumble Dry 45 min Energy: 27.65 kWh CO ₂ Em: 44 lb
● Wash Cold/Cold, Tumble Dry 15 min Energy: 7 kWh CO ₂ Em: 11 lb
● Wash Cold/Cold, Air Dry Energy: 0.7 kWh CO ₂ Em: 1 lb

DISPOSAL

● Landfill - possibility of anaerobic decomposition resulting in Methane gas
● Incineration - Produces .8 kWh of energy
● Composting

DISCLAIMER: This information is illustrative based on available data on typical t-shirts and general assumptions. It does not reflect the actual data for the t-shirts shown.



T-Shirt Logos:

The dots represent narrative behaviors of a red and a green clothing care user.

Which one is most like you?

APPENDIX U: Green Clothing Care (GCC) Exhibit Poster

Design: Green Clothing Care Label

Design Goals: to promote consumer awareness of the potentially large impact their clothing care behavior has on the environment

Design Results: a new set of care symbols that suggest eco-friendly clothing care behaviors that extend the concept of care beyond just washing to repairing, reusing and recycling our clothing

GREEN CLOTHING CARE



Wash Only When
Dirty or Stinky



Non-Chlorine Bleach



Repair



Full Loads



Hang Dry



Reuse



Wash Cold



Don't Dry Clean



Recycle

(Design on the Back of the T-Shirts)



For some innovative yet easy reuse ideas, check out the items in the "No Sew" Projects display

APPENDIX V: "Suit Yourself" Exhibit Poster

Design: "Suit Yourself"

Design Goals: to create high quality clothing from eco-friendly materials that meets the wearer's needs of fit and fashion
Design Results: suits that can transform and adjust as both styles and the wearer's body change over time while also reducing resource use

Abby Suit

Abby has a pear shaped figure (narrow, sloping shoulders and wide at the hip)



Transformable Features: zippers along the neckline, sleeve hem, and waistband hem allow for changes in collars, sleeve cuffs, and bottoms (both skirts and pants)

Adjustable Fit Features: slide buckles on the waistband, often seen on rented tuxedo pants, allow for up to 6" of adjustable fit, and the back seam of the waistband is constructed to be easily let out for more permanent size adjustment. Fit in the jacket body alters by inserting different widths of collars

Jane Suit

Jane has an inverted triangle figure (broad shoulders, large bust, and narrow hips)



Transformable Features: zippers along the neckline, sleeve hem, jacket hem, and waistband hem allow for changes in collars, sleeve cuffs, jacket length, and bottoms (both skirts and pants)

Adjustable Fit Features: lacings down the front of the waistband allows for up to 3" of adjustable fit. Fit in the jacket body alters by inserting different widths of collars

APPENDIX W: "No Sew" Projects Exhibit Poster

Design: "No Sew" Projects

Design Goals: to encourage people to be creative with their clothing and provide a new life for old, unwanted clothing
Design Results: simple yet sophisticated and durable methods of refashioning old clothing that are easily accessible to most people since they require no sewing skills or supplies to make, just a pair of scissors and maybe a safety pin

The Knot



The "Faux" Knit



APPENDIX X: "The Dowry Dress" Exhibit Poster

Design: The Dowry Dress

Design Goals: to redesign the life path of a garment in order to better fit its purpose and increase usefulness

Design Results: a wedding dress that reflects the bride and reforms into keepsakes marking the life of the marriage

Phase 1: Design Embodies the Bride



The Inner lining of the corset: recycled blue jeans and fabric scraps

- **The Bride's Sense of Style:** bride can codesign her dress
- **The Bride's Shape:** the corset forms a mold of her body
- **The Bride's Memories:** recycling her favorite old pair of jeans for corset lining (see above-also counts as her something blue)
- **The Bride's Personality and Name:** scraps from the corset fashion fabric used to create appliquéed design on the lining the reflects her personality; Chinese characters symbolize her name
- **The Bride's Life:** reversible corset that she can wear again and silk veil becomes a scarf to wear on anniversaries (for veil see right)
- **The Bride's Gift:** adjustable fit and easily removable decorations allow the bride to pass on her wedding corset to a loved one

Phase 2: Bride Sanctifies the Cloth



Skirt trained, veil lying down along the train

Skirt bustled, veil tied to hands

The Wedding Ceremony- June 3, 2006



Phase 3: Cloth Reformed as Life of the Marriage Grows



Dress on Exhibit at Cornell University

Skirt formed from a cleverly draped, unfashioned length cloth that becomes keepsakes that mark the milestones in the life of the marriage

Step 1: Deconstruct the Skirt

- Remove center back seam and hems
- Detach from the waistband section

Step 2: Cut-out Patterns

- Pattern shapes designed for little waste
- Pattern layout to maximize cloth use for this cloth is sacred must be conserved (see diagram above the keepsakes)

Step 3: Construct Keepsakes

Embellishments utilize other eco-friendly materials (see captions below)



Baby Blanket
Eco-Wool filling

Christening Dress
Vintage Lace and Tussah "Peace" Silk

Wedding Album
Silk Scraps and Tussah "Peace" Silk

Baby Birthday
Embroidery
Vintage Lace and
Tussah "Peace" Silk

Christmas
Tree Skirt
Vintage Lace and
Buttons

APPENDIX Y: Postcard from Exhibit-Goer about Influence of LCA T-Shirts

Kenojuak Ashevak
Sivilavut, Nunavut, 1999
Lithograph diptych, 113 x 76 cm (44⁷/₁₆ x 29¹⁵/₁₆ in.)
Printer: Pitseolak Niviaqsi
© Dorset Fine Arts
2361 POMEGRANATE COMMUNICATIONS, INC.

Dear clothing artist —
I have been wanting to
tell you how thought-provoking
it was to see your 2 shirts
in the environmental
clothing exhibit at CSMA.
I have actually altered

PRINTED IN KOREA

BOX #08032 PETALUMA CA 94975

Pomegranate

- 2 -
my laundry routine
as a result of your
exhibit.
Thank you !,

APPENDIX Z a: Exhibit Questionnaire, Front Side

Re-fashioning the Future

Subject #:

Instructions: Please provide some basic information about yourself. All information will be kept confidential. **Don't write your name** on this form in order to further insure your privacy.

1. AGE: _____ 2. GENDER: M or F 3. ZIP CODE (where you live): _____
4. INCOME: < \$30,000 \$30,000 - \$60,000 \$60,001 - \$90,000 >\$90,000
5. EDUCATION (Completed): High School Some College Bachelor's Master's Doctorate

Design Assessment

>>**Before you begin:** View the various displays and explanations and then answering the following questions.

Lifecycle Analysis (LCA) Label & T-shirts

How interested are you in each of the following aspects of the LABEL design?

Use a 5 point scale with 1 = "Very Interested", 3 = "Neutral", and 5 = "Not at all interested"

- | | |
|--|--|
| <input type="checkbox"/> Energy consumption | <input type="checkbox"/> Consumer Use: wash and dry options |
| <input type="checkbox"/> CO ₂ Emissions Rates | <input type="checkbox"/> Disposal: landfill, incineration, compost |
| <input type="checkbox"/> Environmental Issues: erosion, desertification, dioxins | |

Do you find this LABEL design appealing? Yes | Somewhat | Neutral | Not much | No

Would having this info available to you on a label influence how you buy and use clothing? Yes | Somewhat | Neutral | Not much | No

Did you like the narrative "Dots" on the T-shirts? Yes | Somewhat | Neutral | Not much | No

Which "Dot" narrative is more like you? Green Red In-Between

Green Clothing Care Label & T-shirts

How much do you like each of the new care symbols on the LABEL?

Use a 5 point scale with 1 = "Liked a lot", 3 = "Neutral" and 5 = "Didn't like"

- Wash when stinky Wash Full loads Repair Reuse

Would this Label influence you to alter your clothing care behaviors? Yes | Somewhat | Neutral | Not much | No
OR I, already care for my clothing this way

How much do you like each of the T-shirt Logos?

Use a 5 point scale with 1 = "Liked a lot", 3 = "Neutral" and 5 = "Didn't like"

- "Wash only when dirty" "Fill before you wash" "Energy Hogs" "Dry Green, it's FREE"

Would these T-shirt Logos influence you to alter your clothing care behaviors? Yes | Somewhat | Neutral | Not much | No
OR I, already care for my clothing this way

"Suit Yourself"

Do you find these transformable/adjustable designs appealing? Yes | Somewhat | Neutral | Not much | No

How interested are you in the following aspects of these clothing designs?

Use a 5 point scale with 1 = "Very Interested", 3 = "Neutral", and 5 = "Not at all interested"

- | | |
|---|--|
| <input type="checkbox"/> Transformable collars, cuff, and bottoms | What Eco-friendly fabric was your favorite? |
| <input type="checkbox"/> Adjustable fit in waistbands | _____ |
| <input type="checkbox"/> Eco-friendly fabrics and buttons | |

Which suit "look" was your favorite? _____

Do you think you would buy fewer clothes if they had transformable and/or adjustable features? Yes | Somewhat | Neutral | Not much | No

APPENDIX AA: 17-item Scale for Research Methods Class Project

Fill in the circle that corresponds with your level of <u>agreement</u> with the listed statements.	Disagree	Somewhat Disagree	Unsure	Somewhat Agree	Agree
1 If something is on sale or clearance, I'll buy it even if I don't really need it. I can't pass up a good deal!	<input type="radio"/>				
2 My local environment would really have to deteriorate before I would consider altering the way I consume.	<input type="radio"/>				
3 I usually buy trendy clothes that I wear for one season. Then they are forgotten in my closet or thrown away, and I buy new clothes for the next season.	<input type="radio"/>				
4 I avoid buying products and packages that are difficult to recycle.	<input type="radio"/>				
5 I am willing to pay a fair price for the goods I buy, so that those who make them will earn a decent living.	<input type="radio"/>				
6 When I see something I like in a store, I ask myself, "Do I REALLY need this?" Most often the answer is no, and I walk away.	<input type="radio"/>				
7 If I had more money I would definitely buy more and more things.	<input type="radio"/>				
8 I buy fewer things than the average person my age.	<input type="radio"/>				
9 When I go shopping, I usually plan out what I'm going to buy beforehand and I usually end up buying only what I planned.	<input type="radio"/>				
10 I like shopping at second hand shops BECAUSE I feel like I'm reducing new resource use.	<input type="radio"/>				
11 I don't feel I have enough knowledge to make well-informed decisions on environmental issues.	<input type="radio"/>				
12 I read and compare labels to look for environmental safe ingredients/practices.	<input type="radio"/>				
13 Consuming efficiently is part of my values.	<input type="radio"/>				
14 I don't consider the environmental and social issues major crises.	<input type="radio"/>				
15 I feel a personal and moral obligation to do whatever I can to help improve the environment.	<input type="radio"/>				
16 Having more things would make me happier.	<input type="radio"/>				
17 This is the first time I really thought about the effects of my own consumption.	<input type="radio"/>				

APPENDIX BB: Design Response Tables for Most and Least Liked Rankings

Design	(Part#) Reason for Most Liked Design
LCA	(9) Consider it an effective way to convey information to influence consumer buying decisions
GCC	(74) Most applicable to me
SY	(11) Surprising!
SY	(15) Very useful for lots of occasions
SY	(18) I would wear these clothes
SY	(21) I think the idea is the most novel and would catch on well & they're beautifully executed
SY	(38) Variety, well-made, gorgeous!
SY	(42) Good design, better idea
SY	(44) Wedding dress and Jane's suit; beautiful, unusual
NS	(41) I could see myself doing this at home
NS	(48) Looked fun to try
NS	(67) Looks cool
NS	(68) Did not require any sewing (I don't know how to sew)
NS	(70) These projects are easy to understand and practical- inexpensive too
DD	(1) Great design
DD	(3) Lovely, and has nostalgic appeal; family heirlooms
DD	(8) Design is wonderful and idea is also wonderful
DD	(10) Personal aspect of the design
DD	(13) So cleverly and beautifully done
DD	(17) It's something I could do with things I own for my children & grandchildren
DD	(19) I loved the idea of making keepsakes out of the dress
DD	(25) Aesthetics & beautiful stitching
DD	(26) Beautiful design
DD	(29) The idea of making the wedding dress a part of your life
DD	(30) Most imaginative, best design, most usable, I can picture having it in my life
DD	(39) The look was great!
DD	(40) "Traditional" dimension
DD	(44) Wedding dress and Jane's suit- beautiful, unusual
DD	(45) Most creative, more personal meaning
DD	(51) I really liked the skirt reuse plan, carrying cherished garment into other cherished moments
DD	(60) Most fashionable, most relevant to my lifestyle
DD	(62) I really liked all of them, but especially the wedding dress because it was beautifully designed and constructed as were all the keepsakes; something I could do and <u>would</u> do
DD	(64) It was very creative and clearly took a lot of skill! Neat idea, so meaningful
DD	(66) Beautiful dress and corset
DD	(72) Beautiful fabrics
DD	(79) Very creative and inspiring
DD	(100) Sanctifying the material

Design	(Part#) Reason for Least Liked Design
LCA	(1) Didn't get it
LCA	(8) A lot of information, maybe too much
LCA	(10) Not interested in wearing that info, though I like to be aware and use the info
LCA	(17) Not as "sexy" a topic!
LCA	(41) The dots are too wordy and complicated, I like the label idea
LCA	(44) T-shirts, just don't wear t-shirts with messages on them
LCA	(45) More confusing/less interesting if one doesn't have much fiber science knowledge
LCA	(70) I think it is too much for a consumer to take in all at once
LCA	(79) Seems better in an article or brochure than in clothing I would wear
LCA	(100) Too complicated
GCC	(19) Not interested in wearing t-shirts with logos or "slogans"
GCC	(39) Something had to be last
GCC	(44) T-shirts, just don't wear t-shirts with messages on them
GCC	(60) Like graphics, but is least important to me
GCC	(62) The green clothing care is a great idea with the labels, but I wouldn't really wear any of the t-shirts
GCC	(64) I don't think people would be very affected by it; I don't think they'd bother to look at symbols. They'll think about it but not do anything about it (we're too <u>much</u> about convenience)
GCC	(67) T-shirts that tell you how to wash them, in bold font, are obnoxious and annoying
SY	(29) Not my style
SY	(30) Dowdy, clunky, not very flexible or sexy!
SY	(40) Something had to be last
SY	(48) Didn't like look of suit
NS	(66) I'm not crafty
NS	(3) Just not into "knitting" looks
NS	(13) Not interested in doing it
NS	(15) Look like "hippie" projects, which I can't wear to work, except the scarf!
NS	(18) Although I like the projects, I probably wouldn't do them
NS	(21) I still like them, but I think maybe I've just heard about them a lot so they're not *quite* as exciting
NS	(25) It is for youth market
NS	(42) I just can't see myself sitting around crocheting old t-shirts
DD	(9) Not convinced I'd cut my wedding dress up into other items; consider it an heirloom
DD	(74) Least applicable to me

KEY: LCA: LCA Label & T-Shirts
 GCC: GCC Label & T-Shirts
 SY: "Suit Yourself"
 NS: "No Sew" Projects
 DD: "The Dowry Dress"

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