

Ethics and Aesthetics of Biomaterials and the Impermanence of Fashion

Elizabeth Shane Quinn

Albright College, USA

Abstract

The fashion industry is a major contributor to climate change, with destruction to people and the planet baked into its supply chain from start to finish. Material innovation, an emerging field within the fashion industry, offers the potential of using bio-based components and naturally regenerative resources that could help shift the fashion industry toward a more circular design model. However, with the recent and quickly spreading adoption of biomaterials, critical questions about the product life cycle are being overlooked as brands scramble to meet consumer and societal demands for more 'sustainable' designs. Additionally, despite a push for apparel and accessories with greater longevity, overconsumption remains a key factor in the fashion industry's post-consumer waste dilemma.

Much research has been written on the separate topics of consumption and material innovation, highlighting these as important considerations when addressing the social and environmental impacts of the fashion industry. However, virtually no research has linked these topics as integral to each other in identifying viable industry solutions. Those seeking new approaches to the design process and consumer behavior will be interested in this unorthodox approach and participative practice.

This first-phase research was conducted based on literature and industry reports, hands-on investigation, and experimental course curricula exploring the intersections between historical references and future-thinking material innovations to answer the question: "How can we continue to create new products season after season without further cluttering and destroying the Earth?"

Keywords: biomaterials, consumer behavior, ethics and aesthetics.

DOI: 10.57649/GFC.978-989-54263

ISBN: 978-989-54263-3-1

1. Introduction

1.1 Explaining the Urgency

The Earth is at a tipping point, and so is the fashion industry. “The twentieth century has left us with a design heritage – and burden – whereby industrial societies are consuming and polluting the planet at an exponential rate, towards alarming outcomes.” (Solanki, 2018) The clothing manufacturing process that has been in place since the Industrial Revolution is not viable and drastic changes must be made to slow the negative impacts caused by garment production, use, and disposal. Research and innovation in the textile and fashion sectors are no longer simply compelling trends, but rather essential endeavors for industry professionals and educators alike. “Companies have long known that design decisions determine most of a product’s manufacturing, operating, and maintenance costs,” and in fact, up to 80 percent of a product’s lifetime impact on people and the planet are determined during the research and development phase. (Mohr et al., 2022) Those factors consist of everything from fiber content and color, to seam construction and zipper quality, to transportation and customer wear and care.

“The next decade will define the fashion industry as brands decide if they will take action and uphold their commitments to a circular transition to mitigate their impact or if they will fail to meet the new global expectations.” (HEY FASHION!, n.d.) Brands have an urgent responsibility to analyze their supply chains and develop new systems that will reduce or eliminate these exceedingly harmful consequences that occur during the entire product life cycle. According to the Global Fashion Agenda, “consumer considerations of sustainable practices are not yet powerful enough to be the most important driver of purchasing behaviour,” and, “it is up to the fashion leaders to take bolder moves today to transition to a sustainable industry.” (Lehmann et al., 2019)

1.2 Formulating the Question

How can we continue to create new products season after season without further cluttering and destroying the Earth? This fundamental question is the catalyst for the exploration, hands-on investigation, and experimental coursework detailed in this research. This paper first lays out the fashion industry’s current framework and trajectory, an overview of the current speed of fashion production and consumer spending behaviors, and research on advances in material innovation. Analysis of this research led to an unusual consideration: by leaning into the impermanence of fashion, designers might be able to reinvent the term ‘fast fashion’ to have positive impacts. With this unconventional design strategy in mind, the second half of the paper provides details of an experimental college-level course that utilized biomaterials to design and create fashion accessories with planned obsolescence as the keystone.

Though there is not one approach to sustainability that will work for all designers, institutions, and consumers, this paper aims to provide one potential pathway toward a more environmentally positive model of production and consumption. While the proposed approach may seem outlandish, it is exactly for that reason it should be considered. “If we want to change the fashion system towards a new kind of balance, we need new kinds of radical design and business thinking.” (Niinimäki, 2015)

2. Contextualizing the Current Fashion Industry

2.1 The Dilemma of Consumption

The fashion industry is one of the largest global economic drivers (FashionUnited, 2022) and overconsumption of fashion goods is prevalent throughout western cultures. “Fashion consumption has become a passive act, and consumers no longer care for the longevity of our clothing.” (D’Itria and Colombi, 2022) As climate change increasingly devastates the globe, many researchers, critics, and analysts point to consumer spending habits as a major contributor to the over-industrialization of the planet and the over-production of goods. The link between consumerism and climate crisis is examined at great length by J.B. Mackinnon in his recent book, *The Day the World Stops Shopping: How Ending Consumerism Saves the Environment and Ourselves*. In this book, Mackinnon makes this connection clear, stating that climate change is “a cost of consumption that was left off the books until it threatened the future of civilization.” (Mackinnon, 2021) Pleas for consumers to reduce their spending have come from environmentalists, activists, and even some product manufacturing companies (Figure 1), all to ultimately reduce waste and the corresponding negative environmental effects.

Figure 1: Photo of Patagonia advertisement from the Friday, November 25, 2011 edition of The New York Times (Patagonia, 2011)

DON'T BUY THIS JACKET



It's Black Friday, the day in the year when some folks head to the mall and others to make mall stores. But Black Friday and the cult of consumerism it reflects, puts the economy of nature systems that sustain all life into the red. This is how selling the equivalent of one and a half planes on one day and only planes.

Businesses have to invest in the business for long-term or it's a dead end. For us, we want to do the opposite of what other businesses do. We sell you to buy less and to be better before you want to come and find us. Our goal is to be a business that's good for the planet and the people who work for it.

Environmental damage, with its multiple benefits, can happen very slowly. There's a lot of it. This is what we have done in these stores. They're the damage. We're taking care of them with repair, repair, repair, repair. It's our goal to support natural systems and resources that support business, and life, including our own.

The environmental cost of everything we make is astronomical. Consider the "R2" Jacket shown, one of our best sellers. To make it required 100 tons of water enough to meet the daily needs of three people a day of 40 people. The journey from its origin as 100% recycled polyester to our store warehouses generated nearly 20 pounds of carbon dioxide, 24 times the weight of the finished product. The jacket left behind a trail of 10 tons of fibers, too fine to be caught in water.

As a result, the jacket is not just a piece of clothing, but also a high-intensity, high-pollution product. And even though it's made from recycled materials, it's not a product of lower value. But, as in the case of all things we sell, we care and you care. Buy this jacket comes with an environmental cost higher than its price.

There is much to be done and plenty for us all to do. Don't buy what you don't need. Think twice before you buy anything. Go to patagonia.com/CommonThreads or scan the QR code below. See the Common Threads Initiative page, and join us in the "R2" to reimagine a world where we take long-term value over profit.

COMMON THREADS INITIATIVE

- REDUCE**
We make sure that each long-term product you buy is made with recycled materials.
- REPAIR**
We help you repair your Patagonia gear. You decide to fix it or not.
- REUSE**
We help find homes for Patagonia gear you no longer need. You sell or give it off.
- RECYCLE**
We will take back your Patagonia gear that is worn out. You provide the rest of the story.
- REIMAGINE**
TOGETHER we reimagine a world where we take only what nature can replace.



But consumerism, and more specifically, overconsumption, is not part of a new dilemma. Humans have always been consumers by nature, collecting and using essential items (food, water, shelter, and clothing) for survival and prosperity throughout history. While the role of consumer was embraced by people in America as far back as the 1920s (Higgs, n.d.), it wasn't until the decade following World War II that business analysts started to seriously look at the negative impacts of American consumerism. John Kerryn Higgs recalled the work of prominent economist, Kenneth Galbraith, citing his 1958 essay in which he warns of his growing concerns: "'What of the appetite itself?' he asks. 'Surely this is the ultimate source of the problem. If it continues its geometric course, will it not one day have to be restrained?'" (Higgs, n.d.)

The warnings and protests to combat wastefulness soon gave way to new generations of shoppers looking to set themselves apart from their elders, magnifying the cycle of overconsumption. And businesses saw an opportunity to increase profits by artificially intensifying consumer demand by using planned obsolescence, a concept that originated early in the twentieth century but became prevalent in the 1950s. There are several reasons a product can be perceived as obsolete by the owner. The two most important to this research being physical inferiority (in which a product wears out, breaks down, or falls apart quickly) and emotional detachment (in which a product is deemed unfashionable or unfavorable after a period). Manufacturers

utilized both strategies to drive spending, leading to the rapid growth of the overproduction and over-consumption problem. “History tells us, in no uncertain terms, that the forces stacked in favour of consumerism – from social inertia to pressure to conform to governments that rise or fall on a percentage point of economic growth, to the vast machineries of advertising and multi-trillion-dollar markets with investors to serve – have always been a stronger influence than popular movements urging us to live simply.” (Mackinnon, 2021)

The question today remains whether consumer behavior can change to combat overconsumption. There are many well-intentioned brands trying to halt the fast fashion cycle of make-buy-dispose-repeat by introducing a “slow fashion” movement in which fewer and smaller collections are released each year. While this has introduced well-constructed products using higher quality materials, there is no evidence people are fundamentally changing their shopping behavior. Amid growing concern about the climate crisis, a 2020 IMB report stated that “57% of consumers are willing to change their purchasing habits to help reduce negative environmental impact.” (Haller et al., 2020) However, FashionUnited cites reports showing a different reality, stating that “after lockdown restrictions were lifted... the fashion industry returned to pre-pandemic levels,” and in fact, “according to Euromonitor, the global apparel and footwear industry grew by 18.1% at current prices in 2020-2021.” (FashionUnited, 2022) J.B. Mackinnon clearly pinpoints the dilemma of consumerism, stating, “If you want fewer, better things, you can certainly buy them [...] Your purchase, however, does little to change the fact that the system is stacked against those businesses and against you as their consumer [...] we probably can shop our way to a niche market of premium-priced, long-lasting products that few people are willing or able to buy; we can’t shop our way to a world that stops shopping.” (Mackinnon, 2021)

2.2 The Rise of Fast Fashion

“Fast Fashion” is a term that was coined in the 1990’s to describe a significant shift in the product development cycle that allowed companies to manufacture products more quickly than ever before. However, indicators of consumer demand for quickly changing fashion at affordable prices were already emerging much earlier in the twentieth century. The strategy of planned obsolescence utilized by brands and manufactures to stimulate the market in the 1950s increased the need for speed-to-market production and lower costs to keep up with consumer demand. Even though “fast fashion” hadn’t originated alongside “planned obsolescence,” the concept of quickly cycling through inexpensive trends certainly had.

In 1966, the American paper company, Scott Paper, ran a promotional advertisement featuring its paper products in the form of a dress (Figure 2). The dress was not meant to be a new category of business for the brand but took American by storm with more than 500,000 orders in one year. (Victoria and Albert Museum, n.d.) Fashion brands in America and the United Kingdom jumped on this trend and the paper dress quickly

rose in popularity as individuals became fascinated with the idea of wearing and disposing of trendy clothes. “It perfectly suited the era of consumerism and the optimistic, ‘who cares’ spirit of the ‘60s.” (Fashion Roundtable, n.d.) Marketing campaigns leaned into this carefree mentality, with slogans like, “‘Won’t last forever... who cares? Wear it for kicks – then give it the air.’ It wasn’t waste; it was liberation.” (Buck, 2017)

Figure 2: Photo of Scott Paper’s advertisement for the paper dress in 1966. (Collectors Weekly, 2017)

While the concept and production model of fast fashion didn’t officially take shape until two decades later, the paper dress has been cited as the first garment introduced into the fashion market that was “cheap and ‘disposable’ - designed to be worn only once or twice...” (Victoria and Albert Museum, n.d.) The rise of the paper dress signaled a notable shift in the relationship between a person and their clothes – since this garment would not last long, it had little to no value in the mind of the purchaser. Because it was very easy to simply throw away things that have no value, the long-term care and appreciation for clothing faded into history. Current reports show that, “In just the past twenty years, the number of garments purchased per person has increased by more than 60 percent, while the lifespan of those clothes has been cut nearly in

half.” (Mackinnon, 2021) The majority of clothing, over 80 percent, is discarded when the owner has deemed it obsolete, ending up in landfills or incinerators. (Buck, 2017)

Although it was an obscure micro-trend in the 1960s, the paper dress phenomenon brings about an interesting paradox. Had the infrastructure for commercial paper recycling been in place when the paper dress was introduced, could this disposable trend have helped to decrease consumer waste through a circular system? Offering consumers aesthetically pleasing clothing that could be recycled or composted at the end of use would have been a completely different approach to the paper dress trend with drastically different outcomes.

3. Examining Responsible Material Strategies

3.1 The Motivation for Innovation

As noted earlier, the product development phase plays a critical role in a product’s lifetime impact on people and the planet. The fabric used to make a product is determined during this phase, and as the main component of clothing, it contributes significantly to the overall garment footprint. “The impact of fiber production on the environment is profound, ranging from excessive water waste, to polluting pesticides, to climate changes, just to name a few.” (Farley Gordon and Hill, 2015) Natural fibers, such as cotton, wool, and silk, are traditionally thought of as more environmentally friendly than their synthetic alternatives. However, chemical dyes and finishes are often added once these fibers are woven and knit into textiles, rendering many natural materials harmful to the environment. Polyester is the most used man-made textile in the fashion industry because of its low cost, quick production time, and ability to mimic the characteristics of more expensive natural fibers. At the same time, polyester has an extensive list of negative environmental impacts. “It is derived from nonrenewable resources, requires a great deal of energy for extraction and processing and releases significant byproducts.” (Pucker, 2022)

The recycling of existing textiles through a process of deconstruction and reconstruction into new textiles is a current popular method of keeping discarded clothing out of landfills. However, recycling textiles has a myriad of negative impacts as well, ranging from limited technology and infrastructure to the low quality of recycled fibers. (Pucker, 2022) Additionally, “a recent life cycle analysis (LCA) on cotton jeans revealed that the climate change impact of buying and disposing of a pair of jeans is almost the same as upcycling the jeans into a new pair.” (Pucker, 2022) Current supply chain infrastructure and production methods, coupled with consumer demand for low-cost goods, prevent large segments of the industry from effectively changing their material strategies. Consequently, the fashion industry finds itself in need of textile solutions. Innovation offers unlimited potential for new materials that are less harmful to the Earth and its inhabitants.

3.2 The Misconception of Bio-Based Materials

It is important to note there is often a misconception about the word 'biodegradable' itself, which means, "capable of being broken down especially into innocuous products by the action of living things (such as microorganisms)." (Merriam-webster.com, 2019) Everything on the planet Earth is biodegradable given time. For example, a 100 percent cotton t-shirt can break down in as quickly as a few weeks to a several months, while a 100 percent polyester t-shirt will take many decades or several centuries to biodegrade. To state a product is 'biodegradable' is misleading because it is simply inevitable. Additionally, the term 'biodegradable' makes no reference to negative impacts a material expels throughout and after this degradation process.

'Compostable', on the other hand, is a word with more significant meaning: "Something that is compostable can be used as compost when it decays." (Cambridge Dictionary, 2022) Only materials made from natural elements are compostable. The 100 percent cotton t-shirt may decay into a healthy soil nutrient for a vegetable garden if it is not dyed or finished with chemicals during the production process; but the 100 percent polyester t-shirt will release methane as it breaks down, polluting the soil. Therefore, all things that are compostable are biodegradable; but not all things that are biodegradable are compostable. This critical distinction left out of the equation from innovators and brands who are currently developing new materials has great impact on a material's life cycle.

Materials are currently being developed which make use of a variety of biological resources (for example, tree bark fibers, mushrooms, and food waste and byproducts), in an effort to replace synthetic man-made materials. There is much excitement in the sector of material innovation, and the fashion and textile industries have taken a leading role in funding research and development, designing into new fabrics, and promoting the positive impacts of these fabrics to their customers. In fact, "by 2024, the bioplastics market is expected to increase by 36%, fueled by an urgent need to divest from fossil fuels." (Doyle, 2022) Having significantly lower negative inputs and outputs during the production process, bio-based materials are more environmentally friendly than most synthetic petroleum-based textiles and utilizing bio-based components and naturally regenerative resources could help put the fashion industry on a path to a circular design model. Brands such as Stella McCartney, Nike, Adidas, lululemon, and Esprit have invested in and launched product lines utilizing bio-based materials that boast significantly less severe negative environmental impacts than their synthetic predecessors.

However, as biomaterials are quickly adopted, crucial questions about the product life cycle are being overlooked. It is important to note that currently, virtually none of these bio-based material made from regenerative resources are compostable. Materials made from biological sources do not have the same characteristics as traditional textiles and are often combined with synthetic components during the finishing

process. “Often the final result of this blending is an unsustainable yarn or textile that loses its sustainable characteristic during the production phase.” (D’Itria and Colombi, 2022).

History has repeatedly proven innovation based in nature and biology does not always lead to long-term positive impacts, as evidenced in the development of rayon, a regenerative cellulose textile. Studies in recent years have revealed the negative social and environmental impacts of rayon, but this information has not become common knowledge among brands and consumers. “Rayon production is generally too toxic to comply with the EPA’s standards,” and “rayon factory workers are at high risk of neurophysiological effects, nerve damage, heart disease, and stroke.” (Wicker, 2021)

The innovation of new materials requires time and attention to ensure all aspects of the production process and product life cycle are critically analyzed for environmental and social impacts; time and attention the fashion industry seems unwilling or unable to consider. If designers, brands, and fashion design students embrace new materials on a large scale before they are part of a circular system, these innovations have the potential to do more harm than good. “While brands are eager to find alternative materials, it would be disastrous if the push for rapid innovation led to those same efforts creating a new generation of harmful products.” (Lee et al., 2020).

3.3 The Argument for Circularity

Dr. Ashley Holdings, a chemist and sustainable materials expert, was quoted in the early months of 2022, saying, “I’m concerned about the proliferation of materials without any focus on the end-of-life implications [...] This rush to replace things with biobased [components] needs to be tempered by evidence-based analysis, solid data, facts, and a consideration of the whole life cycle analysis.” (Doyle, 2022). Without proper investigation of the impacts of these new materials, and considerable examination of the purpose behind producing more and more goods, the question being asked by brands seems to be ‘How can we make products that are less bad,’ instead of ‘How can we make truly good products?’ By limiting their scope and responsibility, material innovators designers do themselves a disservice alongside the harm they do to the planet and its people. “This is the ultimate failure of the ‘be less bad’ approach: a failure of the imagination... What about an entirely different model? What would it mean to be 100 percent good?” (Braungart and McDonogh, 2009)

In its simplest form, circularity would be the answer to this challenge. The Ellen Macarthur Foundation defines a circular economy as having three core principles: eliminating waste and pollution, keeping products and materials in use, and regenerating nature. (Ellen Macarthur Foundation, n.d.) Designing into this concept of circularity would require those innovating, designing, and making products to fully understand the

properties of materials used and ensure they do not end up in landfills when the user is finished with them. Circularity is a process that was discussed at great length in Braungart and McDonough's book, *Cradle to Cradle*. Their proposition is that designers must take a more active role in redefining the entire product development process to achieve circularity. "Instead of fine-tuning the existing destructive framework, why don't people and industries set out to create the following:... products that, when their useful life is over, do not become useless waste but can be tossed into the ground to decompose and become food for plants and animals and nutrients for soil; or, alternatively, that can return to industrial cycles to supply high-quality raw materials for new products." (Braungart and McDonough, 2009)

Brands continue to produce, and people continue to consume; however, neither group is putting much real effort into keeping products out of landfills. It is almost with a panicked frenzy that innovators and brands are releasing new materials and products; but without deeper examination of the entire life cycle, these biomaterials are just a bandage on a much larger wound. All the while, consumers believe they are making better purchasing decisions, which ultimately perpetuates problems that these brands and innovators set out to fix. "Some companies perceive the use of sustainable materials as a 'quick fix' – a relatively simple way to appear more eco-friendly, without necessarily incorporating more sustainable or ethical practices in their business operations as a whole." (Farley Gordon and Hill, 2015)

4. Expanding the Role of Academia

4.1 The Opportunity for Change

Traditional higher education textile and fashion design programs offer students a wide range of practical and technical skills necessary to build careers in the existing fashion industry. Working closely with professionals to determine the most needed skillsets for incoming entry-level employees, curriculum developers focus on the essentials of product development, patternmaking, garment construction, and textile science so graduating students are well-equipped to secure positions at established companies. However, as the fashion industry scrambles to keep up with changing consumer values and struggles to clean up its dirty and unethical processes, higher education has an opportunity to reimagine the fashion industry by focusing on radical speculation, critical thinking, and ethics. "Learning in the future will integrate thinking with rich forms of feeling and doing, all at the same time [...] students have a chance to explore purpose in learning and life." (Wehner, 2018)

In the manufacturing model of producing goods faster, cheaper, and in much larger quantities, has turned craft into industry and makers into designers and producers. This detachment to craft has led to a disconnection to, or exemption from, the impacts and implications of the goods being generated.

Additionally, that 'finish line' for a designer has become the point at which a customer purchases a product; but that purchase is just the beginning of a product's second phase of life. Educators can adapt tools and instructional models to create a framework for profound change and encourage students to question existing models. What if students, educators, and those working in the textile and fashion systems started at the end of a product's journey instead of focusing only on creating newness? How can the context and concepts of the circular economy allow designers to conceptualize, explore, and critique materials and design itself? Questioning standard processes and industry norms brings about a much richer creative practice with endless possibilities. Bruce Mau stated it best in *Massive Change*: "Design is evolving from its position of relative insignificance within business (and the larger envelope of nature), to become the biggest project of all... Empowered as such, we have a responsibility to address the new set of questions that go along with that power." (Mau et al.,2010)

4.2 The Development of Coursework

Considering the current fashion industry, consumer behavior, and environmental implications, new ways of thinking about how design is taught and what outcomes should be expected is a worthy endeavor. And speculative thinking in the practice of design is needed to imagine better ways of working, creating, and doing business. Using the paper dress from 1966 as a critical point of reference, an experimental course was developed for graduate and undergraduate design students at Drexel University (Philadelphia, Pennsylvania, USA) to look at biomaterial innovation through the lens of circularity and with an emphasis on material end of life. If the creator of the paper dress had felt responsible for what happened to the product once the consumer was finished with it, could it have been designed into a circular economy with an environmentally beneficial outcome? Could material recycling and composting infrastructure have been put into place and become an integral part of the product life cycle process?

In the Spring 2021 term, 22 adventurous students participated in an elective course entitled *Material Innovation in Accessory Design*, performing their own experiments to develop new materials yielding unique, creative, and inventive accessories. By thinking outside the norms of what materials can and should be used, students began to imagine how materiality and design strategies can be refocused to satisfy the needs and desires of consumers today while doing no harm. Students were introduced to ethical frameworks and given reflection time throughout the design process to ensure that connections to people and the planet were being made with and through their designs. This also ensured differentiations were identified between "CAN we make this" and "OUGHT we make this." These examinations echoed David Moorish's statement that "by encouraging learners to reflect on their own behavior and their relationship to their own clothing through its life cycle [...] it helps create future designers who have a better understanding [...] of emotional consumer

connectivity, empathy and how improved quality can positively impact on reducing waste through changed consumer behavior.” (Morrish, 2017).

Research, inspiration, and technical skills are essential for the creation of new concepts and dynamic solutions to design problems. For this reason, the course first provided a basic technical foundation for creating various accessories and challenged students to visualize the future possibilities of design. Because the pandemic was underway and required response, this process included in-depth research of historic costume in the categories of traditionally protective accessories (shoes, gloves, and masks). Simultaneously, the need for material innovation experiments with bioplastics, kombucha leather, and mycelium was discussed. Students were tasked with researching historical material innovations and discussing the concerns of using bio-based materials that are not compostable.

The first four weeks of this ten-week course consisted of developing a research journal that included: (1) research on the function and form of historical accessories, (2) swatches of traditional stitching techniques, and (3) recipes, processes, and samples of experimental materials. While developing this journal, students had the opportunity to begin more organically and thoughtfully working through the five stages of design thinking (empathize, define, ideate, prototype, test) needed to develop their final projects. This final project, completed during the second part of the course consisted of the design and creation of a fashion accessory that addressed both function and form. Students examined consumer habits as a catalyst for designing with materials that are intentionally impermanent and came up with creative solutions for the question, ‘What happens to a product when the consumer is done with it?’

4.3 The Course Outcomes

This course was offered to students during the shelter-in-place time of the Covid-19 pandemic, a term when the university was conducting fully remote-learning classes. With strict quarantining guidelines in place, students worked with what they had on-hand as well as some supplies that the instructor was able to ship to their locations. Many of the course supplies were common kitchen ingredients (water, flour, agar-agar powder, and tea) and tools came in the form of pots, spatulas, and cooking tins. Impeded by time zone differences, remote locations, and limited access to resources could have rendered this course insignificant at best, or disastrous at worst. However, one of the key findings that presented itself during term was the intensified drive students had for finding better ways of working given their constraints. Creativity has a way of flourishing in the most adverse circumstances. Both instructor and students took to heart the words presented by Seetal Solanski in *Why Materials Matter*: “Approaching the commonplace with an open, even naïve mindset, it is possible to turn established industrial systems upside down, working with what we already have access to in plentiful quantities.” (Solanki, 2018)

In just 10 weeks (30 hours of active class time) all 22 students produced finished products made from a variety of compostable materials spanning from bioplastic hats and harnesses to homemade paper masks and mycelium-soled sandals. Figures 3-5 show some of the work created in this course. Feedback from one graduate student provided reinforcement for the need for this type of coursework: “My experience in the experimental accessories course really challenged me to think in different ways and learn how to use what already exists to create something new and original [...] I love the merging of subjects and the overlap of science and creativity – an intersection that is often overlooked or judged.” (Sajankila, 2022) While the intention of this course was not to design scalable or production-ready goods, it instead challenged students to analyze their design process and consider completely divergent ways of working. These aesthetically pleasing accessories also gave both designer and consumer the ability to actively participate in the entire product lifecycle. As part of the development process, the design students considered how consumers would engage in the transformation of these compostable accessories. Whether by allowing the products to decompose naturally over time or imposing the change by soaking them in water or burying them in soil, the owner can experience the metamorphosis, participating in the impermanence of fashion in a much more real and responsible way. While these are certainly not practical creations, doesn't most of the fashion industry really thrive on emotional connections rather than practical purchases?

Figure 3: Lexa Dugan's headpiece made of mycelium and cotton cording. (Dugan, 2021)

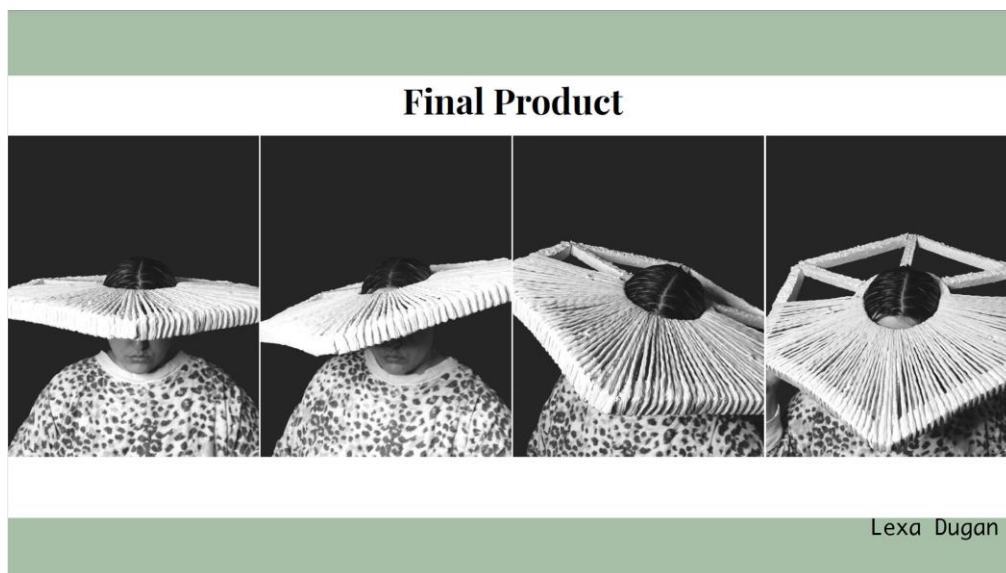


Figure 4: Emma Dietz's goggles made of bioplastic and cotton thread. (Dietz, 2021)

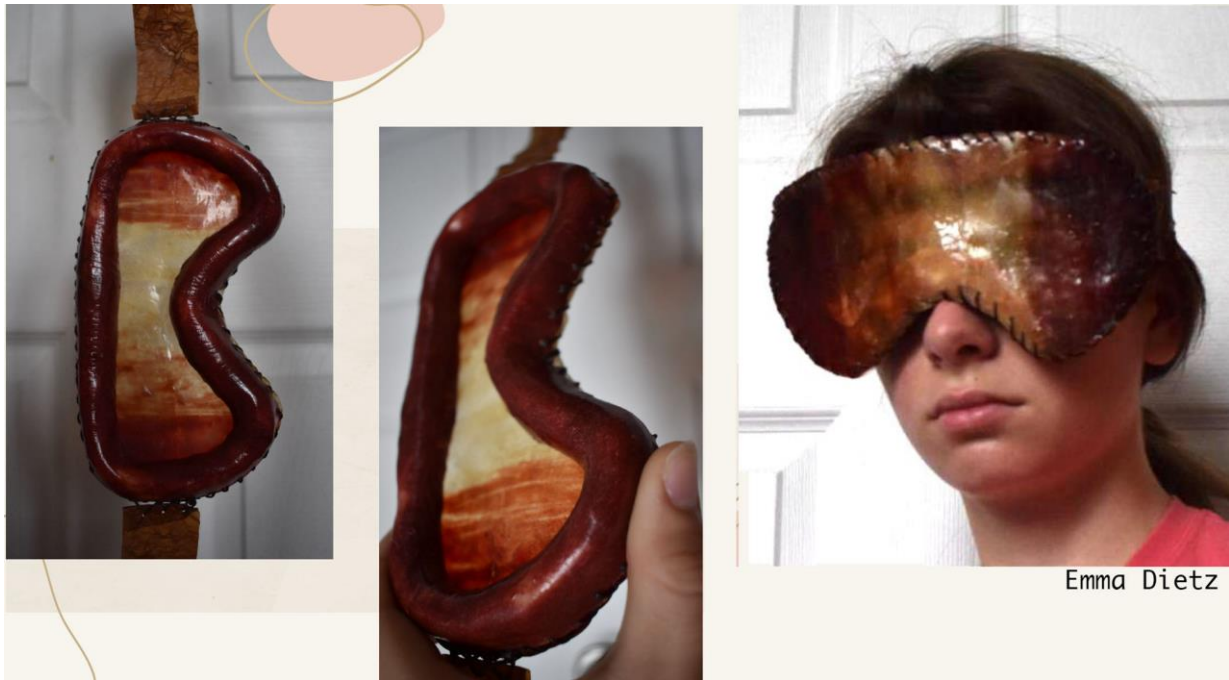


Figure 5: Owen Rogoff's Sandal made of mycelium sole, bioplastic straps, and steel tacks. (Rogoff, 2021)



One student found this process to be so compelling that she went on to develop an entire 5-look collection out of bioplastics as her senior thesis. Shirk, who graduated in Spring of 2022, reflected on the work done in the Material Innovation in Accessory Design course as a motivation for her thesis collection. "My senior

collection was heavily reliant on algae-based bioplastics, and thanks to all the trials and errors of previous exploration, it was possible to be worn and runway-ready. The thesis focused on the relationship between human design and natural design. What I learned in accessory design was a big picture moment, working with circular design feels really natural and it's the only way humanity will progress further.” (Shirp, 2022) Figures 6 and 7 show images from Shirp’s senior thesis collection.

Figure 6: Shirp’s Senior Thesis Collection bodice, skirt, and hand coverings made of bioplastics.



Figure 7: Shirp's Senior Thesis Collection gloves and harness made of bioplastics.



5. Limitations and Further Research

The scope of this research had obvious limitations worth mentioning by way of outlining the next steps planned by the author. First and foremost, research of this nature requires collaboration and interdisciplinary study. While this paper makes use of exemplary work by other researchers, designers, and professionals, it lacks a collaborative spirit that would greatly enhance the quality of results. Second, given the constraints of the pandemic and the author's limited program support, this research focused on a very minuscule cross-section of material innovation in the fashion sector. Further research, hands on investigation, and experimental coursework development will be needed for a much broader understanding of the possibilities to give more far-reaching recommendations for both academia and industry. "The future of global design is fundamentally collaborative. In this condition there is no room for censorship." (Mau et al.,2010) For this reason, the next phase of this research and course development will include collaboration with individuals outside of the fashion design sector.

6. Commencement

The ideas presented here are not meant to be a “one size fits all” solution to the fashion industry’s many challenges. Instead, consider this research as an alternative to conventional thinking that can allow design students and industry professionals an opportunity to pause, ideate, and challenge the norm. In place of a traditional conclusion, this paper will instead offer a beginning. Do not continue to rely on a broken product development process riddled with environmental and social atrocities. Do not pretend business as usual can continue and people will stop shopping. Rather, lean into the unknown, the unusual, the impossible. It is here, in the midst of great uncertainty and insecurity, that new ideas will emerge and better ways of making can start to take shape.

References

Braungart, M. and McDonough, W. (2009), *Cradle to cradle*, Vintage, London.

Buck, S. (2017), “This wild paper clothing trend of the 1960s was the early version of fast fashion”, available at: <https://timeline.com/paper-fashion-1960s-43dd00590bce> (accessed 24 September 2022).

Cambridge Dictionary, (2022), “compostable”, available at:

<https://dictionary.cambridge.org/us/dictionary/english/compostable> (accessed 24 September 2022).

Collectors Weekly ed., (2017), “One of Scott’s original ads for the paper-dress promotion in 1966” [Print advertisement] Available at: <https://www.collectorsweekly.com/articles/from-hospital-gowns-to-paper-couture/> (accessed 30 September 2022).

Dietz, E. (2021), *Accessories Final Project*.

D’Itria, E. and Colombi, C. (2022), “Biobased Innovation as a Fashion and Textile Design Must: A European Perspective”, *Sustainability*, 14(1), p. 570, doi:10.3390/su14010570.

Doyle, M. (2022), “Can Bioplastics Really Make Fashion More Sustainable, Biodegradable, or Recyclable?”, available at: <https://ecocult.com/bioplastics-eco-friendly-fashion/> (accessed 19 September 2022).

Dugan, L. (2021), *Accessories Final Project*.

Farley Gordon, J. and Hill, C. (2015), *Sustainable fashion: past, present, and future*, Bloomsbury, London.

Fashion Roundtable. (n.d.), “Paper Clothes: How A Swedish Research Project Is Creating Sustainable Fabric From Paper”, available at: <https://www.fashionroundtable.co.uk/news/fabric-made-from-paper>

FashionUnited (2022), Global Fashion Industry Statistics, fashionunited.com, available at: <https://fashionunited.com/global-fashion-industry-statistics> (accessed 19 September 2022).

Haller, K., Lee, J. and Cheung, J. (2020), "Meet the 2020 Consumers Driving Change Why Brands Must Deliver on omnipresence, agility, and Sustainability in Association with Research Insights", IBM, available at: <https://www.ibm.com/downloads/cas/EXK4XKX8> (accessed 19 September 2022).

HEY FASHION! (n.d.), "HEY FASHION! — Fashion's Waste Crisis and How to Solve It - Prepared for Eileen Fisher Foundation by Pentatonic®" available at: <https://www.heyfashion.org/report> (accessed 17 September 2022).

Higgs, K. (n.d.), "How the world embraced consumerism", www.bbc.com, available at: <https://www.bbc.com/future/article/20210120-how-the-world-became-consumerist#:~:text=The%20notion%20of%20human%20beings> (accessed 19 September 2022).

Lee, S., Congdon, A., Parker, G. and Borst, C. (2020), "Understanding "Bio" Material Innovation: A Primer for the Fashion Industry", Biofabricate and Fashion for Good, available at: <https://app.box.com/s/amjq9anszv8hvwdexoxg6wubes4aaxqa> (accessed 31 May 2022).

Lehmann, M., Arici, G., Boger, S., Martinez-Pardo, C., Krueger, F., Schneider, M., Carrière-Pradal, B. and Schou, D. (2019), "Pulse of the Fashion Industry: 2019 Update", Global Fashion Agenda, Boston Consulting Group, and Sustainable Apparel Coalition, available at: <http://media-publications.bcg.com/france/Pulse-of-the-Fashion-Industry2019.pdf> (accessed 31 May 2022).

Ellen Macarthur Foundation (n.d.), "New to circular economy overview", ellenmacarthurfoundation.org. available at: <https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview#:~:text=A%20circular%20economy%20decouples%20economic> (accessed 30 September 2022).

Mackinnon, J.B. (2021), The day the world stops shopping: how ending consumerism saves the environment and ourselves, Ecco, New York, NY.

Mau, B., Leonard, J. and Institute Without Boundaries (2010), Massive change, Phaidon Press, London.

Merriam-webster.com. (2019), "Definition of BIODEGRADABLE", available at: <https://www.merriam-webster.com/dictionary/biodegradable> (accessed 19 September 2022).

Mohr, S., Orebäck, M. and Rys, J. (2022), "Product sustainability: Back to the drawing board", McKinsey & Company available at: <https://www.mckinsey.com/capabilities/operations/our-insights/product-sustainability-back-to-the-drawing-board> (accessed 19 September 2022).

Morrish (2017), "Sustainable Fashion Tailoring: An approach for creating a heightened emotional attachment to garment apparel at undergraduate level, through pedagogy, storytelling, digital technologies and traditional craftsmanship", *Product Lifetimes And The Environment*, pp.280–286, available at: <https://ebooks.iospress.nl/publication/47885> (accessed 21 June 2022).

Niinimäki, K. (2015), Ethical foundations in sustainable fashion, *Textiles and Clothing Sustainability*, 1(1).

Patagonia (2011), Patagonia advertisement from the Friday, November, 25, 2011 edition of *The New York Times*, [Print advertisement] available at: <https://eu.patagonia.com/gb/en/stories/dont-buy-this-jacket-black-friday-and-the-new-york-times/story-18615.html> (accessed 30 Sep. 2022).

Pucker, K.P. (2022), "The Myth of Sustainable Fashion", *Harvard Business Review*, available at: <https://hbr.org/2022/01/the-myth-of-sustainable-fashion>. (accessed 19 September 2022).

Rogoff, O. (2021), *Accessories Final Project*.

Sajankila, N. (2022), Student Feedback on Material Innovation in Accessory Design course, 21 Mar.

Shirp (2022), Student Feedback on Material Innovation in Accessory Design course, 30 Sep.

Solanki, S. (2018), *Why materials matter: responsible design for a better world*, Prestel, Munich.

Victoria and Albert Museum. (n.d.), "V&A · Paper dresses", Available at: <https://www.vam.ac.uk/articles/paper-dresses> (accessed 19 September 2022).

Wehner, R. (2018), "Purpose Learning: Reimagining What and How Students Learn. Independent School: Leadership, Conversation, Community", available at: <https://www.nais.org/magazine/independent-school/winter-2022/purpose-learning-reimagining-what-and-how-students-learn/> (accessed 24 September 2022).

Wicker, A. (2021), "Greenwashing Alert: Rayon Viscose Is Made From Plants, but Is Also Toxic and Destructive", *Ecocult*, available at: <https://ecocult.com/greenwashing-alert-that-natural-fabric-made-from-plants-might-be-toxic/> (accessed 21 Sep. 2022).