

# Mending Fashion: Using Virtual Reality to Build Empathy and Foster Sustainable Behavior Change

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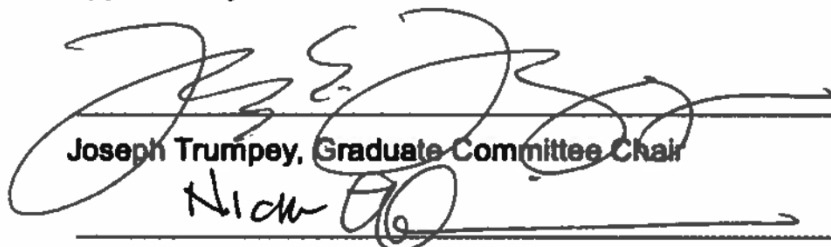
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Foster Sustainable Behavior Change**

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Masters Thesis  
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**Abstract:** This project utilized a systems design approach to address wicked problems in the fashion industry and identify an intervention point for shifting consumer behavior towards more sustainable practices. By combining Participatory Action Research (PAR) and Design for Sustainable Behavior (DfSB) methodologies, a VR experience was developed and tested on 156 participants in a lab setting. The results showed that 85% of people care about the environment and 77% are willing to make changes to support sustainable habits reflective of the UN SDGs. VR delivered through a headset had a significant impact on actionable behavior, particularly for those with a desire to adopt new habits. This project demonstrates the effectiveness of VR as a tool for promoting sustainable behavior change and provides valuable insights for sustainable design interventions. Further research is necessary to explore the potential of VR in promoting sustainable practices in other industries.

**Keywords:** Sustainability, Sustainable Development Goals (SDGs), Design for Sustainable Behavior (DfSB), Fashion, Clothing, Supply Chain, Consumer Behavior, Virtual Reality

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# 1.Introduction:

The fashion industry is one of the largest and most lucrative industries in the world, generating 1.7 trillion dollars in 2022, and an annual growth rate over 5% (Zippia, 2023). In recent decades, however, this industry has come under intense scrutiny due to its negative impact on the environment and the exploitation of workers in developing countries (Taplin,2014). Given the fashion industry's exploitative practices, the pressure for continual growth, and rising extractive costs to the environment, both critics and even those within the industry have called for sweeping changes to address sustainability concerns (Heuer et al, 201).



Figure 1. *Us Clothing Sales Per Capita*. March 6, 2021. *How Much Is the Fashion Industry Worth?* <https://www.zippia.com/advice/fashion-industry-statistics>.

Whether engaged in fashion consumption as a style choice or consuming clothing for its utility, each of us engages with this industry as we make daily clothing decisions. Many nuances related to dress are deeply embedded in our social lives, such as dress being reflective of class and underpinning the pursuit of being in vogue

(Hassan et al, 2013). Much of history—social, political, and economic—is both relevant and tangential to this pursuit.

This thesis will explore why the fashion industry is not sustainable, the reasons behind this, and the ideation process of designing a disruption to the industry. The creation of a virtual reality experience intended to shift values and nudge actionable behavior towards sustainability will be detailed. In the paper, I will explain the experiments I conducted and I will analyze the results to test the viability of VR versus alternative informational delivery methods as related to behavior change.

This thesis's primary goal is to provide the reader with a general understanding of the industry as a whole and the underlying problems therein as a basis from which to engage in harnessing the properties of design thinking as a jumping off point from which to begin to solve the wicked problem of fashion. The focus of this work is not on the problems of the industry and practice but rather on the exploration, development, and testing of potential solutions.

This thesis aims to contribute not only to the growing body of research on the extractive and exploitative current state of the fashion industry but also to provide insight into innovative potential solutions. The study demonstrates the validity of VR as a method of nudging behavior. Through this research, I hope to raise awareness about the negative impact of the fashion industry on the environment and society, and also provide support for the use of technology to close the behavior gap between current and needed shifts in individual decisions needed to, in essence, reject the current standard and make a shift towards buying less and a willingness to pay more as needed to adapt for a sustainable future.



## 1.1 Background of the Research Problem

Fashion is a complex industry which touches almost everyone globally. We are all consumers of clothing and engage with a cycle of producing, purchasing, and disposing tied to the industry of fashion (MacKinnon, 2021). I came to be interested in the conceptualization of fashion as a wicked problem, and its role of “extractive costs” to the environment and predatory labor practices while a professional practicing within the fashion industry. Throughout my 20-year career in the industry, I have been involved in the design process, domestic and international manufacturing and production, supply chain management and logistics, as well as retail and marketing.

While the fashion industry has begun to recognize its own role in contributing to climate change, perpetuating environmental damage, and consumers desire to see a change, critics contend that it might appear more interested in "greenwashing" than actually confronting these problems. A rise in concern for ethical, environmental, and human rights has been exploited through 'greenwashing' for economic gain by industry concerns (Blasi et al, 2021). In addition to not having a clearly defined standard there was no unified governing body with authority or penalties imposed on entities in violation of standards (Bozic and Bateman, 2018). These practices have added to a consumer environment that is wary of sustainability claims and skeptical of large corporations who are repeatedly sued for false claims (Gazzola et al, 2020).

Consumers buy 60% more clothing than compared with consumption patterns 15 years ago (Fashion Revolution, 2017). Many studies have highlighted opportunities to address sustainability goals through zero waste design practices, supply chain transparency, governing policy and laws/regulations being drafted, NGOs entering the field as protecting interests, and the list goes on (Carrigan et al, 2001). If we boil down the fashion industry to its most simple form it can be viewed in terms of: what we make, what we make it out of, how we make it, who makes it, how it is transported, who sells it, how it is sold, who buys it, why they buy it, how long it is worn, when is it disposed of, and how it is disposed of.

The fashion industry represents \$1.7 trillion in global trade annually. The industry employs more than 250 million people around the world (Sumner, 2018). Many workers inside the fashion industry fit the United Nations 1998 definition of vulnerable workers living in a state of poverty.<sup>1</sup> The fashion industry thrives on predatory labor practices exploiting poor and vulnerable populations, constantly hunting to decrease costs and increase profits (Ross, 2021).

The majority of workers in low skilled and low paid positions are young women, and it is reported that 1 in 3 female garment workers have experienced sexual harassment in the past 12 months (Fashion Revolution, 2017). On April 24th 2013 in a single factory disaster at Rana Plaza in Bangladesh more than 1,100 people were killed and another 2,500 were injured. This was by no means a singular event, but a well documented event that acted as a catalyst to highlight the deep roots of the systemic ills in the fashion industry, and expose the real world impacts taking place, affecting both people and the environment as a direct result of standard industry practices (Barrett et al, 2018).

*“The rise of today’s fast-moving, mass market and globalised fashion system has created convoluted and unequal supply chains, plagued by labour abuses that range from poor wages and excessive overtime to fatally unsafe conditions, child labour and modern slavery. Decades of effort to manage the problems through private inspections and certifications have created a multi-billion-dollar audit industry, but no solution...High-profile scandals in recent years highlight how endemic these problems remain.” (Business of Fashion, Sustainability Index 2021)*

It is clear given these statistics and recent reports that there needs to be meaningful, immediate, and deep reaching systematic change (called ‘transformational

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<sup>1</sup> “Fundamentally, poverty is a denial of choices and opportunities, a violation of human dignity. It means a lack of basic capacity to participate effectively in society. It means not having enough to feed and cloth[e] a family, not having a school or clinic to go to, not having the land on which to grow one’s food or a job to earn one’s living, not having access to credit. It means insecurity, powerlessness and exclusion.

change' herein) in both the fashion industry as well as the way we as a collective society consume fashion goods and products.

The contemporary fashion industry, supply chain, and marketplace are largely governed by the interests of capitalist, multi-nationalist corporations (Anner et al, 2013). Stemming from the emergence of liberal democracies following the second industrial revolution, the modern corporation was born, one whose primary aim was to increase profit, by selling the most goods, with the highest margins, while maintaining the lowest internal costs possible (Arnesson, 2018).

The fast fashion business model, which encourages consumers to buy and dispose of clothing quickly, is highly profitable but has negative environmental and social impacts, including massive waste and pollution, exploitation of labor, and depletion of natural resources. Researchers and advocates see the pitfalls of tangling with this linear economic model and extractive economic system (Sullivan, 2017). The global supply chain for fashion is complex and opaque, making it difficult to track the origins and sustainability of raw materials, production methods, and labor practices. This lack of transparency makes it challenging for governments and consumers to hold fashion brands accountable for their actions. With the current globalized system there are almost no identifiable unified industry standards, or international governing bodies to enforce policy (Choi, 2015). However, the nature of this system allows, indeed requires, consumers' purchasing decisions to direct the system (Amed et al, 2019). Customers' purchasing decisions play a critical role in shaping the fashion industry's shift away from fast fashion and towards sustainability. By choosing to buy sustainable and ethical clothing, consumers are sending a signal to fashion brands that there is a demand for more responsible and environmentally friendly products.

A multi-discipline legacy of study informs the answer to the question: Why do consumers not buy already available sustainable and ethical fashion products? Often it is because these products are viewed as being prohibitively expensive, or because the customer is unaware what the terms "fair trade" or sustainability encompass, and if there is understanding there is skepticism about the validity of the claims (Devinney et. al., 2010). I believe that there is a breakdown in conveying that fashion goods adhere to representative standards of sustainability, and that consumers lack trust in such claims

being valid. Addressing this gap between valuing sustainability as a principal and making choices that reflect said value structure could be one key to unlocking behavior change (Buell, 2019).

## 1.2 Description of the Research Problem



Figure 2. *Fashion Industry Wicked Problems*. Niki Fairchild Azevedo. March 6, 2020.

The global fashion industry is a complex and multifaceted market, with a long and complex supply chain dominated by large multinational corporations. The industry's corporate structure and supply chain have significant implications for sustainability, with concerns about exploitative labor practices, poor working conditions, overconsumption, and waste (Cline, 2013). For the purposes of this thesis, the fashion industry will be defined as the global industry and all connected concerns that are involved with and service the creation of clothing. Therefore, when we reference the fashion industry this will encompass any goods or services that are involved in the creation, promotion, distribution or sale of articles of clothing.

The fashion industry's supply chain is long and complex, with multiple actors involved in the production, distribution, and consumption of clothing. The supply chain begins with the sourcing of raw materials, such as cotton or wool, which are then processed into textiles and fabrics. These fabrics are then used to manufacture clothing, which is then distributed to retailers and ultimately sold to consumers.

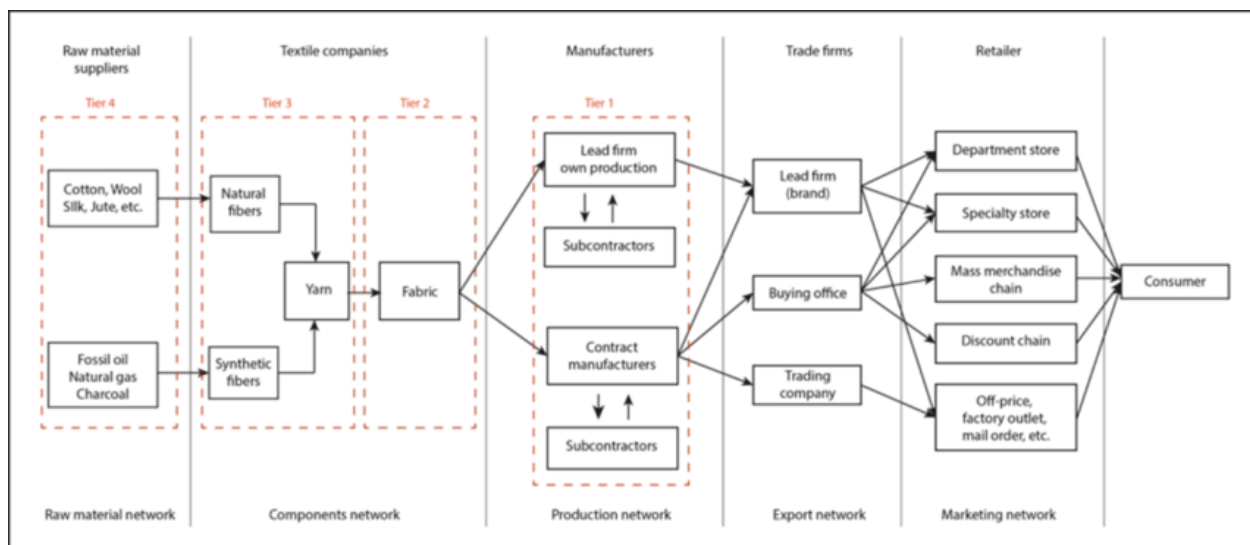


Figure 3. Obser, Sarah. (2015). Transparency and Traceability in the Textile and Clothing Supply Chain. 10.13140/RG.2.2.16892.74883.

The global nature of the fashion industry means that many clothing companies source raw materials and manufacture their products in different countries, often in developing nations where labor is cheaper. This has led to concerns about exploitative labor practices and poor working conditions in the fashion industry's supply chain (Choi

et al, 2015).



Figure 4. Still from *Problems in Fashion*. Niki Fairchild Azevedo. February 2023.

The growing environmental and human rights problems associated with the fashion industry highlight the need for change, and the potential for a more sustainable and equitable fashion market.<sup>2</sup> There are many definitions for sustainability as well as metrics for measuring impacts (Holden et al, 2014). For the clarification of discussion, the definition of sustainability will be drawn from and guided by the United Nations' Sustainability Goals (SDGs) as adopted by all [United Nations Members Stated in 2015](#)<sup>3</sup>.

Because I want to nudge behavior towards paying more and buying less, I developed a VR learning experience about fashion production, and tested its effectiveness in shifting behaviors. Research shows evidence that there are a complex set of factors that contribute to consumer decisions including both emotional and logical factors (Becker-Leifhold, 2018). One of these factors is uncertainty (Hassan, Louise, et al., 2013). This thesis investigates the complex set of factors influencing behavior and examines how to address both uncertainty and authenticity perceptions (Berbery an et al., 2018). This understanding drivers of behavior informed the creation of a VR

<sup>2</sup> A video I produced covering these facts may be found in the appendix.

<sup>3</sup> A list of the UN SDGs as well as description on how they relate to the fashion industry can be found in the index.



experience that aims to nudge consumers towards taking actions based on sustainability principles.

This VR experience follows the creation of a pair of jeans on a global journey through a cotton farm, textile mill, design firm, garment factory, ending at a shipping container. The experience highlights both the process of creating a pair of jeans, as well as the stories and experiences of the people involved at each step of the journey. This story is told from original content researched, collected, edited and crafted into *Woven: A VR Journey of Jeans*. Below are stills from the stills from the VR experience which capture a portion of the 360° environment, educational videos, and gamified interactive quiz.

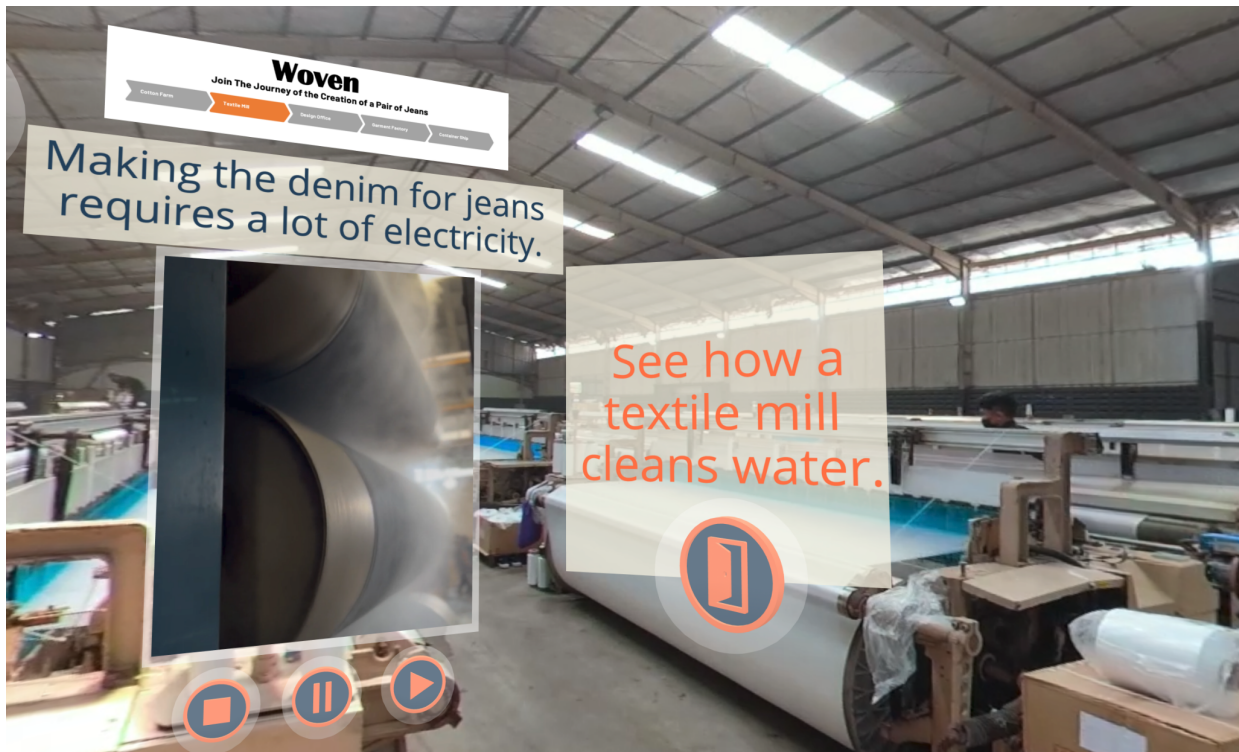


Figure 4.

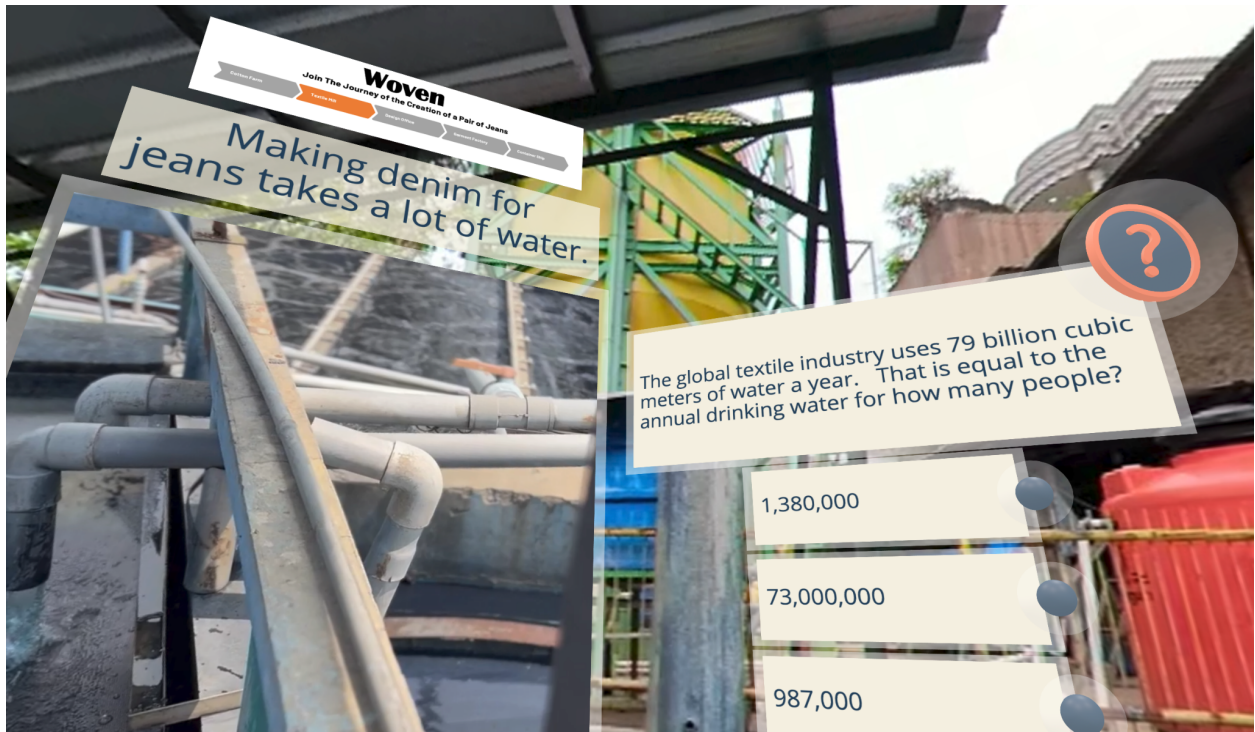


Figure 5.



Figure 6.





Figure 7.

Figures 4-7 Stills from *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. March 2023

If people believe they can make a difference, and perhaps accept the responsibility that purchases reflect values, they will discover the power they have to impact change and challenge systems that reinforce inequalities (Muthu, 2019). This promotes the significant role consumers may play in fostering change in the fashion industry given its global nature and the difficulty of regulation. Which makes a case for a bottom up intervention.

Initial Questions:

- Can we address consumer uncertainty with a design intervention employing immersive VR technology that calls attention to how clothing is produced highlighting extractive costs and exploitative practices?
- Does exposing individuals to this VR experience influence their buying behaviors?
- If it does have an influence, does influencing buying behaviors contribute to the transformational change needed in the fashion industry?

- If it does have an influence but not enough to contribute to transformational change, could this influence help stabilize or grow niche markets in a way that allows companies to quickly adapt to emerging, and increasingly relevant, consumer values?
- Is VR an effective tool to help build knowledge and empathy?

There is a small margin outside the parameters of price, quality, and convenience that consumers are willing to traverse to purchase “ethical” or Sustainable products (Devinney et al, 2010). The attitude-behavior gap can be understood using the EAST (easy, attractive, social, timely) framework.<sup>4</sup> The EAST model, according to the Behavioral Insights Team, “is designed to improve public policy by using nudging, social engineering, and other psychological and economic methods”. In order for consumers to change behavioral patterns it should adhere to ideally multiple aspects of the EAST framework. Gaps in the metrics of price, quality, and convenience when stacked up against the comparable ethical products, negates the individual motives, and perhaps outweighs the collective benefit in the mind of the consumer; thus accounting for the wide variation in the survey of individuals claiming to always be concerned with ethics and the purchasing behaviors of the same survey participants.<sup>5</sup>

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<sup>4</sup> The EAST framework was developed by the Behavioral Insights Team in 2012.  
<https://thedeisionlab.com/reference-guide/management/east-framework>

<sup>5</sup> A detailed account of this research, and results from the findings, conducted by this research team may be found in the appendix.

## 1.3 Historical Context and development of Global Fashion Market

### A. The murderous, meaningless caprices of fashion

In *Das Kapital* (Marx, 1867), Marx writes about fashion. He talks about uncertain seasons and unfair conditions, using coats and textiles as illustrative examples.

In *Grundrisse* (Marx, 1861), Marx lays out the dialectic of production and consumption with specific reference to clothing. A product, a garment, he notes, becomes a real product, a real garment only in being worn, becoming worn out, being consumed. (I would add into this schematic the triggering action of choice by purchase.) Through use, it disintegrates and negates itself. This stimulates more production. Consumption creates the need for new production: ‘Consumption creates the motive for production; it also creates the object which is active in production as its determinant aim.’ (Leslie, 2018).<sup>6</sup>

Marx attacked fashion’s “murderous caprices,” angered by the human cost of its cycle of stylistic change, which can be linked directly through history as being exponentially sped up to ultimately produce what we now call fast fashion. Highlighting the tragedy of a 20 year old milliner, Walkley, who “worked uninterruptedly for 26 ½ hours” before her short life expired, Marx hoped that the invention of what he called the “decisively revolutionary” sewing machine would transform the production of garments. Marx goes on to explain why this hope was not fulfilled and the sewing machine intensified the exploitative pressure on garment workers rather than alleviating it (Sullivan, 2017).

Marx believed that capitalism was inherently exploitative, with workers being subjected to poor working conditions and low wages in order to maximize profits for business owners. The contemporary fast fashion industry is known for its low prices, which are achieved by cutting costs and reducing labor wages. Marx would argue that

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<sup>6</sup> This is in contrast to contemporary consumption which can be described as being driven by the desire to obtain, resulting in rapidly increasing consumption driving the production of fast fashion.

this exploitation of workers is a direct result of the capitalist system and its focus on profit above all else. Karl Marx would have likely criticized the fast fashion industry for its exploitation of workers and unsustainable practices, seeing it as a symptom of the larger issues inherent in the capitalist system.

## **B. The Birth of Fast Fashion**

The Industrial Revolution, which took place in the late 18th and early 19th centuries, brought about a significant change in the fashion industry. Prior to the industrial revolution, clothing was hand-made by skilled artisans and tailors, and was primarily bespoke, meaning it was made-to-measure for the individual customer. However, with the introduction of machines and factories, the production of clothing became much faster and more efficient. This led to the creation of ready-to-wear clothing, which was mass-produced in standard sizes and sold in stores. This shift from bespoke to ready-to-wear clothing transformed the fashion industry, making it more accessible to a wider range of people.

The introduction of ready-to-wear clothing not only changed the way people consumed fashion, but also the way fashion was produced. The fashion industry became more focused on producing a higher volume of clothing items at a faster pace, which led to the birth of fast fashion. Fast fashion refers to the practice of quickly producing and selling inexpensive, trendy clothing items to meet consumer demand. While fast fashion has made fashion more accessible to a wider audience, it has also been criticized for its negative impact on the environment and the exploitation of workers in developing countries.

In the time since the industrial revolution, fashion has continued to speed up. The industry started with four seasons, ballooned to six, and continued to expand into the system of twelve seasons, and future projections have the industry shifting to an on demand model.<sup>7</sup> This drastic speeding up of the industry has produced fast fashion. Fast fashion, characterized by rapidly changing trends and low-cost production, has

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<sup>7</sup> This transition in the fashion industry is described by Rahul Anand, creative director at Amara, during a personal interview conducted in August of 2022. An edited version of the interview including this discussion may be found in the appendix.

come under criticism for its environmental and social impact. Many consumers and advocacy groups are now pushing for more sustainable and ethical practices in the industry. This has led to a backlash against fast fashion, with consumers increasingly seeking out brands that prioritize sustainability and ethical production.

Veblen developed a social theory during the rise of the industrial revolution. *'The Theory of the Leisure Class'* (Veblen, 1899) strides forward with a series of detailed examinations of the human costs paid when social institutions (banks, churches, and academies) exploit the consumption of unessential goods for the sake of personal profit, while ignoring the disinterested modes of productivity and the pride of workmanship that furnish a sound society with its true necessities.' (Veblen, 1899).

Veblen speaks to both taste, dress, and shifting fashions in his critique of the leisure class. Despite technological innovations, and the broader social-political influences, it is unlikely that Veblen could have foreseen what we know today as fast fashion. His term 'conspicuous consumption' retains relevance nonetheless. He lived in a time where a good coat was more important than a visit to the doctor, where "inexpensive is unworthy" (Veblen, 1899). He digs deep into understanding issues like dress serving as a function of class and other ethnographic observations at a time when capitalist liberal democracy was competing with facism and communism. I argue that Veblen, in his work, contextualized the groundwork being laid for the capitalist based growth model of the fashion industry, and predicted many of the associated wicked problems.

The creation of the advertising industry in the early 20th century had a significant influence on the fashion industry. Advertising allowed for the widespread promotion of new trends, styles, and products to consumers, creating a desire for the latest and most fashionable items. The creation of advertising fueled what Veblen termed "conspicuous consumption". Advertisements for clothing, cosmetics, and accessories were designed to appeal to the desires and aspirations of consumers, often using images of attractive models and celebrities to sell products. This led to the development of a consumer culture that placed a high value on fashion and material goods. The influence of advertising on fashion continued to grow in the following decades, as television and the internet allowed for even more widespread promotion of fashion products. Today, the

fashion industry is closely tied to the advertising industry, with fashion brands spending millions of dollars on advertising campaigns to promote their products and create a desire for the latest fashion trends among consumers.

This use of advertising to create a desire that replaced need and drove what Veblen termed conspicuous consumption spread from the bourgeoisie down throughout the economic class system. As a result of the industrial revolution goods were being produced cheaper and faster, and there was a hunger for them as consumption spread and incomes in western countries started being able to support “disposable income”.

The fast fashion industry emerged in the 1990s, as a result of a shift towards globalization, consumerism, and technological advancements. During this time, companies began to outsource their manufacturing to developing countries, where labor costs were significantly lower than in developed countries. This allowed for the production of clothing at a much lower cost, which was then sold at a lower price to consumers. Fast fashion retailers such as Zara, H&M, and Forever 21 took advantage of this trend, by producing trendy and affordable clothing at a rapid pace. These retailers would release new collections every few weeks, encouraging consumers to constantly buy new clothing to keep up with the latest trends. The rise of e-commerce and social media has also played a significant role in the growth of the fast fashion industry, by allowing for the easy distribution of clothing and the promotion of new trends. The industry has also been criticized for poor working conditions and exploitation of workers in developing countries. Despite these criticisms, the fast fashion industry has continued to grow, driven by consumer demand for trendy and affordable clothing.

From the beginning of the industrial revolution to the globalization of the fashion industry production has sped up and grown exponentially. 80 billion items of clothing are sold each year, that is more than 400% increase from the number of goods produced only 20 years ago. Advertising and social media fuel this industry by creating a voracious appetite for newness, and fast fashion answers with a seemingly endless supply of cheap goods. This cycle must be rejected and new standards must be set to normalize levels of consumption if we are to meet sustainability goals.

### **C. The Wicked Problem of Shifting the Global Fashion Industry towards UN Sustainable Development Goals.**

In 1973, design theorists Horst Rittel and Melvin Webber introduced the term "wicked problem." A wicked problem is a complex, systemic problem that is difficult to solve because of its interconnectedness and uncertainty (Rittel and Webber, 1973). Wicked problems have multiple stakeholders with different values and interests, making it challenging to find a solution that satisfies everyone. The global fashion industry's sustainability challenges are a classic example of a wicked problem.<sup>8</sup>

Shifting the global fashion industry towards UN SDGs is a wicked problem because it is complex, interconnected, and has significant upstream and downstream consequences of change. The fashion industry's supply chain involves numerous stages, from sourcing materials to production to retail to disposal, and it has numerous actors, including producers, designers, retailers, and consumers; each with their own goals and perspectives. Each segment of the supply chain has unique environmental and social impacts, and any effort to shift towards SDGs needs to consider the supply chain and industry as an interconnected whole (Bick et al, 2018).

The global fashion industry's complexity arises from its interconnectedness, diversity, and dynamism. The industry is characterized by a constant flow of new trends, styles, and designs, which require rapid production and distribution. This makes the industry inherently unsustainable because of the high levels of resource consumption, waste generation, and emissions (Gazzola 2020). Moreover, the global nature of the industry means that the supply chain is often geographically dispersed, with sourcing, production, and retailing taking place in different parts of the world. This results in complex upstream and downstream consequences of change that need to be considered when shifting towards SDGs (Bhardwaj, 2010).

Shifting the global fashion industry towards SDGs will require changes throughout the supply chain, from raw material sourcing to product design, production, and consumption. These changes will have complex and interconnected effects, for example, changing sourcing practices to prioritize sustainable materials may impact the

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<sup>8</sup>Rittel and Webber describe 10 characteristics of a wicked problem. This list may be found in the appendix.

livelihoods of farmers and other actors in the supply chain. Similarly, changing production practices may impact the availability and affordability of clothing for consumers (Choi, 2015). The nature of wicked problems is such that they may have downstream negative effects as a result of an upstream solution. However, the good news is that Rittle and Webber declare, “There is no end to the number of solutions or approaches to a wicked problem”.

## 1.7 How and Where to Intervene

Identifying the best disruption point to nudge the global fashion market towards UN SDGs requires an understanding of the industry's complexity and interdependencies (Kong et al., 2016). One of the most effective disruption points is the design stage, where product concepts and specifications are developed. Designing sustainable products with minimal environmental and social impacts can help shift the industry towards SDGs. For example, using sustainable materials, reducing waste, and designing for circularity can help reduce the industry's environmental footprint (Becker-Leifhold, 2018). Furthermore, promoting fair labor practices, ethical sourcing, and transparency can improve the industry's social impact.

Top-down interventions involve government policies and regulations that aim to change the behavior of the fashion industry. Governments can use regulations, taxes, and subsidies to encourage sustainable practices, such as the use of sustainable materials and circular production processes. Top-down interventions can create a level playing field and promote sustainability by forcing the industry to internalize the environmental and social costs of its activities (Barnett et al, 2005).

Bottom-up interventions involve grassroots movements, consumer behavior, and industry initiatives that aim to change the fashion industry's behavior. Consumers can drive change by demanding sustainable products and boycotting products that do not meet sustainability criteria (Niinimäki, 2010). The fashion industry can also implement initiatives to promote sustainability, such as certification schemes, supplier partnerships, and circular business models. Bottom-up interventions can create a sense of shared responsibility and promote innovation by allowing stakeholders to experiment with new



sustainable practices. A bottom-up approach to shifting purchasing behaviors can take place from outside the industry and still have significant impact (Meadows, 2020).

## A. Designing Disruptions to the Global Fashion Industry at the Consumer Level to Nudge Behaviors Reflective of the UN SDGs

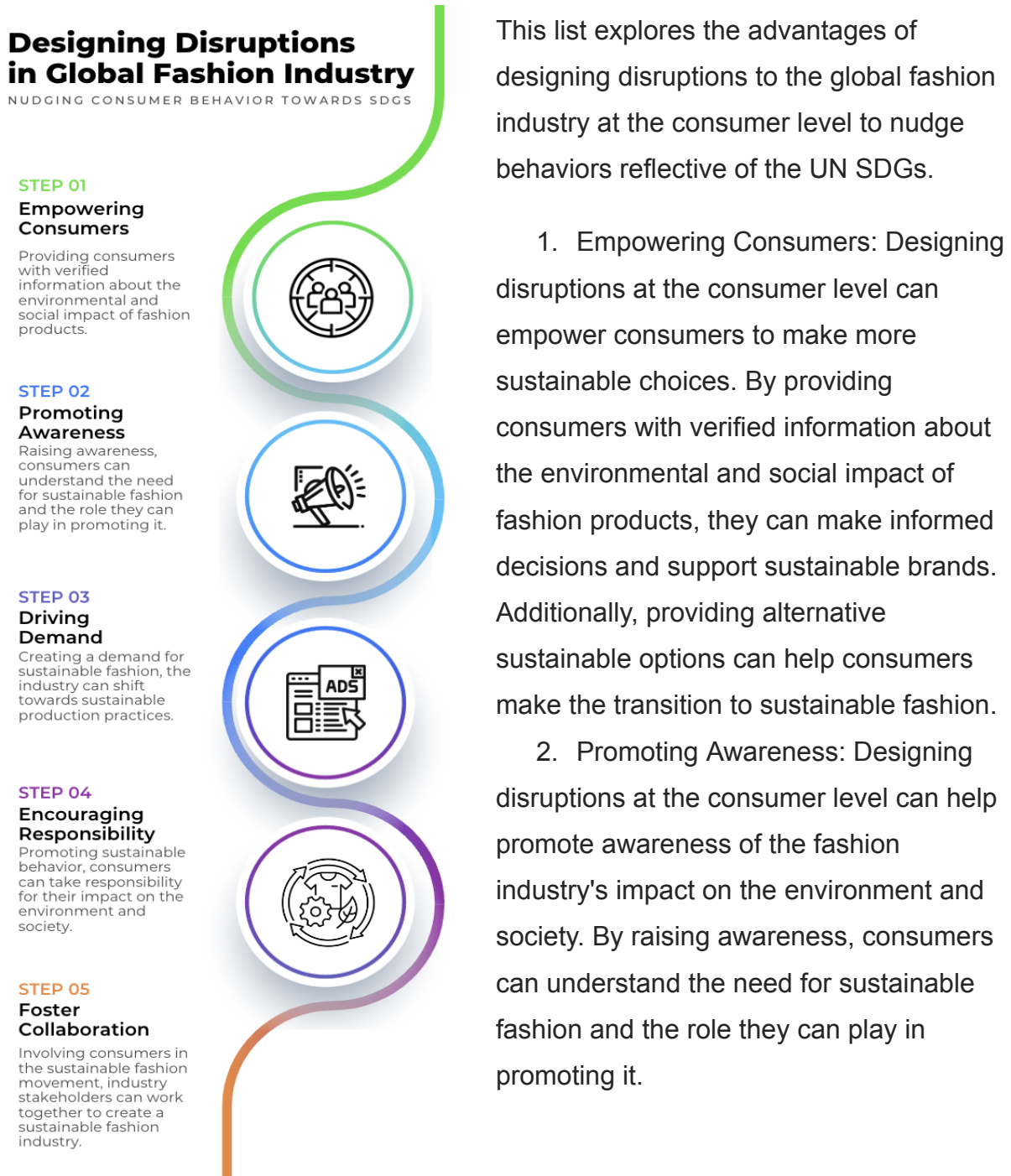


Figure 8. *Designing Disruptions in the Global Fashion Industry: Nudging Consumer Behavior Towards SDGs.* Niki Fairchild Azevedo. March 2023.

3. Driving Demand: Designing disruptions at the consumer level can drive demand for sustainable fashion products by promoting innovation and investment in sustainable practices. By creating a demand for sustainable fashion, the industry can shift towards sustainable production practices and meet the UN SDGs.
4. Encouraging Responsibility: Designing disruptions at the consumer level can encourage responsibility for sustainable consumption. By promoting sustainable behavior, consumers can take responsibility for their impact on the environment and society and promote sustainable practices.
5. Fostering Collaboration: Designing disruptions at the consumer level can foster collaboration between stakeholders in the fashion industry. By involving consumers in the sustainable fashion movement, industry stakeholders can work together to create a sustainable fashion industry that meets the UN SDGs.

All of these points are viable places for interjecting disruption or instituting change to support the goals of addressing the SDGs. I will be investigating an intervention that is centered around shifting purchasing behavior towards actions reflective of sustainability.

## 2. Design Intervention and Associated Research

Much attention has been paid to the areas of the fashion industry that encompass design and development, logistics and production, as well as marketing and sales; nonetheless, there continues to be little focus on consumer behavior with regards to shifting behaviors to align with self-reported values and ethics centered on sustainability concerns (Wagner et al, 2019). Niinimaki points out in her research, "Despite the amount of research attention given to sustainable fashion or eco-fashion (green fashion) in recent years, the buyer side of the exchange process remains under-researched." (Niinimaki, 2010).

Most studies in this area have been conducted through surveys and, as such, have been limited to relying on information self-reported by participants, which may not reflect actual behaviors and decisions with regards to fashion consumption. Two exceptions to this standard are studies from Buell and Kalkan, and Blasi et al. Buell and Kalkan conducted a study in 2019, "*How Transparency into Internal and External Responsibility Initiatives Influences Consumer Choice: Evidence from the Field and Lab*" which used video footage from retail locations analyzing data from 80,000 customer transactions. Blasi et al. conducted an innovative study using social media, "*Eco-Friendliness and Fashion Perceptual Attributes of Fashion Brands: An Analysis of Consumers' Perceptions Based on Twitter Data Mining*", which employed Social Network Analysis (SNA) applied to social media accounts to study brand perception.<sup>9</sup> There continues to be an air of mystery around what happens at the exact time of purchase and what triggers behavior. My research attempts to demystify this decision process and quantitatively chart an attempt to employ DfSB methodology to nudge behavior through the use of VR to build empathy and influence actionable behavior.

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<sup>9</sup> is the process of investigating social structures through the use of networks and graph theory. It characterizes networked structures in terms of *nodes* (individual actors, people, or things within the network) and the *ties, edges, or links* (relationships or interactions) that connect them.

## 2.1 Technology Overview

Virtual reality (VR) is an emerging technology that has the potential to revolutionize the way we approach behavior change. VR can provide an immersive and interactive experience that can be used to promote sustainable behavior. In 2019 Christopher Ball completed a PhD with a dissertation called, *Nurturing Nature in Virtual Reality: A Study of Public Service Experiences and Their Effects on Environmental Attitudes and Behavioral Intentions*. The study “was to explore the potential importance and impacts of perceived narrative interactivity on narrative transportation and persuasion.” The study explored different methods of UX locomotion within virtual space as well as different narrative structure within VR experiences and their effects on behavior. The behavioral findings relevant to this study indicated that, the more participants were afforded opportunities to interact with the narrative and alter the environment within the VR experience the increased immersion levels and empathy with users resulting in greater degrees of behavior and attitude shifts.

As demonstrated in Ball’s work, VR has the potential to change behavior and is a viable tool for promoting sustainable behavior. The list below outlines some of the benefits and limitations of VR as it may be applied to the altering fashion related consumer behavior.

1. **Immersive Experience:** VR can provide an immersive experience that allows consumers to experience learning about the fashion industry in a way that traditional media cannot. Individuals can see, feel, and interact with learning material in a way that is more engaging and memorable.
2. **Accessibility:** VR is becoming more accessible with the development of affordable VR headsets and mobile VR apps. Open-source applications and the ability to share via the internet can also contribute to greater accessibility.
3. **Cost-effective:** VR can be a cost-effective tool for promoting sustainable behavior change. It can be used to educate individuals without the cost of physical resources or events.

These benefits are not free of challenges, such as:

1. Limited Reach: Although VR is becoming more accessible, it is still not accessible to everyone. Consumers without access to VR technology may not be able to benefit from its potential to promote sustainable behavior change.
2. Implementation: Implementing VR technology can be challenging and may require investment in equipment and resources, as well as developer expertise.
3. Adoption: Consumers may be hesitant to adopt new technology, including VR, which may limit its effectiveness.

VR has the potential to be a powerful tool for building empathy and promoting sustainable behavior. The immersive experience, experiential learning, emotional connection, and narrative interactive storytelling capabilities of VR make it an attractive option for building empathy. Empathy is a critical component of promoting sustainable behavior, as it promotes connections and activates behavior change. Empathy allows individuals to understand and relate to the experiences of others, including the environmental and social impacts of the fashion industry (Cotton, 2021). However, challenges such as authenticity, bias, and adoption as well as novelty must be addressed to fully realize the potential of VR in building empathy and promoting sustainable behavior.

## 2.2 Theoretical and Contextual Literature Review

Consumer behavior is motivated by a complex array of factors, including personal needs and desires, social and cultural norms, and marketing and advertising influences. Consumers may be driven by practical considerations, such as the need for basic necessities like food, clothing, and shelter, or by more psychological factors, such as the desire for status, belonging, or self-expression. However, despite growing awareness and concern about issues such as labor exploitation, environmental degradation, and animal welfare, consumers may still make purchases that go against their personal ethical beliefs. This can be due to a variety of factors, such as lack of information, convenience, price considerations, or social pressure. Additionally, consumers may struggle to reconcile their personal ethical beliefs with the complexities of global supply chains and the difficult trade-offs that can arise when attempting to make ethical purchasing decisions. In some cases, consumers may also prioritize their

immediate wants and needs over longer-term ethical considerations, such as the impact of their purchases on the environment or on human rights.

Devinney, Auger, and Echaradt focus on what they refer to as CnSR (consumer social responsibility and provide shocking examples in their work and the associated film, *The Myth of the Ethical Consumer*. Their global dataset and fascinating qualitative work intend to show researchers the complex personal considerations at play in 'individual social consumption behavior'. Contrasting directly with Harrison, Newholm, and Shaws' *The Myth of the Ethical Consumer* (2005), Devinney et al. state, "Despite the hype, the reality is that most 'ethical' products have occupied niche market positions, except in the few circumstances in which major multinational corporations have taken on the cause" (Devinney et al., 2005).

Central to understanding their argument is a tri-fold definition of myth. Greatly paraphrased, this myth can be defined as follows: "It is a characterization that is false, despite the fact that it serves a communicative function for those that present it as an idealized behavior." Pointing squarely at the ethnographic examples they provide where interviewees say, "Morals stop at the pocketbook. People may say they care, but they will always buy a cheaper brand." (Devinney et al., 11). They further their claim with Slavoj iek's assertion that "emotive appeals are used by corporations so that they can continue their complicity in economic exploitation." (Devinney et al., 21). While later chapters go into detail about their data and complex methodologies, the message of this text is clear.

"Unlike ethical consumerism, our notion of the CnSR is one that implies evolution... Just because social consumerism is good," it does not mean that it is inevitable. Evolution is known for both stunning successes and a significant number of dead ends and extinctions." Devinney et al. work hard to prove how wicked this problem is not purely because of industry and production but because consumers themselves face a complex set of choices, often putting some factors over values they would more publicly avow.

Niinimaki is in some ways in agreement with the others discussed above but often with a lighter touch. She writes, "Consumer choices are somewhat irrational and not always well connected to values. A consumer fulfills deep inner motivations and

unconscious needs by consuming. Consumption includes two kinds of function when answering a person's needs, targets, and values: the consumer can try to achieve individual or collective benefit by consuming. Ethical products manifest individual motives or collective benefits for the person buying them. Individual benefit involves issues such as price, quality, saving of time, and purchase convenience." (Niinimaki, 2010).

She continues in *Knowing Better But Behaving Emotionally*. In our Western society, consumers have a continual internal discussion between the rational self and emotional choices in fashion consumption. Seeking pleasure through fashion has obvious hedonistic aspects. Hedonic consumption refers to the need to get emotional satisfaction from consumption (Kirgiz, 2014). Hedonistic satisfaction is linked to emotional, sensorial, and fantasy aspects of product usage, and therefore the aim is to gain pleasure and delight through obtaining the product. In 2009 Niinimaki and her team conducted a survey of 246 people in Finland. The survey discovered a wide behavior gap between people who said they always have an ethical interest and people who always make ethical purchases.

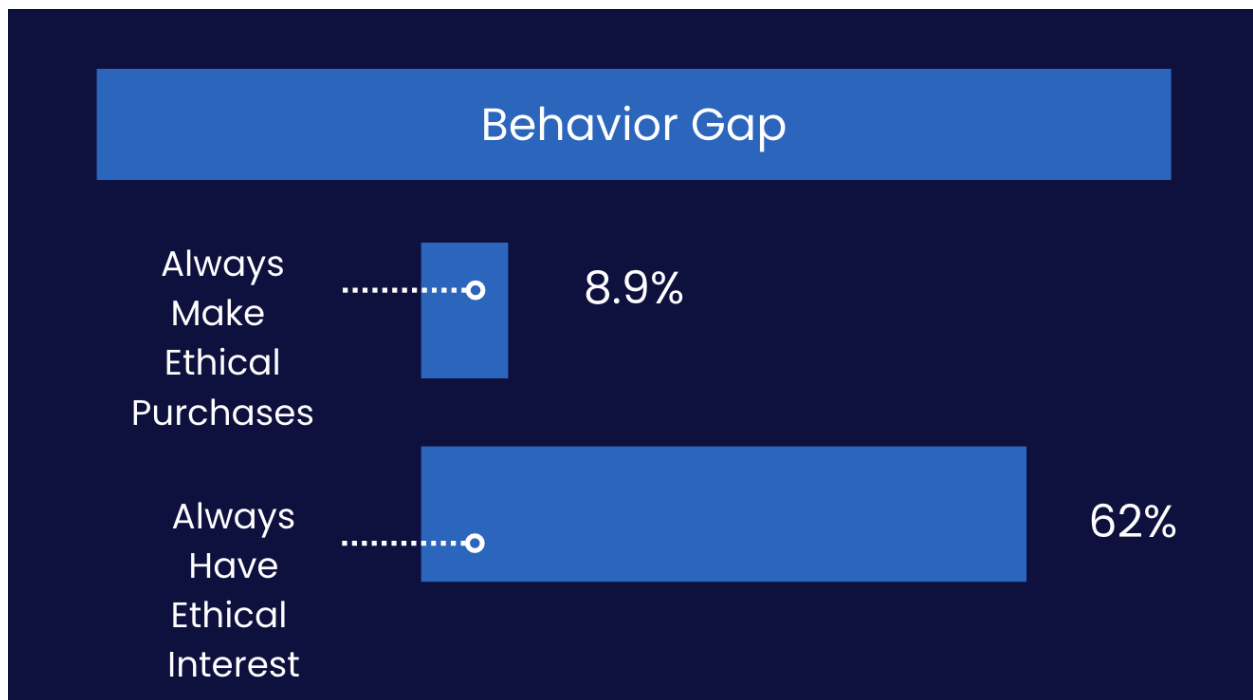


Figure 9. Behavior gap of ethical purchase and values. Niki Fairchild Azevedo, based on the research done in 2009 by Niinimaki. April 2023.



Niinimaki celebrates the 'ethical consumer subset' (2010) and provides a clear alternative to revolutionary, immediate change and instead a pathway to incremental, meaningful change. When I discuss 'increasing the niche market' for sustainable products, this evidence supports my assumption that this market is emerging, although whether it is a niche market or not is unclear.

Zara Berberyan, Sarah Margaretha Jastram, and Barry A. Friedman pull together a clear and concise piece of scholarship in an (Leifhold, Hauer ed., 2018, p. 55) article titled Drivers and Obstacles of Ethical Fashion Consumption. Together with the broader body of writing in this collection, it serves to illuminate the workings of the wicked problem. While it doesn't dive as deep as the other work, it does provide a clear description of factors that inform production and purchasing behaviors.



Figure 10. Leifhold, Hauer et al, Drivers and Obstacles of Ethical Fashion Consumption, 2018.

As illustrated in the above diagram, the authors provide cause to connect contemporary research that considers convenience and price as core factors, but also values and authenticity perceptions, which connect to my broader theoretical foundational background. However, this article makes two other important connections. One is that considering all these factors allows for further consideration of what is called the "attitude-behavior gap" which is explored further in the next section. The other is that, having identified this gap, researchers are currently investigating ways to intervene. They agree with Devinney, but they seek to integrate the work of researchers

like Shaw, D., and Shiu, E., whose work focuses on the importance of addressing skepticism in ethical consumption decision-making.

The research of Bender and Broderick investigates phenomenology analysis of VR using what they term the 'researcher-critic'. Bender and Broderick define the term of 'researcher-critic as, "a scholarly analysis of a VR experience beginning with their own personal and subjective encounter with it, yet reflecting on that process with strong research integrity." (Bender and Broderick, 2021). In addition to the research-critic approach they use a methodological framework of film phenomenology study developed by Vivian Sobchack, author of *The Address of the Eye: A Phenomenology of Film Experience*. In this work Sobchack argues that, 'Cinema is a sensuous object, but in our presence it becomes also a sensing, sensual, sense-making subject.' Taking this approach to the formalized study of the experiential viewer of film and applying it to VR is a novel approach. Bender and Broderick say of film phenomenology that it, "aims to foreground the sensuous and experiential encounter a viewer has with the film. The film is actively felt by the viewer...in a visceral and corporeal rather than cerebral sense."

Bender and Broderick go on to argue that if a researcher cannot experience these sensations for themselves in VR due to motion sickness or another limitation, then "they would be a poor VR phenomenologist unless they limited their analysis to the sensation of nausea and under what conditions it is caused". In essence the authors argue that VR is a further extension of the phenomenological experience of film, and that phenomenological sensations are heightened as a result of VR. They further argue that if a researcher is unable to experience VR in its intended state then researchers have limitations to the understanding of the experience of human-computer interaction (HCI).

From this framework the researchers spent many hours playing a VR game *Onward* in order to provide, "an auto-ethnographic insight into others' real-time phenomenological experience". This approach leads to the following observation, "it is a combination of the gameplay, the audio-visual experience and the bodily experience that is capable of such a strong phenomenological impact."

The takeaway from this research is that it is imperative to embed yourself into the VR experience in order to fully synthesize the phenomenological experience of a

participant. VR may be positioned as a phenomenological extension of film, and as a developer these aspects need to be incorporated into design.

Three chapters of Matthew Cotton's book *Virtual Reality, Empathy and Ethics* are extremely relevant to informing the hypothesis of this research as well as the design, development, and implementation of the resulting VR experience. Chapter 2, "The Ethical Challenges of Virtual Reality", Chapter 4 "Empathy and Ethics" as well as Chapter 6 "Developing a Virtual Reality Tool" are related to the central research question of using Virtual Reality to build empathy and illicit behavior change. Questions of ethics and innovation arise as, "technological change alters the broader moral landscape...by changing the range of decisions and options available to moral decision makers and by altering human nature and social interactions" (Cotton, 2021). Cotton argues empathy from a perspective built on the philosopher John Dewy's conception of empathy combined with contemporary social emotional, cognitive and psychological research conducted in VR. Cotton argues that, "One facet of VR that is specifically of philosophical interest is the technology's capacity to improve the emotional attachment that users feel towards the decisions that they make. The key to this attachment is the capacity of the technology to inculcate feelings of empathy towards others through simulated interaction". Empathy consists of two primary components; a cognitive and affective aspect. The cognitive aspect is how individuals perceive, relate, and understand others, a largely passive observational state. The affective aspect is how individuals relate their emotional reactions to others; a more active rational, reactionary state.

Cotton ties this reactionary state to development within VR, creating what he calls a "dramatic rehearsal". He uses this dramatic rehearsal as a structure to create VR experiences. Within this structure you can see the viewer being taken through a model of divergence and convergence as they shift from active observational states into active engagement states. Cotton points out that "the development of ethical tools necessarily involves an imaginative process of engagement between thought and action". In his conclusion Cotton points out that, "VR is a judgment aid because it compensates for the limitations of our thinking; it disrupts our habits of thought, implicit biases, and improves our imaginative capacity to engage with others." VR is an effective

tool at capturing users' imagination and taking us outside of our phenomenological experience, and facilitates a shift between observation and passive reception of knowledge and active engagement, allowing for higher levels of synthesis and related behavioral change.

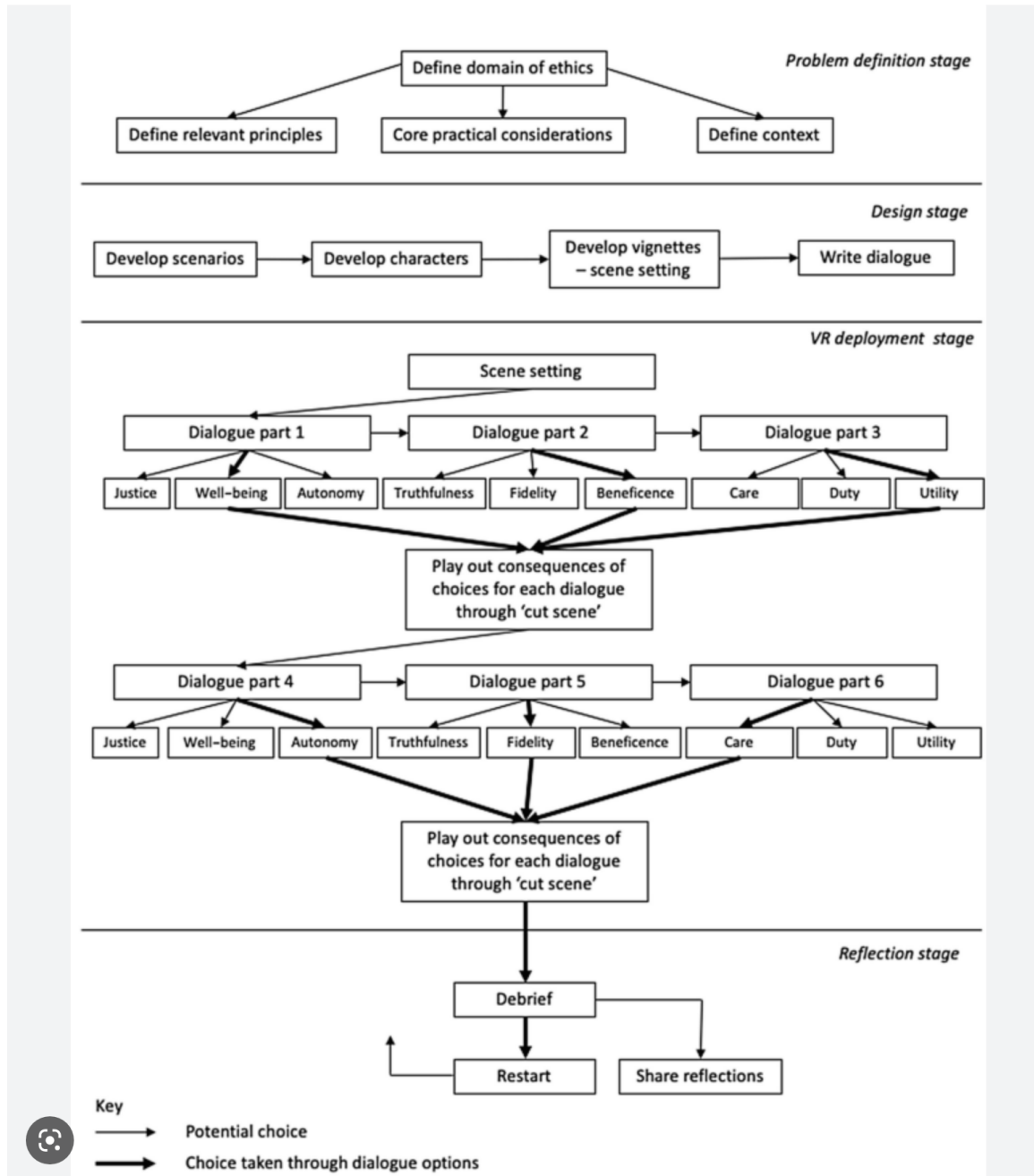


Figure 11. Developing a Virtual Reality Ethical Tool. Matthew Cotton. September 2021.

### 3. Methodology

Combining methodologies from the fields of design as well as marketing, behavioral economics, and consumer behavior, my research sets a new precedent for a unique interdisciplinary approach to wicked problem solving. Referencing the topline forces that drive the current system, such as economics and consumption, with the formalized associated academic fields of behavioral economics and consumer behavior in a prototype designed employing the methodologies of design for sustainable behavior and choice architecture creates a unique integrative design approach.

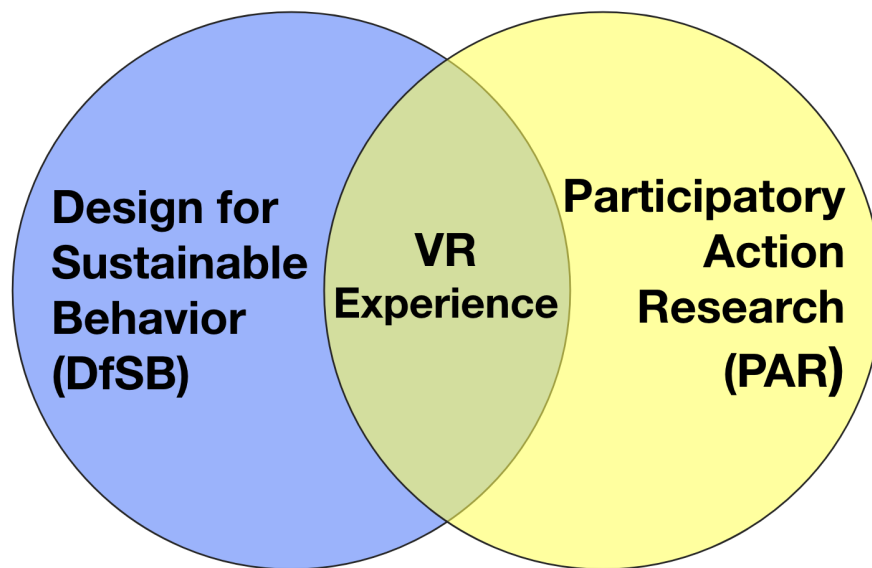


Figure 12. Combined Methodologies and the Positioning of VR Experience Design. Niki Fairchild Azevedo. April 2023.

If the wicked problem that is the fashion industry can be addressed through an intervention resulting in a meaningful change in consumer behaviors regarding what and how much people buy, then the theme of "making justice" can be seen as directly related to "making responsible consumer choices." The adage voting with your wallet is a power that each individual practices with every purchase. If this perspective/power dynamic can be highlighted and used as an empowering force to encourage individuals to make choosing sustainable fashion a cornerstone of the purchase decision-making process, then justice will be done. Not only will justice be done in the choice of the individual consumer, but if reflected on, repeated, and adopted as a society, there will

be a quick and significant shift in the fashion industry to adapt to the will and values of its consumers. (Hartl, Hoffmann, and Kirchler, 2016) The great hope is that if this change can be made, then justice will be done along all routes of the fashion industry, from the design and production methods to the manufacture of raw goods and materials to the life cycles of the goods themselves.

Fashion contributes to extracting ecological value and replacing it with waste; it disconnects people from their labor and replaces it with repetitive tasks; it consolidates wealth and replaces it with inequality. Industry must discontinue the extractive economy based on recent impacts, not to mention a history of disasters and abuses.

## 2.3 Design for sustainable behavior (DfSB)

Design for Sustainable Behavior Change (DfSBC) is a methodology that integrates theories of behavior change, human-centered design, and sustainability to promote behavior change. The DfSB methodology occurs in the following steps and is a fundamental guiding principle throughout this study and work.

1. **Understand the User:** The first step in DfSB is to understand the user and their behavior. This includes understanding their motivations, barriers, and current habits related to clothing consumption.
2. **Define the Problem:** The second step in DfSB is to define the problem. This includes identifying the specific behavior that needs to change and the desired outcome.
3. **Ideate Solutions:** The third step in DfSB is to ideate solutions. This includes brainstorming ideas for nudges that can be used to encourage the desired behavior change.
4. **Prototype:** The fourth step in DfSB is to prototype the solutions. This includes creating a prototype of the VR experience to test with users.
5. **Test and Iterate:** The final step in DfSB is to test and iterate the solution. This includes testing the prototype with users and making changes based on feedback.

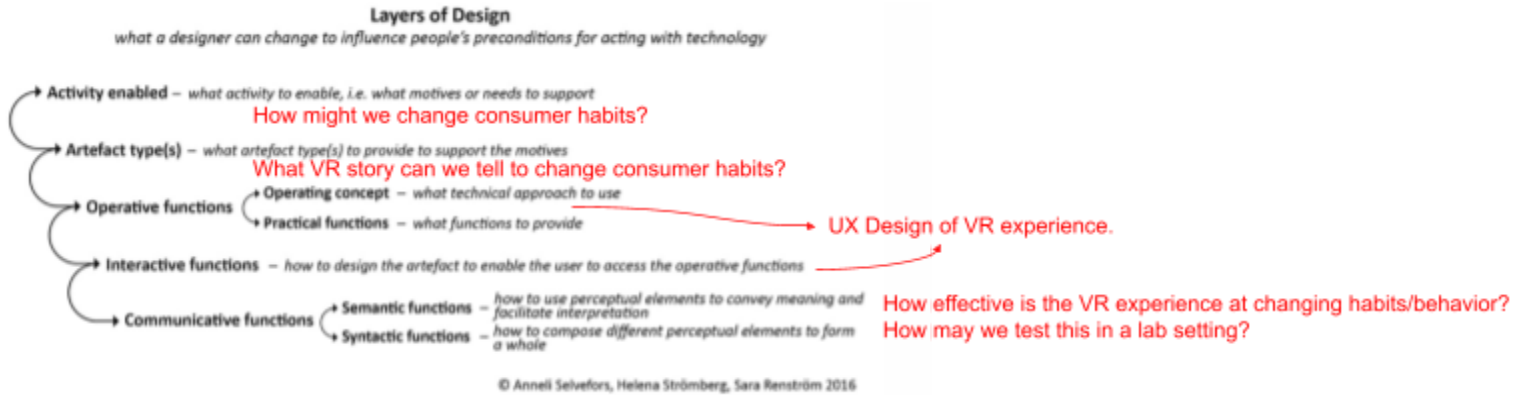


Figure 13. DfSB layers of Design. Combination of Selvefors et al, and Niki Fairchild Azevedo (in red)

### DfSB and VR Experience

DfSB provides a valuable framework for developing a VR experience to nudge consumer behavior as related to clothing consumption. The methodology emphasizes the importance of understanding the user, defining the problem, ideating solutions, prototyping, and testing and iterating the solution. The above graph from Selvefors et al. (2016) depicts DfSB methodology broken down into designerly steps and processes, with the red text incorporating specific inquiries related to this research project at each step. Below is the DfSB methodology broken down into five steps, this time each incorporating VR into the design methodology.

1. **Understand the User:** To use DfSB to develop a VR experience, it is essential to understand the user and their behavior related to clothing consumption. This includes understanding their motivations, barriers, and current habits.
2. **Define the Problem:** The problem that needs to be addressed is the unsustainable behavior of clothing consumption. The desired outcome is to promote sustainable habits by building a willingness to pay more and purchase less.
3. **Ideate Solutions:** Nudges that can be used to encourage sustainable clothing consumption practices in a VR experience can include showing the environmental and social impact of clothing production, encouraging the use of

second-hand clothing, and highlighting the benefits of sustainable clothing practices.

4. Prototype: A prototype VR experiences can be created to test with users. The prototype can include various nudges designed to promote sustainable clothing consumption practices, including the gamification of sustainability information alongside related storytelling documentation.
5. Test and iterate: The VR experience can be tested with users, and feedback can be used to make changes and improve the experience. This UX-developed prototype can be taken to a lab to study efficacy in changing values and nudging behaviors.

## 2.4 Participatory Action Research

Participatory Action Research (PAR) is a methodology in which researchers and the community collaborate to address issues related to social justice and bring about positive social change (Vijay 2013). PAR is an iterative process that involves a cycle of planning, action, reflection, and evaluation and is based on the principles of participation and inclusion.

In the context of developing a VR experience to nudge consumer behavior as related to clothing consumption, PAR can be used to involve users and stakeholders in the design process, understand their perspectives and experiences, and co-create a solution that is relevant and effective.

The PAR process can be broken down into several stages, including:

1. Planning: This involves identifying the research question, the objectives, and the scope of the study. It is important to involve stakeholders and users at this stage to ensure that the research is relevant and aligned with their needs and priorities.
2. Action: This stage involves data collection and analysis. PAR relies on multiple methods of data collection, including surveys, interviews, observations, and focus groups. The data collected is used to identify the key issues and challenges.
3. Reflection: This stage involves critically examining the data collected and reflecting on the insights gained. It is important to involve stakeholders and users at this stage to ensure that their perspectives are taken into account.



4. Evaluation: Evaluation is an ongoing process that involves collecting feedback from users and stakeholders to identify areas for improvement.

By involving users and stakeholders in the design process and, in this project, interviewing the stakeholders throughout the supply chain, the VR experience can be tailored to nudge the end user in the supply chain to alter their behavior. Additionally, involving users and stakeholders in the design process can increase their ownership and commitment to the solution, increasing the likelihood of sustained behavior change.<sup>10</sup>

## Design Process

### Hypothesis

Through survey data this experiment seeks to prove that Virtual Reality creates an immersive experience; and subsequently that this immersion in turn creates a value and/or behavioral modification shift. Through conducting this experiment we believe that Virtual Reality will prove a more effective information delivery system than a traditional computer screen, resulting in significant nudge in values and associated behaviors.

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<sup>10</sup> This is a specific area of inquiry in our lab research. In the following section the results of the VR experience on commitment to a solution, and sustained behavior are discussed.

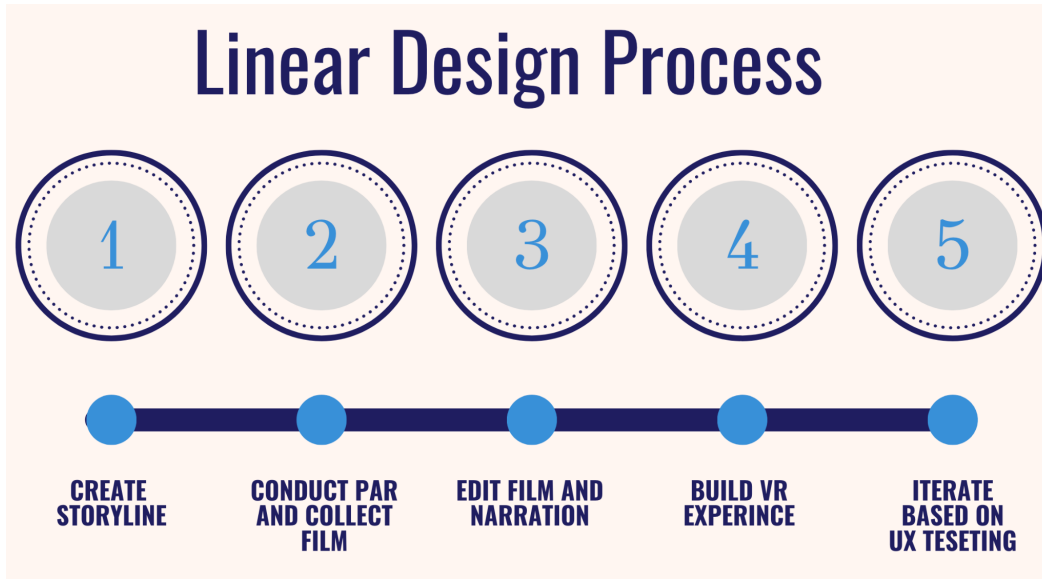


Figure 14. Linear Design Process. Niki Fairchild Azevedo. April 2023

## Project Description:

Through a unique combination of Participatory Action Research (PAR) and Design for Sustainable Behavior (DfSB) methodologies, an informational experience was created. The immersive experience will be created using expert interviews (EI) and then crafted following DfSB principles. The resulting artifact is a gamified virtual reality experience that participants will both actively engage with and passively view.

Participants were randomly split into two groups. One group viewed the experience on a computer, and the other group will experience the same experience on a VR device. After the viewing experience, participants will be given an exit survey. The survey will gauge possible shifts in attitudes, beliefs, and values related to sustainability and circular fashion. The participants will then be asked if they wish to donate any portion of their honoraria to the United Nations Fashion Alliance.

The goal of the study is to compare attitude and behavior shifts as related to informational delivery systems. Survey results from the group that viewed the material on a computer and the group that viewed the same material in VR will be compared. The hypothesis is that the shift in attitudes and behaviors will be greater in the group that experienced the information delivery in VR.

The study will be completed in one day. The IRB application is the pre- and post-experience surveys as well as the VR and computer engagement with the informational experience.

### **Virtual Reality Experience:**

The Virtual Reality (VR) Experience was built on the Uptale platform. It can be viewed using a VR device such as an Oculus or experienced on a desktop computer.

The VR experience follows the creation of a pair of jeans from a cotton farm, textile mill, garment factory, design firm and across the sea as it journeys towards its end user. The research for this experience was collected through a unique combination of Participatory Action Research (PAR) and Design for Sustainable Behavior (DfSB) methodologies. A team of international research partners traveled across the USA and to SouthEast Asia conducting Expert Interviews (EI). The interviews were then edited and crafted into an educational immersive experience following DfSB principals.



Figure 15. Students Experiencing VR in a Classroom. University of Michigan. Niki Fairchild Azevedo. April 2023.

## 1. Initial Concept Design

The initial design for *Woven: A VR Journey of Jeans* grew from exposure to an education tool I discovered while teaching an art history class for children. The Chauvet Cave has developed a VR tour that is available online. I was struck by the value of this technological innovation. When I first learned the history of the cave paintings, I read the history in a book and then viewed static images.

Now I was able to share with students an interactive experience that they could control, which was naturally more engaging but also provided a depth of knowledge that was not available in the more traditional formats. When I looked at the static image, it was a frozen photo of hand-painted images on a wall, and I was left to imagine the context. In contrast, these students began taking in contextual information from the beginning of the interactive experience. Immediately they saw the cave entrance and could tell the landscape, creating a story of the people who created the art. As they entered the cave, they could continue down long passages and get a sense of not only the space itself but draw connections to what it would be like to live and work in an atmosphere.

To compare, I had experienced the prehistoric images and then unconsciously built a context around my own imagination, and the mental picture I had created was a large open space, situated in one room with a large opening that provided ample light. Being able to virtually explore the cave, these students understood that there was a small entrance and long tunnels with low ceilings, and that the images were positioned in a small space with very little light. This was such a powerful experience that it led me to question what other assumptions I had made in my education, how easily these assumptions are passed on, and what a powerful tool virtual reality could be in an educational setting.

I continued to ponder this idea of how to harness new virtual reality tools as I continued to work as a designer and educator. As the technology developed, there were small cameras that could capture 360° footage. When I began investigating development in this area around the year 2016, the standard was still specialized,

expensive equipment that needed large amounts of training and was both time and cost prohibitive. The Leica BLK360 was one of the most common, and with all of the attachments and required gear, the cost was around \$2,500. The next challenge to address was the workflow.

Matterport was one of the early companies that could take 360° file formats and create tours of virtual space. This was utilized by markets such as real estate to provide virtual tours. However, the experience was delivered on a flat screen, and interaction with the experience was limited to pointing and clicking to choose where you would like to move. Oculus VR headsets were commercially available for purchase, but they were around \$800, an amount that negated their purchase by the casual user. The barriers to entry were cost, development platforms, and limited forms of user interaction.

As VR innovation continued to be fueled by large tech companies such as Facebook (now Metaverse), development was subsidized by corporate interests. Facebook bought Oculus, and in 2019, the price for an Oculus VR headset dropped to around \$250. GoPro, the makers of the small portable video camera used primarily to film rugged outdoor adventures, entered the 360° film camera market in 2019 with the GoPro Max camera, retailing for approximately \$500 and a Ricoh Theta for \$225. Online video hosting sites such as Youtube and Vimeo have developed the ability to support stereoscopic 360° video. Below is an example of a stereoscopic photo taken with a ricoh, which has 2 fish eyed lenses and captures images from both sides allowing the image to be digitally stitched together.

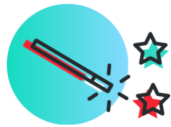


Figure 16. 360° Stereoscopic image example and Ricoh Theta Camera. Niki Fairchild Azevedo. April 2023.

The major barrier that still existed to entering VR experience design was the build platform. You could build from scratch using Unity, Blender, or Unreal Engine software, but that required time-intensive investments to both learn and then create even simple elements. I kept looking for a platform that could support video, was editable, and had the capability of incorporating interactive elements. In the winter semester of 2022, I took a course called AR/VR for Sustainability with Mark Lindquest, Associate Professor of Landscape Architecture, School for Environment and Sustainability at the University of Michigan.



After discussing previous investigations and outlining the end goals of using video to create educational interactive experiences, Lindquest suggested I take a look at the Uptale VR building platform.



01

## Authoring tools

Transform your 360°/180° media into learning experiences

- Intuitive and automated VR authoring tool (platform)
- 360°/180°/stereoscopic media manager
- Audio creation in +23 languages
- Collaborative work with file versioning
- Gamified and educational interactions (magic tags)
- +50 types of interaction
- Custom sets of icons and launch pages

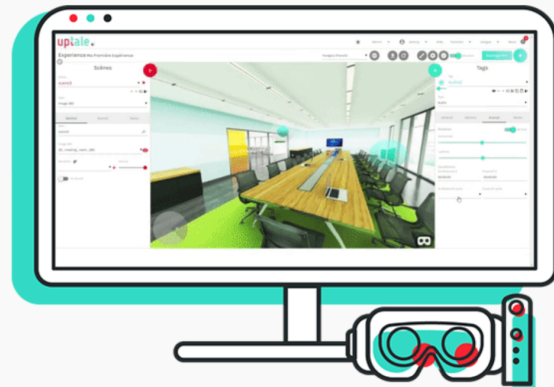


Figure 17. Uptale Website. Screen Shot. uptale.io. April 2023

I now had access to a build platform, inexpensive, simple-to-use recording equipment that I could operate alone, and support from experts at the University of Michigan. After assembling all of the pieces required to build a VR experience and making several prototypes, all that remained was creating a captivating narrative that could shape an interactive experience.

The fashion industry is extremely large and complex in its nature. My primary goal is to change people's relationships with their clothing and hopefully encourage them to buy less and build a willingness to spend more. If people could see the people that made their clothes and could experience firsthand the extractive cost to the environment that was required to produce clothing, they may reject the notion of fast fashion and disposable clothing. This understanding was developed through working for years as a designer, traveling to China and developing nations, and seeing the toll that was taken on workers and the havoc that was wreaked on the environment. I felt that if individuals could see what I had seen as a designer working in these spaces, they too would develop a concern and alter their behavior.

John Marshall, Associate Professor of Art and Design, Penny W. Stamps School of Art and Design, who was acting as my primary advisor at the time, suggested that I create a narrative around one aspect of the clothing industry as a way to simplify the problems and craft a story that was relatable. This brought to mind a project that was completed by Planet Money.

Planet Money is primarily a podcast produced by NPR, which in 2013 came up with the simple story idea, "We wanted to see the hidden world behind clothes sold in this country, so we decided to make a T-shirt." Their team followed the creation of a t-shirt and documented the process with film, photos, and interviews. Starting at a cotton farm, they traveled to factories and finished the project by delivering the t-shirts that they had sold to fund the project. In essence, they created a farm to closet item of clothing and documented its creation at each step of the process.

This made for great media content. I had remembered hearing it years ago, but my concern was that, much like the research discussed earlier, there was a disconnect between knowing, caring, and doing. We clearly already knew that there were problems in the fashion industry. Numerous documentaries and books had reached widespread audiences and entered popular culture. Researchers had proven that people professed to hold values that supported environmentalism and sustainability. But, still, the fashion industry was experiencing exponential growth at an alarming rate. In the last 20 years, clothing consumption has increased by 400%.<sup>11</sup> (Algamal, 2019) We know the story, and we say we care, but we still are not making a change in the right direction. What is missing?

### a. Selection and Recruitment of Partners

The concept of the VR experience was simple in design and followed the creation of a pair of jeans. Start at a cotton farm, show denim being made at a textile mill, continue onto a garment factory, show how a brand and design firm fit into the process, and then close by showing the jeans as they travel on a container ship. In concept, this was a simple design, but in execution, it was a painstaking process to gain access to all of the people and places necessary to tell this story. Historically, the fashion industry has been an extremely closed and private industry. This lack of transparency, as discussed in the opening sections, has exasperated many of the problems related to sustainability. Not only is there a natural inclination to remain

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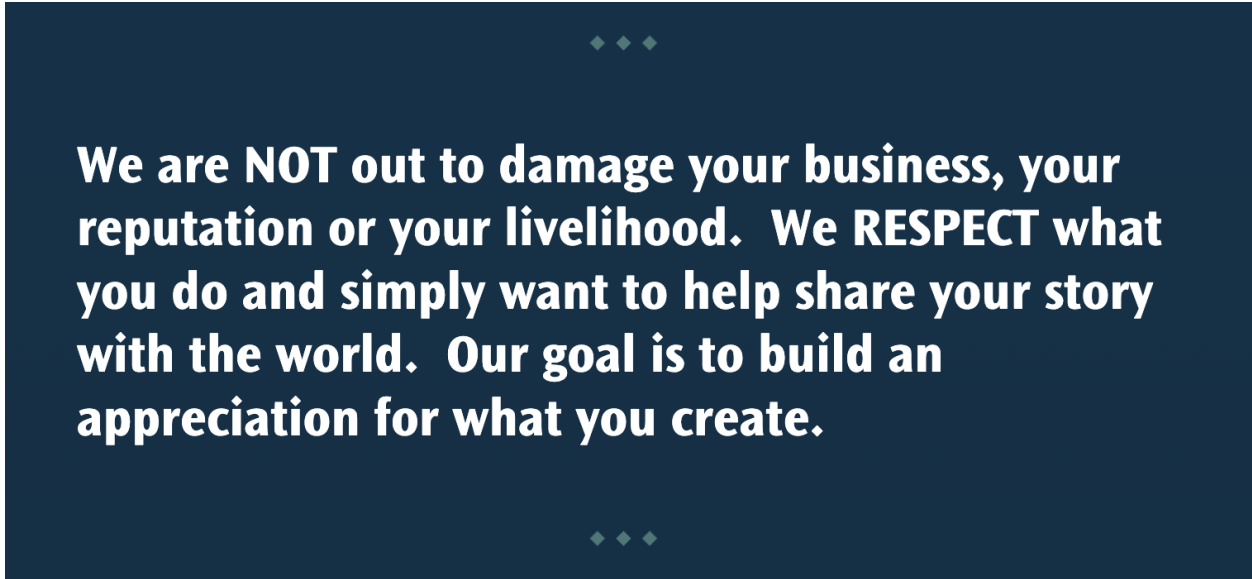
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<https://www.oxfam.org.uk/oxfam-in-action/oxfam-blog/new-shocking-facts-about-the-impact-of-fast-fashion-on-our-climate/>



closed, but oftentimes when granted access, documentarians frame their stories as exposes, damaging their businesses and livelihoods. Overcoming these barriers and gaining access was a challenging process that required a lot of outreach, networking, and a healthy dose of luck. The key was developing relationships based on mutual respect and trust.

Participatory Action Research (PAR) is the cornerstone of my research process. PAR's core principles include respect for diversity, community strengths, reflection of cultural identities, power sharing and co-learning, as well as a foundation for co-creation. ([Minkler, 2000](#)) These principles meant that the people in each place that we were going to visit were going to be our research partners, and together we were going to tell the story of how a pair of jeans were created. A great deal of trust needed to be built in order to build a partnership.



**We are NOT out to damage your business, your reputation or your livelihood. We RESPECT what you do and simply want to help share your story with the world. Our goal is to build an appreciation for what you create.**

Figure 18. Screen shot from Journey of Jeans website. Storymaps.arcgis.com. Niki Fairchild Azevedo. May 2022.

As a first step in the research process, I created a website to share with potential partners. This website stated explicitly our research goals, showed similar projects, and tried to demonstrate that we were looking for partners to tell their stories. The website also outlined the process for involvement and made it known

that the resulting VR experience would be available to share freely. Sadly, this website was not effective in gaining people's trust or even in getting potential partners to respond to an invitation to participate.

**We Want YOU to be a Part of this Project**

- Why Should YOU Join Us**

You, your team, and your company has a unique set of amazing skills. This project will let you showcase your expertise. You will be able to share the finished project with others around the world, not only to share your story, but to build and showcase your business.
- What is Required to be Involved**

One hour of your time. We will come to you. Talk to our 2 person crew and tell us all about what you do and your story. A small amount of time and the desire to share your experience is all you need to be a part of the project.
- What Will You Get Out of being Involved**

You will get the thrill of connecting with people all over the world who will hear your story. This is your chance to talk to the world. A small gift of money will be given to you out of respect for the value of your time.
- What is the Final Project**

You will be a part of a Virtual Reality experience that will follow the creation of a pair of jeans from a cotton farm, to the weaving of denim fabric, the design of jeans, and the process of sewing the final garment. This project will be available for you to view and share. Look below to see how your story will look in Virtual Reality.
- When**

We will be in your country in AUGUST 2022 and want to come talk to YOU.

Figure 19. Screen shot from Journey of Jeans website. Storymaps.arcgis.com. Niki Fairchild Azevedo. May 2022.

Early in the process of recruiting potential partners, I realized that I needed to align with production partners that were in the location where I wanted to film. Most notably the textile mills and garment factories. During the research period, there was still a global pandemic of COVID-19, and the University of Michigan had strict travel and safety regulations in place as a result. By cross-referencing the countries open to travel

supported by the university with countries that had a high level of denim production, the following locations were selected: Vietnam, Bangladesh, and Indonesia. A priority was given to Indonesia, as I have lived in the country, speak a bit of the language, have a working understanding of the culture, and have personal connections there.

While teaching a workshop in Bali, Indonesia, I was lucky enough to meet Ayu Norma. Ayu was born in Java and received a degree in textile art and design from the Institute of Technology in Bandung. She now runs and operates a successful child care business in Bali, where she spends as much time as she can on creative projects while running several businesses centered on design, education, and environmental sustainability. I approached Ayu and outlined the design concept, goals, and timeline, and asked her if she would join me as a producing partner. Ayu understands the cultural subtleties needed to conduct business and form partnerships in Indonesia. She is warm, incredibly well spoken, a natural problem solver, and knows the textile industry. Thankfully, Ayu agreed, and I had the joy of working with a friend and an amazing collaborator.

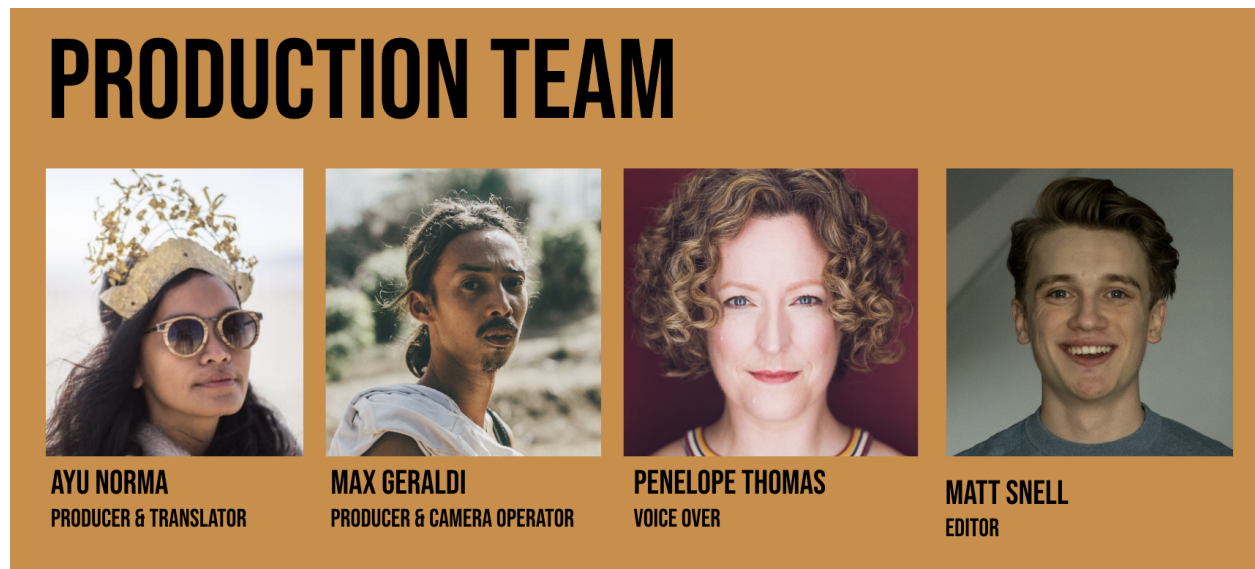


Figure 20. Woven: A VR Journey of Jeans Production Team. April 2023.

## The Learning Journey

Ayu and I began to hold meetings over Whatsapp and Zoom. In order to be as productive as possible, I kept meeting notes, outlined meetings in terms of what was needed, and planned next steps. Max Geraldi joined the team. A native of Jakarta, Max has been at the hub of various creative endeavors, traveling and working with arts communities around the globe. The team pulled our connections and started reaching out to potential partners. Using databases from companies such as Levi's, I was able to gain information on where they produced textiles and garments. We used this information to build a database and started contacting organizations. Our first partnership was the Caywood Cotton Farm in Casa Grande, Arizona.



Figure 21. Caywood Family on the Caywood Cotton Farm. Costa Mesa, Arizona. CaywoodFarms.com. June 2022.

The Caywood Cotton Farm is a 5th generation cotton farm in the south central region of Arizona. Nancy Caywood is the current coordinator of tours at the farm and also holds a Masters Degree in Agricultural Education from the University of Arizona. Nancy says, "It is my goal in life to make people aware of the importance of natural and

renewable resources, including agriculture, so they can be conserved, managed, and available for future generations." On June 1st, 2022, I met with Nancy on her farm and sat down to hear about her experiences.<sup>12</sup> Nancy also introduced us to her grandson Travis, age 15, who hopes to continue working on the farm.



Figure 22. Still from “Cotton Farming History” Video. Costa Mesa, Arizona. Niki Fairchild Azevedo. March 2023.

Having the multigenerational perspective was a very valuable addition to the research as it clearly outlined the history and the concerns facing the future concerning operating a farm in the United States. Nancy shared the history of the farm, showing family photos and telling stories from her grandparents. Holding a master's in agricultural education, she clearly and robustly described the scientific process of growing cotton as well as the economic aspects. Following our conversation, she gave me a tour of the farm from the back of the hay cart.

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<sup>12</sup> A record of this conversation can be seen in the VR experience, and is available as a film clip

## BUSINESS OF GROWING COTTON



Figure 23. Business of Cotton Infographic. Created as a result of PAR with Caywood Farms. Niki Fairchild Azevedo. March 2023.

This first connection to a research partner provided great insight into the business of cotton and was key in understanding the beginning of the denim supply chain. Not only did visiting Caywood Farms provide great research, represented in film, but also valuable practice in conducting PAR as well as practical troubleshooting of running film equipment. I was able to gather footage from both the interview and the tour to make several sections of the finished VR project and gather 360° photos and film of the cotton farm that was used as a key background element in the experience. All told, about 3 hours of footage and 75 photos were gathered.

With this first research connection formed and the documentation gathered and sorted, Ayu, Max, and I had a better understanding of how much time would be needed with each research partner as well as what footage and various elements would be needed to build the VR experience. Using funding from the Smucker Wagstaff Grant from STAMPS as well as the Rackham International Research Award (RIRA) from the University of Michigan, I was able to fly to Indonesia and begin work in person with the rest of the team in August of 2022.



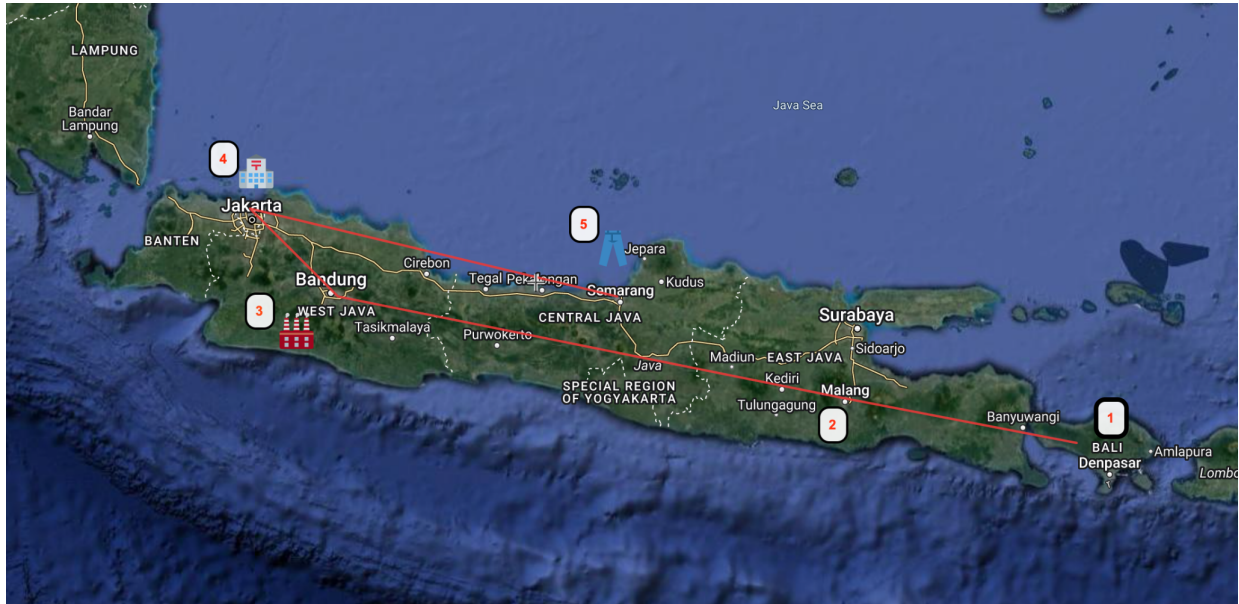


Figure 24. Map of PAR research locations in Java, Indonesia. Niki Fairchild Azevedo. April 2023.

At the time of my arrival, the team had not yet secured any confirmed research partners. This was stressful, but also within cultural norms. Having lived and worked in the country previously, I understood that a lot of business and relationships were built face-to-face, and that connection was the best way to build trust. With this understanding, the team set off from Bali to fly to the island of Java. We landed in Malang, in the central-west corner of Java, and then traveled 14 hours by train to Bandung.

Bandung, Java Indonesia is the clothing industry's heartland. We chose this as the place to begin meeting research partners because it is home to many manufacturers as well as suppliers. Also located in Bandung was the Bandung Institute of Technology (Indonesian: Institut Teknologi Bandung, abbreviated as ITB), a leading university in Indonesia teaching fashion design and production. ITB is also the alma mater of Ayu, and she arranged for us to meet with several professors at the institution. During this timeframe, the team went directly to the fashion supply district and tried to find any information or build connections with denim manufacturers.



Figure 25. Still Photo of Fabric Market in Bandung, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

Although we gathered footage of industry suppliers, this contact method did not produce any fruitful leads for research partners. We also traveled directly to the factories and requested to meet with management to discuss the project. Most often, we were not allowed past the gates, and this too failed to provide any viable connections. Ayu used social media to find a local producer of jeans, and he agreed to meet with us.

Buddy is a local born in Bandung who owns and operates Buddy Jeans. Buddy told us about his story and his passion for making jeans. We conducted our first dual-language interview with Ayu translating.<sup>13</sup> Buddy shared with us his process and current struggles. He runs a shop with one employee where he cuts and sews jeans,

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<sup>13</sup> The edited interview with Buddy can be viewed with the following link [https://drive.google.com/drive/folders/132-u3IYLfckpQtNTfudOp\\_Ca3Pi4gnct](https://drive.google.com/drive/folders/132-u3IYLfckpQtNTfudOp_Ca3Pi4gnct)



completing the whole process in a one-room workshop, making goods for sale in the local Bandung area.



Figure 26. Still Photo of Buddy Designer and Owner of Buddy Jeans. Bandung, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

Our next interview took place at ITB, where we were able to speak to a number of professors. The day of our arrival, a review of graduating design students' work was being conducted with their work on display. Kafiti Katel, professor of design and image analysis, sat down to speak with us.<sup>14</sup> She shared about her design process and her work incorporating denim and weaving techniques indigenous to Indonesia. We spoke with her about our goals for this project and how we hoped to use the resulting VR

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<sup>14</sup> The edited interview with Kafiti Katel, can be viewed using the following link <https://drive.google.com/file/d/14NizJpUIYdSMMxIBWQn4K6hmv8uxMo8D/view?usp=sharing>

experience as a tool to educate and change behaviors. She was so enthusiastic that she connected us with a personal contact at a local textile mill, Garmatex.



Figure 27. Still Photo of Gate to Denim Village. Text reads “Selamat datang di Kampung Jeans. Desa Kutawaringin” english translation “Welcome to the Village of Jeans. Kutawaringin Village.” Kutawaringin, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

Ayu, a master of researching locations, found a small village that was known as "Denim Village" We could not find any information, so we set out on a 90-minute drive and knocked on the factory door, where we met Didin. The village comprised one main street with a large white house attached to an industrial building in the middle and traditional homes arranged next to rice fields. The owner of the white house started a denim factory and was so successful that he put up a sign renaming the village.

The factory employs around 30 people and produces jeans for sale in Indonesia, with the capacity to make 1,000 pairs a day. Speaking with Didin, we learned about life

in the factory and the opportunities for work it supplied in the village. Didin said, "The most important thing here is that you can work. You just need to graduate from junior high school. After all these days, education is no guarantee of employment; even a lot of university graduates are unemployed."



Figure 28. Still Photo of Sewer at the Village Denim Factory. Kutawaringin, Java, Indonesia. Niki Fairchild Azevedo. August 2022.





Figure 29. Still Photo of Didin, Manager at the Village Denim Factory, With Quote From Interview. Kutawaringin, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

The interview with Didin as well as the tour allowed us to gain insight into what a typical workplace may look like when producing goods for domestic sale.<sup>15</sup> As discussed in previous sections, some rules and regulations governing factories come from governments where factories are located; however, many more strict rules and regulations, affecting both employee working conditions and environmental practices, come from the brands placing orders at factories. Without this added oversight, harsh and even dangerous work conditions can exist. At Didin's workplace, we saw working

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<sup>15</sup> The edited interview with Didin can be viewed using the following link.  
<https://drive.google.com/file/d/1oudiyd7VydZSDTPuFycuMWn6lPrvbbdy/view?usp=sharing>

conditions that would be unacceptable at large factories producing products for foreign brands. However, Didin reported being happy with his employment, and during a tour, the owner took special care to point out the upgraded system they used to filter and clean water after the denim dyeing process. This visit, along with the interview with Buddy, were key as they provided a contrast to the next facilities we were to tour.

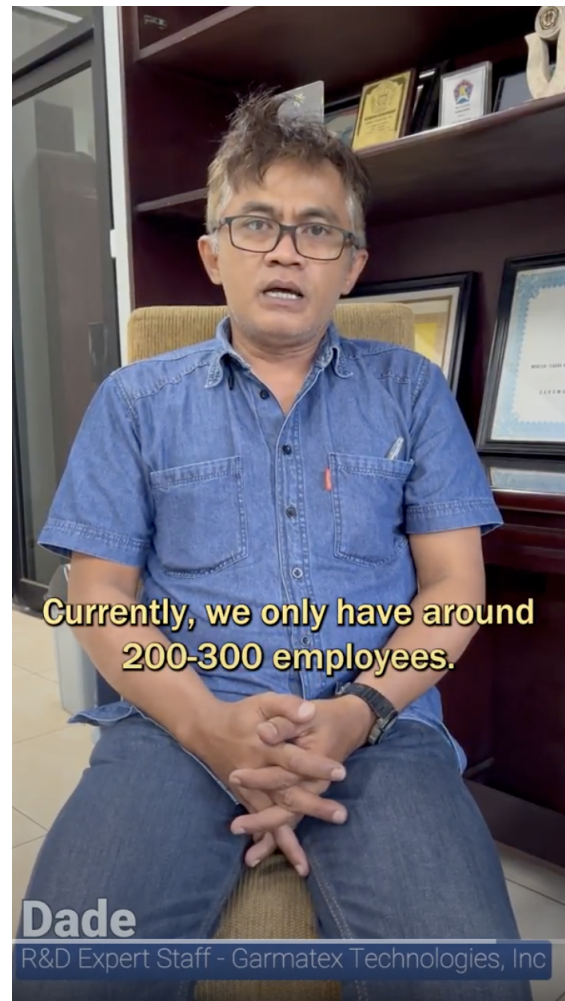


Figure 29. Still Photo of a Loom At Gamatex. Bandung, Java, Indonesia. Niki Fairchild Azevedo. August 2022.



Figure 30. Gamatex Logo. Bandung, Java, Indonesia. Gamatex.co.id. April 2023

Gamatex, founded in 1981, is a textile mill located in Bandung that has the capability of producing 14,500,000 yards of denim annually. We spoke with Dade, the research and development manager. Dade told us about the factory, the process of creating denim, and his role as manager.<sup>16</sup> He also provided us with a 2-hour tour of the mill, which employs about 200–300 people. During the tour, Dade highlighted special projects Gamatex was developing to address environmental sustainability. The company is committed to pursuing sustainable production. Critically, however, it must be pointed out that the process of producing and especially dying denim is highly extractive to the environment by its nature. This mill is also powered by a privately housed coal-fueled power plant. Gamatex partnered with us on this research project out of their concern for the environment, and their partnership and transparency allowed us to see and document the nature of this industry and



share that with others who may be able to further ideate and innovate solutions.

Figure 31. Still Photo of Dade, R&D Manager at Gamatex, With Quote From Interview. Bandung, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

<sup>16</sup> The edited interview with Dade, can be viewed using the following link [https://drive.google.com/file/d/1M2gnDV0jBOUvmtT\\_bInTHZ2armHQri4K/view?usp=sharing](https://drive.google.com/file/d/1M2gnDV0jBOUvmtT_bInTHZ2armHQri4K/view?usp=sharing)



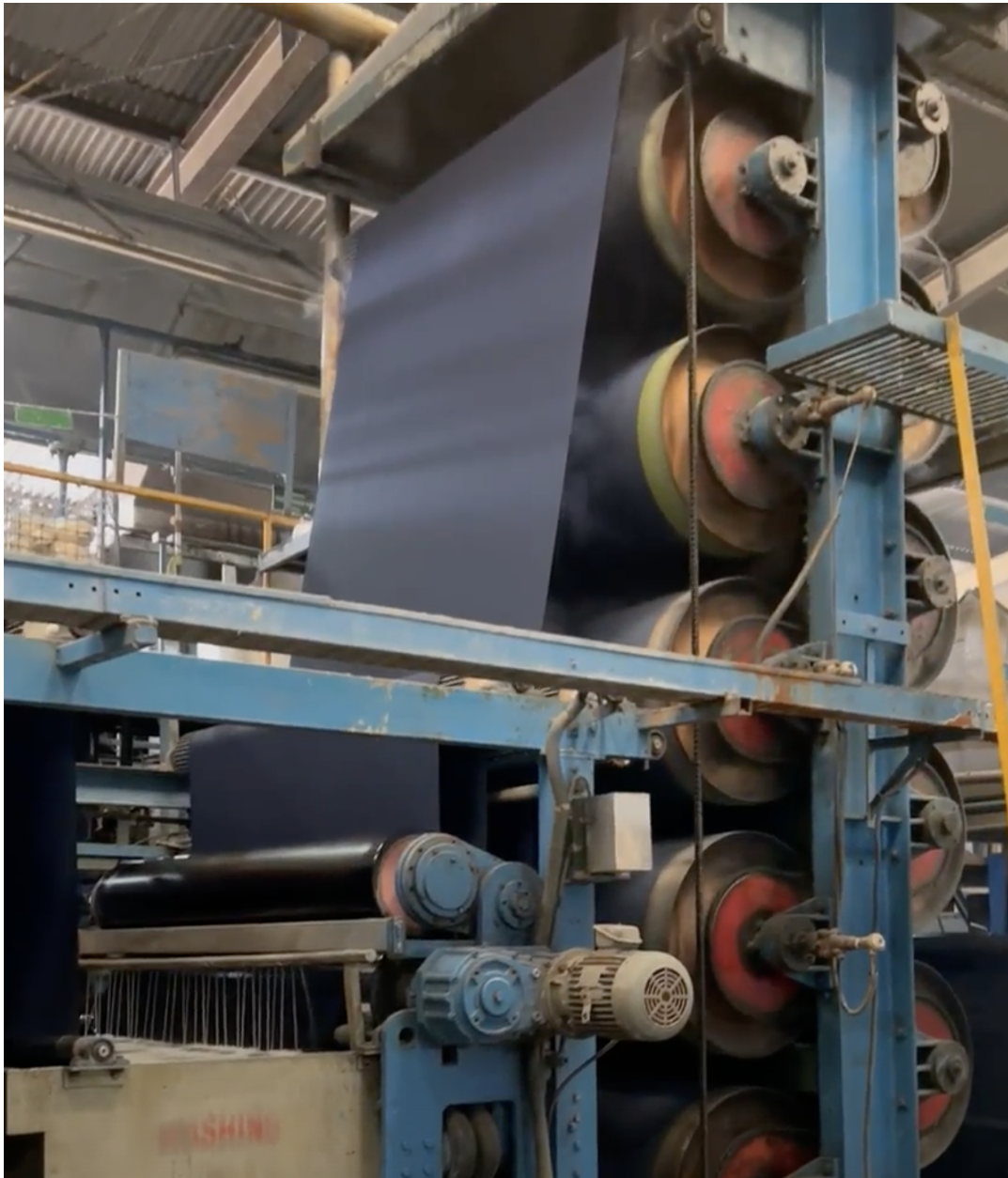


Figure 32. Still Photo of Denim Production at Gamatex. Bandung, Java, Indonesia. Niki Fairchild Azevedo. August 2022.



Figure 33. Asmara Logo. Bogor, Java, Indonesia. Asmaragroup.com. April 2023

We drove 7 hours to a town outside of Jakarta called Bogor to visit with a design production firm called [Asmara](#). Asmara is a multinational company working in fashion production, producing goods for their own in-house label as well as for fashion labels. Known in the industry as a production agent, Asmara will act as a go-between between design labels and factories that produce finished goods.



Figure 33. Still Photo of Workers at Asmara. Bogor, Java, Indonesia. Niki Fairchild Azevedo. August 2022.



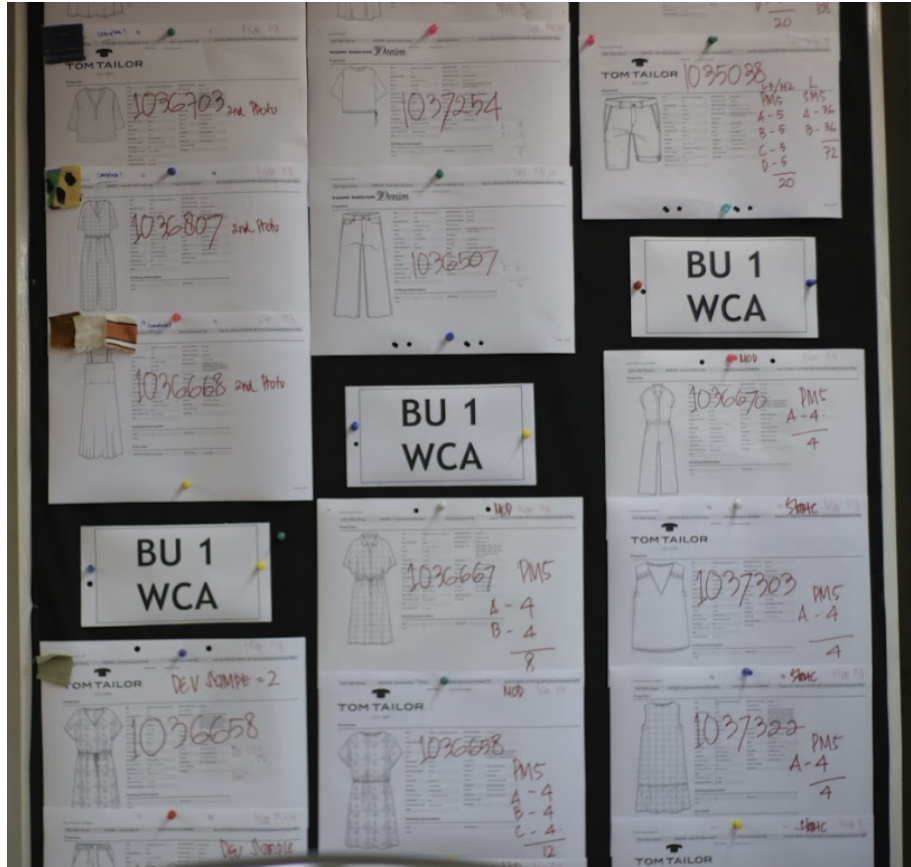


Figure 34. Production Document Tech Packs at Asmara. Bogor, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

Production agents specialize in the technical process of taking designs from a paper sketch to placing an order in a factory and receiving properly fit-tested samples. They are little known and often overlooked. We toured the office, which housed a sample room, fabric libraries, and office space filled with employees working on orders. Having many years of experience working in design offices, I can say that Asmara was a great example of a typical design office.

While there, we spoke with the Head of Product Development and Design, Rahul Anand.<sup>17</sup> When asked about the changes he has seen in his career and the rise of fast fashion, he said, "Now there are fast fashion brands trying to turn their millions into billions, and they see an opportunity there. Why just do two seasons when you could do

<sup>17</sup> The edited interview with Rahul Anand can be viewed using the following link [https://drive.google.com/file/d/1LCK6yE0TjXZbpvNkIfELzjLlSKMUz\\_4Z/view?usp=sharing](https://drive.google.com/file/d/1LCK6yE0TjXZbpvNkIfELzjLlSKMUz_4Z/view?usp=sharing)

four? Why just do four when you could do eight when you could change the trend every second or third week? This led to the current 12 seasons. If it (fast fashion) needs to be destabilized, so be it." Asmara and Anand are another example of a company working inside the fashion industry that wants to see changes that reflect sustainability but also wants to continue to conduct a successful business. Speaking with Anand both reinforced all of the research discussed earlier, which outlines the problems within the fashion industry, but also demonstrates that people in positions of authority are vested in seeing changes for the betterment of the environment, even if it comes at the expense of profits and growth.



Figure 35. Still Photo of Rahul Anand, Head of Product Design at Asmara. Bogor, Java, Indonesia. Niki Fairchild Azevedo. August 2022.



Figure 36. PT. Sandang Asia Maju Abadi. Semarang, Java, Indonesia.  
Sandangasia.com. April 2023

The missing piece of the research team was still a garment factory. There are a lot more garment factories in Indonesia than textile mills, so we were surprised that even after all of our outreach, we still had not secured a factory. We were coming to the end of our research trip, and there was anxiety. In stepped Hemant Jain, the owner of Asmara, who connected us with one of the factories that they use for their denim production, PT. Sandang Asia Maju Abadi. This was yet another example of how working with one partner, meeting in person, and conducting PAR built trust and led to one partner building a bridge to include more partners.



Figure 37. Still Photo of PT. Sandang Asia Maju Abadi. Semarang, Java, Indonesia. Niki Fairchild Azevedo. August 2022.



Visiting PT. Sandang Asia Maju Abadi (SAMA) required us to fly from Jakarta to Semarang on the central northern coast of Java. We were welcomed by the senior staff, who graciously sat down with us and talked about our research. They agreed to discuss their roles with us and then give us a tour of their extensive factory. SAMA is a huge facility over 7 acres in size, employing 2,500, housing 1,984 production machines, and capable of producing 300,000 pairs of jeans a month. Being such a large operation, they have both corporate social responsibility (CSR) and business social responsibility (BSR) as part of their corporate structure. SAMA also has an Environmental Awareness Policy, which states, "SAMA is committed to development that is balanced between economic development and conservation of the environment." They also hold a "Completion of Self-Assessment" from the Sustainable Apparel Coalition, which uses the [Higg Index](#)<sup>18</sup> to grow and measure its sustainability practices.



Figure 38. Still Photo of PT. Sandang Asia Maju Abadi. Semarang, Java, Indonesia. Niki Fairchild Azevedo. August 2022.

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<sup>18</sup> The Higg Index is a suite of tools for the standardized measurement of value chain sustainability, created and managed by the Sustainable Apparel Coalition.

We spoke with Amalia, the compliance officer; Sirihatari, the quality control officer; and Sigarus, the senior merchandiser.<sup>19</sup> All three women are part of the senior staff required to oversee production. Each shared their backgrounds, including their educational studies and what led them to work in the factory, as well as outlining their roles and responsibilities. Speaking with them, we were able to start to see what was required to manage such a complex process on such a large scale. After our discussion, Sigarus and Sirihatari gave us a tour of the factory. We reviewed each step of the manufacturing process by watching the final product being loaded onto a container for shipping.<sup>20</sup> We were at SAMA for seven hours and were able to gather all of the documentation and 360-degree footage necessary to finish the build of the VR experience.



Figure 39. Still Photo Interview Videos inside *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. April 2023.

<sup>19</sup> The edited interview with Amalia can be viewed using the following link <https://drive.google.com/file/d/1ySTP7a4WTLO9K5NjBQs8OvXjSjEUoRvT/view?usp=sharing>

The edited interview with Sirihatari can be viewed using the following link [https://drive.google.com/file/d/1txzTSjHRctH0HdTyVT\\_wU-UcCo3-6xAg/view?usp=sharing](https://drive.google.com/file/d/1txzTSjHRctH0HdTyVT_wU-UcCo3-6xAg/view?usp=sharing)

The edited interview with Sigarus can be viewed using the following link [https://drive.google.com/file/d/1WGewbw8DBDJRzI\\_y7MivKbD1YDBogc5/view?usp=sharing](https://drive.google.com/file/d/1WGewbw8DBDJRzI_y7MivKbD1YDBogc5/view?usp=sharing)

<sup>20</sup> An edited version of the tour can be found in 2 parts. The first part can be viewed at [https://drive.google.com/file/d/1Y7A\\_UJCodZyMoRZ-MrT9KBUzI0eA6Hk2/view?usp=sharing](https://drive.google.com/file/d/1Y7A_UJCodZyMoRZ-MrT9KBUzI0eA6Hk2/view?usp=sharing) and the second part of the tour may be viewed at <https://drive.google.com/file/d/1rSlsspRMqA-NZrbABmGEj6eRjoH0rtVC/view?usp=sharing>



Figure 40. *Woven: A VR Journey of Jeans* Participatory Action Research Partners. Niki Fairchild Azevedo. April 2023.

After leaving Indonesia, I continued to work with Ayu and Max to translate all of the interviews and documentation we had gathered. I began processing and organizing the footage that we had gathered in preparation for editing. Matt Snell, an undergraduate student majoring in Film and Television Studies at the University of Michigan, became another key member of the producing team. Snell worked with me to edit all of the footage and prepare it to be inserted into the VR experience.



Figure 41. Screen Shot. *Woven: A VR Journey of Jeans* being edited in Adobe Premiere. Niki Fairchild Azevedo. April 2023.

The literature review and further research lead to the questions and informational text embedded in the VR experience. Combined the interviews from PAR sessions combined with facts from research form a gamification element designed to further engage the user and encourage synthesis and integration of learning.

## Using Design for Sustainable Behavior (DfSB) as a foundation for integrating PAR artifacts into VR

As noted in the methodology section, "Design for Sustainable Behavior" (DfSB) is a methodology that integrates theories of behavior change, human-centered design, and sustainability to promote sustainable behavior.

Lilley, D. & Wilson, G., Design for Sustainable Behavior, June 3, 2013, graphic.

Above is a model outlining the steps used to create DfSB. From the perspective of this model, the user is the consumer of jeans and the viewer of the VR experience. This denotes an important shift from engaging in PAR with our research partners and taking the artifacts gathered as part of that research and shifting focus to put the user of the VR experience as the central focus. Our goal with the VR experience, as related to each step of the above model, was as follows:

1. Understand the motivation behind clothing purchase choices.
2. Try to shift your purchase habits.
1. Integrate PAR artifacts into a VR experience.
2. Test the effectiveness of the VR experience in a lab setting.
3. Evaluate the results of the lab experiment against the goal of shifting behavior.

The outside ethical consideration came in the form of questioning the ethics of seeking to modify behavior and using VR as a new tool to manipulate individuals. The goal of this project was not to use VR to effectively manipulate others into adapting a behavioral model that we deemed "sustainable". Our ethical guide for the design of this VR experience was to remain neutral, attempt to educate the participants using facts, and then share the interviews of people directly involved in the process.



## Uptale as a Development Platform

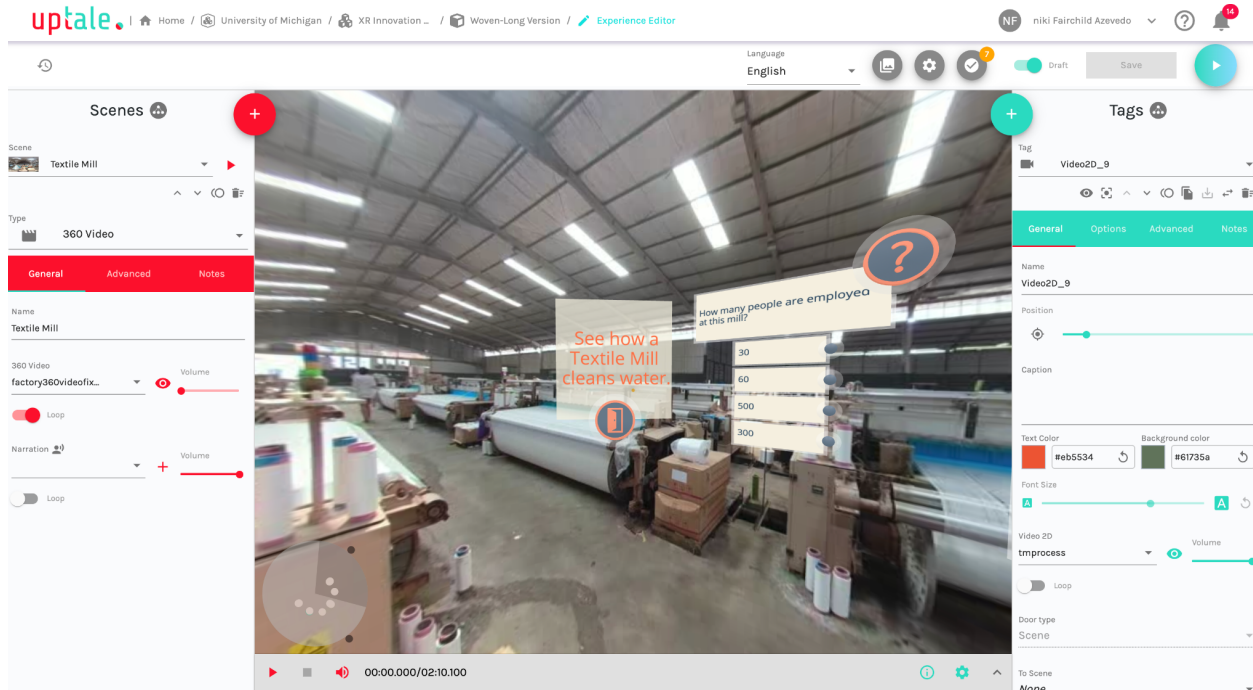


Figure 42. *Woven: A VR Journey of Jeans Being Created in the Uptale Platform.* Niki Fairchild Azevedo. April 2023.

Uptale is a new VR development platform created by a company in France and used to create interactive learning and training experiences. Experiences built in Uptale can be viewed in a VR headset such as the Oculus, on a computer screen, or in a sort of augmented reality (AR) format using a phone. It is still in development, and through the Center for Academic Innovation XR initiative at the University of Michigan, I was able to secure a developer license. Uptale is a relatively easy platform to learn, and I was able to create a wireframe prototype for the VR experience before traveling to collect research. This allowed me to conceptualize how to best create an interactive experience as well as gain an informed understanding of the footage that would be needed to build an experience.

Uptale has the capability to create individual scenes that consist of 360° still photos or video. On top of these images, there is the capability to add still photos, videos, and interactive quizzes. Each scene is built using the experience editor pictured above. Elements are added in a drag-and-drop form and editable much like you would



add or edit an element in Adobe Illustrator. The added design element is that you are creating not a static flat image but an image in the round, with the viewer placed in the center. As a designer, this is a unique perspective, and it took a number of iterations to develop the best use of space. Uptale still being in development was a challenge, in so much as a number of times during the development a new release would be issued and the methods for building would change, but the design in process would also experience undesirable changes such as no longer displaying text.

There are a lot of positives for Uptale as a building platform. The platform is simple and easy to learn, and once you master the basics, you can quickly build an experience. Polishing an experience for a final version much the way you would edit a presentation, making sure that all of the elements are in a consistent color, that text is in the same font, and that sizing is consistent across scenes, is still a tedious and time-consuming process, taking much more time than the initial build. These issues continue to be addressed by their development team. The major limitations I see to Uptale as a build platform are that there is only one basic format: having a scene with enclosed elements and then moving to the next scene by clicking through a door. From a storytelling perspective, this format is much more akin to a slightly interactive lecture series than a fully immersive theatrical experience. There are also limited options to add user interactions, with the main option being gamification using a quiz format. As the platform continues to be developed, some of these issues are being addressed, and additional interactive options are being integrated. I see great potential for quickly building low-cost educational VR experiences using this platform.



Figure 43. *Woven: A VR Journey of Jeans* Scene Design and Navigation. Niki Fairchild Azevedo. April 2023.

## User Experience (UX) testing for Virtual Reality (VR): Process, and iterating Improvement

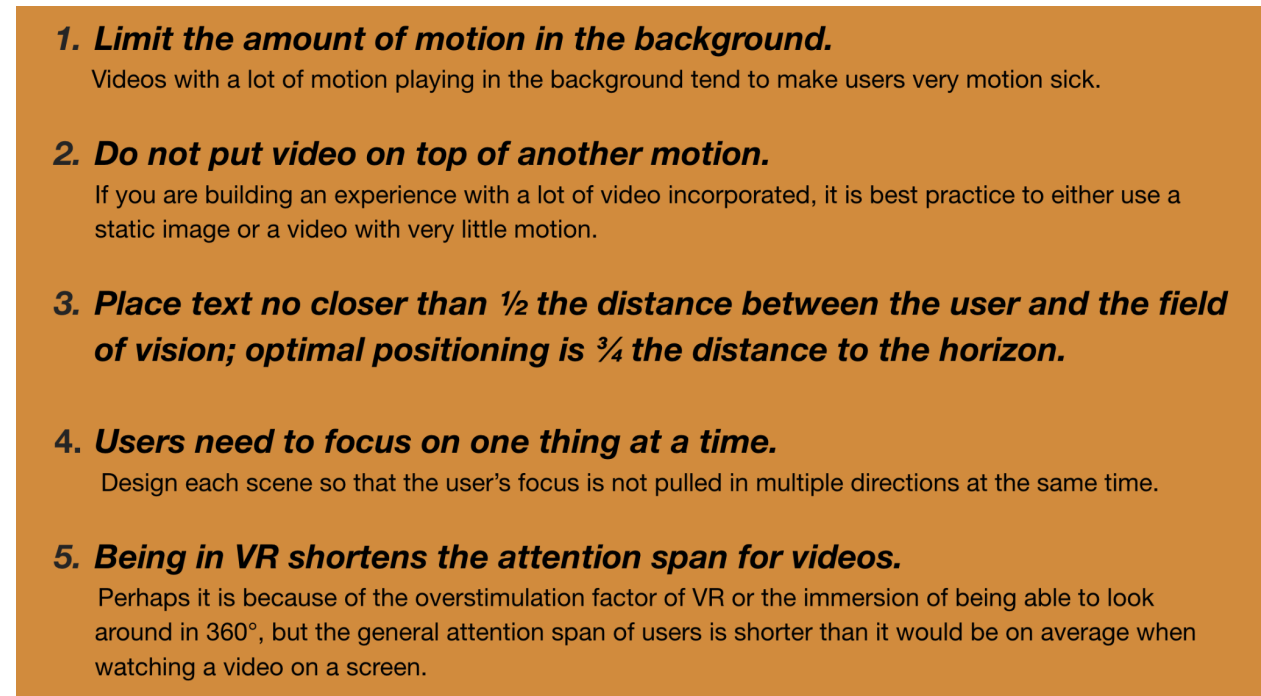


Figure 44. UX Guidelines for VR Development in Uptale . Niki Fairchild Azevedo. April 2023.

When I first began to use an Oculus, I experienced motion sickness after about 10 minutes. This is a major barrier to the user experience, and there are reports that between 40 and 70% of first-time VR users experience motion sickness after 15 minutes.<sup>21</sup> I knew that many of our participants would be first-time users, and I feared creating an experience that had the potential to make more than 50% of people sick.

There is very little documentation available for user experience (UX) guidelines in VR. As a result, the development process required a large number of builds, UX testing,

and revisions. However, after this experience, I have developed a number of key takeaways that form a guideline for best practices:

1. *Limit the amount of motion in the background.*

*Videos with a lot of motion playing in the background tend to make users very motion sick.*

360° videos that included forward, backward, or up/down movement made people sick almost immediately. The ideal 360° video to use has a clear horizon line with slow latent motion that takes place primarily on the horizon.

2. *Do not put video on top of another motion.*

If you are building an experience with a lot of video incorporated, it is best practice to either use a static image or a video with very little motion. Putting a video into the experience pulls a user's visual focus to that video, and if there is motion going on in the peripheral view of any video, this also causes motion sickness.

3. *Place text no closer than  $\frac{1}{2}$  the distance between the user and the field of vision; optimal positioning is  $\frac{3}{4}$  the distance to the horizon.*

Placing text, either in the form of a title or quiz, too close to the user creates a sensation of encroachment so pronounced that the user may physically step back. Placing text too close to the user also limits what can be seen in the scene and serves to flatten the overall experience. The distance while building on a screen and the UX while in a VR headset are very different and difficult to gauge. It is worth spending the time to find an optimal distance (in Uptale, this is a number) and then applying that same distance to all text throughout each scene.

4. *Users need to focus on one thing at a time.*

Design each scene so that the user's focus is not pulled in multiple directions at the same time. People tend to experience sensory overload in VR, especially if they are novice users, and as such, limiting the amount of stimulation sequentially can be beneficial. Do not have multiple videos playing at one time or have multiple things pop up in different directions, as this is disorienting. Having an orderly timing of watching and interaction inside of each scene, as well as sequential spacing, helps the overall flow. Pulling the user's focus in drastic directions can add to motion sickness, so try not

to place things on the right and then require a quick turn to the left, as this can trigger motion sickness.

5. *Being in VR shortens the attention span for videos.*

Perhaps it is because of the overstimulation factor of VR or the immersion of being able to look around in 360°, but the general attention span of users is shorter than it would be on average when watching a video on a screen. The optimal time limit for video length is 40 seconds to one minute and twenty seconds; any longer than this and users tend to zone out and skip past video content.



Figure 45. UX Testing Being Conducted on *Woven: A VR Journey of Jeans* VR Experience Being Projected from Oculus onto External Screen. Niki Fairchild Azevedo. April 2023.

I developed these best practices through the iterative design process. Uptale's design and development are done on a computer screen, which is fundamentally

different from being in VR with a headset. The design workflow would involve making changes to the experience on the Utale design workspace, loading the experience into an Oculus, trying the experience in VR, going back to the workspace, and making changes. This process was repeated many times until the experience was adjusted to reflect all of the best practices listed above. Once an iteration was in a testable state, I would ask a volunteer to test the VR experience on a headset. The user would provide feedback, and that would be incorporated into the experience. This extensive testing paid off as we took the VR into the lab experiment. Over 150 people engaged in the experience, and not a single person needed to be removed from the experience or reported experiencing motion sickness.

## UX FEEDBACK

***“I remember the questions the most”***

***“I felt overwhelmed at first then I figured it out.”***

***“I had trouble using the right trigger button on the controller.”***

***“Some of the videos are too long. I lost interest.”***

***“The people in the experience are so happy. I want to go out and buy more jeans to support them”***

Figure 46. UX Feedback from *Woven: A VR Journey of Jeans* VR Experience, Quotes from Users. Niki Fairchild Azevedo. April 2023.

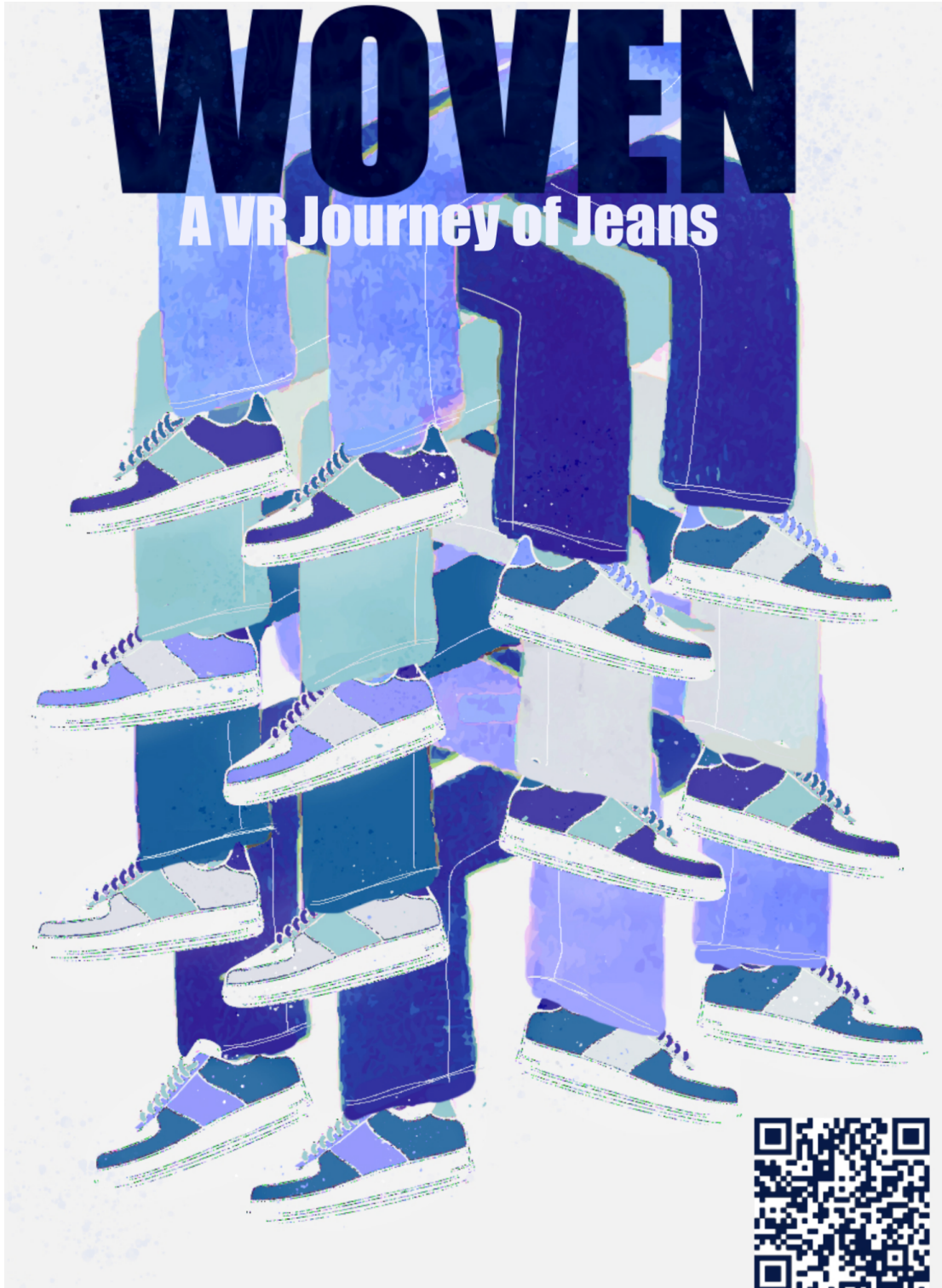


Figure 46. Poster with QR Code for Mobile Phone Version of *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. April 2023.



## Woven: A VR Journey of Jeans

The concept of woven came from a farm to table approach of looking at fashion production, harnessing VR as a way to see into the world where clothing is produced and make a narrative journey of each step of the production process. On the right is an early wire frame idea of how to execute this concept. The goal was to empower experience participants to learn, change their relationship to their clothing, and feel empowered to change their behavior. The VR experience was designed to be both passive and interactive as a phenomenological driver to feel immersed and build empathy. Users are taken through the creation of a pair of jeans starting at a cotton farm and ending on a container ship.

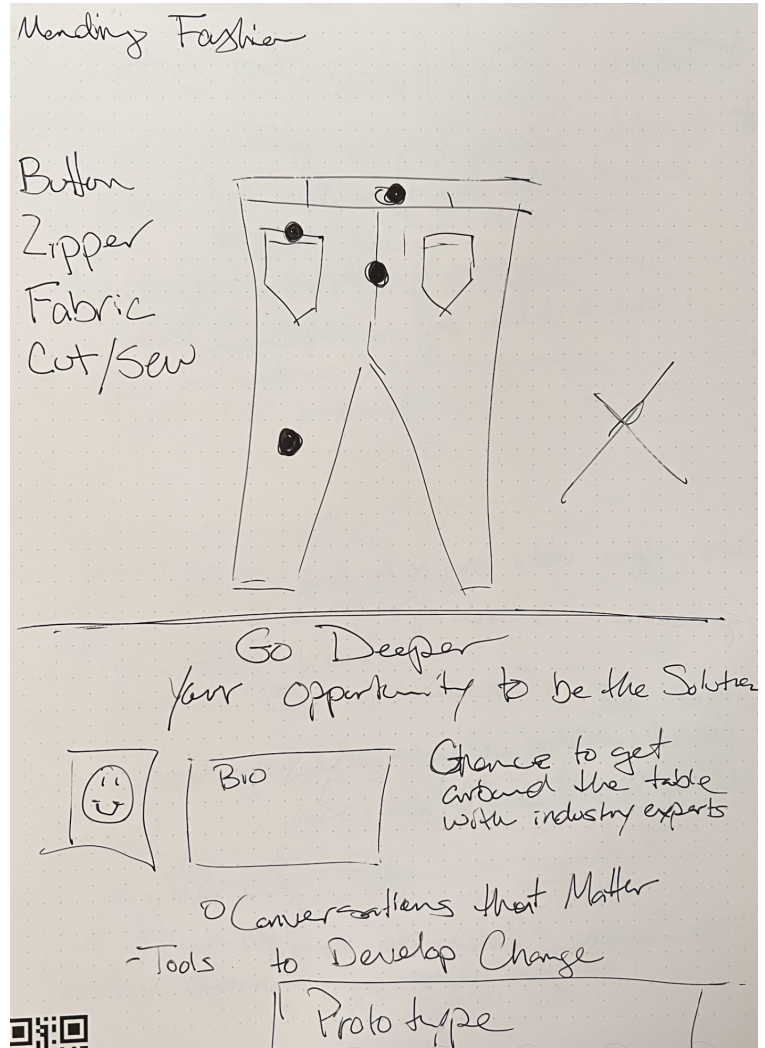


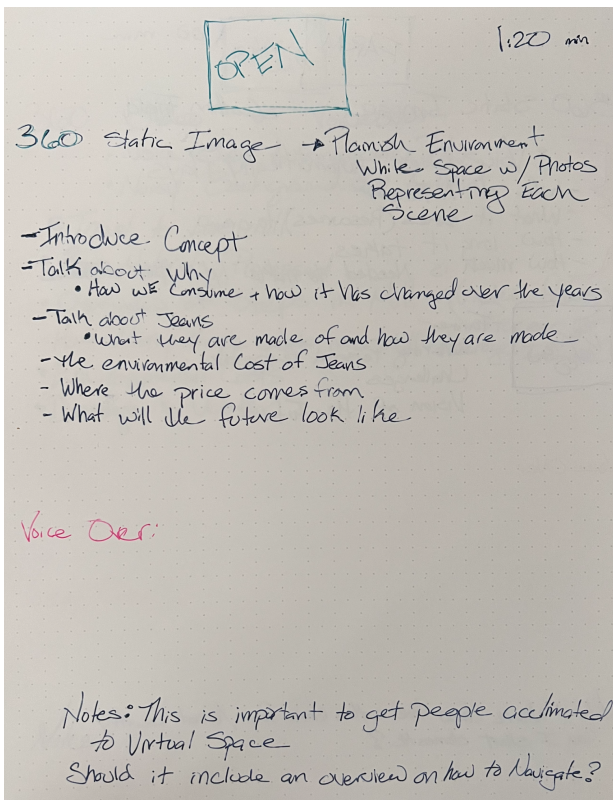
Figure 47. Early Concept Drawing for *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. March 2022.



Figure 48. User Journey Map from *Woven: A VR Journey of Jeans* VR Experience. Niki Fairchild Azevedo. April 2023.

The journey was broken down into five scenes.<sup>22</sup> Each scene is a closed environment where a user can watch videos, in which they have the ability to stop and start, explore their surroundings in 360°, and win stars by answering quiz questions based on the content relevant to the scene. In the photo is an early wireframe design of what each scene would incorporate and how it would function within the experience. The wireframing of the the VR experience allowed for an organized approach to gathering the needed artifacts through the PAR

This development process was completed early in the prototyping phase, before the PAR research began. An iteration of the experience was built in Uptale in order to decide on the UX design. It was decided that each scene would be built from filmed 360° static footage, and then videos describing both the process as well as personal interviews would be overlaid on the experience.



<sup>22</sup> This version of *Woven* with 5 sequential scenes is the version which was tested in the lab. A longer version which incorporates a comparison of producers of local goods was developed. After UX testing it was thought to be too long for the lab experiment.



Figure 49. Early Concept Drawing Outline Notes for *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. March 2022.

A design decision was made to guide the user through the experience by employing a Voice Over (VO) narration. This allowed users to more easily and quickly orient to the VR space, as well as providing a cohesive through line to the story. It was discovered through testing that using a VO alone versus including a narrator either in avatar or in filmed format increased levels of sensory immersion. Users reported feeling more connected to the spaces and less distracted by a “person” element. This level of immersion and the absence of an embodied presence was also found to increase empathy levels.



Figure 50. Still from Welcome Scene Showing Journey Map and Navigation. *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. April 2023.

Based on UX testing a Journey Map was added to each scene of the experience. This allowed the user to be grounded in the experience, and relate each step back to the the underlying each scene relative to the process of creating a pair of jeans. In figure 50 you can see an example of the Journey Map as well as the navigation. The door buttons were added in each scene and placed in prominent positions. This

enabled the user to move forward through each scene at their own pace. One navigation iteration was tested where users had the option to make multiple choices on which path they would like to take; being offered two scenes (example: history of cotton farming, or GMOs in Cotton Farming). This was reported to be confusing and users said that they were overwhelmed by the choices of alternative paths and feared missing out on information. One problem in the Uptale platform is that it is difficult to allow users to move backward through scenes. Although this seems a simple navigation, it proved difficult and thus after testing users were only offered navigation options to one scene and were only able to move forward through the experience.

## PARTICIPANTS HAVE CONTROL OVER POINT OF VIEW ADDING A DEEPER LEVEL OF CONTEXT



Figure 51. Still from Textile Mill Water Cleaning Scene Showing a View From the Right and Left Perspective. *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. April 2023.

In traditional media the POV is dictated by the creator but in VR the user is free to explore space. Figure 51 illustrates this by showing a view from the left and right of the 360° environment of the same scene. This may seem a simple aspect of VR, but our research shows that this added immensely to the feelings of immersion. It also allows the viewer to feel empowered by guiding their own experience. The research

also pointed to very high levels of learning taking place, which can be attributed to the additional context provided by VR. If you look to the left in this scene you realize the water treatment is taking place next to a rice field, where the water is returned after use. This enriched contextual understanding provides users the ability to form correlated connections and aids in users' valuable learning synthesis to occur.



Figure 52. Still from Garment Factory Scene Showing Personal Interviews.  
*Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. April 2023.

The switch between process and personal stories is an intentional design choice and serves to build understanding and empathy by creating emotional connections and associating people with the finished pair of jeans. A conscious decision was made to tell not only the technical process behind the creation of a pair of jeans but also the personal stories and experiences of the workers involved throughout the process. This decision was made to give insight to the production process and its global nature, but also to attempt to build personal connections to the people behind the clothing we wear. Building this connection was seen as an important leverage point in changing the relationship to clothing items and an entry point into shifting behaviors. Figure 52 shows how these interviews were integrated into the VR experience, showing three embedded videos of personal interviews inside a 360° environment where the interviews took place.

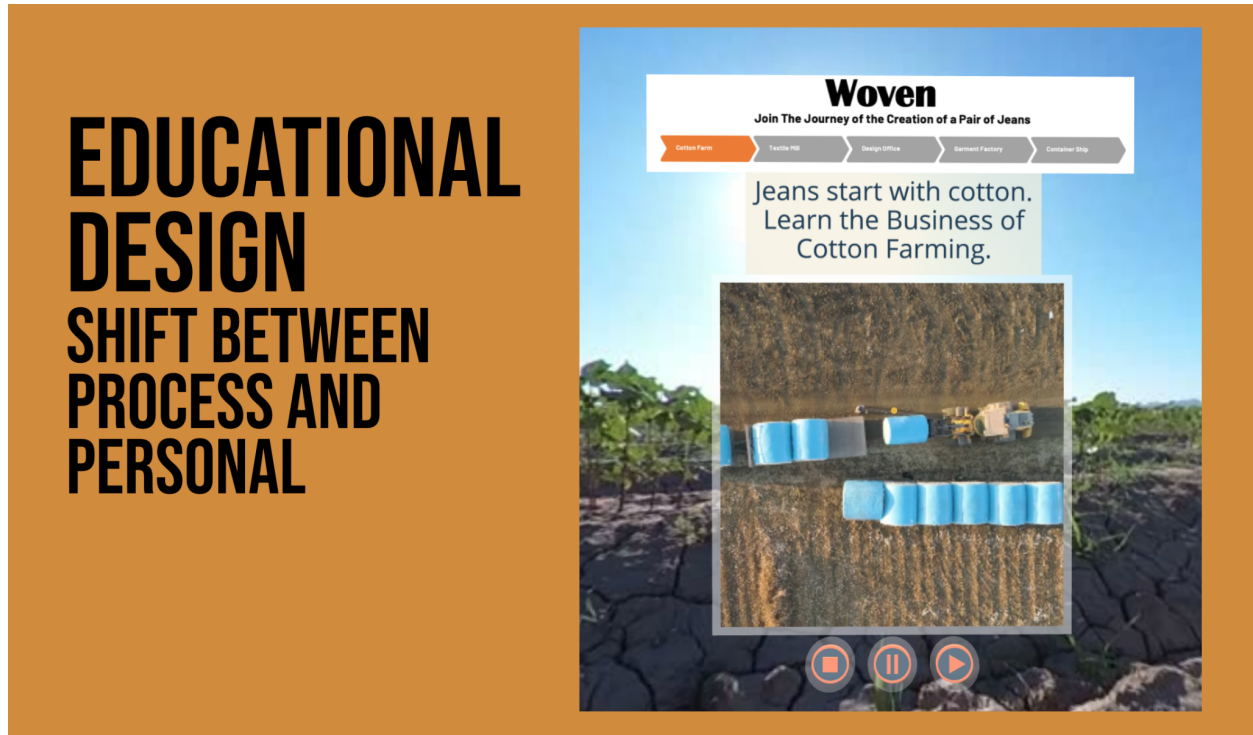


Figure 53. Still from Cotton Farm Scene Showing An Embedded Process Video. *Woven: A VR Journey of Jeans*. Niki Fairchild Azevedo. April 2023.

Both personal interviews as well as videos explaining each step of the process were created from the information and film gathered as part of the PAR research. Figure 53 shows the educational design of how short (60 second to 1:20 minute) videos were used to highlight each step of the process of creating a pair of jeans. UX testing showed that being immersed in VR shortened users attention span to take in embedded videos. To reflect this user preference videos were shortened and re edited to facilitate users moving from one scene to the next in approximately 2 minutes.



Figure 54. Still from Cotton Farm Scene Showing A Gamified Quiz Question.  
*Woven: A VR Journey of Jeans.* Niki Fairchild Azevedo. April 2023.

Research shows that empathy is most strongly built in VR when the user has a phenomenological shift from passive receiving of information to an active engagement. Gamification was added as a strategy to actively engage users while highlighting the extractive costs of the production process. During the interview portion of UX testing several users talked about the quiz questions as being the most memorable part of the experience.

The quiz gamification element of the design became an important tool to highlight the damaging and extractive costs of the process users were watching unfold. During UX testing one user commented, “Everyone in the video is so happy. I want to go out and buy more jeans to support them.”. This was a disturbing comment, as this reaction was an antithesis to the goal of shifting behaviors towards consuming less. Stepping back and using a critical lens it was possible to see how the user came to this conclusion. Workers do appear happy and proud to talk about their work, this is also highlighted by the use of PAR to create the experience. People interviewed in the videos were partners in the creation of this experience and as such this VR experience was not an expose on the evils of the fashion industry.

It was a delicate balance to strike, staying true to the PAR promise of not damaging business or livelihoods of participants, but also delivering the facts of the environmental and social extractive and exploitative costs of this process. The quiz questions were rewritten in the final version more explicitly to highlight the facts of

these extractive costs, emphasizing environmental tolls and impacts on workers through the supply chain.



## 5. Description of the Research

Once the design of the VR experience was finalized, it was taken into a lab setting to test its effectiveness as a tool to shift behavioral habits. The goal of the research was to answer the question, "Can VR be an effective tool to change actionable behavior habits related to fashion and clothing consumption?" This portion of the study was being conducted in collaboration with David Finken, a visiting scholar. Finken is a PhD candidate at the University of Lucerne, where she works in VR and consumer studies, specializing in survey design and analysis. The goal was to have a sample pool of 150 participants. Working together, we designed the following experiment to be conducted in the Ross School of Business Behavioral Lab. Research was conducted under the approval of an Internal Review Board (IRB) approval process.<sup>23</sup>

### Design of the Research Experiment:

The following section discusses the design of the research experiment, and includes both the process and the rationale for the experiment. This section concludes with a description of our study, and sets the stage for both preliminary findings and conclusions of this thesis.

This research experiment uses design, recruitment, consent, survey and data security. These are described below. The technology used to study the concept described above is quite novel, the assistance of the UMich program and specialists provided a unique engagement and an interesting test.

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<sup>23</sup> A copy of the IRB application and approval can be viewed in the appendix.

# Design & Manipulation

**Two-cell design:** Screen Monitor (0) vs. VR (0)

- **Interactive learning environment** about the supply chain in fashion
  - **Steps:** Harvesting, producing, designing, constructing, shipping, retail
  - Short quizzes
- **Incentive compatible:** 10 dollars endowment – lab study, Ross paid pool, February 2023
- Collaborating with the **School of Arts and Design (designed VR)**
- **VR-Content:** created by master student (worked in Fashion for 20 years)

Figure 55. Table Outlining Design of Lab Experiment of *Woven: A VR Journey of Jeans*. David Finken. April 2023.

## Recruitment and Screening

Participants will be recruited through and conducted at the University of Michigan Ross Behavioral Lab. Potential participants will be invited to ask questions and will be provided with all information related to the study. They will be screened and verified to be over the age of 18, provided a detailed consent form.

## Consent Process

All participants will be given a written consent form and will provide their signature. The consent form can be viewed here: [Woven Consent Form](#)

## Description of what happens to the subject during the research

Participants will be given a survey, which they will fill out using the platform Qualtrics. The survey will be completed digitally and take approximately 5 minutes to complete. Participants are then randomly assigned a number; those with odd numbers will experience the information on a computer, and those with even numbers will experience the information on a Meta Oculus Quest VR device. Participants will spend approximately 7–10 minutes engaging with the same material, with the only difference being delivery systems. After the viewing experience, participants will be given an exit survey. The survey will gauge possible shifts in attitudes, beliefs, and values related to



sustainability and fashion/clothing. The participants will then be asked if they wish to donate any portion of their honoraria to the United Nations Fashion Alliance. Participants are then informed that the study has concluded.

### **Surveys, questionnaires, data security and interview protocols**

Two surveys will be conducted using Qualtrics. Qualtrics is a digital platform that largely automates the administration of the survey, and expedites outputs and results for the survey team. All data will be anonymized using a random number generator, which will assign each participant a random number, replacing all identifying information.

### **Description of the type of compensation and method of distribution**

In person, participants will be paid in cash. Payment will be distributed after their participation in the VR experience. Participants recruited through Prolific will be compensated in the same amount. Payment will be distributed to participants through the Prolific website.

The design of the experiment was to evenly distribute and randomly assign participants into two groups. One group would be a screen group, and the other a VR group. Each group would experience the exact same information; only the delivery method would vary. The trigger for testing whether actionable behavior change took place centered around an option to donate all or part of your participation to an NGO working in fashion sustainability. This experiment design is referred to as an A/B two-cell design with an endowment effect present. The A/B design refers to the screen versus the VR comparison, and the endowment is the up-front cash payment made to participants, which they could choose to donate.

# Procedure during the Experiment

- Participants entered the lab, started the study, with **10 dollars** endowment on their table in 1-dollar bills
- **Consumer Traits: Environmental**, Empathetic Concern (People), Impulsive Buying
- **Manipulation – Interactive Learning Environment:** Screen vs. VR
- **Alliance:** United Nations of Sustainable Fashion and Goals
- **Donation-DV:** Likelihood and Actual donation (out of endowment)
- Process / Accounts:
  - Presence
  - Intrinsic Motivation / Empowerment

- 
- **Distance:** to people, time, hypothetical
  - **Emotions**
  - **Randomized** Questions & Controls
  - **Final Questions**

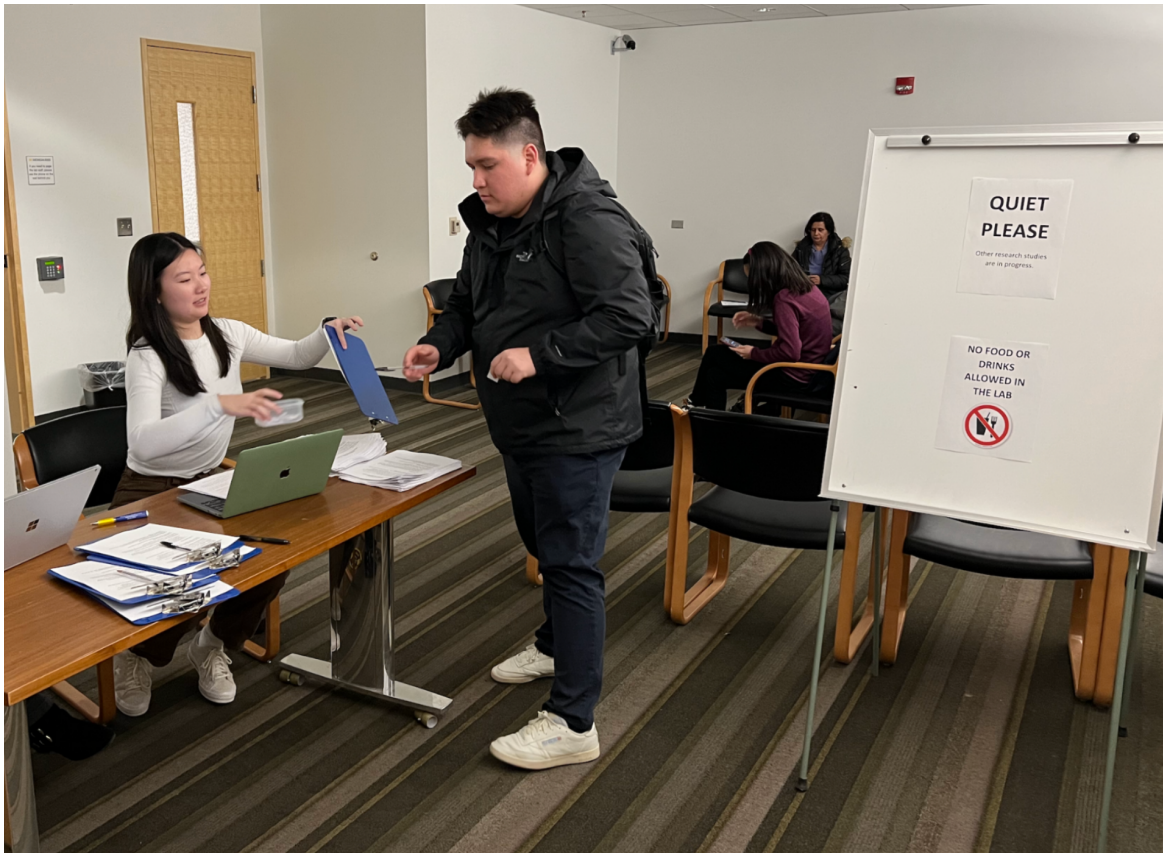


Figure 56. Still Photo of Experiment Waiting Room During Testing at the Ross Behavior Lab. Niki Fairchild Azevedo. February 2023.

The experiment was conducted in February of 2023 at the Ross Behavioral Lab on the central campus of the University of Michigan. Noel Dockett, the manager of the behavioral lab, used their participant database and filled all spots in less than one week. Possible participants were sent the following message:

*Dear participants,*

*Researchers are currently conducting a 15-17 minutes long study at the Ross Behavioral Lab. Participants will receive a payment of 10 Dollars. Researchers intend to recruit 110 participants. The study will take place over two days, with multiple slots available. For each slot, 10 participants can join.*

*Slots:*

*Thursday 16 th February, 10.00 am – 6.00 pm*

*Friday, 17th February, 10.00 am – 4.00 pm*

*The study will introduce participants to an interactive learning environment and ask questions about the experience. There is no prerequisite for participation. The researchers appreciate your time and look forward to your participation. Hearty thanks in advance and best wishes,*

*Ross Behavioral Lab Team*

The experiment was scheduled to run once an hour with 12 participants scheduled for each hour, with the two extra participants being overbooked to cover no-shows. Participants entered the lab and were given a container of numbers to pick from, a consent form to fill out, and an opportunity to ask questions. They were informed that this study was about "general knowledge about the fashion supply chain" After all participants had completed the paperwork and were seated, lab staff read the following script:

*Welcome to the Ross Behavioral Lab and thank you for taking the time to be here today. The research conducted here contributes to generating general knowledge.*

*Our Study requires that participants have full concentration through the study, so we ask you to put away your cell phones in your backpack or coat. Please ensure that the vibration is off so that it does not disturb anyone in the session. There is no drinking or eating allowed during the study. The overall study takes on average 16 minutes. There are also hand sanitizers and tissues available. However, we ensure that everything is cleaned prior to entering the laboratory.*

*All your responses are anonymous. Please take your time to answer all questions honestly. All additional information will be provided on the survey. Should you encounter technical problems please quietly step out of the Computer Lab - a research assistant will be waiting outside.*

*Once you have completed the survey, please step out of the room and leave the exit on the left door.*

*This study is about an interactive learning experience activity about the fashion supply chains. You will receive additional instruction in the computer lab. If you have not done so, please sign this check in sheet and the consent form. Please remember the number throughout the whole study. Please if the number from before is ODD, you can now stand up and join me walking to the computer lab. We will pick up all other people with EVEN numbers in approximately 1-2 minutes.*

Participants with ODD numbers were placed in the VR group. These participants then walked down the hall to the computer lab, where they were seated at individual computer carts. Each computer cart had a laptop with the survey open and \$10 in cash on the desk.



Figure 57. Still Photo of Experiment Computer Room During Testing at the Ross Behavior Lab. Niki Fairchild Azevedo. February 2023.



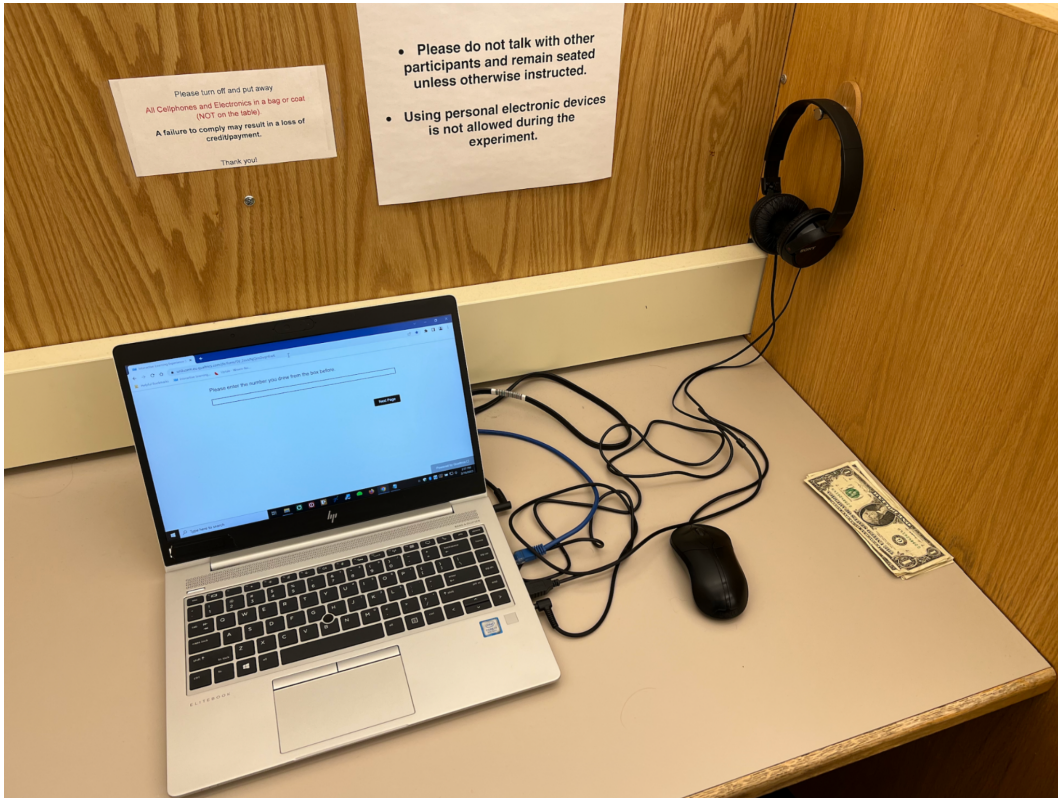


Figure 58. Still Photo of Experiment Computer Set Up with Survey and \$10 Participant Payment During Testing at the Ross Behavior Lab. Niki Fairchild Azevedo. February 2023.

The presence of the \$10 was an important element because it triggered the endowment effect.<sup>24</sup> The endowment effect can be described as having the following effects: people are less likely to part with an asset, in this case cash, once they gain possession. In this study, this was relevant because participants were asked to donate to the United Nations Sustainable Alliance Fund. Previous research shows that donation rates would be higher if the money was hypothetical and lower if the cash was already paid to participants and donations involved handing over money that was already in their possession, controlling for the endowment effect was a key element of the study because this effect mimics more closely the behavior patterns in the "real world" Since a

<sup>24</sup> The endowment effect describes a circumstance in which an individual places a higher value on an object that they already own than the value they would place on that same object if they did not own it.

main investigation of the study was to see if VR could shift behavioral habits by mimicking real-world actions, the fidelity of the findings as related to the efficacy of colleted behavioral change was key. Simply stated, the correlation between donation levels signaled the presence of a behavioral change taking place. This correlation will be discussed in the following results section.

Participants completed the first section of the survey, which collected demographic information as well as gauged baselines for levels of empathy, purchasing habits, and environmental concerns. A complete copy of the survey can be found in the appendix.

After completing the first section of the survey, participants in the VR section were gathered, informed that they were going to participate in a VR experience, and given instructions. Lab staff read the following script:

*Please go to the area marked in your room with a blue X on the floor. The VR Experience requires that you only move in this area, that is you should not move around, however you can turn around.<sup>25</sup>*

After receiving instructions, lab staff walked each participant into a private space to begin the VR experience. Lab staff was available to assist participants with any technical difficulties or answer any questions. It took on average 12–17 minutes for participants to complete the VR experience. After completing the VR experience, each participant returned to their original computer cart and finished the survey.

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<sup>25</sup> A complete copy of the staff script for the experiment can be found in the appendix.

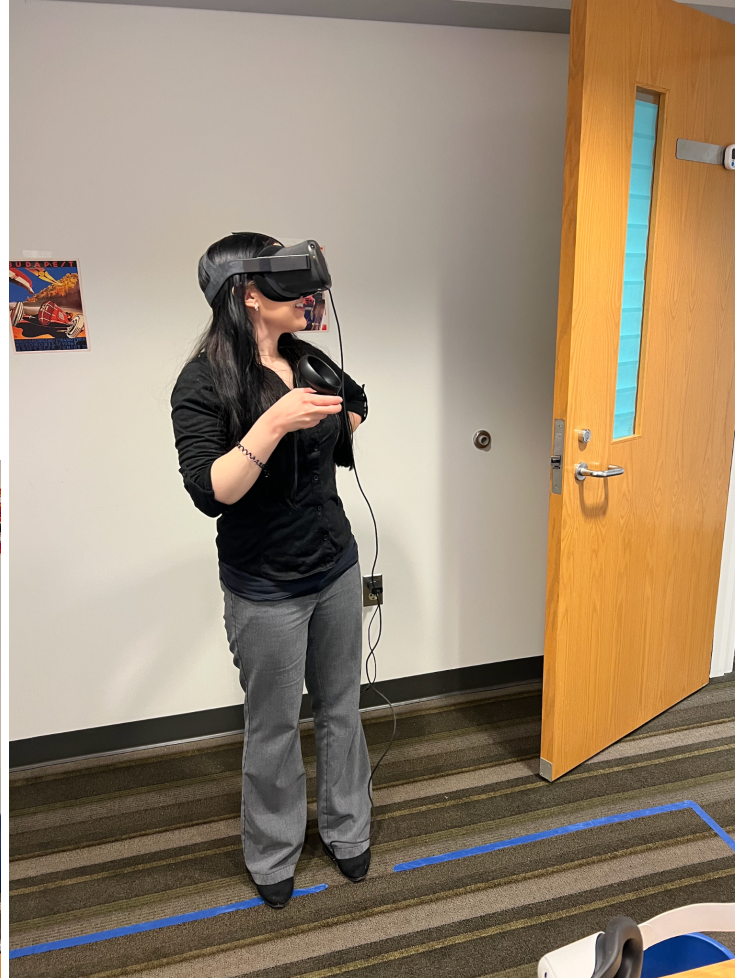
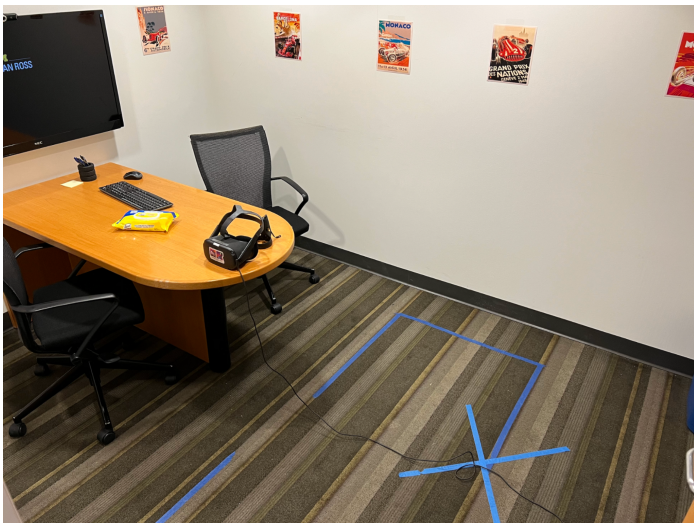


Figure 59 & 60. Still Photo of Private VR Rooms During Testing at the Ross Behavior Lab. Niki Fairchild Azevedo. February 2023.

While the participants assigned odd numbers were in the VR experience, the participants with even numbers were welcomed into the computer lab and read the following script:

**Script:** Please sit at one of the computers numbered 14-24 on the **RIGHT SIDE**. You will find the survey open on your computer. Please pick any seat that has preloaded the survey. Follow the directions on the survey on the screen. When you have to start the interactive learning experience go to the **second tab opened in the browser "Chrome"**

The participants with even numbers completed the whole experience seated at the same computer cart. They received the exact same interactive experience as the



VR group. The only difference was the delivery method: VR with an Oculus headset and a laptop screen with the traditional click and drag mouse. The screen group was separated from the VR group at all times and did not know that the other section was receiving a different experience or that VR was involved in the study.

After completing the experience, either on a screen or in a VR headset, all participants completed the same survey. The survey asked questions about their reactions and feelings in response to the experience.

**How much do you agree or disagree with the following statements concerning your learning experience?**

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
The interactive learning experience made me feel <b>I could make a difference</b> in improving the Fashion Supply Chain.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The interactive learning experience made me feel like <b>I have the power</b> to make the Fashion Supply Chain <b>better</b> .	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The interactive learning experience made me feel that <b>I have been empowered</b> to improve the Fashion Supply Chain.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 61. Sample Survey Question from Testing at the Ross Behavior Lab. Niki Fairchild Azevedo & David Finken. February 2023.

Participants were also asked questions related to how empowered they felt to make changes to affect changes to the fashion supply chain.

**How much do you agree or disagree with the following statement?**

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I am <b>confident in my ability</b> to affect the Fashion Supply Chain positively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 62. Sample Survey Question from Testing at the Ross Behavior Lab. Niki Fairchild Azevedo & David Finken. February 2023.

The final section of the survey asked participants if they would be willing to donate all or any part of their participation payment to the United Nations Alliance for Sustainable Fashion.

You will get a **maximum payment of 10 dollars for this study.**

However, we give you **the opportunity** to actually support the '**United Nations Alliance for Sustainable Fashion**' with a **donation** that is fully in your control.

The Alliance will use your donation to **improve working conditions for employees, fight pollution and related environmental issues**, and, thus, improve the overall supply chain in fashion

Page Break

donation

☆

How much of your current payment (i.e., 10 Dollars laying in front of you) are you willing to **donate** to the '**United Nations Alliance for Sustainable Fashion**' HERE AND NOW?

**Reminder:** We will donate all participant shares to the '**United Nations Alliance for Sustainable Fashion**'; the **difference** will be **your new payment** for this study.

There is a donation box for the **United Nations Alliance for Sustainable Fashion** at the front of the Room! All proceeds will be **DONATED**.



Figure 62. Sample Survey Question from Testing at the Ross Behavior Lab. Niki Fairchild Azevedo & David Finken. February 2023.

As participants finished the study, they were greeted by lab staff, who asked them to sign an exit sheet and place their donations into a box marked with the United Nations Sustainable Fashion Alliance logo. A debriefing handout was available for any participants who desired to take one.<sup>26</sup>

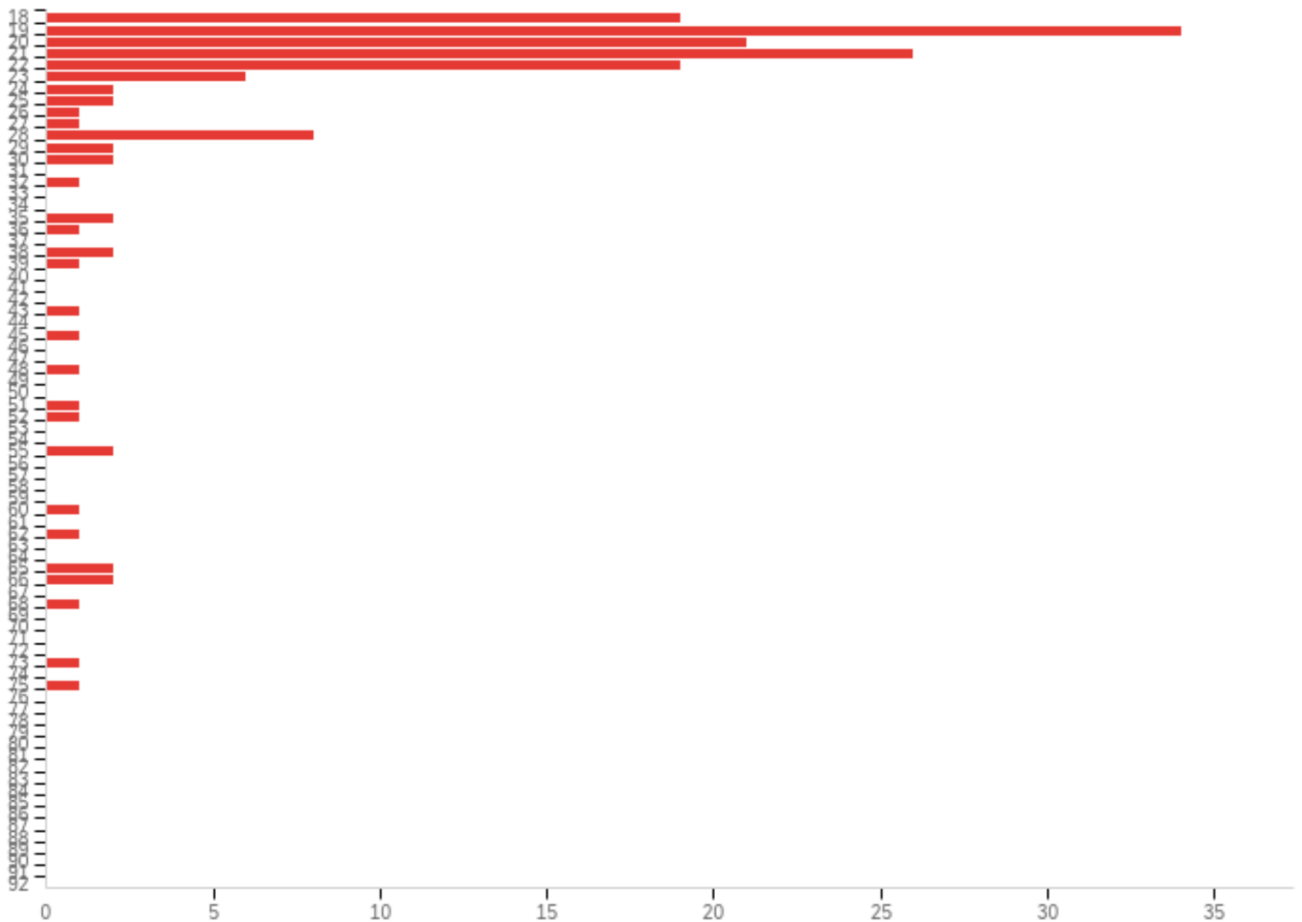
<sup>26</sup> A copy of the debrief form may be found in the appendix.

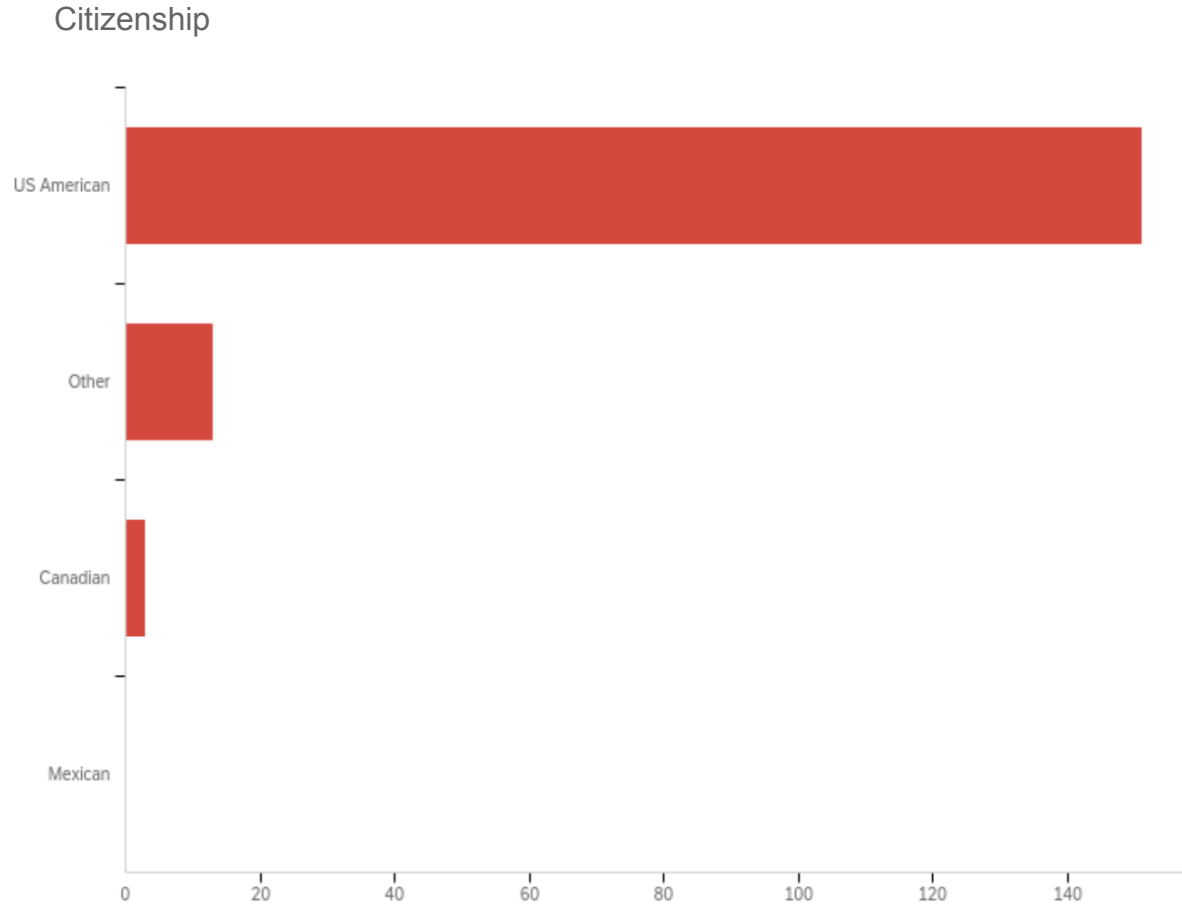
## Participant Demographics

In total, 156 participants took part in the experiment over 2 days. The participants consisted of both members of the community as well as university students. The following sections illustrate their demographics and reported consumer tendencies.

### Self Defined Gender & Reported Age

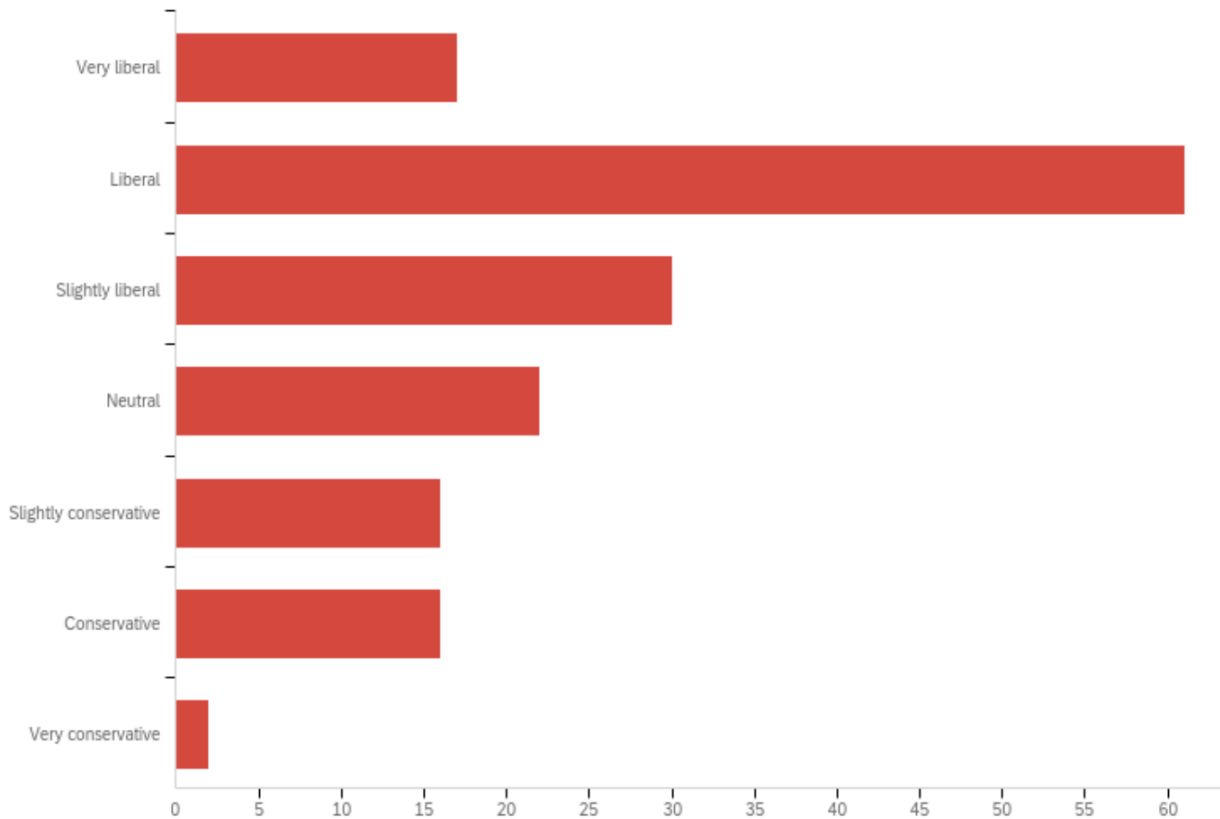
Participants ranged in age from 18 to 75 with the majority of participants centered in the 18-22 age group. Most students were University of Michigan undergraduate students. 60 participants (35.93%) were male, 101 female (60.48), 3 non-binary or third gendered, and 3 preferred not to disclose.





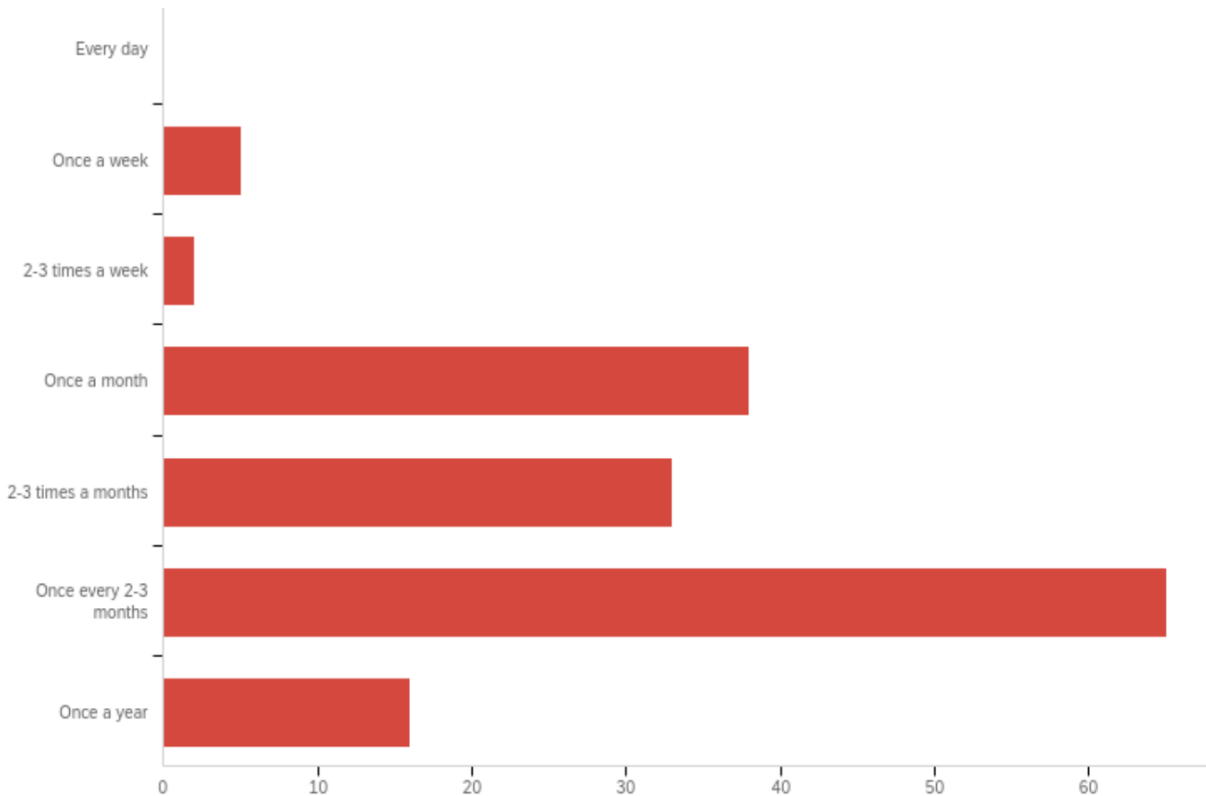
151 Participants were United States of America citizens, making up 90.42% of the participants pool. The other 7.78% of participants were India, Japan, Swedish, Bangladesh, Peru, South Korea, and Singapore citizens. The second largest citizenship ranking was Canada with 1.8% of participants.

## Political Spectrum



Participants self-described their political orientation, with the overwhelming majority of 61 participants (37.2%) identifying as liberal. 30 (18.29%) participants reported being slightly liberal, and 17 (10.37%) were very liberal. Combined into one category of liberalism, 108 participants (65.86%) self-identified as being on the liberal political spectrum, compared with 34 (20.74%) who identified as being on the conservative political spectrum. 22 participants identified themselves as neutral.

## Purchasing Trends



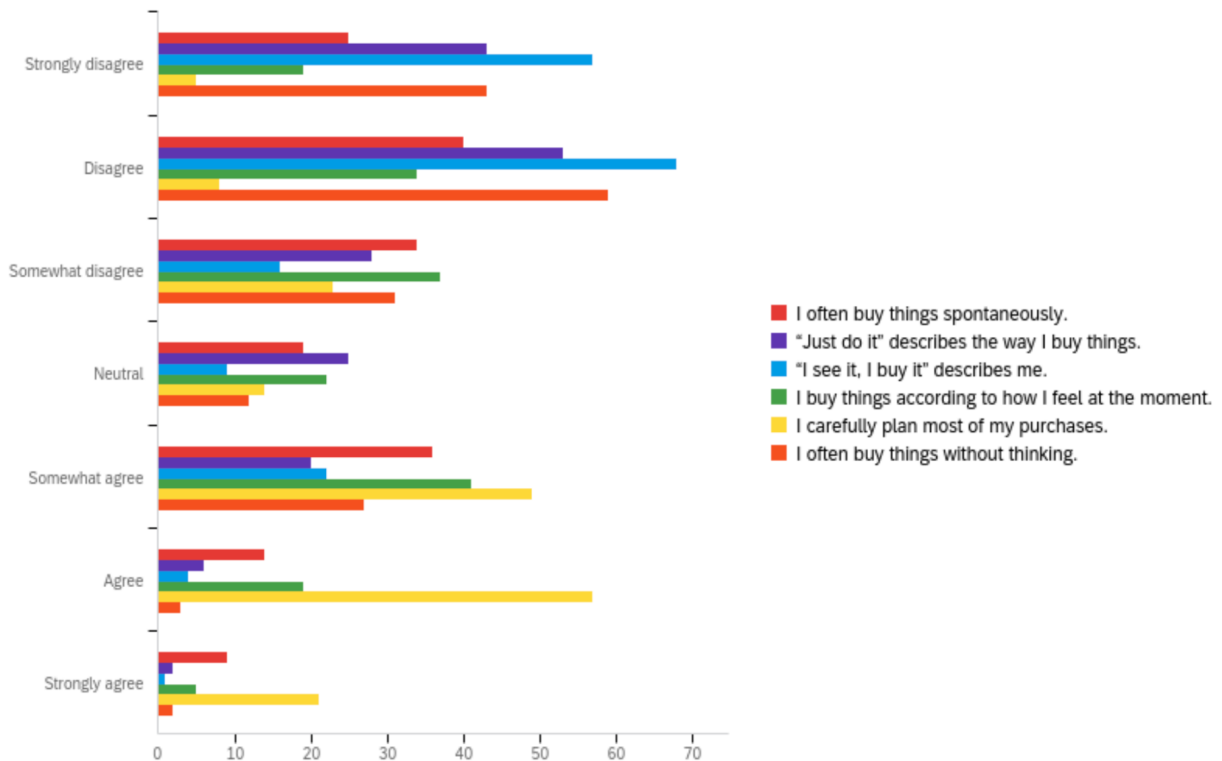
Participants did not reflect the shopping habits of the average American. According to a survey of 1,000 participants from Klarna, individuals aged 16–24, reported shopping 18 times per year, with nearly a quarter (23%) of them admitting to shopping online 1-3 times per month. Millennials, aged 27-42 are shown to shop online 14 times per year, while the 55+ age group shops online 8 times per year. (Howerton, 2019)<sup>27</sup> Women are reported to spend 76% more on clothing than men. (Bowling, 2023)<sup>28</sup>

This is in contrast to our sample, which is made up of a majority of 18–22 year olds who report to shop only once every 2-3 months. The shopping habits of our sample were well below average. Participants reported spending between 0-\$752 a month on clothing, averaging to \$94.27 a month.

<sup>27</sup><https://www.klarna.com/international/press/us-trying-before-buying-leads-to-higher-online-spend-shoppers-say/>

<sup>28</sup> <https://financialbestlife.com/how-much-should-i-spend-on-clothing/>

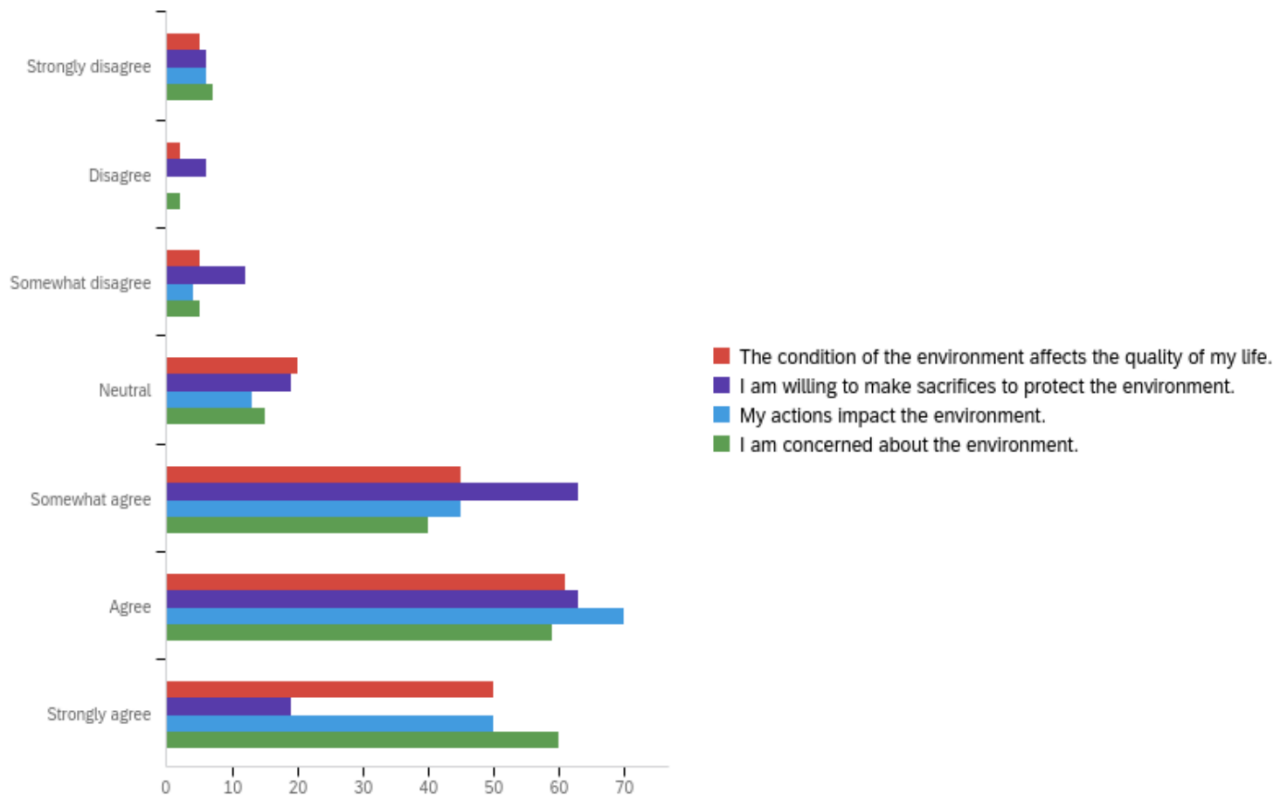
## Impulse Purchasing



Participants were asked a series of six questions related to their shopping habits, motivations, and impulse buying. When asked, "I often buy things spontaneously," 40 participants disagreed and 36 somewhat agreed, indicating a somewhat even split leaning slightly towards the majority of participants not making impulsive purchases. 124 of 177 participants disagreed to some degree with the statement, "Just do it. This statement describes the way I buy things, indicating thoughtful, intentional purchases. 65 participants identified to some degree with the statement, "I buy things according to the way I feel in the moment," indicating 36.71% are emotional purchasers. Participants tended to make "carefully planned purchases" at a rate of 71.74%, and only 18.07% claimed to "often buy things without thinking".

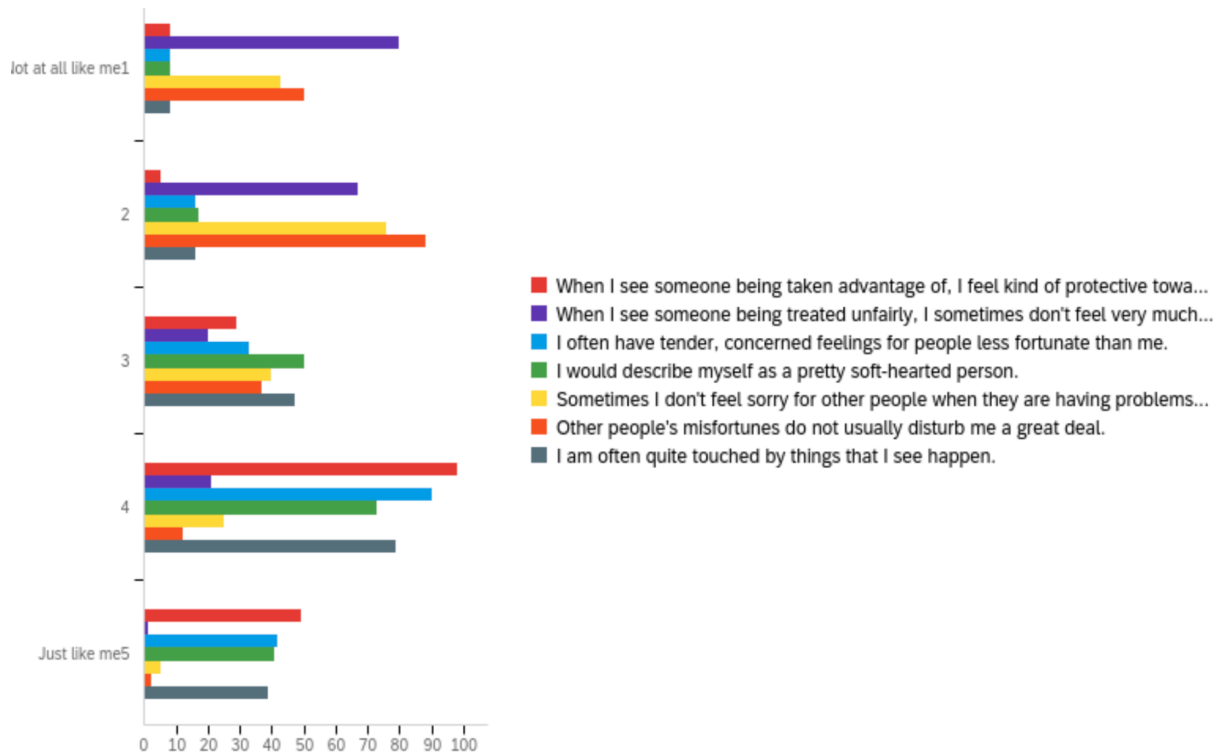


## Environmental Concerns



When asked about environmental concerns, 83 percent of participants agreed to some degree that their lives were affected by the environment. 87.7% agreed to some degree that their actions impacted the environment, and 84.57% expressed some level of concern about the environment. A majority of 77.13% reported a willingness to make sacrifices to protect the environment. This willingness to make sacrifices indicates an increase from similar studies in the past. In 2021, the Guardian reported that in a survey of participants in 10 countries, "Only 51% said they would definitely act to protect the planet". (Henley, 2021) This increase could be a result of a general shift in attitudes, a reflection of the attitudes and value systems of the young 18–21 demographic, or it could be tied to the higher than average levels of liberal politics in the sample, as this is generally associated with pro-environment values. (Geiger et al., 2021)

## Self Reported Empathy



Participants exhibited a range of results related to concern and empathy traits. Overall, 77.78% identified with the statement, "When I see someone being taken advantage of, I feel kind of protective toward them," signifying high levels of empathy. The distribution between reported care/empathy and ambivalence is such that it deserves further research. When asked, "Other people's misfortunes do not usually disturb me a great deal." 19.5% reported feeling neutral, and 73.02% identified, signifying a high level of empathy. Participants were also asked how satisfied, happy, and confident they perceived workers in the experience and reported generally feeling neutral on all three; combined, these perceptions and feelings may effect levels of depression.

When comparing 62.43% of participants who identify with the statement "I am often quite touched by things that I see happen." with 15.88% of participants also reporting that they "Sometimes don't feel sorry for other people when they are having problems," there appears to be a disconnect. It could be a case of wording in the survey triggering results, or more interestingly, there could be a hidden trigger in the cue: "see things happen" versus a more passive "feeling sorry for other people."

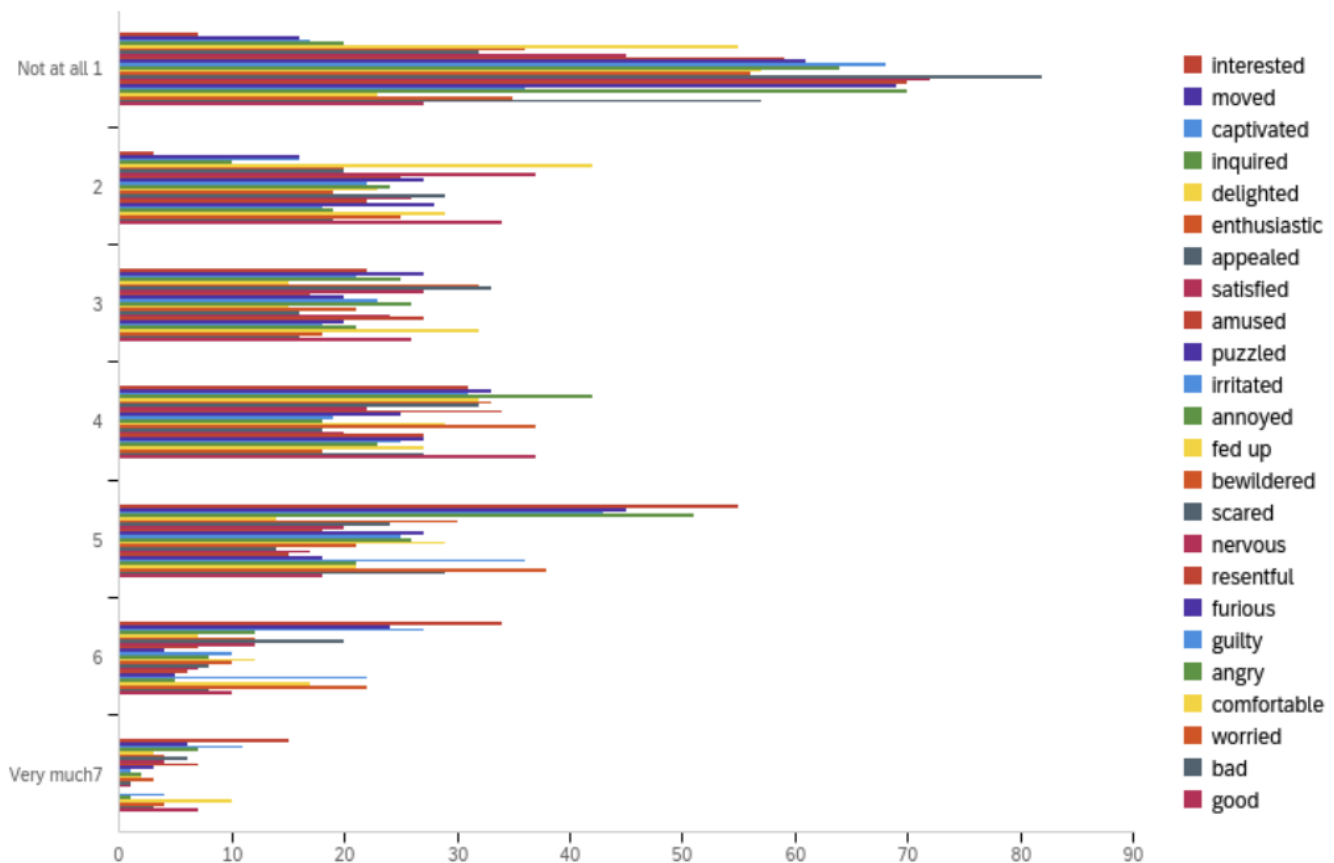
## Summary

To summarize participants' demographics, the majority age range was 18–22; they were mostly female and United States citizens with liberal political leanings. The sample represented fewer frequent shoppers than the average American in the same age range. Most purchases are planned and carefully considered, but emotional. A strong majority of participants expressed concern for the environment, saw a correlation between environmental concerns and their quality of life, and expressed a willingness to make sacrifices for the betterment of the environment. Participants also exhibited high levels of empathy and care for others, caring about misfortune and injustice.

## Preliminary Results of the Research

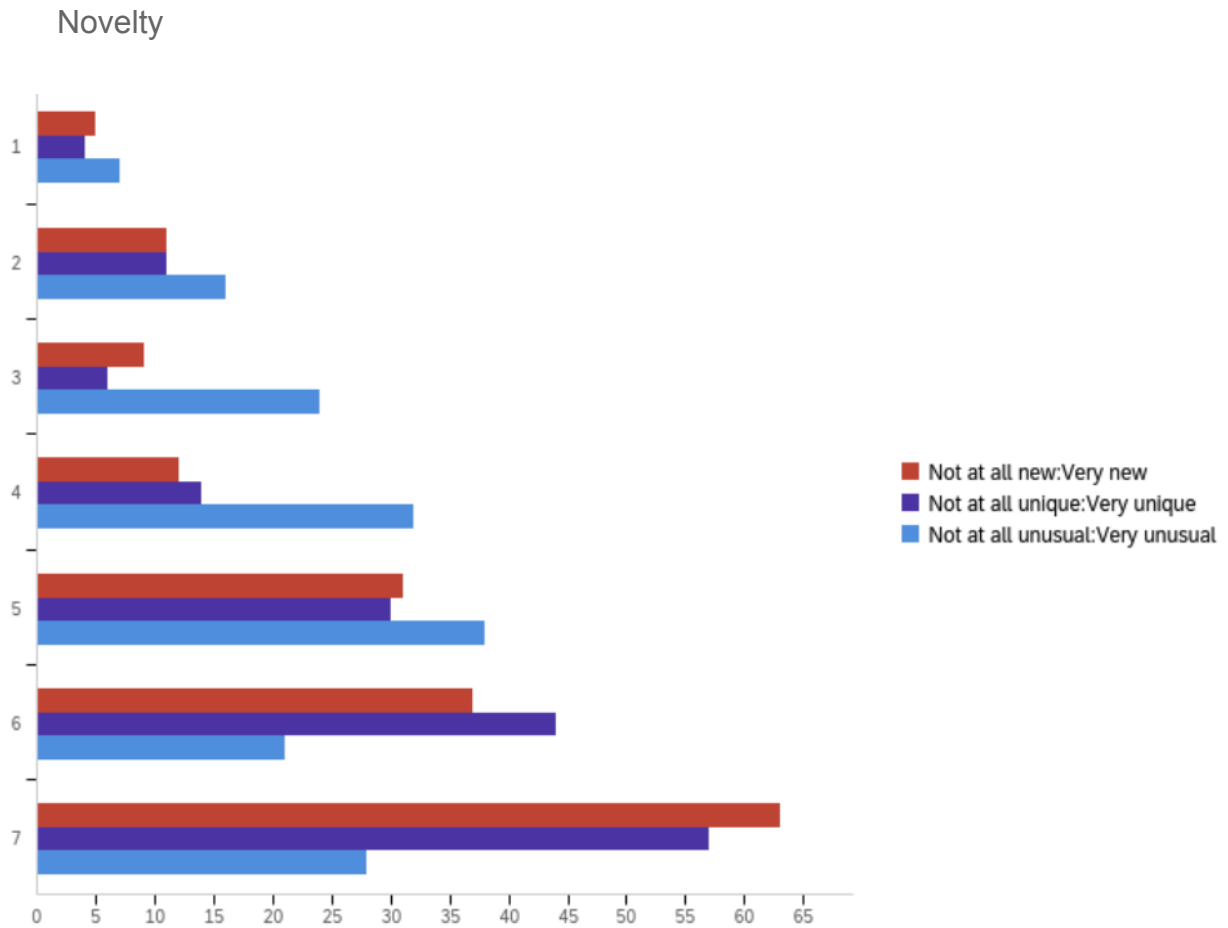
The following survey results were recorded after both the screen and VR control group participants exited the learning experience. When asked about their reactions to the learning experience, participants said the following: The first analysis will be the combined results of all participants from both the VR and screen control groups. After sharing the results of the participants as a whole, a comparison will be made between the control groups. And finally, a rationale for the results will be presented and discussed.

## Positive and Negative Affect Schedule (PANAS)



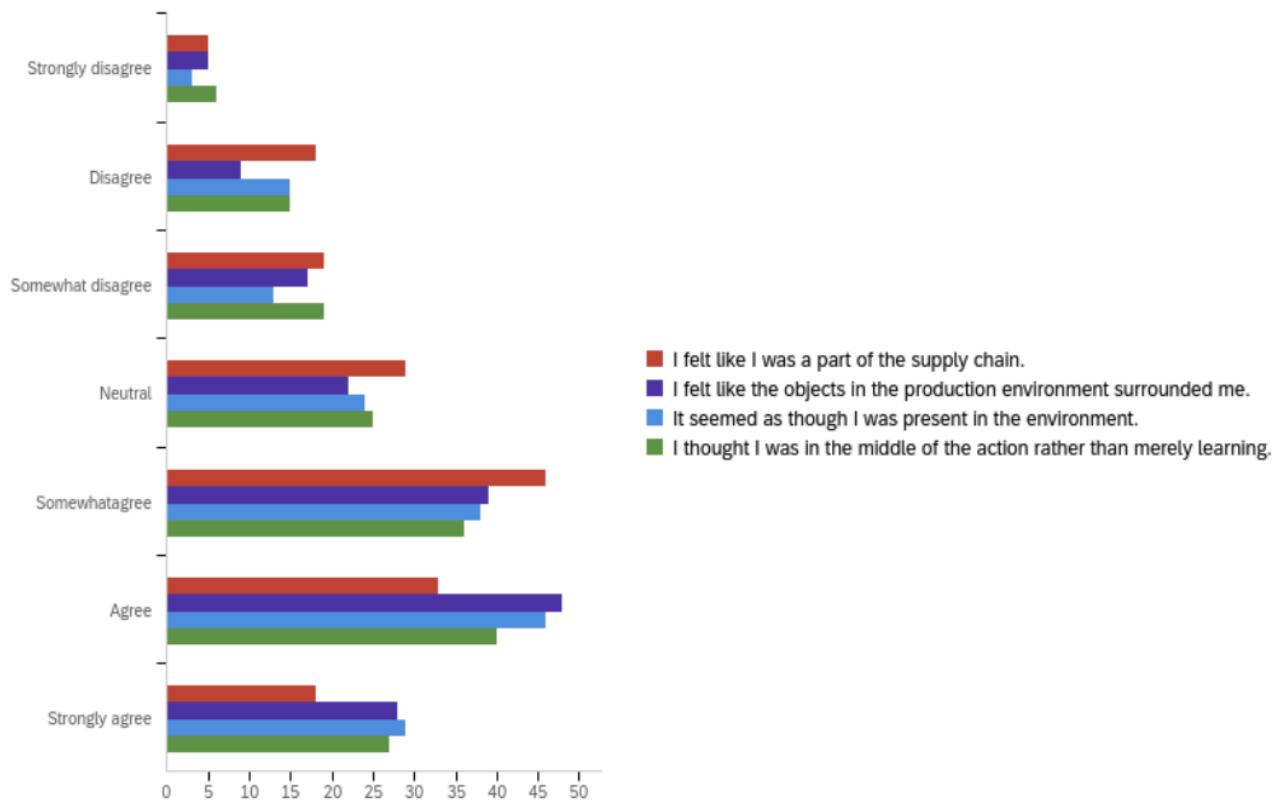
Participants reported feeling a variety of emotions and sensations throughout the experience. The feeling reported at the highest level was *interested*, and the lowest was *good*. Ranked in order of appearance and intensity, the top ten feelings and emotions are: *interested*, *moved*, *captivated*, *inquired*, *delighted*, *enthusiastic*, *appealed*, *satisfied*, *amused*, and *puzzled*. The lowest (least and weakest) emotions ranked by appearance and intensity were *bewildered*, *scared*, *nervous*, *resentful*, *furious*, *guilty*, *angry*, *comfortable*, *worried*, *bad*, and *good*. One would expect the opposites of *bad* and *good* to not be adjacent in such a ranking, which sheds light on the strong associations that can be attached to each term. It is therefore important to take from this a general overall sense of the participants' reported experiences.

The data shows that participants were having an experience that could be described as engaging. It is also important to note that the experience did not cause harm in the form of emotional distress.



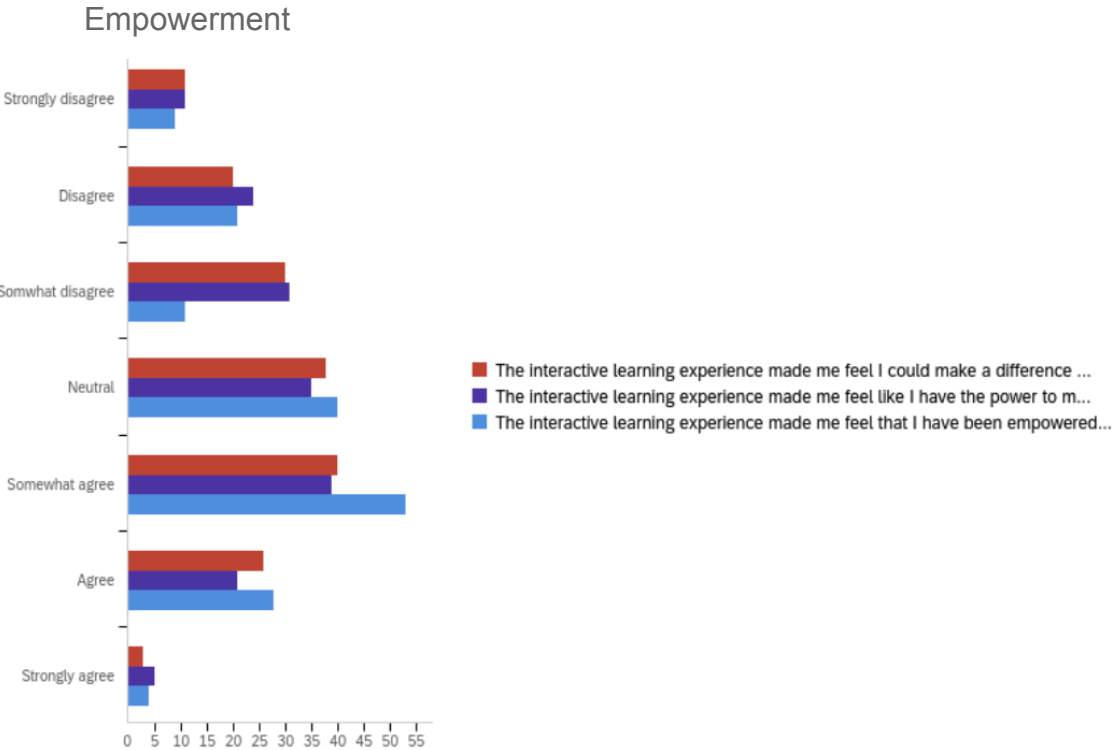
On a scale from 1 to 7, with 1 representing the lowest level of novelty and 7 the highest, 63 participants described the experience as very new and 57 as very unique. Unusual was reported in a neutral position by 70 participants, which could be explained by the content being somewhat familiar but the delivery system (even in the screen control) being more novel.

## Immersion and Contextual Relationships



Participants reported feeling very high levels of immersion, with 67.26% feeling as though they were "present in the environment" and 68.45% reporting feeling that "objects in the production environment surrounded them" High reports of immersion can indicate high levels of active engagement. The next page outlines the social and emotional results of participants feeling connected to people within the experience. Participants at relatively even rates described feeling both near and far to people. This points to an interesting contrast in cognitive states: participants are more likely to connect to and feel immersed in environments and less connected to and empathetic towards people within VR..

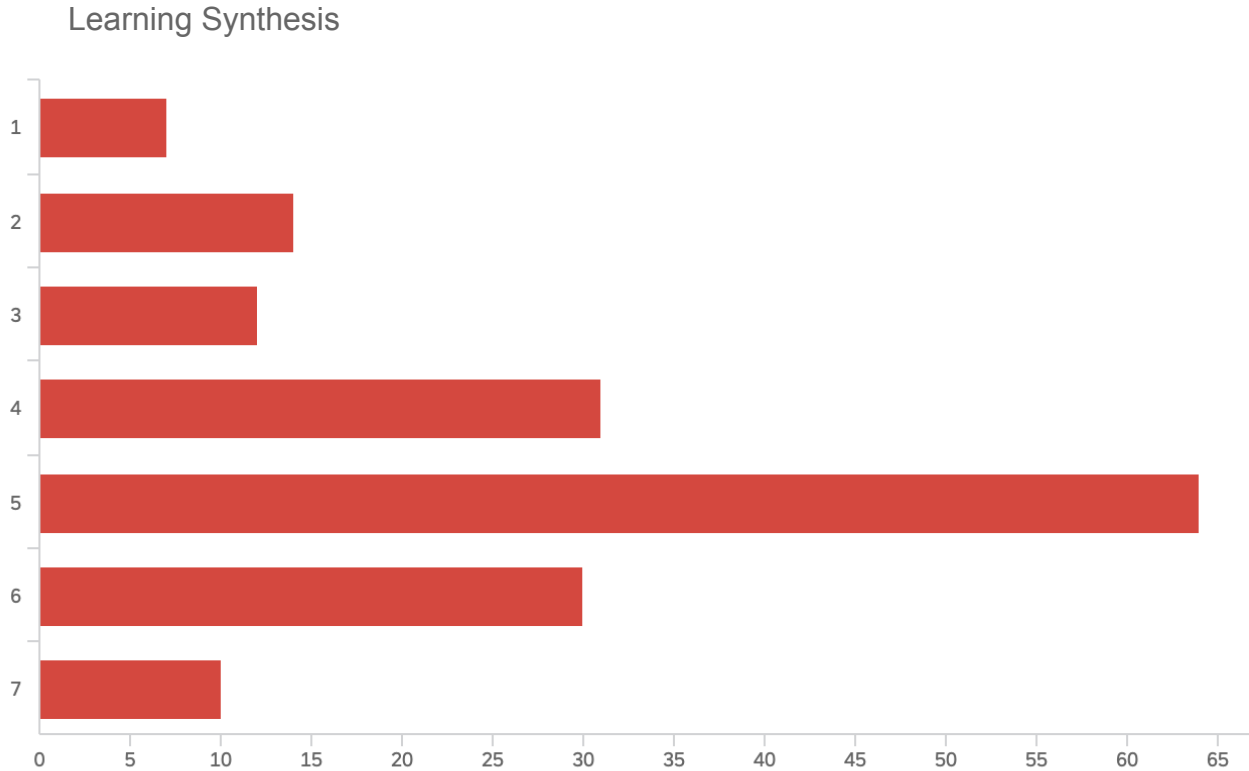




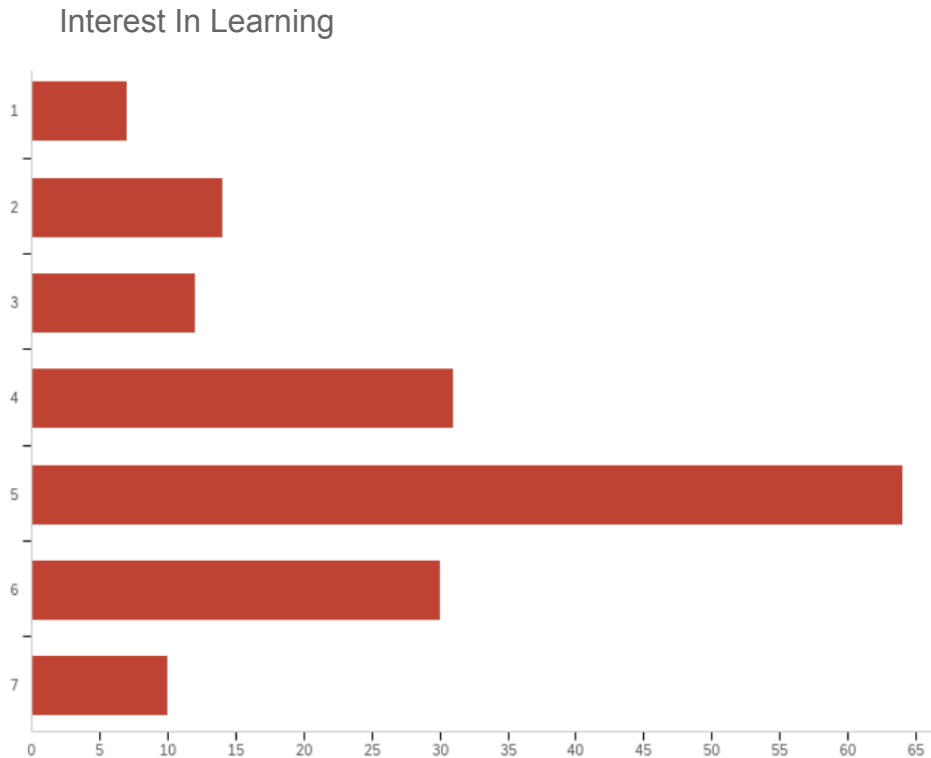
How much do you agree or disagree with the following statements concerning your learning experience?

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
The interactive learning experience made me feel <b>I could make a difference</b> in improving the Fashion Supply Chain.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The interactive learning experience made me feel like <b>I have the power</b> to make the Fashion Supply Chain <b>better</b> .	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The interactive learning experience made me feel that <b>I have been empowered</b> to improve the Fashion Supply Chain.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The three questions in this section seek to ascertain the participant's sense of empowerment in relation to the experience. The cue "I could make a difference" correlates to the potential for future empowerment and change, "I have the power" correlates to the current state of imbued power, and "I have been empowered" relates to a sense of power being endowed as a result of the experience. The strongest level (52.21%) of empowerment was reported in response to the cue, "I have been" empowered, which signifies that as a result of the experience, a shift has taken place and a sense of empowerment has grown.



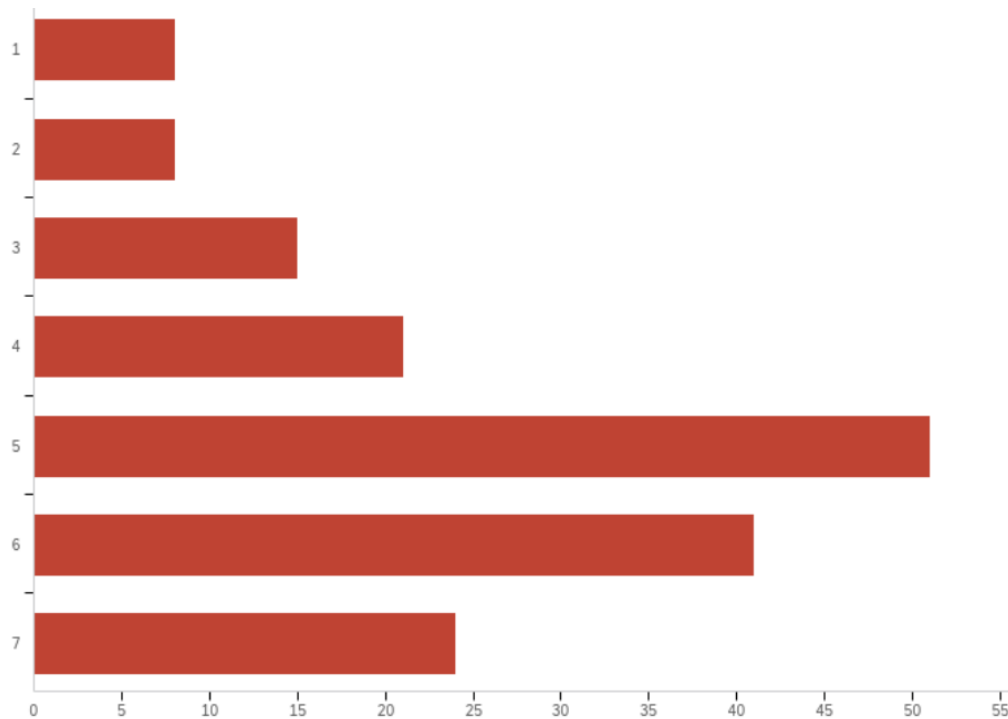
When asked, “To what extent did the interactive learning experience contribute to better understanding the supply chain in fashion?” (1 being the lowest level of learning and 7 being the highest) 76.79% of participants reported a high to very high level of learning taking place as a result of the VR experience. 20.24% of participants reported the highest level of learning took place. This level of self-reported learning indicates that VR has high value as an educational tool.



Participants reported a high interest in large numbers and a desire to learn more about the material covered in the experience. This information, especially when combined with the above, indicates that VR is not only an effective tool at educating but also a valuable tool in sparking interest and leaving participants seeking further knowledge as a result of an interactive VR experience. The results below depict a high likelihood of thinking back on the experience when they purchase clothing. This suggests a connection to the content of the experience and real-world interactions, such as clothing consumption.

The combination of participants describing high levels of immersion and connecting this experience to actions and behaviors in their lives signals that VR is a tool that could be effective in shaping behavior change. Another element that supports this theory is that participants anticipate high levels of experience retention and future referencing. This information retention and future referencing could be a key to altering long-term habits, as the VR experience may embed in long-term memory more thoroughly than other traditional forms of information delivery such as lectures or audiovisual presentations.

## Reflection



When asked, “How likely will you think back to the learning experience the next time you buy fashion?” 69% of participants indicated a likelihood to reflect on the experience. This indicates a connection between learning material and behavior, clothing purchase, and demonstrates that not only has learning been absorbed and synthesized, but contextual relational pathways between material (learning) and behavior (shopping) were formed with predicted long term effects (future reflection).

When asked, “How likely will you talk about the supply chain in fashion the next time you see your friends?” 46.42% of participants reported a likelihood to discuss the material from the VR experience. This result when combined with the reported high (69%) likelihood to refer back to the experience material when shopping, and a high level of learning (76.9%) taking place, the results indicate a strong likelihood that behavior shifts have occurred.

## Behavior Nudge

Thus far, the results of the participants' responses in regards to feelings, emotions, perceptions, empowerment, and learning have been discussed. However, the original inquiry centered around behavior change: "Could VR be an effective tool to shift behavioral patterns to more sustainable habits?" It is extremely difficult to estimate behavioral changes in a lab setting, and the stand-in for a change in behavior was the decision to give up an asset, in this case the \$10 payment, as a donation to aid in fighting the "wicked problems" within the fashion industry.

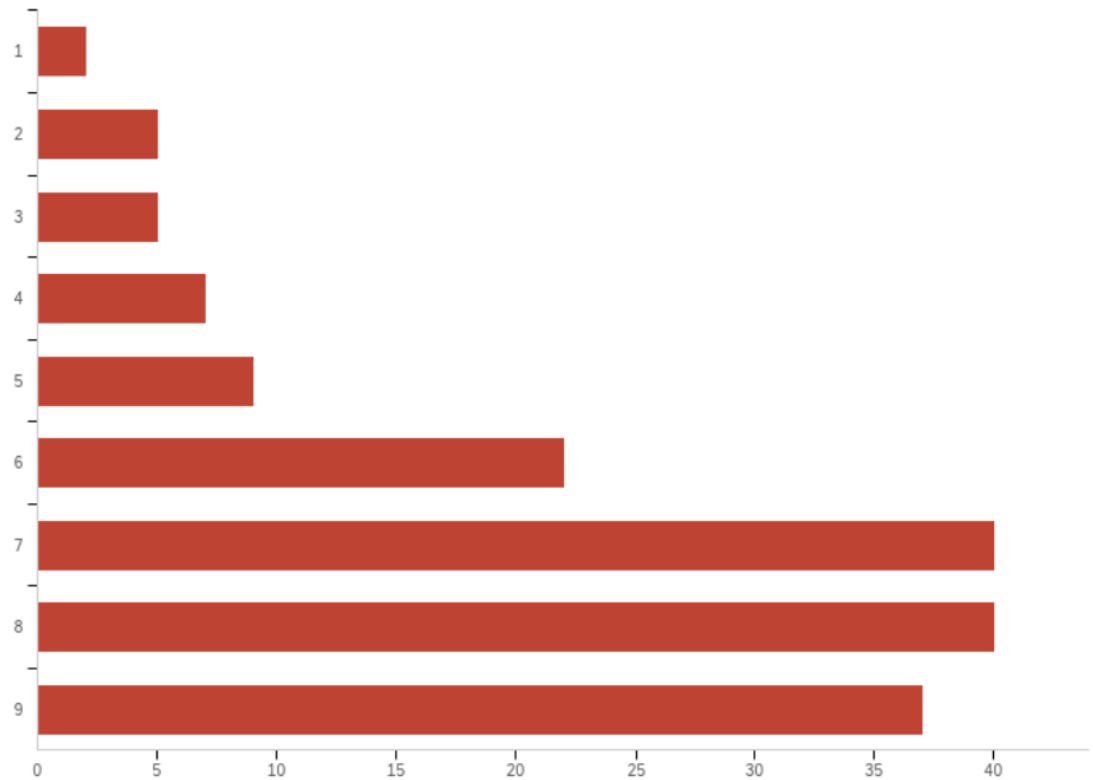
This element of the experiment design came directly from Tanya Rosenblat PhD. Rosenblat is a professor at the University of Michigan whose research centers on experimental economics. Rosenblat was consulted on the experiment design, specifically asked for a way to gauge a shift in consumer behavior habits within a lab setting. Rosenblat argued that since all research had to be complete in one day that giving participants \$10 would trigger the endowment effect, and thus asking them to give back their money in the form of a donation was a valid signifier of real world behavior, and could be used to gauge a behavior shift.

The option to donate to the UN Alliance for Sustainable Fashion (UNAfSF) was embedded into the study to test potential behavior change. The rationale was that when participants placed their cash payments into the donation box as they exited the study, this action would signify future behavior.

A survey question asking about the likelihood of donating to the UNAfSF was asked before participants engaged in the VR experience to gather a baseline of willingness to donate. After the VR experience, participants were asked how much they would like to donate. This date set enabled us to see if a measurable shift had taken place.

### Likelihood to Support

likelihood - How likely would you be to support the 'United Nations Alliance for Sustainable Fashion' in achieving their goals (such as improving working conditions or fighting pollution and environmental issues within supply chain in fashion)?



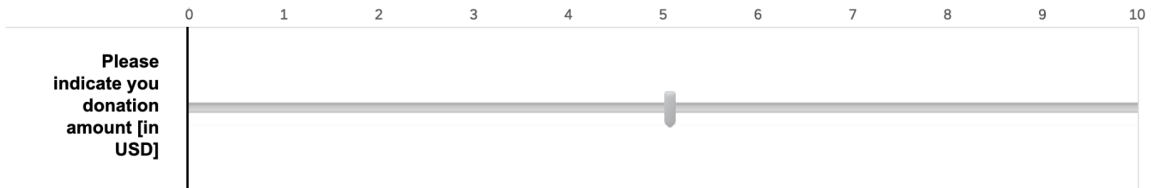
Participants reported a 70% likelihood of donating to the United Nations Alliance for Sustainable Fashion (UNAFSF). The following was the information that was given to participants about the organization, along with an embedded copy of the UNAFSF website.

## Actual Donations

How much of your current payment (i.e., 10 Dollars laying in front of you) are you willing **to donate** to the **'United Nations Alliance for Sustainable Fashion'** HERE AND NOW?

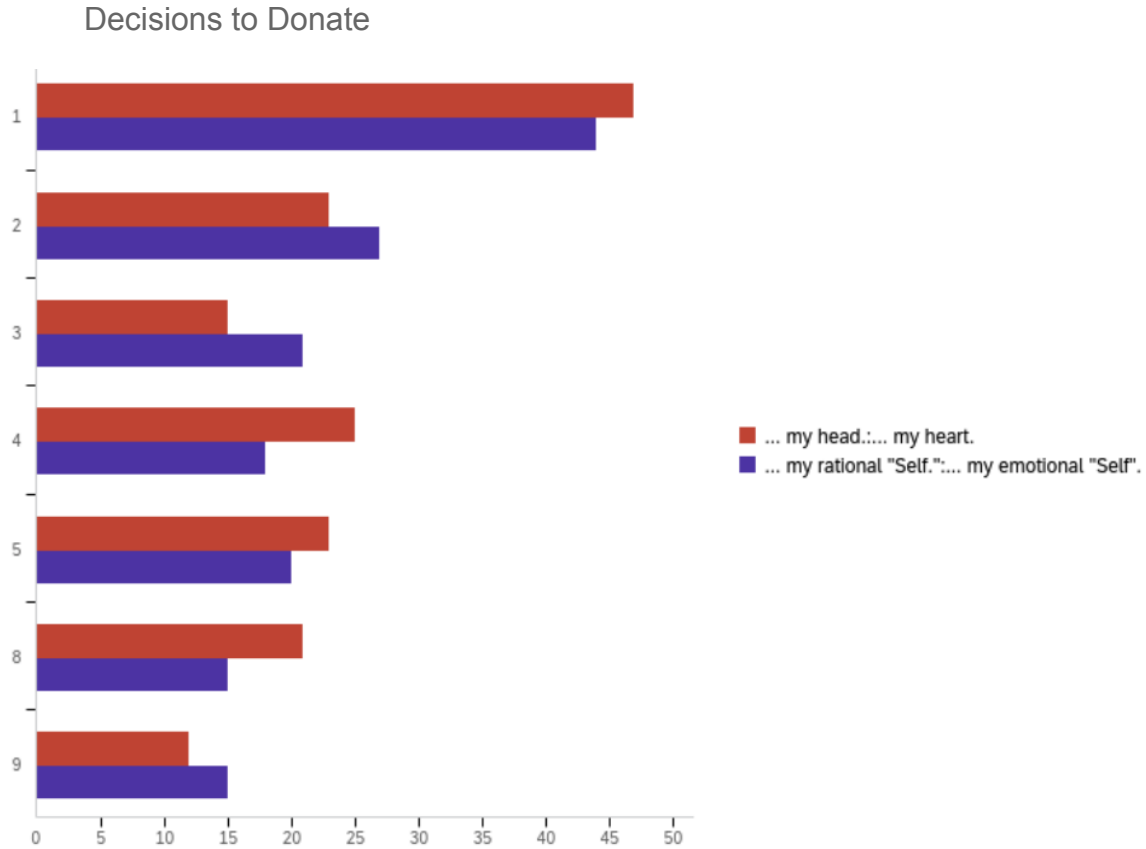
**Reminder:** We will donate all participant shares to the **'United Nations Alliance for Sustainable Fashion'**; the **difference** will be **your new payment** for this study.

There is a donation box for the **United Nations Alliance for Sustainable Fashion'** at the front of the Room! **All proceeds will be DONATED.**



Participants used the slider to select how many, if any, of the dollar bills they were willing to donate. These donations were collected as participants left. The total amount of all donations came to \$283 out of a possible \$1,560.





Decision-Style

My decision to donate or not to donate was driven by ...



When asked about the motivation for donations, the participants answered that their decision to donate was driven by an intellectual, rational motivation rather than an emotional motivation. Combined with the highly reported feelings of interest, captivation, and inquiry, and with 77% of participants having experienced learning and reporting a higher level of understanding of the fashion supply chain, this can be interpreted as indicating that the decision to donate came from an intellectual understanding. This is an important finding because it points to the act of donation as being the result of a rational decision, and thus the experience was not manipulating participants into making emotional behavioral decisions. The combination of findings also indicates that the decision to donate is a viable stand-in for long-term behavioral shifts to support more

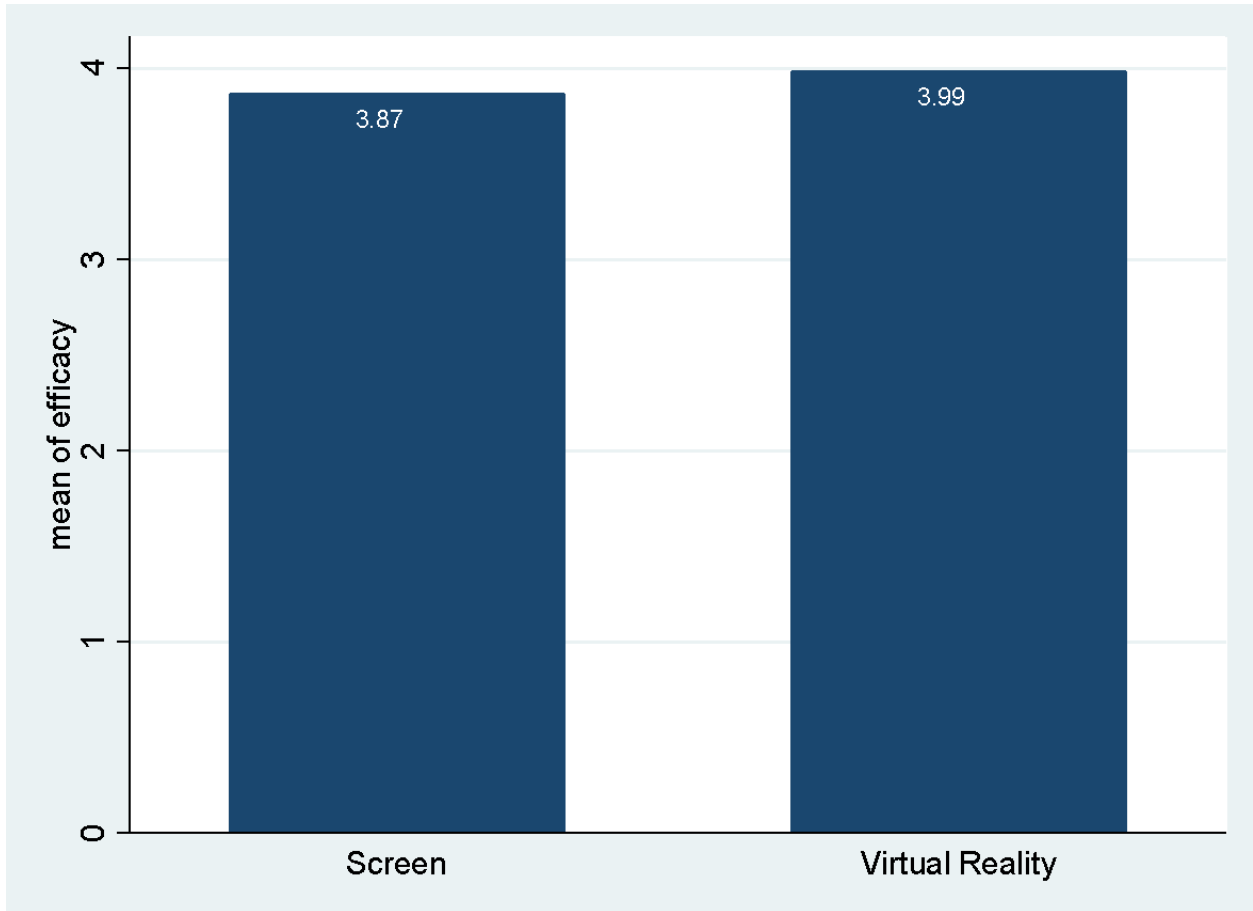
sustainable behaviors versus a novel short-term emotional reaction, due to the intellectual motivation, high level of new understanding, as well as the high levels of predicting a return to the experience material when faced with a clothing-based purchase decision.

## Results: Control Screen Group vs. VR Group

The following are comparisons between control groups. The screen group and the VR group were randomly assigned and evenly distributed. In the hourly runs of the experiment the number of participants were split between screen and VR each run. Both groups had the same experience, and filled out the same survey. The only difference between each group was the delivery of the immersive learning experience, *Woven: A VR Journey of Jeans*. The screen group interacted with the experience on a laptop computer as pictured in Figure 58. Screen users could click and drag to explore in 360° using a mouse. VR users were given an Oculus and interacted with the experience in private rooms as seen in Figures 59 & 60.

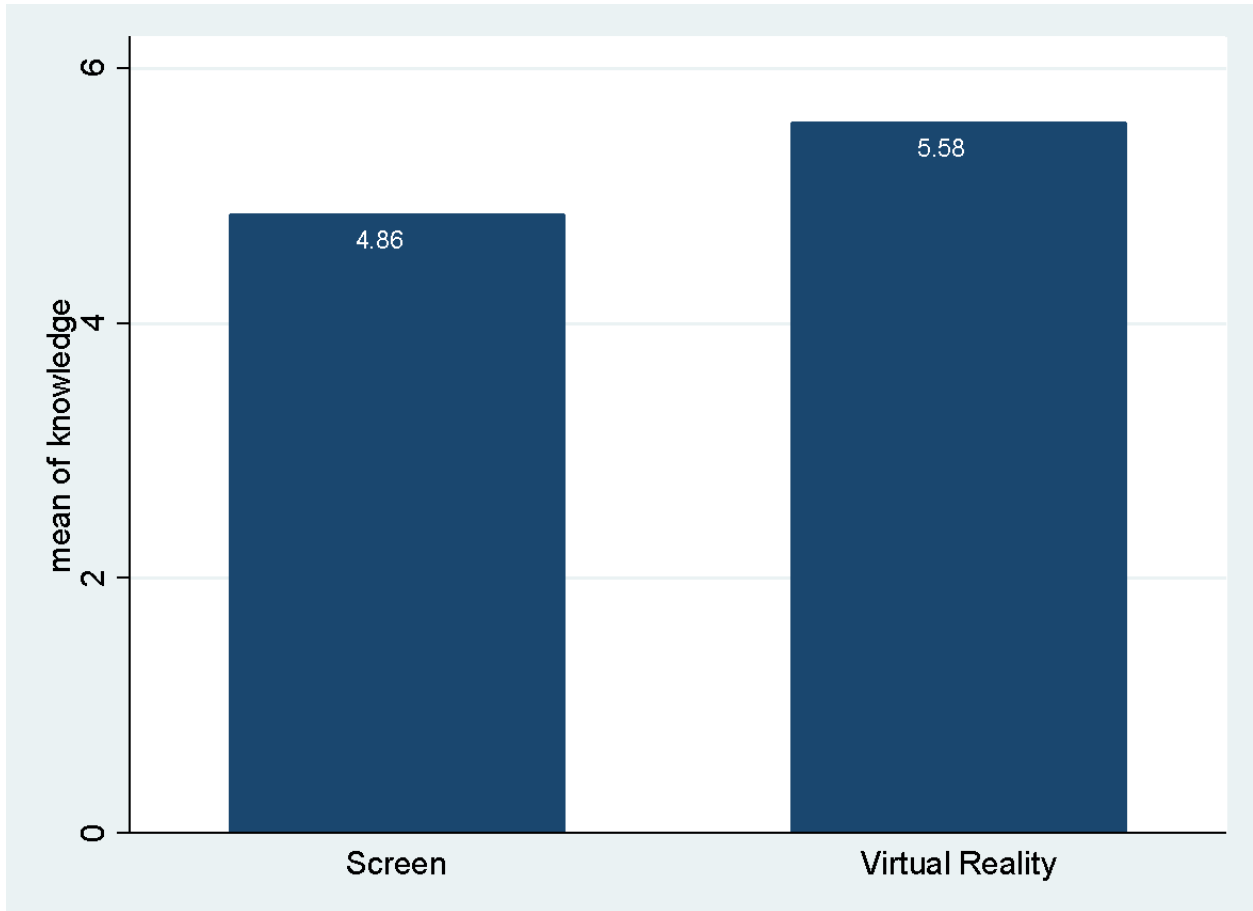
The original research hypothesis was that the VR group would report a higher level of learning, a more immersive experience, a stronger social and emotional connection and this would result in a higher level of donations.

## Difference in Empowerment



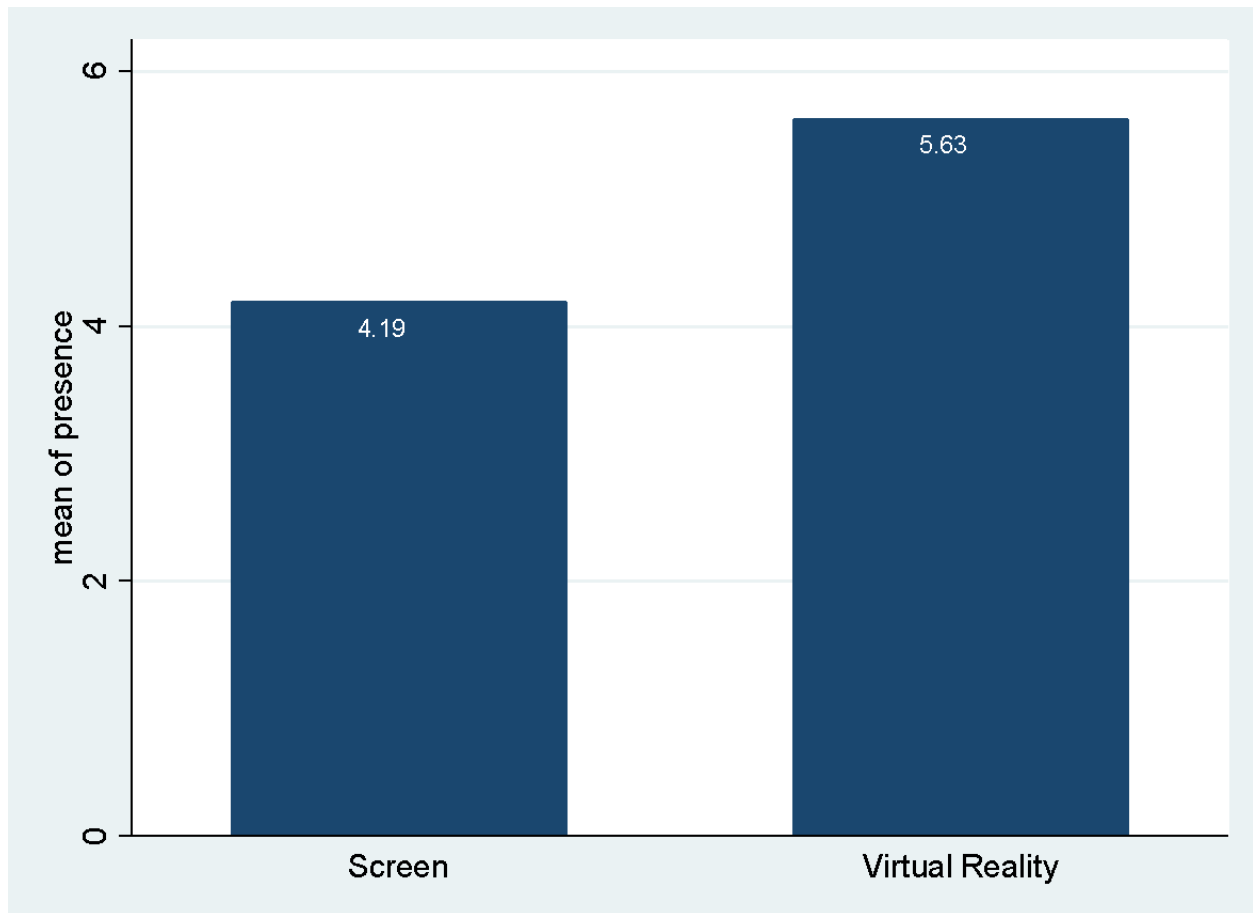
The screen and VR group reported experiencing near equal levels of empowerment as a result of experiencing the interactive learning experience. This was a surprise. It had been hypothesized that the VR group would report experiencing a higher level of empowerment.

## Knowledge Gained



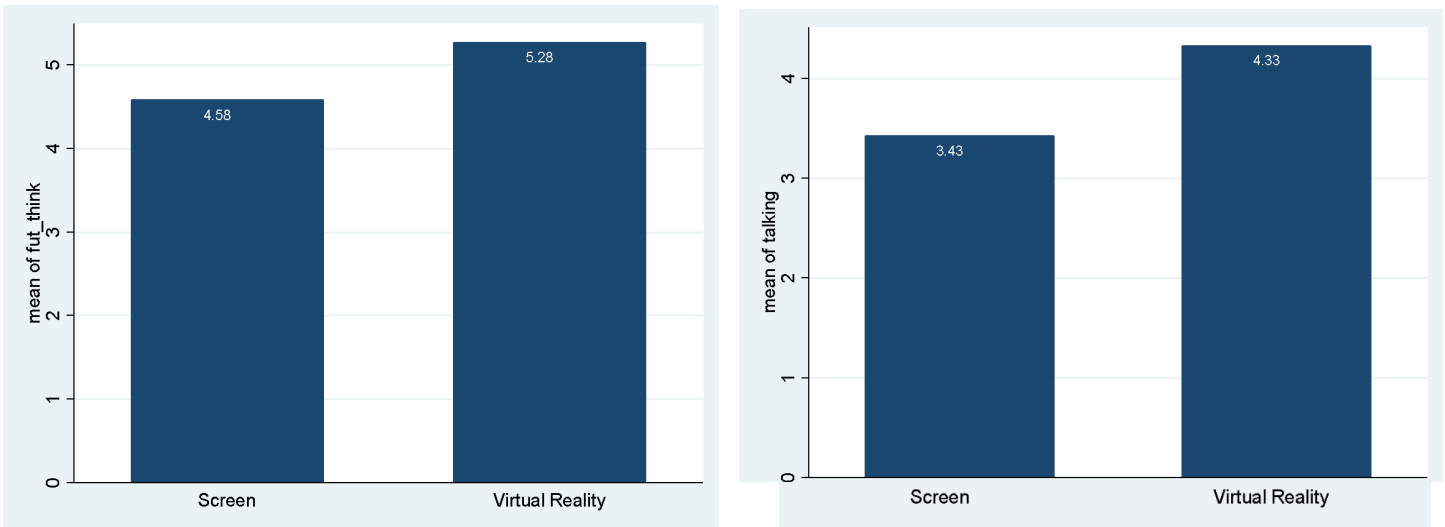
The VR group did report a higher level of knowledge gained as a result of the experience. This result was hypothesized.

## Social Emotional Connection



The VR group reported feeling a significantly higher level of social and emotional connection to the material and environments explored within the experience. This was as hypothesized. The theory for this increase in connection is due to the increased sense of immersion from the VR delivery.

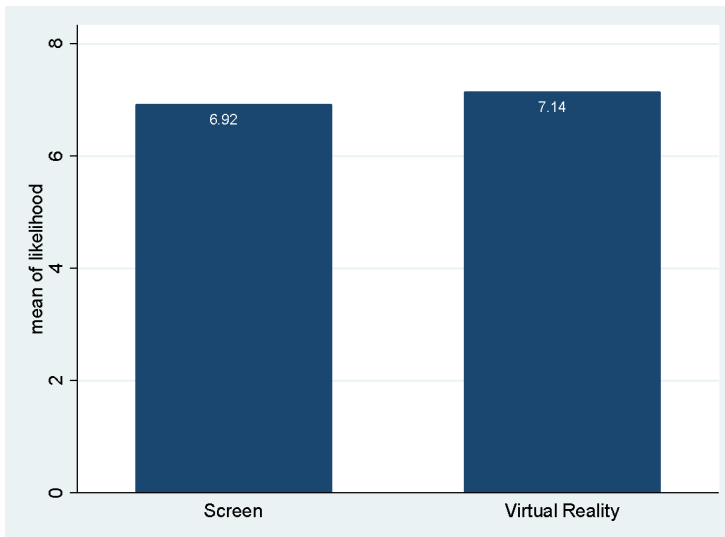
## Future Reflections



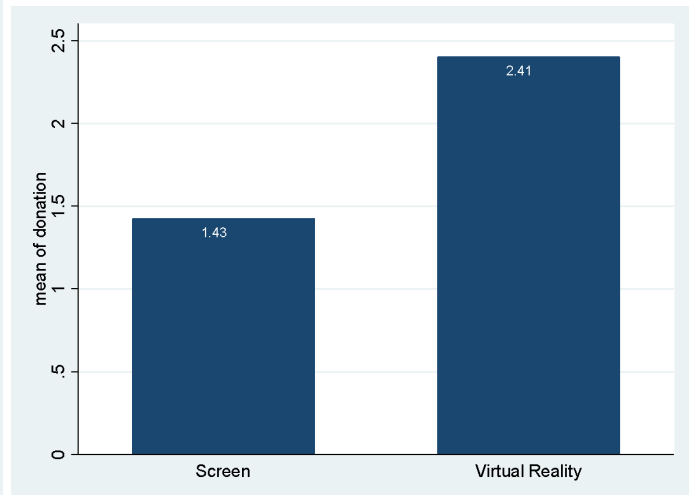
VR users reported a higher level of thinking back to the experience in the future. VR users also reported a higher likelihood of talking about the experience to their family and friends. These two results were as hypothesized. The result could be an effect of the novelty of the VR delivery method, or could also be due to increased levels of immersion and experience through VR. Further testing would need to be conducted with experienced VR users to rule out novelty as a factor in these results.



## Reported Likelihood of Donation vs Actual Donation



Likelihood of Donation



Actual Donation

Both VR and screen groups reported nearly the same likelihood to make a donation to the Un Sustainable Fashion Alliance. However, after interacting with the experience the VR group showed a statistically significant higher level of actual donations. This result was as hypothesized, and provides proof that VR is an effective tool in altering behavior.

## Conclusion of Research Findings

In conclusion, the study aimed to investigate whether VR could be an effective tool to shift behavioral patterns towards more sustainable habits. The study utilized a control group and a VR group, and both groups reported near equal levels of empowerment. However, the VR group reported a significantly higher level of social and emotional connection to the material and environments explored, as well as a higher level of thinking back to the experience and discussing it with others.

The study also used the decision to donate money to measure behavior change, as a way to gauge the participants' willingness to engage in sustainable practices. The VR group showed a statistically significant higher level of actual donations, indicating that VR can be an effective tool in altering behavior towards more sustainable practices.

Although the study was limited to a lab setting, the results suggest that VR can be a valuable tool in promoting sustainable practices and behavior change. Further research is necessary to confirm the results and determine the extent of VR's impact on sustainable behavior.

## Conclusion

In conclusion, this project utilized a systems design approach to identify wicked problems in the fashion industry and pinpoint an intervention point for shifting consumer behavior towards more sustainable practices. This project was a successful combination of PAR and DfSB methodologies and contributed original knowledge to the field of Integrative Design. Through the integration of innovative technology and design methodologies, a VR experience was created that focused on the creation of a pair of jeans and tested on 156 people in a lab setting.

The findings of the study revealed that 85% of people care about the environment and 77% are willing to make changes to support sustainable habits reflective of the UN SDGs. The VR experience proved to be an effective tool for nudging habits, particularly when there is already a desire to adopt new habits present. Moreover, VR delivered through a headset demonstrated a greater impact on actionable behavior compared to the experience on a screen.

This project contributes original knowledge in the field of Integrative Design by demonstrating the effectiveness of VR as a tool for promoting sustainable behavior change. The results suggest that VR experiences can be a valuable addition to sustainable design interventions, particularly in cases where there is a desire to engage and educate consumers about the impacts of their choices. VR delivered both on a screen and in a VR headset has positive learning benefits. Further research is necessary to confirm these findings and explore the potential of VR in promoting sustainable practices in other industries beyond fashion.

## Future Work

There are plans in place to continue using Woven: A VR Journey of Jeans in lab experiments. Plans to conduct experiments in other countries are being developed, with the focus being cross culture comparison. A version of Woven has been adapted by Ryan Koepp, a Graduate Student XR Fellow at the Center for Academic Innovation

at the University of Michigan for use in the classroom. In the Winter 2023 semester it was utilized in M'Lis Bartlett, Professor at the School for Environment and Sustainability, course Introduction to Environmental Justice.

In the next year I plan to continue working as a creative director and as a VR developer. I have been engaged as an Art Director for Guerilla Science, a collaborative art science organization, to design a live interactive experience taking place in the fall of 2024. Work with David Finken, the research partner with whom I collaborated on the lab portion of this thesis project, is being planned for the summer of 2023. David and I are investigating incorporating VR and AR into further lab based research. One project being discussed is an investigation into sensory drivers in VR, specifically the inclination to reach a level of immersion where one is driven to try to smell elements in virtual reality. In the fall of 2023 I will apply for a Fullbright scholarship to continue research into sustainability based innovations within the fashion industry.

Post MDes I seek to incorporate the fundamentals learned as part of the Master's of Integrative Design degree, closely following the systems of analysis, design methodology, prototyping and iterative design as a foundation for all future work. I continue thinking about whether I wish to return to work inside the system or work outside the fashion industry, but in either position I will continue to work to redesign the system of fashion to promote a more sustainable future.

## Appendix 1

### A Brief History of the Fashion Industry and its Impact on Sustainability

The fashion industry has undergone significant changes since the Industrial Revolution, with advancements in technology, transportation, and communication enabling the mass production and distribution of clothing. The Industrial Revolution marked a turning point in the history of the fashion industry. The development of textile machinery, such as the spinning jenny and power loom, enabled the mass production of clothing, reducing the cost and increasing availability of clothing.

The 20th century saw significant changes in the fashion industry, with the emergence of fast fashion and the globalization of clothing production. The rise of fast fashion enabled retailers to produce clothing quickly and cheaply, fueling a culture of overconsumption and disposability. Consumers began to purchase clothing more frequently, with many items of clothing only worn a few times before being discarded. In the last 15 years, clothing purchases have increased by 60%, and up to 50% of fast fashion purchases are discarded within a year.

Fast fashion refers to a business model in the fashion industry, where clothing manufacturers and retailers produce and sell trendy, low-cost clothing that is quickly and frequently updated to keep up with the latest fashion trends. The production process is typically done at a rapid pace, using cheap materials and labor, in order to offer the latest styles at extremely low prices, with companies making profits by harnessing low margins and mass sales. Fast fashion companies often prioritize speed and profit over ethical and sustainable practices, resulting in negative environmental and social impacts.

This shift towards fast fashion and overconsumption has had significant, negative impacts on sustainability. The fashion industry is now one of the largest contributors to environmental pollution, with clothing production and disposal contributing to water pollution, greenhouse gas emissions, and waste. The industry also has a significant social impact, with exploitative labor practices and poor working conditions prevalent in many developing countries where clothing is produced. The rise of online shopping has

also contributed to the growth of fast fashion and overconsumption, with retailers offering rapid delivery and a constant stream of new products to feed and grow consumer demand.

The fashion industry's history has been characterized by a constant drive towards increased efficiency and mass production, as well as constant growth. While these developments have enabled the production of affordable clothing and increased access to fashion for many people, they have also had significant negative impacts on sustainability. The rise of fast fashion, overconsumption, and the globalization of clothing production have contributed to environmental degradation, social injustices, and waste.

## Appendix 2

### The Fashion Industry and the United Nations Sustainable Development Goals (SDGs)

The United Nations Sustainable Development Goals (SDGs) are a set of 17 goals that were established in 2015 to provide a blueprint for a more sustainable future. The goals cover a wide range of issues, from poverty reduction and gender equality to environmental sustainability and economic growth. When sustainability is discussed here within it is a reference to the entirety of the 17 SDGs. The following goals build a framework as well as a definition of what is required to achieve a state of “sustainability”. The fashion industry, as one of the largest and most influential industries in the world, has a significant role to play in achieving the SDGs. However, the industry is falling short in meeting many of the goals.

One of the primary goals of the SDGs is to eradicate poverty in all its forms. However, the fashion industry has been criticized for perpetuating poverty through exploitative labor practices and low wages in developing countries. Many garment workers, particularly women, work in hazardous conditions, receive very low wages, and lack basic rights and protections. This not only perpetuates poverty but also contributes to gender inequality, which is a critical issue addressed in SDG 5.

#### **SDG 2: Zero Hunger**

SDG 2 aims to end hunger, achieve food security and improve nutrition. The fashion industry is a significant contributor to food waste and, in turn, hunger. For example, the use of cotton, a primary material in fashion, requires vast amounts of water and land, which can have negative impacts on food production. Additionally, the industry's reliance on fast fashion and the production of clothing in large quantities has contributed to overconsumption and waste, resulting in the disposal of clothing and textiles that could be repurposed or recycled.

#### **SDG 8: Decent Work and Economic Growth**



SDG 8 aims to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. The fashion industry has a significant role to play in achieving this goal by providing decent work and employment opportunities. However, the industry's exploitation of workers in developing countries, as mentioned earlier, undermines this goal.

### **SDG 12: Responsible Consumption and Production**

SDG 12 aims to ensure sustainable consumption and production patterns. The fashion industry's overconsumption and fast fashion practices have resulted in massive amounts of waste and pollution. The industry is the second-largest polluter in the world, emitting more greenhouse gasses than aviation and shipping combined. Furthermore, the industry's production of synthetic fibers, such as polyester, contributes to the pollution of waterways and oceans. The industry must adopt more sustainable and circular production methods to achieve SDG 12.

### **SDG 13: Climate Action**

SDG 13 aims to take urgent action to combat climate change and its impacts. The fashion industry is a significant contributor to greenhouse gas emissions, water pollution, and other environmental issues. The industry must take significant steps to reduce its carbon footprint, promote renewable energy, and adopt circular economies to achieve this goal.

### **SDG 14: Life Below Water**

SDG 14 aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development. The fashion industry's production of synthetic fibers and microplastics has contributed to water pollution and ocean acidification, threatening marine life and ecosystems.

The fashion industry's impact on the SDGs is significant, and it is clear that the industry as a whole is not meeting many of the goals. Achieving the SDGs will require a collective effort from industry leaders, policymakers, and consumers, and historically this has been waylaid by the complex global nature of the industry.

## Appendix 3

### Policy and Regulations in the Global Fashion Industry

The global fashion industry has a significant impact on the environment and society, and as a result, policymakers have developed regulations and policies to address these issues. The fashion industry has historically been self-regulating, with little government intervention. However, concerns about the industry's environmental and social impact have led to increased regulatory efforts in recent years. The first significant policy intervention in the fashion industry came in the 1970s, with the passage of the Clean Water Act in the United States. This legislation targeted textile dyeing and finishing operations, which were significant contributors to water pollution.

Since then, regulations and policies have been developed at both national and international levels to address environmental and social issues in the fashion industry. Examples of such regulations include the European Union's REACH regulation, which aims to reduce the use of hazardous chemicals in textiles, and the United Nations' Guiding Principles on Business and Human Rights, which provide guidelines for companies to respect human rights throughout their supply chain.

Currently, regulations and policies in the fashion industry are diverse and often fragmented. Different countries and regions have varying levels of regulation, which can create challenges for companies operating globally. For example, the European Union has strict regulations on chemical use in textiles, while many Asian countries have laxer standards.

The fashion industry also faces significant pressure from consumers and civil society to adopt more sustainable and ethical practices, which has led to the development of voluntary standards and certifications. Examples of such certifications include the Global Organic Textile Standard (GOTS) and the Better Cotton Initiative (BCI), which aim to promote sustainable and ethical practices throughout the supply chain.

Regulations and policies in the fashion industry are increasingly being used to address the SDGs. For example, the EU's Circular Economy Action Plan aims to

increase the use of sustainable materials and reduce waste, contributing to SDG 12: Responsible Consumption and Production. Additionally, the United Nations' Fashion Industry Charter for Climate Action aims to reduce the industry's greenhouse gas emissions, contributing to SDG 13: Climate Action.

Enforcing regulations in the fashion industry is a significant challenge. The industry's global nature makes it difficult for regulators to monitor and enforce compliance, particularly in countries with weaker regulatory environments. Additionally, the complexity of the fashion supply chain, with multiple tiers of suppliers and subcontractors, can make it challenging to trace and regulate production practices.

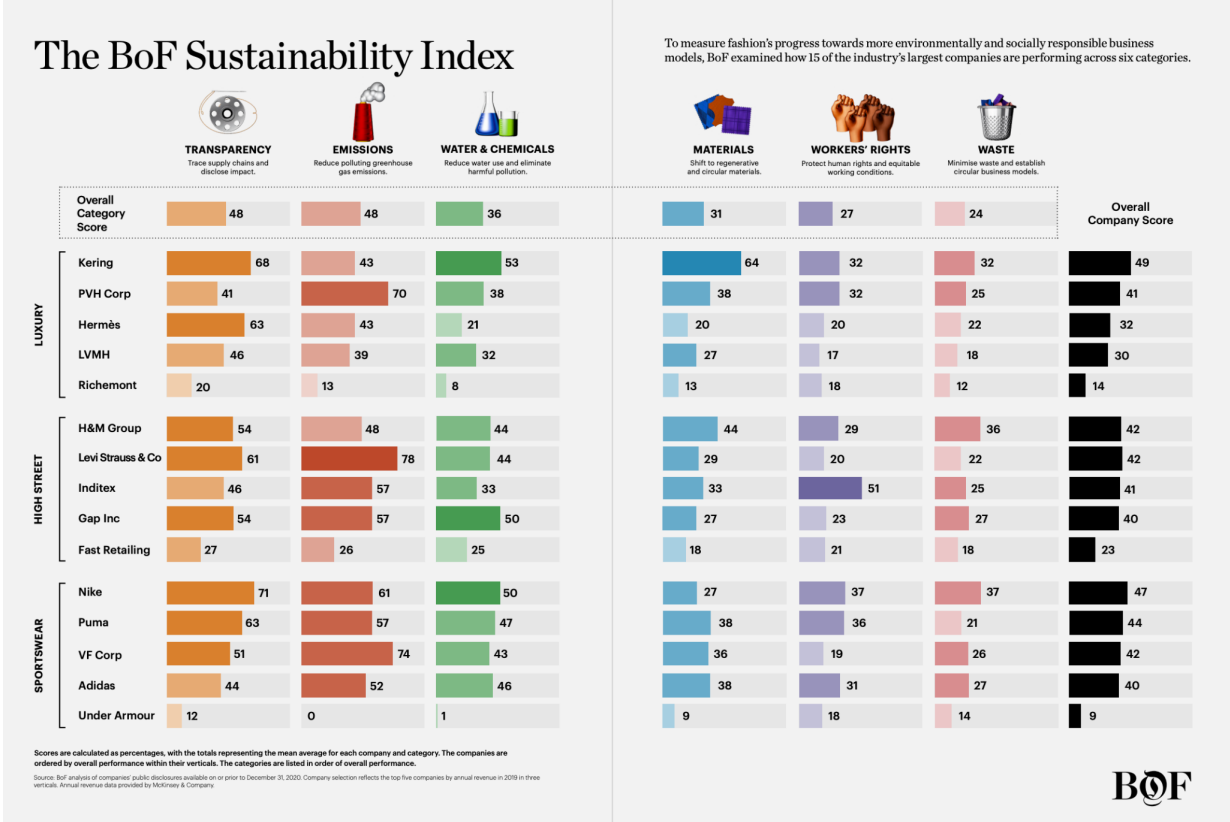
Regulations and policies in the fashion industry are increasingly being developed to address the environmental and social impacts of the industry. While regulations can create challenges for companies, they can also provide opportunities for innovation and differentiation. However, enforcing regulations in the global fashion industry remains a significant challenge, and will require cooperation between governments, industry actors, and civil society to ensure a more sustainable and ethical industry.

## Appendix 4

### Roadblock to Achieving Sustainability in the Fashion Industry

#### **Current Supply Chain, Lack of Transparency, and its Impact**

Historically there has been a global breakdown of transparency and accountability between corporations, their complex system of supply chains and manufacturers. It is extremely difficult to gain a firm understanding of the current situation because most of the fashion industry is a closely guarded opaque and complex network. “Companies largely continue to rely on voluntary initiatives and private auditing firms, notwithstanding criticism that this approach has historically acted as a self-regulated corporate fig leaf and failed to bring about real change.” (Business of Fashion, Sustainability Index 2021). The Business of Fashion, a leading reporter on the industry, produced a Sustainability Index in 2021. The aim of this report is to review 15 companies and chart their positions using the matrices of transparency, emissions, water & chemicals, materials, workers rights, and waste. It should be noted that this index is based on self reports from the individual companies. As you can see in the chart below there is great room for improvement, and this directly addresses the need for “making justice” within the specific areas of environmental justice, workers rights, safety and economic security.



Sustainable and Fairtrade models exist within the current marketplace but they struggle to take hold and form a significant share of the market (Niinimaki, 2020). Currently Sustainable Fashion represents a very small percentage of goods available for purchase. The greater the share of the market these products represent the greater the benefit to the growth of a global generative economy and significant environmental recovery.

The fashion industry needs to fix its misinformation problem by creating truly transparent supply chains and publishing quality data. Many of fashion's biggest companies still don't know or don't disclose where their products come from, and the further down the supply chain you go, the more opaque things become. This enables exploitation and human rights abuses and creates difficulties measuring the industry's environmental impact. More and better information is needed to enable strategic decisions that drive change (BoF Sustainability Index 2021).

Business of Fashion, Sustainability Index 2021, [https://cdn.businessoffashion.com/reports/The\\_Sustainability\\_Index\\_2021.pdf](https://cdn.businessoffashion.com/reports/The_Sustainability_Index_2021.pdf)

**Exhibit 4: Supply Chain Opacity**

The complex and opaque tiers of fashion's supply chain make it challenging to trace the origin of products and components.

Sustainalytics' research shows that out of 457 researched companies in the retailing and apparel sector, only 5% have disclosed a strong supply chain management program with monitoring and auditing practices and detailed reporting on their supply chain performance. Sadly, 56% of researched companies do not disclose supply chain management programs. (Sustainalytics, <https://cdn.businessoffashion.com/rep>)

*“The transparency analysis reveals what environmental professionals have long feared: most companies are still neither collecting nor disclosing the information they need to reduce their environmental footprint. Moreover, the quality of the data they do manage to collect is widely acknowledged to be unscientific and unreliable — self-reported and seldom verified by third parties. Until this changes, companies’ commitments to reducing their environmental impact cannot be taken seriously. How do you craft a reduction plan without quantifying a starting point? How do you identify where to target reduction initiatives? How do you track progress, disqualify egregious polluters, curate your supplier base to reward less energy-intensive producers, develop minimum performance standards, or truthfully communicate with your customers or shareholders about your green performance? Public disclosure of this information, which would drive improvements in data quality and create accountability for progress, is still in its infancy but it is a foundational and urgent area for the industry to address.” Linda E. Greer USA Global Fellow, Institute of Public and Environmental Affairs  
Business of Fashion Sustainability Index 2021*

## Appendix 5

### Projections for the Global Fashion Market and their Impact on the UN SDGs

The global fashion market is projected to continue growing in the coming years, at a rate over 6% annually (Fashion United, 2023) driven by increasing demand for fast fashion and online shopping. This section will examine projections for the fashion industry's size and value over the next five, ten, and twenty years, and explore their potential environmental and social impacts in relation to the United Nations' Sustainable Development Goals (SDGs).

#### Five-Year Projections

Over the next five years, the global fashion market is projected to continue growing at a steady rate. According to a report by McKinsey, the market is expected to grow at a compound annual growth rate of 3.5% to 4.5% between 2021 and 2025, reaching a total value of approximately \$2.2 trillion by 2025 (McKinsey, State of Fashion, 2022). This growth is likely to have significant environmental and social impacts, particularly in relation to SDG 12: Responsible Consumption and Production. The continued growth of fast fashion and overconsumption of clothing is likely to lead to increased waste and pollution, exacerbating environmental problems such as climate change and ocean pollution (Earth.org, 2022). Additionally, the exploitation of workers and poor working conditions in the industry's supply chain could violate SDG 8: Decent Work and Economic Growth (Alden, 2021).

#### Ten-Year Projections

Over the next ten years, the fashion industry's growth is projected to slow down slightly, with a projected compound annual growth rate of 2.5% to 3.5% between 2026 and 2030, according to McKinsey. By 2030, the market is expected to be valued at approximately \$2.7 trillion (McKinsey, State of Fashion, 2022). The potential environmental and social impacts of this growth will continue to be a concern, particularly in relation to SDG 13: Climate Action. The fashion industry is projected to contribute significantly to greenhouse gas emissions, and the continued growth of the



industry could make it more challenging to meet global climate goals (EllenMacArthurFoundation.org, 2023).

### **Twenty-Year Projections**

Over the next twenty years, the fashion industry is expected to continue growing, albeit at a slower rate. McKinsey projects a compound annual growth rate of 1.5% to 2.5% between 2031 and 2040, with a total market value of approximately \$3.2 trillion by 2040. The environmental and social impacts of the industry's continued growth will become increasingly urgent over the next twenty years, particularly in relation to SDG 14: Life Below Water. The fashion industry's contribution to ocean pollution through textile dyeing, microfiber shedding, and waste disposal is a significant concern and will need to be addressed to protect marine life and ecosystems (Earth.org, 2022).

## Appendix 6

### Alternatives to Current (Fast) Fashion

#### **The Slow Fashion Movement**

The slow fashion movement emphasizes sustainable and ethical practices in the production and consumption of clothing. This includes using sustainable materials, paying fair wages to workers, and designing clothing with longevity in mind. The slow fashion movement is a response to the fast fashion model, which is characterized by overproduction and overconsumption.

#### **Localization and Production of Fashion Clothing Goods**

Localizing the production of fashion goods can reduce the environmental impact of the industry by reducing transportation emissions and supporting local economies. Additionally, producing clothing in smaller batches can reduce waste and improve quality control. There is a growing trend towards localization and production of fashion goods, with some companies shifting production from countries with lax environmental and labor regulations to countries with stricter standards.

#### **Recycling and Reusing Fibers and Fabrics in Fashion Production**

Recycling and reusing fibers and fabrics in fashion production can significantly reduce the industry's environmental impact. This can be done through upcycling, where existing clothing or materials are repurposed into new products, or through recycling, where fibers and fabrics are broken down and used to create new materials. There is growing innovation in this area, with companies experimenting with new recycling technologies and developing new materials made from recycled fibers.

#### **Second-hand Markets**

The second-hand fashion market has experienced exponential growth in recent years, driven by consumer concerns over sustainability, affordability, and unique style. According to a report by ThredUp, the second-hand fashion market is projected to reach \$64 billion by 2024. Established retailers like The RealReal, Poshmark, and Depop have capitalized on this trend, offering consumers a convenient platform to buy and sell

pre-owned fashion items. Luxury brand Burberry also entered the second-hand market by partnering with The RealReal in 2020 to promote circular fashion. With consumers becoming increasingly environmentally conscious and the rise of the circular economy, the second-hand market in fashion is likely to continue its upward trajectory.

## Appendix 7

A wicked problem is a term used to describe complex, persistent and ambiguous issues that have no straightforward solutions. These problems are characterized by their high level of uncertainty, interconnectedness, and often conflicting interests and values. Examples of wicked problems include climate change, poverty, and healthcare access. Unlike simple or complicated problems, wicked problems cannot be solved by a single solution or a clear path of action. Instead, they require ongoing attention and continuous learning and adaptation. Addressing wicked problems requires a multi-disciplinary approach that involves diverse stakeholders, collaboration, and a willingness to experiment with innovative solutions. Despite the challenges they pose, wicked problems offer opportunities for transformative change and growth.

### **The 10 Characteristics of A Wicked Problem as described by Rittel and Webber (Rittel and Webber, 1973)**

- 1) They do not have a definitive formulation.
- 2) They do not have a “stopping rule.” In other words, these problems lack an inherent logic that signals when they are solved.
- 3) Their solutions are not true or false, only good or bad.
- 4) There is no way to test the solution to a wicked problem.
- 5) They cannot be studied through trial and error. Their solutions are irreversible so, as Rittel and Webber put it, “every trial counts.”
- 6) There is no end to the number of solutions or approaches to a wicked problem.
- 7) All wicked problems are essentially unique.
- 8) Wicked problems can always be described as the symptom of other problems.
- 9) The way a wicked problem is described determines its possible solutions.
- 10) Planners, that is those who present solutions to these problems, have no right to be wrong. Unlike mathematicians, “planners are liable for the consequences of the solutions they generate; the effects can matter a great deal to the people who are touched by those actions.”

## Appendix 8

### STEEPV Analysis of Research Problem

A STEEPV analysis is a strategic tool used to examine the external factors that can impact a business or organization. STEEPV stands for Social, Technological, Economic, Environmental, Political, and Values. The analysis considers the impact of each of these factors on the organization, as well as any potential opportunities and threats that may arise. The Social aspect of the analysis examines demographic and cultural trends, as well as societal values and beliefs. The Technological aspect looks at advances in technology that can either benefit or disrupt the organization. The Economic aspect considers economic conditions such as inflation, interest rates, and consumer confidence. The Environmental aspect examines how the organization impacts the natural world and how changes in the environment may impact the organization. The Political aspect considers the impact of government policies and regulations, while the Values aspect examines ethical and moral considerations.

The following is a STEEPV analysis of the current research problem. Each aspect will be outlined followed by a broader examination.

**Social:** Predatory labor practices continue to expose workers to chemicals and tasks that endanger their health. A system of preying on vulnerable labor sources willing to accept low pay keeps an endless stream of “working poor” willing to accept wages and conditions unrepresentative of basic human rights.

**Technological:** PVA, PVC, and other synthetic materials developed in the last century have created source waste as well as post consumer pollution. The synthetic materials used are often a by-product of the petroleum industry and disproportionately contribute to greenhouse gas emissions during their creation as well as their decomposition. Creating fast fashion products comes at a high cost, despite increasingly efficient production.

**Environmental:** Profit is elevated over pollution throughout the production/manufacturing and supply chain process. From the initial production of raw goods through manufacturing to the time the fashion items hit the retail floor the extractive cost to the environment is detrimental.

**Economic:** Built on an extractive economic model the fashion industry takes from the vulnerable and produces profits at the expense of people and for shareholders not represented in the production process. One main incentive to change or spark a pivot in the marketplace is concern for the bottom line profit.

**Political:** Local governments have oppressed citizens in order to keep a vulnerable workforce to satisfy overseas orders and profit streams. Gender politics have played a significant role as the majority of workers in the fashion industry are women and are almost universally paid less than their male counterparts.

**Values:** Profit over people and environment has been the standard. Multiple large scale disasters continue to occur within the industry due to poor working conditions, and there is little viable pressure, incentive, or enforceable penalties exerted on violators.

**Aesthetics:** Intellectual and cultural property of traditional and indigenous craftspeople is continually mined for profit by brands and corporations without benefit or even acknowledging source materials. It has been proposed that Sustainable and Eco Fashion in its current iteration only appeals to a limited number of consumers based on its design aesthetic as well as the materials and branding.(Niinimaki, 2010)

## Social

*“When it comes to workers’ rights, we have been stuck with the current state of play for more than 10 years and the discourse is still way ahead of the action. The system remains opaque and, crucially, doesn’t include the voices of workers and their representatives. This means it’s incredibly difficult to adequately remediate issues. No matter how many committees are set up in factories, they are just not working. Going forward, there has to be a system of collaboration and binding agreements with workers’ organizations. Commitments to a living wage are meaningless if buying prices do not cover the cost of living wages. “ Anannya Bhattacharjee, International Coordinator, Asia Floor Wage Alliance*

The Rana Plaza tragedy and vocal opposition to fast-fashion from NGOs like The Clean Clothes Campaign<sup>29</sup> and EcoAge<sup>30</sup>, have put extra pressure on both companies and governments to amend existing regulations and business practices. This engagement led the OECD, Organisation for Economic Co-operation and Development, to adopt, in 2017, a global guidance standard on companies' due diligence requirements towards their supply chain. The document addresses some of the most salient topics in the garment supply chain: child labor, forced labor, workers' wages and collective bargaining agreements. While the guidance is not legally binding, it has been ratified by OECD member states<sup>31</sup>, and companies active in this industry are expected to conduct their business in accordance with this document (sustainalytics.com).

The Sustainable Apparel Coalition (SAC)<sup>32</sup>, founded in 2009, is an industry organization aimed at creating a framework for worldwide sustainable apparel production. It has more than 200 global members, covering brands, manufacturers and industry associations, as well as academia. The SAC has recently broadened the scope of its sustainability toolkit creating the HIGG Index, to cover the social, environmental and product development aspects of the apparel and footwear supply chain.

The HIGG Index is a set of tools allowing companies to self-assess and measure environmental and social sustainability throughout their supply chains. The HIGG Index<sup>33</sup> also allows for industry comparison, providing companies the opportunity to compare their performance against peers. Industry leaders like Inditex, H&M, GAP and Kering are tailoring their supply chain audits according to the Index. This is an important milestone to recognize because it signals a corporate willingness to change.

The main areas of focus of these two tools are:

- Child labor
- Discrimination

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<sup>29</sup> <https://cleanclothes.org/>

<sup>30</sup> <https://eco-age.com/>

<sup>31</sup> The OECD's 37 members are: Austria, Australia, Belgium, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

<sup>32</sup> <https://apparelcoalition.org/>

<sup>33</sup> One of the Participatory Action Research Partners, PT. Sandang Asia Maju Abadi (SAMA), has been evaluated and certified using the HIGG Index tool.

- Non-compliance with minimum wage laws
- Work time
- Facility workforce standards

A valuable research starting point for review is Becker Leifhold's 2018 collection *Ecofriendly and Fair: Fast Fashion and Consumer Behavior*. It seeks to advance sustainability and addresses the consequences of fast fashion, an attitude gap in consumer behavior, and alternate methods and ideas for industry.

It is important to note that there are forces within the industry trying to address the concerns highlighted in the SDG. NGOs as well as multinational alliances of industry corporations have moved in the direction needed to achieve sustainability. Legislation is being drafted and passed in many countries to bring transparency forward and make it possible to enforce standards. However, this is not happening at the same pace that the industry continues to grow. Therefore, to achieve a state of sustainability it is necessary to effect change not only from the top down but also from the bottom up, in this case from the consumer level.

## **Technology**

*Billions of dollars will be needed to drive innovation over the coming decade, but companies are not matching sustainability commitments with details of capital expenditure or investment plans as they typically would with corporate transformation strategies. Many of the most impactful changes will occur at the manufacturing level. A more equitable partnership is needed between brands and their suppliers to share the cost of transitioning the industry to a more sustainable model. (Business of Fashion, Sustainability Index 2021)*

As innovations in both technological production methods as well as safety standards and factory upgrades are required there is a continuous debate on who should foot the bill, the producers or the manufacturers (otherwise noted as the foreign



makers and the large capitalist corporations). Both sides argue that the other should carry the burden of the cost, and often the upgrades that do not add to the bottom line profit are pushed to the side. Historically this has led the way to dangerous work conditions. Factories are often unprotected by safety standards enforced by a government oversight organization like OSHA, and workers suffer as a result.

## **Environmental**

*“Voluntary commitments will only get us so far, particularly in addressing climate change. Over my career, I have seen great value in companies setting ambitious sustainability targets. Yet while goals such as zero waste, carbon neutrality and closed-loop production can channel a company’s attention and resources, what’s needed is strong, science based regulation to ensure that the world is reducing emissions at a fast enough pace, and that countries and companies are held accountable.”*  
*Michael Sadowski, Independent Sustainability Advisor*

A key to successfully unraveling the wicked problems in fashion exists establishing a clearly agreed upon operational definition of Sustainable Fashion. Sustainability is broadly defined by the 1987 Brundtland Commission, commonly known as Our Common Future, "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." For the purposes of this thesis I will adhere to the definition of Sustainable Fashion as outlined by Ecofriendly and Fair: Fast Fashion and Consumer Behavior by Leifhold and Hauer defines Sustainable Textiles and Apparel as:

- Safe for humans and the physical environment;
- Made from renewable materials;
- Produced through making the most efficient use of resources such as water and energy;
- Manufactured by people employed in decent working conditions;
- Capable of being washed at low temperature using environmentally friendly laundering agents;

- Capable of being returned safely to the environment at the end of their useful life. (Performance Apparel Market 2009, as from Leifhold 2018 p. ii)<sup>34</sup>

This sustainability statement is useful as a definition, but only speaks to the deeper expertise and honest assessment required to get a true understanding of fashion's impact, often quoted as responsible for 10% of the world's pollution (Ellen MacArthur Foundation). This need for further definition, and the appearance that the current definition does not wholly consider the triple bottom line, reinforces the need to use STEEPV as a tool.

Generally however, it is possible that values may shift, as many of us can see from 'trends' in everyday life, sustainability is a value that has matured in previous decades.

## Economic

*“A transition away from fashion’s current extractive business model would be transformative. But scaling the industry’s access to regeneratively farmed materials and establishing regenerative systems requires investment and commitment. Greater education is required to ensure executives and employees understand the impact of their sourcing choices and are empowered to make better decisions for the planet. Investment is needed to build the capacity of both land stewards (so the risk of shifting ways of working is shared by all stakeholders) and distributed processing infrastructure. Outcome-based data, rather than practice-based commitments, must support any claims of land regeneration. Finally, it will require a transition from obscure and transactional supply chains to transparent and relational value networks.”*  
*Daniela Ibarra-Howell, CEO and Co-Founder Savory Institute.*

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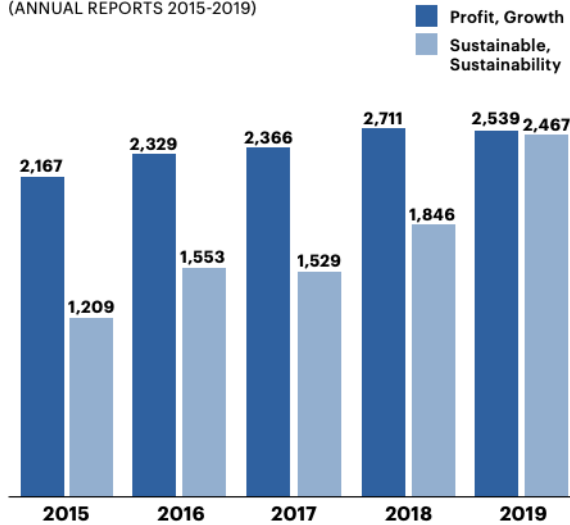
<sup>34</sup> Most definitions of sustainability (Holden, 2014) rely on both ambitious goals and 'continuous improvement' to promote even bolder goals over time - allowing for both practical and achievable change but not restrained by imagined boundaries.

**Exhibit 1: Sustainability Speak**

References to sustainability in the annual reports of the companies featured in the Index have doubled in just five years and now feature as frequently as key financial terms.

**NUMBER OF TIMES THE WORDS ARE MENTIONED IN THE FULL-YEAR REPORTS OF THE 15 COMPANIES ASSESSED BY THE INDEX**

(ANNUAL REPORTS 2015-2019)



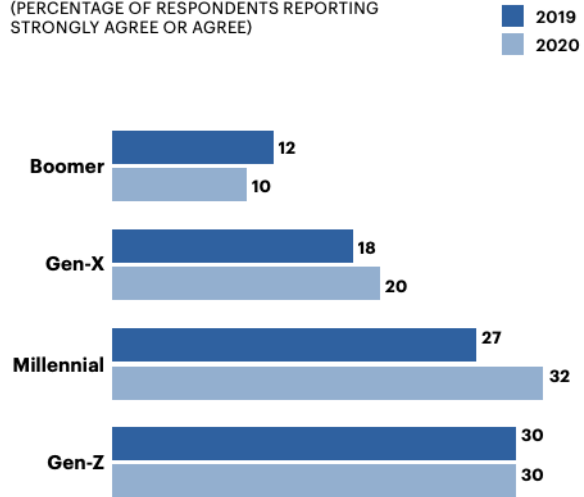
SOURCE: BoF ANALYSIS, COMPANIES' ANNUAL REPORTS  
2018 excludes VF Corp owing to a change in reporting periods.

**Exhibit 2: Increasingly Conscious Consumers**

Younger generations place more emphasis on sustainability and have retained this view through the pandemic.

**US CONSUMERS WHO SAY THEY WILL PAY MORE FOR PRODUCTS THAT HAVE THE LEAST NEGATIVE IMPACT ON THE ENVIRONMENT**

(PERCENTAGE OF RESPONDENTS REPORTING STRONGLY AGREE OR AGREE)



SOURCE: MCKINSEY & COMPANY, NEW AGE OF THE CONSUMER SURVEY 2019 AND JULY 2020

Business of Fashion, Sustainability Index 2021,  
[https://cdn.businessoffashion.com/reports/The\\_Sustainability\\_Index\\_2021.pdf](https://cdn.businessoffashion.com/reports/The_Sustainability_Index_2021.pdf)

The fashion industry faces several economic wicked problems related to sustainability issues. One of the biggest challenges is the fast fashion business model, which emphasizes high volume, low-cost production, and rapid turnover of new trends. This model leads to overproduction, overconsumption, and massive waste, contributing to environmental degradation and resource depletion. Additionally, sustainable fashion practices often require significant investments in materials, manufacturing processes, and marketing, making them less financially feasible for smaller or less established brands. Addressing these economic wicked problems requires systemic changes to the fashion industry, such as circular business models that prioritize longevity and sustainability, and government policies that incentivize sustainable practices. While such changes may require initial investments, they can ultimately lead to long-term economic and environmental benefits for the industry and society as a whole.

## Political

*“Working independently, anthropologists, psychologists, political scientists, sociologists, evolutionary biologists and historians have recently developed strikingly similar theories of cultural and institutional change: they all emphasize the extent to which security from survival threats, such as starvation, war and disease, shape a society’s cultural norms and sociopolitical institutions. Ronald Inglehart, Cultural Evolution, 2018*

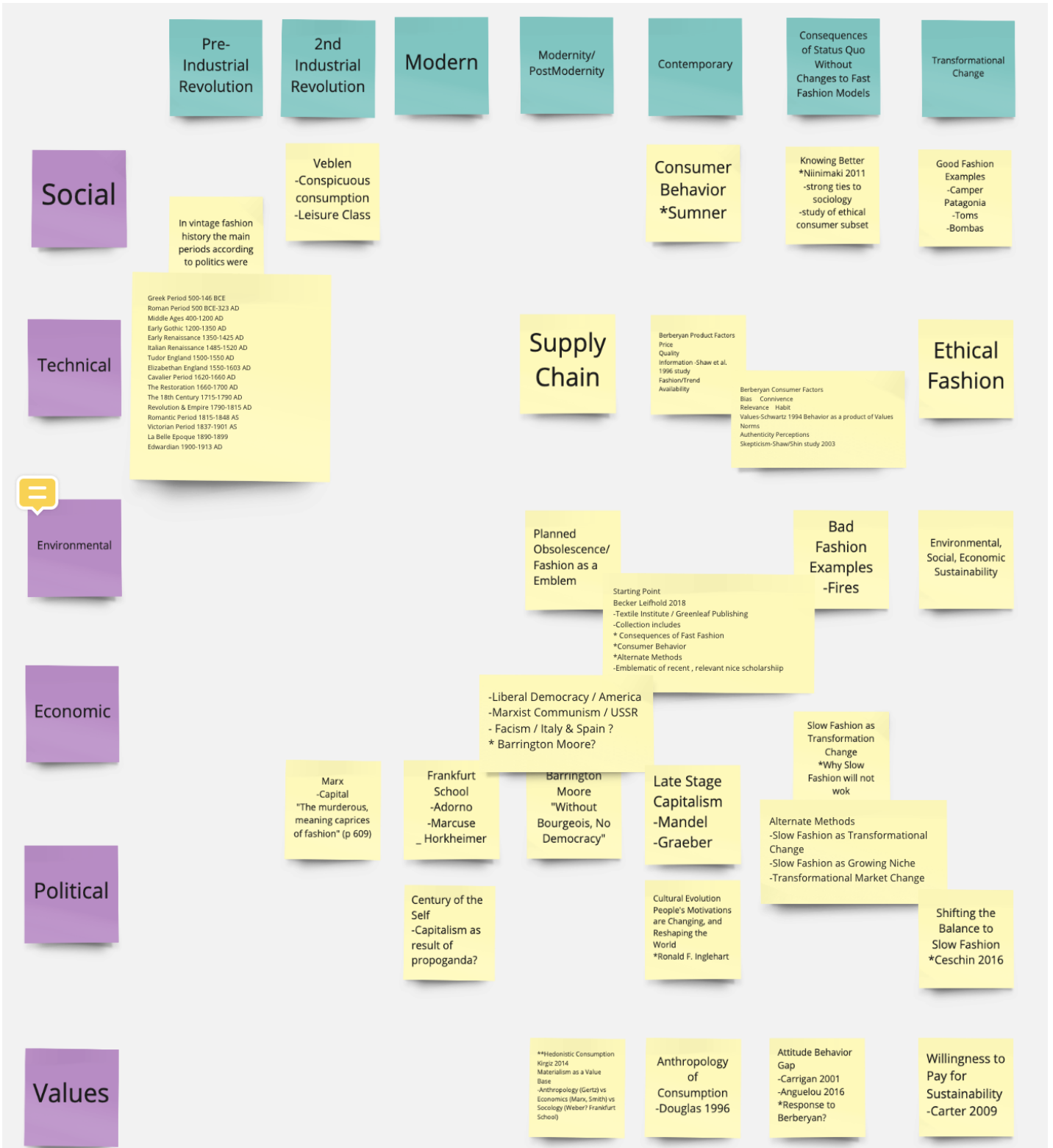
The fashion industry faces several political wicked problems related to sustainability issues. One major challenge is the lack of regulatory frameworks and enforcement mechanisms to ensure that fashion companies meet sustainability standards. This leads to instances of greenwashing, where companies make false or misleading claims about their sustainability practices. Additionally, many governments provide subsidies and tax breaks to the fashion industry, which often exacerbate unsustainable practices. Another political wicked problem is the lack of representation and participation of marginalized groups in the fashion industry, particularly in the design and decision-making processes. This can lead to the perpetuation of unsustainable practices that harm both people and the planet. Addressing these political wicked problems requires collaboration between governments, civil society, and the fashion industry to develop and enforce regulations and policies that promote sustainability and inclusivity. This can include measures such as tax incentives for sustainable practices, public disclosure requirements, and the inclusion of diverse perspectives in decision-making processes.

## Values

*“Global Supply chains in the garment industry are buyer-driven.” (Gereffi, Humphrey, & Sturgeon, 2005) Consumer choices directly affect industry practices and brands seek to adapt to values proven important to customers.(Hartl, Hoffmann, and Kirchner, 2016) Thus, the more customers buy these products the more profits are made by companies representing these standards the more products are produced following*

*the standards, gaining significant and influential shares of the market.*  
(Anner, Bair, Blais, 2013).

The fashion industry faces several wicked problems related to shifting values towards sustainability. One challenge is the perception that sustainable fashion is less fashionable or less desirable than fast fashion. To shift these values, it is important to highlight the benefits of sustainable fashion, such as quality, longevity, and ethical production. Another challenge is the disconnect between consumers and the production process, leading to a lack of awareness and understanding of the impact of their consumption choices. Educating consumers about the environmental and social impacts of fashion, as well as promoting transparency and accountability in the supply chain, can help shift values towards more sustainable consumption. Finally, there is a need to shift values within the industry itself, towards a more sustainable and equitable business model. This can involve promoting the use of sustainable materials and production processes, and ensuring that workers are paid fair wages and work in safe and healthy conditions. Overall, addressing these wicked problems requires a shift in values towards more sustainable and ethical fashion, which can only be achieved through collaboration and concerted efforts by all stakeholders involved.



Fairchild Azevedo, Nicole , 2nd Iteration of Snowcard Methodology: x axis represents STEEPV y axis represents a timeline, April 16, 2020, mirro board.

## Appendix 9

### The Failure of Traditional Media Information Delivery to Influence Behavior Change in the Global Fashion Industry

While traditional media has the potential to influence behavior change in consumers, it has largely failed to do so in the fashion industry in terms of slowing consumption and building a willingness to accept higher prices related to sustainability practices. This list explores the reasons behind this failure and alternative approaches to promoting sustainable behavior in the fashion industry.

#### *Reasons for Failure*

1. **Overwhelming Amount of Information:** Traditional media often delivers an overwhelming amount of information about sustainability, making it difficult for consumers to process and understand.
2. **Lack of Relevance:** Traditional media may fail to make the relevance of sustainability clear to consumers and connect it to their daily lives and fashion choices.
3. **Limited Reach:** Traditional media may not have a broad enough reach to influence the majority of consumers, especially those in developing countries who may not have access to traditional media channels.
4. **Limited Engagement:** Traditional media may not engage consumers in a way that promotes behavior change. Traditional media may not have the interactivity or the personalization to effectively engage consumers.

*Alternative Approaches to Promoting Sustainable Behavior*

1. **Influencers:** Influencers are individuals who have established credibility with their followers and can use their platform to promote sustainable behavior. They can provide a more personal approach to promoting sustainability and connect with consumers in a more relevant and relatable way.
2. **Social Media:** Social media platforms provide an opportunity for more personalized and interactive communication. Social media can also reach a broader audience, including those in developing countries who may not have access to traditional media channels.
3. **Peer-to-Peer Learning:** Peer-to-peer learning is an approach that emphasizes learning from peers who have already made sustainable behavior changes. This approach is effective because it is more relatable and relevant to consumers and can lead to sustainable behavior changes.
4. **Experiential Learning:** Experiential learning is a hands-on approach that allows consumers to learn about sustainability in a more engaging and interactive way. This approach can help consumers connect sustainability to their daily lives and fashion choices.

Peer-to-peer learning and experiential learning can provide more personalized and engaging ways to promote sustainable behavior in the fashion industry.



## Appendix 10

### Detailed Cheat-Sheet - Interactive Learning experience Study

The following is the script and document used in conducting the research at the Ross Behavioral Lab.

***Dear team,***

*Thank you for supporting our research endeavor.*

*We have listed some of the necessary considerations for this study. We have divided them into two parts with Part I being the set ups for the sessions and Part II being the detailed process*

***Thank you*** so much for supporting our research

*Niki & David*

#### **Part I: Set-Ups for each sessions**

- Prepare random numbers (even ⇒ Screen group; odd ⇒ VR group)
- Place cash money on desk: 10 dollars on each desk
- General Set-Up:
  - **Wipe the Computer areas with disinfectant wipe**
  - Restart Survey on all computers (survey-links are in the following folder)
  - **VR-group:** sits only on the left side of the computer room
  - **Screen-group:** sits only on the right side of the computer room
- *Additionally for Screen-Group:* Restart Interactive Learning experience (survey-links are in the following folder)

- *Additionally for VR-Group:*
  - Wipe the VR-Devices with disinfectant wipe
  - Charge VR-Devices after each round
  - Ensure that VR-devices have not gone to sleep (if they have gone to sleep wake them up by pushing the button on the side)
- Empty the donation box (should be empty before new participants come in)

## **Part II: Detailed Process for each Session**

**Color Coding** ORANGE TEXT DENOTES WHOLE GROUP, GREEN TEXT DENOTES VR GROUP, PURPLE TEXT DENOTES SCREEN GROUP

- 1. Sign in at front desk: Show ID (Noel's-Team) and select a number and hand out consent form**
  - a. Attention: there should be the same amount of even as well as odd numbers inside.**
- 2. Welcome**

*Welcome to the Ross Behavioral Lab and thank you for taking the time to be here today.*

*The research conducted here contributes to generating general knowledge.*

*Our Study requires that participants have full concentration through the study, so we ask you to put away your cell phones in your backpack or coat. Please ensure that the vibration is off so that it does not disturb anyone in the session.*

*There is no drinking or eating allowed during the study. The overall study takes on average 16 minutes. There are also hand sanitizers and tissues available. However, we ensure that everything is cleaned prior to entering the laboratory.*

*All your responses are anonymous. Please take your time to answer all questions honestly.*

*All additional information will be provided on the survey. Should you encounter technical problems please quietly step out of the Computer Lab - a research assistant will be waiting outside.*

*Once you have completed the survey, please step out of the room and leave the exit on the left door.*

*This study is about an interactive learning experience activity about the fashion supply chains. You will receive additional instruction in the computer lab. If you have not done so, please sign this check in sheet and the consent form.*

### **Collect signed Consent Form**

*Please remember the number throughout the whole study. Please if the number from before is **ODD**, you can now stand up and join me walking to the computer lab. We will pick up all other people with **EVEN numbers** in approximately 1-2 minutes.*

### **Sitting order**

Please instruct participants with **ODD numbers** to sit on the **left side of the computer lab**

Please instruct participants with **EVEN numbers** to sit on the **right side of the computer**

**lab**

***Please ensure that only one door of the lab is open - the LEFT DOOR***

## ***VR-GROUP (“ODD”-Numbers)***

**Script:** *If you have an odd number please follow me.*

**3. Walk this group to the computer room:**

**Script:** *Please sit at one of the computers numbered 1-13 on the LEFT side. You will find the **survey open on your computer**. Follow the directions on the screen and leave the computer lab if instructed so. Research Assistant will be waiting outside. In general, if you encounter technical difficulties, please contact Research Assistants.*

#### **4. Take the VR group to the Kitchen**

Script: Please follow me to the kitchen. We will now introduce you to the learning activity.

#### **General Instructions On how to Use and Navigate Through the Experience**

Please go to the area marked in your room with a blue X on the floor. The VR Experience requires that you only move in this area, that is you should not move around, however you can turn around.

Next, put the VR-Headset on. Adjust it slightly up and down until the image you see is no longer fuzzy. In case the image gets fuzzy, please readjust the VR-Headset.

#### **DEMONSTRATE HOW TO WEAR AND ADJUST THE VR HEADSET**

The learning experience is **interactive**; you can use your **controllers to answer questions**, and to move through the experience. You can turn around and look 360-degrees. However, please stay in the designated area. Should you leave the area, you may see the real world environment projected in your VR device. That is a sign of stepping slightly back.

A voice will appear and will guide you through the whole learning experience.

**Controller:**

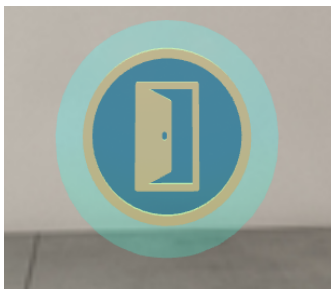
**DEMONSTRATE HOW TO HOLD THE CONTROLLER**

- Place the controller in your right hand with the ring pointing towards you and wrap



your hand around the base like so:

- **When** you point the controller you will see a “line” indicating where you are pointing. To activate this “feature” in the experience or to start the overall learning experience, please use your index finger on the trigger and push the button. The trigger has been marked with a blue tape.



**Navigation through the experience:**

To **navigate through** the experience click on **the circle button** with the door images. By navigating you will be transferred to another area of the supply chain.

- **Learning videos:**
- You can start and stop the learning videos by clicking on the controls in the experience.



### Launching the Learning Experience.

- To launch the learning experience **look down and click on the red and green circle.**
- After you click it will say **“Restart”** click again. This will take you to the **welcome screen.**
- Please move **through the learning experience** at your own pace. **You can guess the question answers multiple times** and there is **no requirement to answer correctly.** Also, not all questions are linked to the contents - some questions are there to give you blind guesses that exceed the actual learning experience, i.e., that learning contents.

**Please note:**

- If you have any questions, or you **experience any technical issues please alert a researcher. If you experience any strong signs of dizziness or motion sickness remove the VR device and alert a researcher**When you have completed the learning experience please return to your original computer and answer some additional questions. Please exit the room and follow all additional instructions.

**At the end, the person at the exit will check out the participant, direct them to put their donation in the box, and sign the form that they have received money.**

## **SCREEN-GROUP (“EVEN”-Numbers)**

**Script:** *Please follow me.*

*Make sure the LEFT DOOR IS CLOSED*

### **5. Walk this group to the computer room:**

**Script:** *Please sit at one of the computers numbered 14-24 on the RIGHT SIDE.*

*You will find the survey open on your computer. Please pick any seat that has preloaded the survey. Follow the directions on the survey on the screen. When you have to start the interactive learning experience go the the **second tab opened in the browser “Chrome”***

### **Please note:**

- If you have any questions, or you **experience any technical issues please alert a researcher.**
- When you have completed the learning experience please return to the survey screen and complete the survey.

*To open the experience select the other tab open on your computer.*

1. The learning experience is **interactive**; you can use your **controllers to answer questions**, and to move through the experience. You can turn around and look 360-degrees. Use the mouse to click and drag around the screen to explore the environment inside the experience. You can explore each scene by clicking, holding and dragging any direction. You can click drag and release multiple times to move the view.



2. When hovering over an interactive button it will become shaded with white. Click to activate these buttons.

**Navigation through the experience:** To navigate through the experience click on **the circle button** with the door images. By navigating you will be transferred to another area of the supply chain.



### Learning videos:

- You can start and stop the learning videos by clicking on the controls in the experience.



**Navigation through the experience:** To navigate through the experience click on **the circle button** with the door images. By navigating you will be transferred to another area of the supply chain.

**At the end, the person at the exit will check out the participant, direct them to put their donation in the box, and sign the form that they have received money.**

## Appendix 11

### Participant Debriefing Form Ross Behavioral Lab Experiment

Debriefing Form: [HUM00225589]

In this survey, you were randomly assigned to one of two conditions where we introduced you to an interactive learning environment of the Fashion Supply Chain, specifically, the production area for fashion. We manipulated the learning environment and assigned participants to an interactive environment on a screen display, or asked participants to walk through the learning environment in Virtual Reality (VR).

Initially, you answered questions on environmental concerns and your altruism tendency. You then responded to a question on your donation amount [in USD] and questions on feeling presence (i.e., immersion) and perceived competence of having an impact on improving the working conditions (i.e., working conditions in the production area). We expect that because of participants' presence, they may feel more component to have an impact, ultimately influencing their donation behavior (i.e., prosocial behavior) positively.

We controlled for several additional variables, such as technical difficulties or novelty of the technology.

Thank you for your participation in this study. If you have further questions about the survey, please get in touch with Niki Fairchild Azevedo ([fairniki@umich.edu](mailto:fairniki@umich.edu)) or David Finken ([davidfi@umich.edu](mailto:davidfi@umich.edu)).

## Appendix 12

### List of Interviews produced from Participatory Action Research

All of the gathered information from the PAR sessions was broken down into the following narrative sections:

- Cotton Farming History (Caywood Farm)
- Cotton Farming Monetization (Caywood Farm)
- Cotton Farming GMOs (Caywood Farm)
- Textile Mill Process (Gamatex)
- Textile Mill Interview with Dade (Gamatex)
- Local Factory Interview with Buddy
- Local Factory Interview with Didin
- Interview with Professor Katel (ITB)
- Design Firm (Asmara)
- Interview with Anand (Asmara)
- Garment Factory Process 1 (SAMA)
- Garment Factory Process 2 (SAMA)
- Interview with Amalia (SAMA)
- Interview with Sirihatari (SAMA)
- Interview with Sigarus (SAMA)
- Container Shipping

## Appendix 13

### Participatory Action Research Website Outreach Tool

 The Journey of Jeans



## The Journey of Jeans

A VR Film Following the Creation of a Pair of Jeans from a Cotton Farm, to a Textile Mill, Design Studio, and Garment Factory.

Help US Bring your Story to the World.  
12 Juli 2022



**When we see something as familiar as a pair of jeans people often do not stop to appreciate the people, skill, and technology required to bring those pants to them. Created in VR this project will share that process, and tell YOUR story in the part of that creation like never before.**



**What YOU do has great value for the World**

With out your unique and special contrabution the world would not be the same place. What you bring into the world is imporatan and powerful. Share your experience with the people all around the world who otherwise would not know what it takes to bring your creations to their doors.



**For the First time in Virtual Reality**



The project will be created in Virtual Reality. This means that when people watch this project they will feel like they are there with you. Being able to look around in 360° and actively interact with the story people will be transported into your world, where you can share your unique skills and story.

## **We Want YOU to be a Part of this Project**

### **Why Should YOU Join Us**

You, your team, and your company has a unique set of amazing skills. This project will let you showcase your expertise. You will be able to share the finished project with others around the world, not only to share your story, but to build and showcase your business.

### **What is Required to be Involved**

One hour of your time. We will come to you. Talk to our 2 person crew and tell us all about what you do and your story. A small amount of time and the desire to share your experience is all you need to be a part of the project.

### **What Will You Get Out of being Involved**

You will get the thrill of connecting with people all over the world who will hear your story. This is your chance to talk to the world. A small gift of money will be given to you out of respect for the value of your time.

### **What is the Final Project**

You will be a part of a Virtual Reality experience that will follow the creation of a pair of jeans from a cotton farm, to the weaving of denim fabric, the design of jeans, and the process of sewing the final garment. This project will be available for you to view and share. Look below to see how your story will look in Virtual Reality.

### **When**

We will be in your country in AUGUST 2022 and want to come talk to YOU.

**We are NOT out to damage your business, your reputation or your livelihood. We RESPECT what you do and simply want to help share your story with the world. Our goal is to build an appreciation for what you create.**



**Take a Look at a Sample of the Project.  
Below is a Link to the VR Prototype**

Please note you will have to create an Uptale account to access the experience.

The Uptale logo, featuring the word "uptale" in a lowercase, sans-serif font. The "u" is red, "p" is blue, "t" is green, "a" is red, "l" is blue, and "e" is green. A small red dot is at the end of the "e".

## **Meet the Team Behind the Project**

### **Niki Fairchild Azevedo**

Niki has been a fashion designer for a long time. She has taken her

love for creating clothing back to school at the University of Michigan where she is getting her Masters Degree in Integratve Design.

[Click for Link to Bibliography](#)

### **Ayu Norma**

Ayu received a degree in textile art and design from ITB, the Institute of Technology in Bandung. She now runs and operates a successful child care business in Bali where she spends as much time as she can on creative projects.

### **Max Gerald**

Max has been at the hub of various creative endeavours; traveling and working with arts communities around the globe. His passion is connecting like minded creatives and artists, building a dynamic network. He currently works at a bio-tech research facility where he runs a coconut waste innovation project.



## Appendix 14

### Survey Conducted at Ross Behavioral Lab

#### Start of Block: Introduction

number Please enter the number you drew from the box before.

---

Page Break

#### Introduction **Welcome to Our Study!**

We are interested in your perception of the **supply chain in fashion**.

But first, some more general information on the study:            This study will take between **15-17 minutes**.

You will receive a maximum payment of **10 dollars for your participation** - the payment is **already available** in front of you (10 dollars in cash). Please leave the payment there until the study is completed.

Follow **all instructions** carefully. They are **important for the rest of the study**. All answers are anonymous. Hence, we appreciate your honest answers. Please take your time with the survey; the payment is **much above average**.

You may stop the survey at any time.

We highly appreciate your participation and hope you enjoy our study! Have fun.

Page Break

*Display This Question:*

*If Please enter the number you drew from the box before. Text Response Is Less Than or Equal to*

50



### **Preliminary Information**

As part of this study, you will engage in an **interactive learning environment** about the **supply chain in fashion**.

The learning environment introduces you to major parts of the **supply chain in fashion** (i.e., from harvesting woven to designing, producing, and shipping clothing).

Please be aware that **all contents represent reality** - no artificial or invented information is presented.

### **Procedure of the Study**

First, we will ask you some **general questions**.

Second, we will introduce you to the **interactive learning environment**. Please **follow all instructions**. This entails to put your **headphones** on and **navigate through the interactive learning** environment. Next, we are interested in your opinion and perception of the learning environment.

We **Thank You** for your participation, and you will receive your payment. You may ask **any questions about the study**.

Please continue with some general questions.

*Display This Question:*

*If If Please enter the number you drew from the box before. Text Response Is Greater Than 50*

*And And Please enter the number you drew from the box before. Text Response Is Less Than or Equal to 100*

### **Preliminary Information**

As part of this study, you will engage in an **interactive learning environment** about the **supply chain in fashion**.

The learning environment introduces you to major parts of the **supply chain in fashion** (i.e., from harvesting woven to designing, producing, and shipping clothing).

Please be aware that **all contents represent reality** - no artificial or invented information is presented.

### **Procedure of the Study**

First, we will ask you some **general questions**.



I am concerned  
about the  
environment. (4)



Impulse Purchase

**How much do you agree or disagree with the following statements?**

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neutral (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I often buy things spontaneously. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"Just do it" describes the way I buy things. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"I see it, I buy it" describes me. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I buy things according to how I feel at the moment. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I carefully plan most of my purchases. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I often buy things without thinking. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Empathy and Concern

**Read each of the following statements and rate how well each of them describes you with the following scale.**

	Not at all like me 1 (1)	2 (2)	3 (3)	4 (4)	Just like me5 (5)
When I see someone being taken advantage of, I feel kind of protective toward them. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I see someone being treated unfairly, I sometimes don't feel very much pity for the person. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I often have tender, concerned feelings for people less fortunate than me. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would describe myself as a pretty soft-hearted person. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Sometimes I don't feel sorry for other people when they are having problems. (5)

Other people's misfortunes do not usually disturb me a great deal. (6)

I am often quite touched by things that I see happen. (7)

Page Break

End of Block: general questions

Start of Block: Introduction next steps

*Display This Question:*

*If Please enter the number you drew from the box before. Text Response Is Less Than or Equal to*

50

Screen

### **Interactive Learning Environment about the Supply Chain in Fashion**

Next, we want you to learn more about the supply chain in fashion and introduce you to an **interactive learning environment**.

Some **information** about the interactive learning experience.

Before continuing to the **second tab** (already **opened in the browser in the TOP**) please read **ALL INFORMATION BELOW**.

The interactive learning environment is **pre-loaded for you in the second tab. Go there after reading the instructions.**

Now, **put on your headphones** - an **audio guide** will give you all the necessary information when you **start** the interactive learning experience **in the second tab.**

As part of the learning process, you will **receive short questions**. Sometimes, the answer is part of the audio; sometimes, we want you to guess. There won't be any **scoring** - this is just for your learning process.

To start the interactive learning experience, the following buttons will appear:

**First, "Click when Ready" starts the interactive learning experience(the screenshot is not a link)**

**After initial oral instruction, you start the experience using the "door."**

**The doors will also navigate you through all steps of the experience**

**Fullscreen is available through the following symbol.**

**Please NOW proceed to the second tab already opened in the browser.**

The experience takes about 5-7 minutes.

**Please continue with this survey AFTER you have finished the interactive learning experience.**

The continue button appears after a few minutes.

*Display This Question:*

*If If Please enter the number you drew from the box before. Text Response Is Greater Than 50*

*And And Please enter the number you drew from the box before. Text Response Is Less Than or Equal to 100*

## VR Interactive Learning Environment about the Supply Chain in Fashion

Next, we want you to learn more about the supply chain in fashion. We will introduce you to an interactive learning environment.

For that purpose, you have to **LEAVE** the **computer room NOW**. Research assistants **are waiting** outside the **computer room** and will instruct you further. Please be quiet.

The whole learning experience takes between 5-7 minutes.

**Please continue with this survey AFTER your return to your computer.**

The continue button appears after a few minutes.

Page Break

*Display This Question:*

*If If Please enter the number you drew from the box before. Text Response Is Greater Than 100*

mistake **Your entered number at the beginning of the survey is not VALID. Please contact the researchers; you need to restart the survey.**

End of Block: Introduction next steps

Start of Block: Welcome Back

*Display This Question:*

*If If Please enter the number you drew from the box before. Text Response Is Less Than or Equal to*

*50*

**Welcome Back to the Survey** We hope you enjoyed your **interactive learning experience.**

Many independent organizations look after how business affects larger societal and environmental circumstances. One of those is the '**United Nations Alliance for**



**Sustainable Fashion'**. We will introduce the Alliance and its goals on the next page.

*Display This Question:*

*If If Please enter the number you drew from the box before. Text Response Is Greater Than 50*

Welcome back after VR **Welcome Back to The Survey**. We hope you enjoyed your **interactive Virtual Reality (VR) learning experience**.

Many independent organizations look after how business affects larger societal and environmental circumstances. One of those is the **'United Nations Alliance for Sustainable Fashion'**. We will introduce the Alliance and its goals on the next page.

End of Block: Welcome Back

Start of Block: Introduction Alliance For Sustainable Fashion

Introduction Environ Please inform yourself about the **'United Nations Alliance for Sustainable Fashion'**

This is the Alliance's website - below, we have summarized some of its contents.

The United Nations Alliance for Sustainable Fashion contributes **to the Sustainable Development Goals** through **coordinated action in the fashion sector, which entails the following, among others. The production of raw materials the manufacturing of garments, accessories, and footwear the distribution, consumption, and disposal**. Through the Alliance, **the United Nations commits to changing the fashion path, reducing its negative environmental (e.g., reduction of the industry's waste stream and decreases in water pollution) and social impacts (e.g., working conditions and remuneration for workers), and turning fashion into a driver of implementing the Sustainable Development Goals. Source:** <https://unfashionalliance.org/>

End of Block: Introduction Alliance For Sustainable Fashion

Start of Block: Donation

Likelihood of Donation

How **likely** would you be to support the '**United Nations Alliance for Sustainable Fashion**' in achieving **their goals** (such as improving working conditions or fighting pollution and environmental issues within the supply chain in fashion)?

	1	2	3	4	5	6	7	8	9	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	
Not at all likel y	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Ver y likel y

Page Break

Explanation

You will get a **maximum payment of 10 dollars for this study.**

However, we give you **the opportunity** to actually support the '**United Nations Alliance for Sustainable Fashion**' with a **donation** that is fully in your control.

The Alliance will use your donation to **improve working conditions for employees, fight pollution and related environmental issues**, and, thus, improve the overall supply chain in fashion

Page Break

Actual Donation

How much of your current payment (i.e., 10 Dollars laying in front of you) are you willing **to donate** to the '**United Nations Alliance for Sustainable Fashion**' **HERE AND NOW?**

**Reminder:** We will donate all participant shares to the '**United Nations Alliance for**





The interactive learning experience made me feel like **I have the power** to make the Fashion Supply Chain **better.** (9)

○ ○ ○ ○ ○ ○ ○

The interactive learning experience made me feel that **I have been empowered** to improve the Fashion Supply Chain. (10)

○ ○ ○ ○ ○ ○ ○

Page Break

Internal Motivation

**How much do you agree or disagree with the following statements?**

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
(1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)

<p><b>I felt internally motivated to lend a hand to the United Nations Alliance for Sustainable Fashion. (1)</b></p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p><b>I experienced a genuine passion for supporting the United Nations Alliance for Sustainable Fashion. (2)</b></p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p><b>I sincerely cared about helping the United Nations Alliance for Sustainable Fashion. (3)</b></p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p><b>I experienced a need to support the United Nations Alliance for Sustainable Fashion. (8)</b></p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Efficacy

**How much do you agree or disagree with the following statement?**

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neutral (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I am confident in my ability to affect the Fashion Supply Chain positively. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

End of Block: Psychology

Start of Block: Distance & Decision Style

Decision-Style

My decision to donate or not to donate was driven by ...

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
... my head.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... my heart.
... my rational "Self."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	... my emotional "Self".

Page Break

Distance

How close or distant did you feel to the people in the interactive learning environment?

	1	2	3	4	5	6	7	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	(6)	(7)	
far	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	close
distant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	near

Belief in Hypothetical Change

How likely is it that the supply chain in fashion will have meaningful improvements in the years to come (i.e., minimizing negative effects on the environment, improving working conditions, etc.)?

	1	2	3	4	5	6	7	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	(6)	(7)	







nervous (21)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
resentful (22)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
furious (23)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
guilty (25)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
angry (26)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
comfortable (27)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
worried (28)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
bad (29)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
good (30)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

End of Block: Emotions

Start of Block: Novelty

Novelty

The interactive learning experience was ...

	1	2	3	4	5	6	7	
--	---	---	---	---	---	---	---	--

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
Not at all new	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very new
Not at all unique	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very unique
Not at all unusual	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very unusual

Page Break

End of Block: Novelty

Start of Block: Final Block



Talking

**How likely will you talk about the supply chain in fashion the next time you see your friends?**

	1	2	3	4	5	6	7	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
Not at all likely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very likely

Learning

**To what extent are you interested in finding out more about the supply chain in fashion?**

	1	2	3	4	5	6	7	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
Not at all interested	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very much interested

Honesty

**How honest were you in filling out the survey?**

	1	2	3	4	5	6	7	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
Not at all honest	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very honest

Technical Issues

**Did you experience larger technical issues while participating in the interactive learning experience?**

(please explain: otherwise, leave the field empty)

---



---

## Start of Block: Demographics

### Gender

What is your gender?

- Male (1)
- Female (2)
- Non-binary / third gender (3)
- Prefer not to say (4)

### Age

What is your age?

▼ 18 (18) ... 92 (92)

### Citizenship

What is your citizenship?

- US American (1)
- Canadian (3)
- Mexican (4)
- Other (2) \_\_\_\_\_

## Page Break

### Shopping Habits

How often do you purchase clothing items?

- Every day (1)
- 2-3 times a week (3)
- Once a week (2)





Payment

**You did it - HEARTY CONGRATULATIONS - What's next:**

Please SPLIT your cash into **two parts**.

The first part is the amount of money you donate, which equals  
 $\{\text{donation/ChoiceNumericEntryValue/1}\}$  dollars.

After this study, we will donate this amount to the '**United Nations Alliance for Sustainable Fashion.**' **THANK you** for your support.

The second part is your **new payment for this study**.

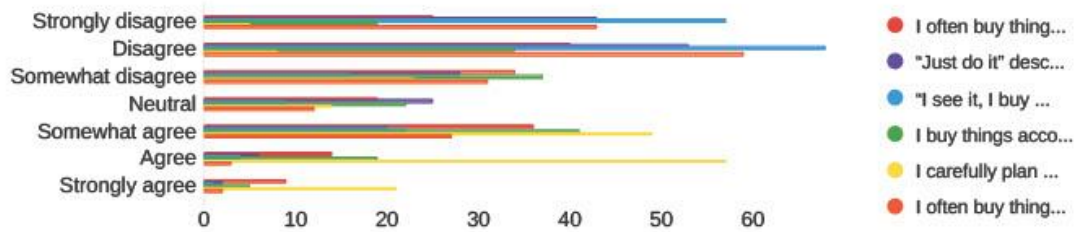
Please click **one more time** to finish this survey and **exit the laboratory** once you are done. We ask you to put your donation into **the donation box at the exit**.

End of Block: payment

## Appendix 15

### Survey Conducted at Ross Behavioral Lab

impluse - How much do you agree or disagree with the following statements?

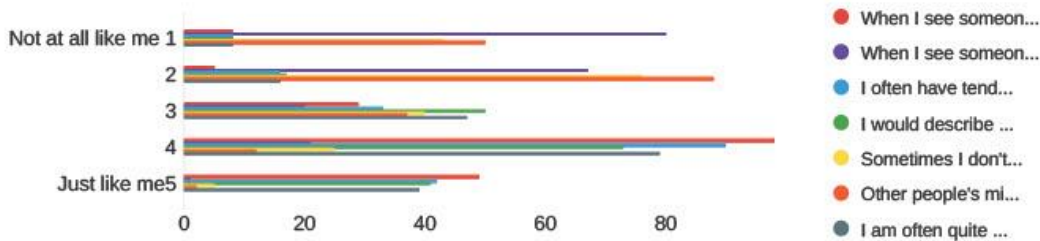


Field	Min	Max	Mean	Standard Deviation	Variance	Responses
I often buy things spontaneously.	1	7	3	2	3	177
"Just do it" describes the way I buy things.	1	7	3	2	2	177
"I see it, I buy it" describes me.	1	7	2	1	2	177
I buy things according to how I feel at the moment.	1	7	4	2	3	177
I carefully plan most of my purchases.	1	7	5	2	2	177
I often buy things without thinking.	1	7	3	1	2	177

Field	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree	Total
I often buy things spontaneously.	25	40	34	19	36	14	9	177
"Just do it" describes the way I buy things.	43	53	28	25	20	6	2	177
"I see it, I buy it" describes me.	57	68	16	9	22	4	1	177

I buy things according to how I feel at the moment.	19	34	37	22	41	19	5	177
I carefully plan most of my purchases.	5	8	23	14	49	57	21	177
I often buy things without thinking.	43	59	31	12	27	3	2	177

empathetic\_concerne - Read each of the following statements and rate how well each of them describes you with the following scale.

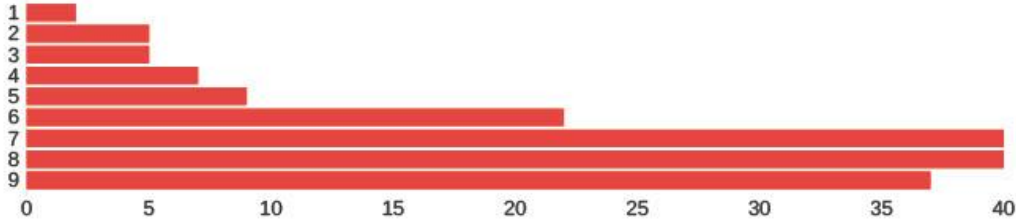


Field	Min	Max	Mean	Standard Deviation	Variance	Responses
When I see someone being taken advantage of, I feel kind of protective toward them.	1	5	4	1	1	189
When I see someone being treated unfairly, I sometimes don't feel very much pity for the person.	1	5	2	1	1	189
I often have tender, concerned feelings for people less fortunate than me.	1	5	4	1	1	189
I would describe myself as a pretty soft-hearted person.	1	5	4	1	1	189
Sometimes I don't feel sorry for other people when they are having problems.	1	5	2	1	1	189
Other people's misfortunes do not usually disturb me a great deal.	1	5	2	1	1	189
I am often quite touched by things that I see happen.	1	5	4	1	1	189

Field	Not at all like me 1	2	3	4	Just like me 5	Total
When I see someone being taken advantage of, I feel kind of protective toward them.	8	5	29	98	49	189

When I see someone being treated unfairly, I sometimes don't feel very much pity for the person.	80	67	20	21	1	189
I often have tender, concerned feelings for people less fortunate than me.	8	16	33	90	42	189
I would describe myself as a pretty soft-hearted person.	8	17	50	73	41	189
Sometimes I don't feel sorry for other people when they are having problems.	43	76	40	25	5	189
Other people's misfortunes do not usually disturb me a great deal.	50	88	37	12	2	189
I am often quite touched by things that I see happen.	8	16	47	79	39	189

likelihood - How likely would you be to support the 'United Nations Alliance for Sustainable Fashion' in achieving their goals (such as improving working conditions or fighting pollution and environmental issues within supply chain in fashion)?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all likely:Very likely	1	9	7	2	4	167

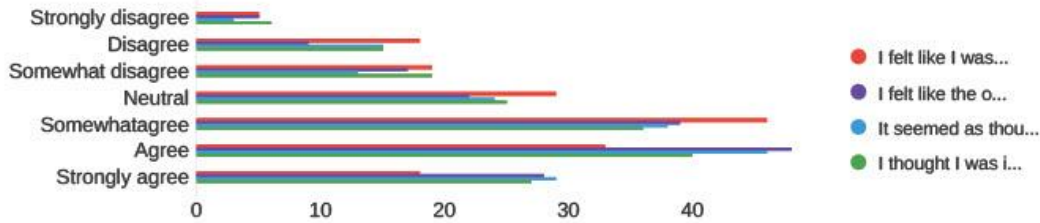
Field	Choice Count
1	2
2	5
3	5
4	7
5	9
6	22
7	40
8	40
9	37
Total	167

8

donation - How much of your current payment (i.e., 10 Dollars laying in front of you) are you willing to donate to the 'United Nations Alliance for Sustainable Fashion' HERE AND NOW? Reminder: We will donate all participant shares to the 'United Nations Alliance for Sustainable Fashion'; the difference will be your new payment for this study. There is a donation box for the United Nations Alliance for Sustainable Fashion' at the front of the Room! All proceeds will be DONATED.

Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Please indicate you donation amount [in USD]	0	10	2	3	9	167

pres - How much do you agree or disagree with the following statements about the interactive learning experience?

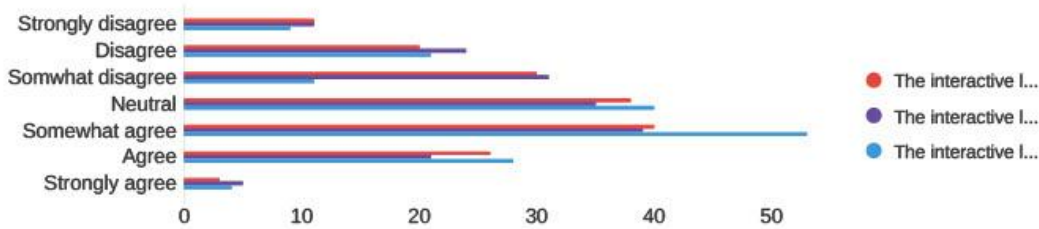


Field	Min	Max	Mean	Standard Deviation	Variance	Responses
I felt like I was a part of the supply chain.	1	7	5	2	3	168
I felt like the objects in the production environment surrounded me.	1	7	5	2	2	168
It seemed as though I was present in the environment.	1	7	5	2	3	168
I thought I was in the middle of the action rather than merely learning.	1	7	5	2	3	168

Field	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree	Total
I felt like I was a part of the supply chain.	5	18	19	29	46	33	18	168
I felt like the objects in the production environment surrounded me.	5	9	17	22	39	48	28	168
It seemed as though I was present in the environment.	3	15	13	24	38	46	29	168
I thought I was in the middle of the action rather than merely learning.	6	15	19	25	36	40	27	168



empower - How much do you agree or disagree with the following statements concerning your learning experience?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
The interactive learning experience made me feel I could make a difference in improving the Fashion Supply Chain.	1	7	4	2	2	168
The interactive learning experience made me feel like I have the power to make the Fashion Supply Chain better.	1	7	4	2	2	166
The interactive learning experience made me feel that I have been empowered to improve the Fashion Supply Chain.	1	7	4	1	2	166

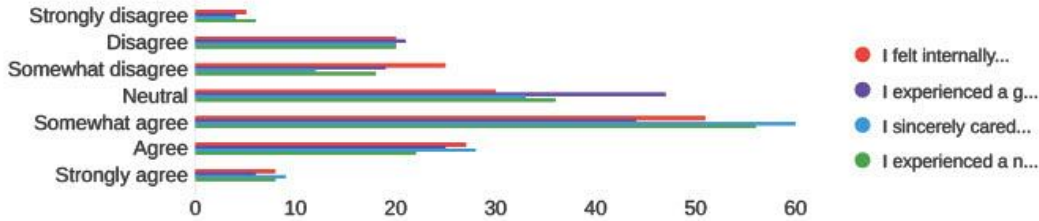
Field	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree	Total
The interactive learning experience made me feel I could make a difference in improving the Fashion Supply Chain.	11	20	30	38	40	26	3	168
The interactive learning experience made me feel like I have the power to make the Fashion Supply Chain better.	11	24	31	35	39	21	5	166

12

The interactive learning experience made me feel that I have been empowered to improve the Fashion Supply Chain.

9 21 11 40 53 28 4 166

int\_moti - How much do you agree or disagree with the following statements?



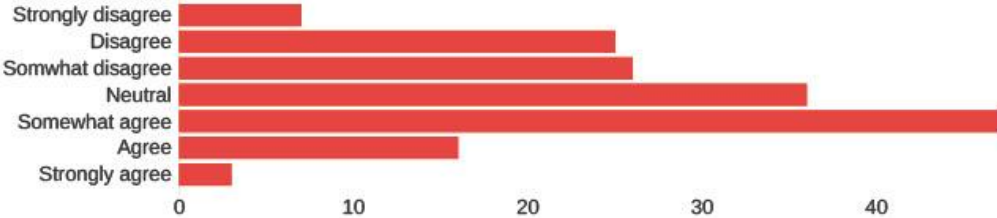
Field	Min	Max	Mean	Standard Deviation	Variance	Responses
I felt internally motivated to lend a hand to the United Nations Alliance for Sustainable Fashion.	1	7	4	1	2	166
I experienced a genuine passion for supporting the United Nations Alliance for Sustainable Fashion.	1	7	4	1	2	166
I sincerely cared about helping the United Nations Alliance for Sustainable Fashion.	1	7	4	1	2	166
I experienced a need to support the United Nations Alliance for Sustainable Fashion.	1	7	4	1	2	166

Field	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree	Total
I felt internally motivated to lend a hand to the United Nations Alliance for Sustainable Fashion.	5	20	25	30	51	27	8	166
I experienced a genuine passion for supporting the United Nations Alliance for Sustainable Fashion.	4	21	19	47	44	25	6	166

I sincerely cared about helping the United Nations Alliance for Sustainable Fashion. 4 20 12 33 60 28 9 166

I experienced a need to support the United Nations Alliance for Sustainable Fashion. 6 20 18 36 56 22 8 166

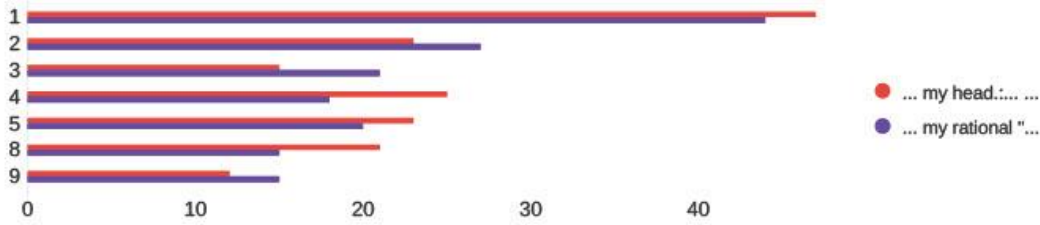
efficacy - How much do you agree or disagree with the following statement?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
I am confident in my ability to affect the Fashion Supply Chain positively.	1	7	4	1	2	160

Field	Choice Count
Strongly disagree	7
Disagree	25
Somewhat disagree	26
Neutral	36
Somewhat agree	47
Agree	16
Strongly agree	3
Total	160

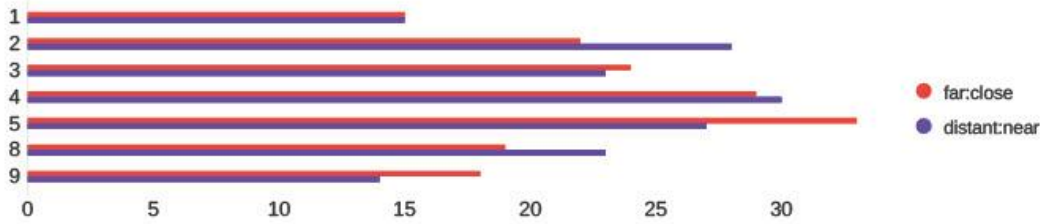
Decision-Style - My decision to donate or not to donate was driven by ...



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
... my head:.... my heart.	1	7	3	2	4	166
... my rational "Self.".... my emotional "Self".	1	7	3	2	4	160

Field	1	2	3	4	5	8	9	Total
... my head:.... my heart.	47	23	15	25	23	21	12	166
... my rational "Self.".... my emotional "Self".	44	27	21	18	20	15	15	160

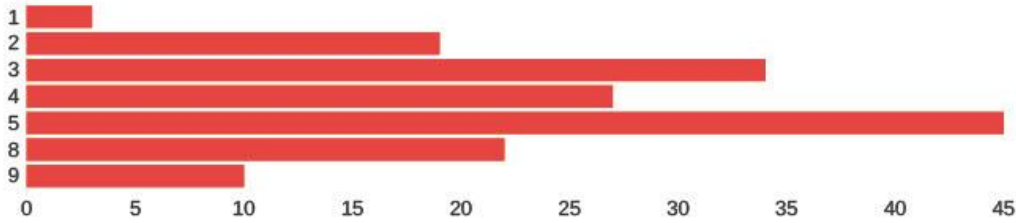
distance - How close or distant did you feel to the people in the interactive learning environment?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
far:close	1	7	4	2	3	160
distant:near	1	7	4	2	3	160

Field	1	2	3	4	5	8	9	Total
far:close	15	22	24	29	33	19	18	160
distant:near	15	28	23	30	27	23	14	160

hypothetical - How likely is it that the supply chain in fashion will have meaningful improvements in the years to come (i.e., minimizing negative effects on the environment, improving working conditions, etc.)?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all likely:Very likely	1	7	4	1	2	160

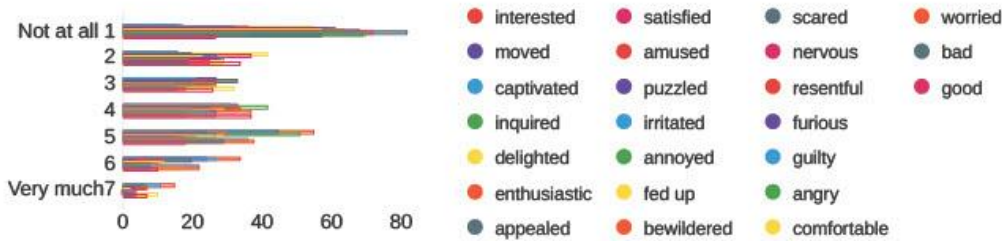
Field	Choice Count
1	3
2	19
3	34
4	27
5	45
8	22
9	10
Total	160



time - How many years from now will it take to have meaningful improvements in fashion supply chain (i.e., minimizing negative effects on the environment, improving working conditions, etc.)?

Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Years it takes to have meaningful improvements	1	100	30	22	500	160

PANAS - Please describe how you felt throughout the interactive learning session. Use the adjectives listed below to describe your feelings.



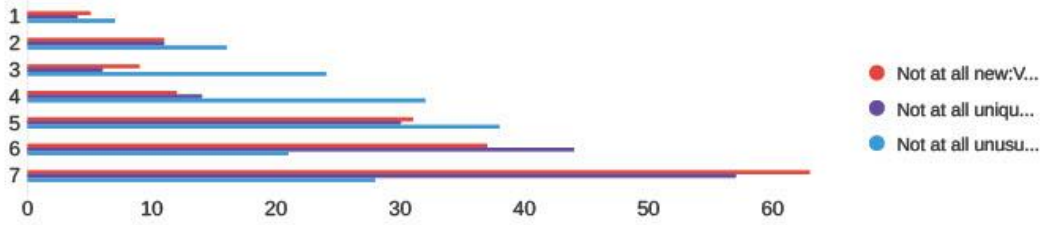
Field	Min	Max	Mean	Standard Deviation	Variance	Responses
interested	1	7	5	1	2	167
moved	1	7	4	2	3	167
captivated	1	7	4	2	3	166
inquired	1	7	4	2	2	167
delighted	1	7	3	2	3	168
enthusiastic	1	7	3	2	3	167
appealed	1	7	3	2	3	167
satisfied	1	7	3	2	3	167
amused	1	7	3	2	3	167
puzzled	1	7	3	2	3	167
irritated	1	7	3	2	3	168
annoyed	1	7	3	2	3	168
fed up	1	7	3	2	3	167
bewildered	1	7	3	2	3	167

scared	1	7	2	2	3	168
nervous	1	7	2	2	3	167
resentful	1	6	2	2	2	167
furious	1	6	2	2	2	167
guilty	1	7	4	2	3	159
angry	1	7	3	2	3	160
comfortable	1	7	4	2	3	159
worried	1	7	4	2	3	160
bad	1	7	3	2	3	159
good	1	7	3	2	3	159

Field	Not at all	1	2	3	4	5	6	Very much	7	Total
interested	7	3	22	31	55	34	15	167		
moved	16	16	27	33	45	24	6	167		
captivated	17	16	21	31	43	27	11	166		
inquired	20	10	25	42	51	12	7	167		
delighted	55	42	15	32	14	7	3	168		
enthusiastic	36	20	32	33	30	12	4	167		
appealed	32	20	33	32	24	20	6	167		
satisfied	45	37	27	22	20	12	4	167		
amused	59	25	17	34	18	7	7	167		
puzzled	61	27	20	25	27	4	3	167		
irritated	68	22	23	19	25	10	1	168		
annoyed	64	24	26	18	26	8	2	168		
fed up	57	23	15	29	29	12	2	167		

bewildered	56	19	21	37	21	10	3	167
scared	82	29	16	18	14	8	1	168
nervous	72	26	24	20	17	7	1	167
resentful	70	22	27	27	15	6	0	167
furious	69	28	20	27	18	5	0	167
guilty	36	18	18	25	36	22	4	159
angry	70	19	21	23	21	5	1	160
comfortable	23	29	32	27	21	17	10	159
worried	35	25	18	18	38	22	4	160
bad	57	19	16	27	29	8	3	159
good	27	34	26	37	18	10	7	159

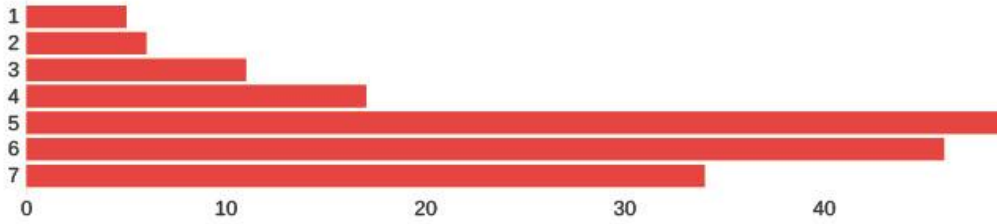
novel - The interactive learning experience was ...



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all new:Very new	1	7	5	2	3	168
Not at all unique:Very unique	1	7	6	2	3	166
Not at all unusual:Very unusual	1	7	5	2	3	166

Field	1	2	3	4	5	6	7	Total
Not at all new:Very new	5	11	9	12	31	37	63	168
Not at all unique:Very unique	4	11	6	14	30	44	57	166
Not at all unusual:Very unusual	7	16	24	32	38	21	28	166

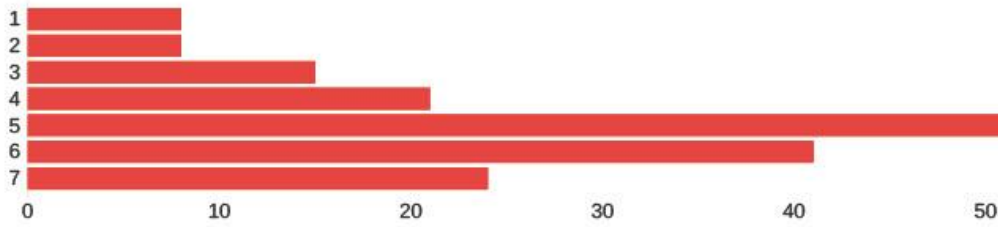
know - To what extent did the interactive learning experience contribute to better understand the supply chain in fashion?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all:Very much	1	7	5	1	2	168

Field	Choice Count
1	5
2	6
3	11
4	17
5	49
6	46
7	34
Total	168

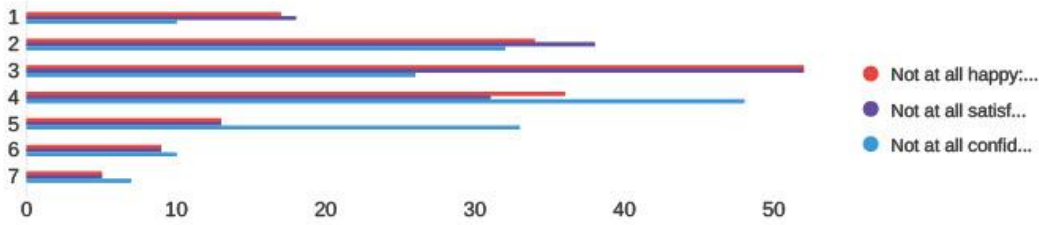
thinking - How likely will you think back to the learning experience the next time you buy fashion?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all likely:Very likely	1	7	5	2	2	168

Field	Choice Count
1	8
2	8
3	15
4	21
5	51
6	41
7	24
Total	168

happy - How did you perceive the workers in the interactive learning experiences?

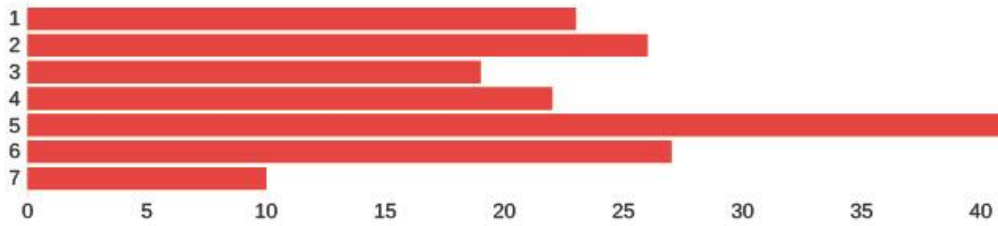


Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all happy:Very happy	1	7	3	1	2	166
Not at all satisfied:Very satisfied	1	7	3	1	2	166
Not at all confident:Very confident	1	7	4	1	2	166

Field	1	2	3	4	5	6	7	Total
Not at all happy:Very happy	17	34	52	36	13	9	5	166
Not at all satisfied:Very satisfied	18	38	52	31	13	9	5	166
Not at all confident:Very confident	10	32	26	48	33	10	7	166



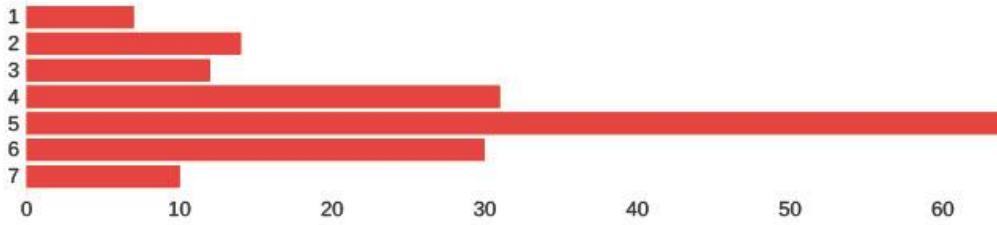
talking - How likely will you talk about the supply chain in fashion the next time you see your friends?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all likely:Very likely	1	7	4	2	3	168

Field	Choice Count
1	23
2	26
3	19
4	22
5	41
6	27
7	10
Total	168

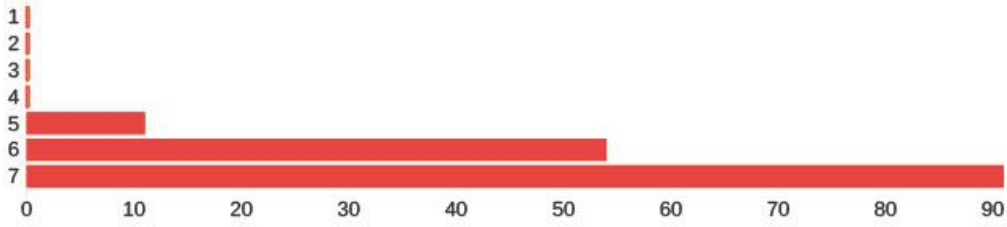
learn - To what extent are you interested in finding out more about the supply chain in fashion?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all interested:Very much interested	1	7	5	1	2	168

Field	Choice Count
1	7
2	14
3	12
4	31
5	64
6	30
7	10
Total	168

honest - How honest were you in filling out the survey?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Not at all honest:Very honest	5	7	7	1	0	156

Field	Choice Count
1	0
2	0
3	0
4	0
5	11
6	54
7	91
Total	156

tech\_issue - Did you experience larger technical issues while participating in the interactive learning experience? (please explain: otherwise, leave the field empty)

Did you experience larger technical issues while participating in the interactive learning experience?

(please explain: otherwise, leave the field empty)

gdfg

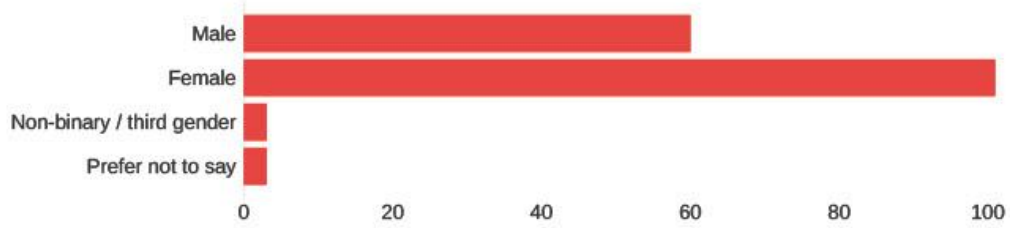
I think sometimes the questions were not very obvious, you had to rotate around the whole screen to see them. Usually the question would drop off when you got it correct, but this was not the case in one of the last 2 screens.

I'm left-handed, so there were notifications popping up whenever I moved the controller over to my other hand

the headphone kept dropping

I was confused at first about how to navigate it

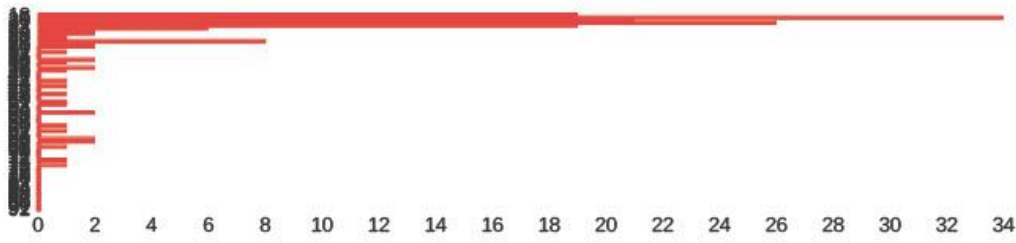
gender - What is your gender?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
What is your gender?	1	4	2	1	0	167

Field	Choice Count
Male	60
Female	101
Non-binary / third gender	3
Prefer not to say	3
Total	167

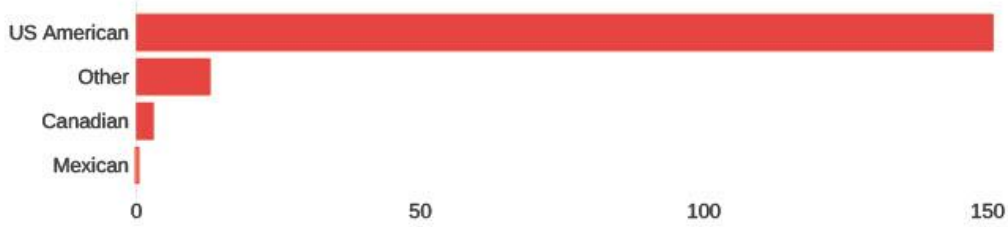
age - What is your age?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
What is your age?	18	75	25	12	148	166

Field	Choice Count
18	19
19	34
20	21
21	26
22	19
23	6
24	2
25	2
26	1
27	1
28	8
29	2
30	2

citizen - What is your citizenship?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
What is your citizenship? - Selected Choice	1	3	1	0	0	167

Field	Choice Count
US American	151
Other	13
Canadian	3
Mexican	0
<b>Total</b>	<b>167</b>

Other - Text

Indian

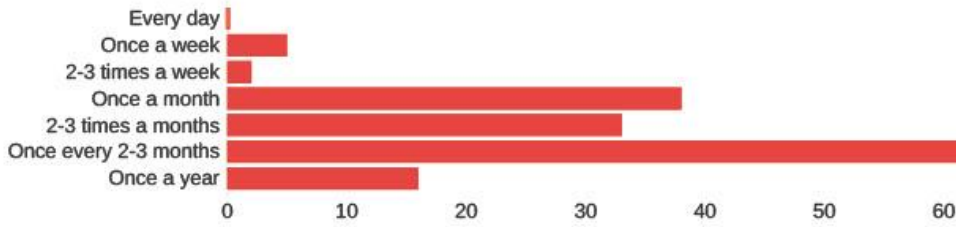
japanese

Canadian and American

Swedish

INDIAN

shopping thoughts - How often do you purchase clothing items?



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
How often do you purchase clothing items?	2	8	6	2	2	159

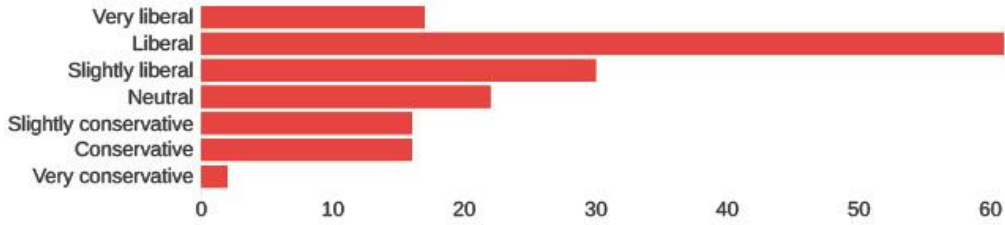
Field	Choice Count
Every day	0
Once a week	5
2-3 times a week	2
Once a month	38
2-3 times a months	33
Once every 2-3 months	65
Once a year	16
Total	159



Please indicate how - Please use the slider to indicate how much money [in USD] you spend on AVERAGE on fashion EVERY MONTH.

Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Amount you spend on Fashion every month [in USD]	0	752	94	121	14626	158

politics - Please select an answer.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
When it comes to politics, do you usually think of yourself as ...	1	7	3	2	2	164

Field	Choice Count
Very liberal	17
Liberal	61
Slightly liberal	30
Neutral	22
Slightly conservative	16
Conservative	16
Very conservative	2
Total	164

## Appendix 16

## Internal Review Board Research Approval



Date: Thursday, February 9, 2023 9:27:50 PM

Print

## 01. General Study Information

The forms menu on the left displays all sections and pages of the application. Pages in **bold** are required. Pages in *italics* may not apply to your project. Use the "Continue" button to advance through the smartform, as it will only display the sections that must be completed.

All questions marked with a red asterisk (\*) are required. Questions without a red asterisk may or may not be required, depending on their relevance to the study.

## 1.1\* Study Title:

Woven

## 1.1.1 Full Study Title:

Woven: A Virtuality Experience Farm to Closet Journey of Jeans

1.1.2 If there are other U-M studies related to this project, enter the eResearch ID number (HUM#) or IRBMED Legacy study number. Examples of related projects include, but are not limited to:

- Projects funded under the same grant
- IRBMED Legacy study being migrated into eResearch
- Previously approved Umbrella applications (such as Center Grants or approvals for release of funding)
- Previously approved projects for which this is a follow up study

## 1.1.3\* Does this application include the study of COVID-19?

For example:

- testing or studying the COVID-19 virus,
- exploring treatment options,
- studying the impact of the COVID-19 pandemic (This could include epidemiological, social, behavioral, or educational research).

Note: Answer "Yes" only if this project includes the study of COVID-19. Inclusion of study procedures solely intended to allow the research to be conducted under pandemic constraints, such as remote interactions with subjects, remote consenting, or at-home drug delivery are not considered the study of COVID-19.

Yes  No

## 1.2\* Principal Investigator:

Niki Fairchild-Azevedo

Note: If the user is not in the system, you may [Create A New User Account...](#)

## 1.3 Study Team Members:

Study Team Member	Study Team Role	Appointment Dept	Appointment Selection Complete?	Student	Friend Account	COI Review Required	Edit Rights	Accepted Role?	PEERRS Human Subjects?
Niki Fairchild-Azevedo	PI	Stamps School of Art & Design	Yes	yes	No	no	yes	N/A	yes
Mark Lindquist	Faculty Advisor	Sch for Environ and Sustain	Yes	no	No	no	yes	Yes	yes
Nicholas Tobier	Faculty Advisor of Art & Design	Stamps School of Art & Design	Yes	no	No	no	yes	Yes	yes
Joseph Trumpey	Faculty Advisor of Art & Design	Stamps School of Art & Design	Yes	no	No	no	yes	Yes	yes

## 1.8\* Project Summary:

Through a unique combination of Participatory Action Research (PAR) and Design for Sustainable Behavior (DfSB) methodologies an informational experience was created.

Participants will be actively engaged in the experience through a computer and Virtual Reality. A pre experience survey will be conducted to gauge participants current attitude and behaviors around purchasing and valuing clothing. The participants will be given an honorarium of \$10.

Participants will randomly be split into 2 groups. One group will view the experience on a computer, and the other group will experience the same experience on a VR device. After the viewing experience participants will be given an exit survey. The survey will gauge possible shifts in attitudes, beliefs, and values related to sustainability and circular fashion. The participants will then be asked if they wish to donate any portion of their honorarium to the United Nations Fashion Alliance.

The goal of the study is to compare the attitude and behavior shifts as related to informational delivery systems. Survey results from the group that viewed the material on a computer and the group that viewed the same material in VR will be compared. The hypothesis is that the shift in attitudes and behavior will be larger in the group that experienced the information delivery in VR.

The study will be completed in one day. The IRB application is the pre and post-experience survey as well as the VR and computer engagement with the informational experience.

**1.9\* Select the appropriate IRB:**

Health Sciences and Behavioral Sciences

**1.10\* Estimated Study Start Date (Not required for IRBMED): (mm/dd/yyyy)**

2/10/2023

**1.11\* Estimated Duration of Study:**

8 weeks

**01-1. Application Type**

**1-1.1\* Select the appropriate application type.**

Application Type	Description
<input checked="" type="checkbox"/> Human Subjects research involving interaction or intervention (formerly Standard, non-exempt research project - or - Exempt)	Studies that involve either or both of the following: <ul style="list-style-type: none"> <li>Interaction, including communication or interpersonal contact between investigator and subject</li> <li>Intervention, including both physical procedures by which information or biospecimens are gathered (e.g., venipuncture) and manipulations of the subject or subject's environment that are performed for research purposes</li> </ul> Interaction/Intervention studies may also have a "secondary research" component.

Does the research involve any of the following:

- a. more than minimal risk to participants?
- b. use of drugs or medical devices?
- c. target prisoners as research subjects?
- d. collection of biospecimens from subjects (including blood, saliva, cheek swabs)?

Yes  No

Some studies involving interaction or intervention with subjects meet the criteria for exemption. Select the category that best describes your research. Detailed questions to verify eligibility are found on the next page. For some studies, you will be able to issue a self-determination.

If none of these categories apply to your research select NONE. Your application will be routed for comprehensive IRB review.

**Exemption Category**

**Exemption 1** applies to research that is:

- conducted in established educational settings (typically schools/colleges); and
- focuses on normal (accepted) educational practices (e.g. instructional techniques, curricula, classroom management methods)

May include use of educational data

**Exemption 2** applies to most research that involves collection of information using ONLY one or more of the following:

- Surveys (with adults only)
- Interviews (with adults only)
- focus groups (with adults only)
- educational tests
- observation of public behavior

May involve audio-visual recording but may not involve an intervention (see exemption 3) or linking to additional personally-identifiable data.

**Exemption 3** applies to research with adults only that involves:

- benign (not harmful) behavioral interventions
  - Examples:
    - Playing an online game
    - Solving puzzles under various noise conditions
    - Playing an economic game
    - Being exposed to stimuli such as color, light or sound (at safe levels)
    - Participating in a nutrition education program
- information collected through verbal or written responses (including methods described in exemption 2 above)
- no physiological data collection (e.g. blood pressure monitoring, EEG, FitBit, etc.)
- subjects' prospective agreement to participate in intervention and information collection

May not involve deception unless subjects are told that they will be misled

- **Exemption 5** applies to research and demonstration projects that are conducted or supported by a Federal department or agency, or otherwise subject to the approval of department or agency heads that are designed to study, evaluate, improve, or otherwise examine public benefit or service programs.

- **Exemption 6 - Taste and food quality evaluation and consumer acceptance studies**

- **NONE** - none of the exemption categories apply to this research.

"Secondary research" are studies that involve ONLY re-using private information and/or biospecimens that are collected for some other "primary" or "initial" activity, such as other earlier research studies, a biorepository holding specimens obtained with "broad consent," clinical care, or educational records. Includes Exemption 4 and not regulated projects.

Do NOT use this application type for:

- Secondary research** uses of private information or biospecimens
  - Studies that also have an interaction/intervention component, such as primary collection of information or biospecimens for the purposes of the study. (Choose instead "Human subjects research involving interaction or intervention.")
  - Projects involving secondary use of information/biospecimens for only non-research purposes, such as QA/QI, case studies on one or two individuals, or use in a class to teach research methods. (Choose instead "Activities not regulated as human subjects research.")

- Activities Not Regulated** as human subjects research
 

Not all activities that involve people, their data, or specimens are covered by the regulations governing human subjects research (45 CFR 46 or 21 CFR 50/56).

IRB review is required for the following activities ONLY to assess compliance with HIPAA or other regulations or institutional policies:

- Research on existing data or specimens that have been coded before the researcher receives them, but identifiers still exist.

- Research Involving Deceased Individuals Only
- Pre-review of Clinical Data Sets Preparatory to Research
- Standard Public Health Surveillance or Prevention Activities

IRB review is not required for the following activities, but researchers may wish complete this brief application to generate a determination letter for funding or publication purposes, or to request IRB review to confirm the Not Regulated determination:

- Case Studies
- Class Activities
- Journalism/Documentary Activities
- Oral History
- Quality Assurance and Quality Improvement Activities
- Research on Organizations
- Research using Publicly Available Data Sets

<input type="checkbox"/>	Projects lacking immediate plans for involvement of human subjects, their data, and/or their specimens	<p>Activities such as training grants, program projects, center grants, or multi-phase studies not involving human subjects until later years. Before release of funding, some agencies may require IRB acknowledgement of the future use of human subjects.</p> <p>These projects are sometimes referred to as "umbrella projects" or "dry applications."</p>
<input type="checkbox"/>	Single-patient Expanded Access Drug or Biologic (Emergency Use or Non-Emergency/Compassionate Use)	<p>Use of an investigational drug or biologic, outside of a clinical trial, under a single-patient IND issued by the FDA for a patient faced with a serious or life-threatening disease or condition.</p> <ul style="list-style-type: none"> <li>• Contact the IRB Chair-on-Call as soon as possible once the decision to use the investigational drug or biologic is made.</li> <li>• Submission for IRB review and approval is required, prior to use if feasible. If this was an emergency use, submit no later than five days after use of the investigational agent.</li> <li>• This includes both one-time use and continuing therapy.</li> </ul>
<input type="checkbox"/>	Single-patient Expanded Access Device Use (Emergency Use or Non-Emergency/Compassionate Use)	<p>Use of an investigational device, outside of a clinical trial, when this is the only option available for a patient faced with a serious or life-threatening disease or condition.</p> <ul style="list-style-type: none"> <li>• Contact the IRB Chair-on-Call as soon as possible once the decision to use the investigational device is made.</li> <li>• Submission for IRB review and approval is required, prior to device use if feasible. If this was an emergency use, submit no later than five days after use of the investigational device.</li> <li>• This includes both one-time use and continuing therapy.</li> </ul>
<input type="checkbox"/>	Humanitarian Use Device (HUD) under a HDE	Non-research, on-label use of an HUD under a Humanitarian Device Exemption (HDE)
<input type="checkbox"/>	Requesting Review by a Non-UM IRB	Use ONLY to request deferral of IRB oversight for UM activities to a non-UM IRB or when UM is a performance site in a multisite research project where UM is the lead site.
<input type="checkbox"/>	Multi-site Research where U-M is a Coordinating Center and/or IRB of Record	<p>Do not use Multi-site Research application type when U-M is only a performance site - select Standard application type.</p> <p>Select when U-M is any of the following:</p> <ul style="list-style-type: none"> <li>• Data Coordinating Center;</li> <li>• Clinical Coordinating Center; or</li> <li>• IRB of Record for non-U-M sites (for U-M to be IRB of Record you must contact your IRB for prior acknowledgement).</li> </ul> <p>When U-M is also a performance site, a separate application is required for local site considerations. Refer to special requirements at the IRB website.</p>



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**1-2.1\* Who initiated this study?**

Student investigator or faculty member on behalf of a student

---

**1-2.2\* Are you or any students working on this project being paid from a federally funded training grant?**

Yes  No

---

**1-2.3 This study is currently associated with the following department. To associate this research with a different department, click Select. If the department has defaulted to "student", click select to specify the department through which this application is being submitted.**

Stamps School of Art & Design

---

**1-2.5\* Is the study related to cancer, cancer risk, or cancer care delivery?**

Yes  No

---

**1-2.7\* Has the scientific merit of this study already been peer reviewed (i.e., reviewed by one or more recognized authorities on the subject)?**

Yes  No

---

**1-2.7.1\* List the peer-review organization(s).**

Peer Review Organization

Faculty advisor, thesis committee, other student review

---

**1-2.8\* Is this a clinical trial?**

Yes  No

---

**01-7. Student Research Information**

---

**1-7.1\* This application is being submitted by a:**

Select all that apply:

Student for a dissertation/thesis

---

**1-7.2 Indicate course number here:**

---

**Study Team Detail**

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**1.4 Team Member:**

Niki Fairchild-Azevedo

Preferred email: fairmiki@umich.edu

Business phone

Business address: Stamps School of Art & Design 2000 Bonisteel Blvd 48109-2069

---

**1.5 Function with respect to project:**

PI

---

**1.6 Allow this person to EDIT the application, including any supporting documents/stipulations requested during the review process:**

Yes

---

**Credentials: Required for PI, Co-Is and Faculty Advisors**


---



---

**Upload or update your CV, resume, or biographical sketch.**

Name	Version
 Fairchild Azevedo Niki CV(0.01)	0.01

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**Conflict of Interest Detail: Required for all roles except Administrative Staff**


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**Current Disclosure Status in M-Inform:** *This study team member has not yet disclosed in M-Inform.*
**D1 Do you or your family members have an outside activity, relationship, or interest with a non-UM entity, where the non-UM entity:**

- Provides financial or non-financial support for this project;
- Supplies a product used in this project (e.g., an app, device, compound, drug, software, survey, evaluation) either for free or at a cost (e.g., purchased);
- Holds an option or license to intellectual property used in this project (e.g., a device, compound, drug, software, survey, evaluation, code, data, schematics, algorithms) that you or your family member developed;
- Will perform work on this project (e.g., subcontract, service agreement, unfunded agreement); or
- Has a financial stake in the outcome of this research?

No

---

**D2 If  Yes  to the question above, provide the name of the outside entity or entities and a brief description of the interest/relationship(s):**


---



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**Study Team Detail**


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**1.4 Team Member:**
[Mark Lindquist](#)

Preferred email: marklin@umich.edu  
 Business phone: 734-763-8860  
 Business address: SNRE 2532 Dana 48109-1041

---

**1.5 Function with respect to project:**

Faculty Advisor

---

**1.6 Allow this person to EDIT the application, including any supporting documents/stipulations requested during the review process:**

Yes

---

**Credentials: Required for PI, Co-Is and Faculty Advisors**


---



---

**Upload or update your CV, resume, or biographical sketch.**

Name	Version
 Mark Lindquist CV(0.01)	0.01



---

**Conflict of Interest Detail: Required for all roles except Administrative Staff**

---

**Current Disclosure Status in M-Inform:** *This study team member has indicated in M-inform that they do not have any outside interests to disclose.*

**D1 Do you or your family members have an outside activity, relationship, or interest with a non-UM entity, where the non-UM entity:**

- Provides financial or non-financial support for this project;
- Supplies a product used in this project (e.g., an app, device, compound, drug, software, survey, evaluation) either for free or at a cost (e.g., purchased);
- Holds an option or license to intellectual property used in this project (e.g., a device, compound, drug, software, survey, evaluation, code, data, schematics, algorithms) that you or your family member developed;
- Will perform work on this project (e.g., subcontract, service agreement, unfunded agreement); or
- Has a financial stake in the outcome of this research?

No

---

**D2 If Yes to the question above, provide the name of the outside entity or entities and a brief description of the interest/relationship(s):**

---

## Study Team Detail

### 1.4 Team Member:

Nicholas Tobier

Preferred email: [nicklob@umich.edu](mailto:nicklob@umich.edu)

Business phone: 734-938-0897

Business address: Stamps School of Art & Design 2080 Art & Arch 48109-2080

---

### 1.5 Function with respect to project:

Faculty Advisor

---

**1.6 Allow this person to EDIT the application, including any supporting documents/stipulations requested during the review process:**

Yes

---

**Credentials: Required for PI, Co-Is and Faculty Advisors**

---

**Upload or update your CV, resume, or biographical sketch.**

Name	Version
 2022 Tobier CV(0.01)	0.01
 NickTobier_cv(0.01)	0.01
 Tobier_cv(0.01)	0.01

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**Conflict of Interest Detail: Required for all roles except Administrative Staff**

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**Current Disclosure Status in M-Inform:** *This study team member has disclosed outside interest(s) or relationship(s) in M-Inform.*

**D1 Do you or your family members have an outside activity, relationship, or interest with a non-UM entity, where the non-UM entity:**

- Provides financial or non-financial support for this project;
- Supplies a product used in this project (e.g., an app, device, compound, drug, software, survey, evaluation) either for free or at a cost (e.g., purchased);
- Holds an option or license to intellectual property used in this project (e.g., a device, compound, drug, software, survey, evaluation, code, data, schematics, algorithms) that you or your family member developed;
- Will perform work on this project (e.g., subcontract, service agreement, unfunded agreement); or
- Has a financial stake in the outcome of this research?

No

**D2 If  Yes  to the question above, provide the name of the outside entity or entities and a brief description of the interest/relationship(s):**

#### Study Team Detail

##### 1.4 Team Member:

Joseph Trumpey

Preferred email: [jtrumpey@umich.edu](mailto:jtrumpey@umich.edu)

Business phone: 734-763-0111

Business address: School of Art & Design 2085 Art & Architecture 48109-2089

##### 1.5 Function with respect to project:

Faculty Advisor

**1.6 Allow this person to EDIT the application, including any supporting documents/stipulations requested during the review process:**

Yes

**Credentials: Required for PI, Co-Is and Faculty Advisors**

**Upload or update your CV, resume, or biographical sketch.**

Name	Version
 Trumpey.cvfull.4.18.docx(0.03)	0.03

**Conflict of Interest Detail: Required for all roles except Administrative Staff**

**Current Disclosure Status in M-Inform:** *This study team member has indicated in M-inform that they do not have any outside interests to disclose.*

**D1 Do you or your family members have an outside activity, relationship, or interest with a non-UM entity, where the non-UM entity:**

- Provides financial or non-financial support for this project;
- Supplies a product used in this project (e.g., an app, device, compound, drug, software, survey, evaluation) either for free or at a cost (e.g., purchased);
- Holds an option or license to intellectual property used in this project (e.g., a device, compound, drug, software, survey, evaluation, code, data, schematics, algorithms) that you or your family member developed;
- Will perform work on this project (e.g., subcontract, service agreement, unfunded agreement); or
- Has a financial stake in the outcome of this research?

02. Sponsor/Support Information

The following sections request details about the current or pending sponsorship/support of this study. Consider all of the choices below and complete the appropriate sections.  
 \* Note: At least one of the following sections must be answered. Multiple forms of funding or support must be added one at a time.

2.1 Please select all Proposal Approval Forms (PAFs), Awards (AWDs), and/or Unfunded Agreements (UFAs) associated with this study.

Click here to indicate that a PAF(s) has not been initiated.

Related PAFs:

ID	Title	PI	Direct Sponsor	Prime Sponsor	State	Has SUBKs?	Related Awards
There are no items to display							

Related AWDs:

Award ID	Title	PI	Direct Sponsor	Prime Sponsor	State	Has SUBKs?	Project Period	Awarded PAFs
There are no items to display								

Related UFAs:

UFA ID	Title	PI	State	Category	Start Date	End Date
There are no items to display						

2.2 Internal UM Sponsor(s)/Support: [Including department or PI discretionary funding]

Type	Department Sponsor	Support Type
<a href="#">View</a> UM Institutional - Department, Pilot Grant Program, or other Institutional funding source	Stamps School of Art & Design	Financial

2.3 Check here if the proposed study does not require external or internal sponsorship or support:

2.4\* Is there any other financial or non-financial sponsorship or support not covered in the sections above?

Yes  No

Internal Sponsor Detail

2.2.1\* Department Sponsor/Support:

Stamps School of Art & Design

2.2.2\* Sponsor Type:

UM Institutional - Department, Pilot Grant Program, or other Institutional funding source

If other, please specify:

2.2.3\* Support Type:

Financial

2.2.4\* Is the support confirmed?

Yes  No

---

**2.2.5\*** Please describe the award/support:

Discretionary Funds

---

**2.2.6** Upload Supporting Documentation

Name	Version
------	---------

There are no items to display

---

03. UM Study Functions

3.1\* Indicate all functions that will be performed at University of Michigan locations.

Select all that apply:

Recruitment (including screening)

Interaction (e.g., information gathering, survey, interview, focus groups, etc.)

Intervention (e.g., use of drug or device, medical procedures, educational intervention, group intervention, social/psychological intervention etc.)

Qualitative research (e.g., 'member checking', open-ended questions, etc.)

Storage (data and/or specimen): Responsible for the management, security and transfer of study data and/or specimens.

If other, please specify.

03-1. Performance Sites

3-1.1\* Performance Sites:

Location	Country	"Engaged" in the research?	Performance Site Type	Site Function
University of Michigan	USA	yes		Qualitative research, Intervention, Storage, Interaction, Recruitment

Performance Site Detail

3-1.2\* Location or Institution:

University of Michigan

3-1.3 Address:

City

State

Country\* USA

3-1.4\* Function of this location with respect to this study:

Select all that apply:

Recruitment (including screening)

Interaction (e.g., information gathering, survey, interview, focus groups, etc.)

Intervention (e.g., use of drug or device, medical procedures, educational intervention, group intervention, social/psychological intervention etc.)

Qualitative research (e.g., 'member checking', open-ended questions, etc.)

Storage (data and/or specimen): Responsible for the management, security and transfer of study data and/or specimens.

If other, please specify:

3-1.5\* Will this site be "engaged" in the conduct of the research?

Yes  No

3-1.6 If known, provide the Federalwide Assurance (FWA) number for this location.

FWA00004089

3-1.7 If applicable, indicate what organization, agency or government office has reviewed this research and provided its approval (e.g., IRB, ethics committee, school district office, prison official, nursing home administrator).

3-1.8 Upload any location site approval documentation here:

Name Version

There are no items to display

### Exemption 3

Completion of this section is required based on the Exemption Category selected in question 1-1.1.

Exemption 3 is limited to research involving benign behavioral interventions. A behavioral intervention involves the performance of cognitive, intellectual, educational or behavioral tasks or the manipulation of the subject's physical, sensory, social or emotional environment. It does not include medical interventions such as medical tests, procedures or use of medical devices.

A benign behavioral intervention must be:

- Brief in duration
- Harmless
- Painless
- Not physically invasive
- Not offensive or embarrassing
- Not likely to pose a significant lasting adverse impact on subjects

Data collection methods are limited to verbal (oral) or written responses from the subject (such as surveys or interviews, test responses, data entry) or observation of the subject. Audiovisual recording is permissible. Data cannot be collected via physical procedures (e.g. blood pressure monitoring, EEG, activity trackers (Fitbit), blood draws).

Examples of behavioral interventions that may qualify for this exemption includes:

- Playing an online game
- Solving puzzles under various noise conditions
- Playing an economic game
- Being exposed to stimuli such as color, light or sound (at safe levels)
- Performing cognitive tasks
- Providing educational materials to participants with the intention of changing their behavior (e.g. smoking cessation, eating habits)

---

**1\*** Based upon the information above, does your project meet the definition of a benign behavioral intervention?

Yes  No

---

**2\*** Confirm that your project involves research with adults only:

Yes  No

---

**3\*** Does the research involve deception?

This means that subjects will be given false information, will be misled about some key aspect of the research, or will not be told the purpose of the research. Examples include: providing false feedback regarding test performance or using a confederate to influence participant's behavior in the research. Note: Use of experimental controls is not deception.

Yes  No

---

**4\*** In order to qualify for this exemption, the researchers must describe the intervention and data collection methods to potential subjects and seek their prospective agreement to participate. Confirm that you obtain prospective agreement to participate:

This exemption does not apply to projects where participants are not aware that they are participating in research, such as videotaping pedestrian behavior when a walk/don't walk sign is being manipulated for research purposes

Yes  No

---

**4.1\*** Describe how prospective agreement will be obtained. For projects where subjects will be informed about deception, include a description of that process.

All participants will be given a written consent form and will provide their signature. The consent form is attached in the support documents. Participants are told explicitly about the study and the time frame. Participants are invited to ask any questions to the researchers for clarification.

---

**5\*** Does the research collect information about the subject in such a manner that their identity can be readily ascertained by the study team, directly or through identifiers linked to the subjects?

This means that the information is collected with direct identifiers (name, address, email, phone number, social security number, student ID, medical record number) or indirect identifiers, such as a code that can link back to the subject or data elements that could be combined to readily re-identify an individual (dates, employment history, etc.).

Yes  No

---

**5.1\*** Will the research generate information that, if revealed outside the research, could reasonably place the subjects at risk of criminal or civil liability, or damage their financial standing, employability, educational advancement or reputation?



This means that the research involves the collection of sensitive information, about the subject, such as information about illegal behaviors, mental health issues, sensitive health conditions (HIV, STDs), genetic information, or negative opinions/attitudes about employers or teachers. A disclosure of this information outside of the research (breach of confidentiality) could pose legal risks or risks of social stigmatization to the subjects.

Yes  No

6\* Will the research involve the access, collection, use, maintenance, or disclosure of protected health information (PHI) to identify eligible subjects? [Require Section 25]








Yes  No

7\* Provide a brief summary of your research (subject population, study procedures(including description of the benign intervention and data collection methods), location of research) or upload protocol below.

Participants will be given a survey which they will fill out using the platform Qualtrics. The survey will be completed digitally and take approximately 5 mins to complete. Participants are then randomly assigned a number, those with odd numbers will experience the information on a computer, and those that are even will experience the information on a Meta Oculus Quest VR device. Participants will spend approximately 7-10 mins engaging with the same material with the only difference being delivery systems. After the viewing experience participants will be given an exit survey. The survey will gauge possible shifts in attitudes, beliefs, and values related to sustainability and fashion/clothing. The participants will then be asked if they wish to donate any portion of their honorarium to the United Nations Fashion Alliance. Participants are then informed that the study has concluded.

8 Upload documents (e.g. protocol document, survey/interview questions, or other documents relevant to your research).

The submission of an informed consent document is not required for studies that do not collect identifiable, sensitive data. Researchers still have an ethical obligation to ensure that participants are fully informed about the nature of a research project so that they can make an informed decision to participate.

Name	Version
 Design Firm Audio Visual Stimuli(0.01)	0.01
 Oral Recruitment Script(0.01)	0.01
 Shipping Container Audio Visual Stimuli(0.01)	0.01
 survey (0.01)	0.01
 Textile Mill Audio Visual Stimuli(0.01)	0.01
 Woven Consent Form(0.01)	0.01
 Woven Methodology Checklist(0.01)	0.01

9\* Will subjects receive payment or other incentives for their participation in the study?

Yes  No

9.1\* What is the estimated maximum total payment to an individual subject?

\$0.01-\$25

9.2\* Please indicate what information you will be collecting from subjects that will be paid for their participation:

Select all that apply:

- Name
- None
- Address
- Email
- Social Security Number (SSN)

## Appendix 17

Related Dynamic System Modeling Research on Denim Production Supply Chain and Carbon Emissions

The Impact of the Denim Industry Carbon Emissions on Consumer Behavior Patterns

Megan Gabruk, Niki Fairchild Azevedo, Tiffany Win, and Yuping Wei

Final Project

April 24, 2023



## Abstract

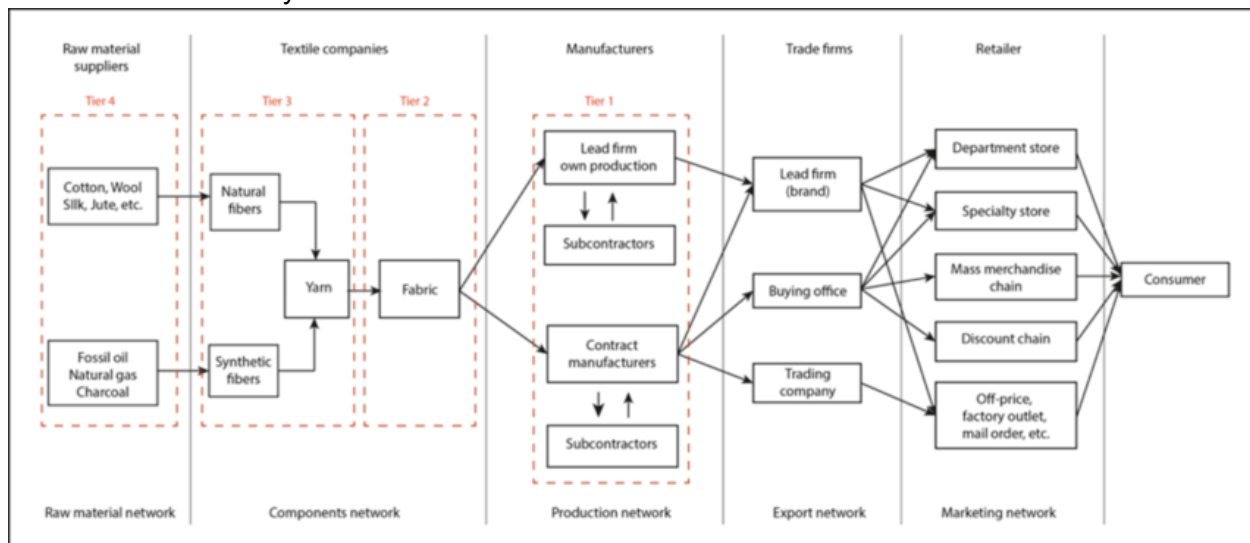
The fashion industry is one of the largest industries in the world and denim is one of the most purchased products in fashion. However, consumers have become more aware of social issues over time and have begun to scrutinize practices within the denim industry, including the negative environmental impact and exploitation of workers. Our project examines how the negative environmental impact, specifically in terms of carbon emissions, of the denim industry affects consumer behavior patterns. While growing cotton to produce denim can reduce carbon emissions, we find that the carbon emissions produced through the denim production and shipping process led to a larger increase in carbon emissions. Furthermore, we find that consumers adjust their behavior in response to both the negative environmental impact and increased prices due to higher carbon taxes by purchasing less denim. Our results may be used to inform practices within the denim industry. We suggest that denim production and shipping companies find ways to reduce the amount of carbon emissions produced from their processes in order to prevent more customers from purchasing less denim.

## Introduction

The fashion industry is one of the largest and most lucrative industries in the world, generating 1.7 trillion dollars in 2022, and an annual growth rate over 5% (Zippia, 2023). In recent decades, however, this industry has come under intense scrutiny due to its negative impact on the environment and the exploitation of workers in developing countries. (Taplin, 2014) The fashion industry's unsustainable practices have contributed to environmental degradation, climate change, and social injustices; it is imperative to address these issues urgently. (Heuer et al, 2018)

This research will discuss the fashion supply chain of denim jeans, as well as consumer demand and its relation to carbon emissions. Various models will be constructed including Causal Loop Diagram, Fuzzy Cognitive Map. Scenarios will be run testing variances within the system, comparing results of manipulating factors within the models. This paper's primary goal is to provide insight into the relations of actors within the supply chain and the resulting effect on total carbon emissions produced as a result of denim jeans production. The focus of this work is not on the problems of the industry and practice but rather on the exploration, development, and testing of trigger points for the iteration of potential solutions and positioning interventions at places of high impact. This paper aims to contribute not only to the growing body of research on the extractive and exploitative current state of the fashion industry but also to provide insight into the entangled relationship of the denim supply chain through systems dynamic modeling.

The fashion industry's supply chain is long and complex, with multiple actors involved in the production, distribution, and consumption of clothing. The supply chain begins with the sourcing of raw materials, such as cotton or wool, which are then processed into textiles and fabrics. These fabrics are then used to manufacture clothing, which is then distributed to retailers and ultimately sold to consumers.



The Textile and Clothing Supply Chain (own illustration based on Appelbaum and Gereffi, 1994, p. 46)<sup>35</sup>

The global nature of the fashion industry means that many clothing companies source raw materials and manufacture their products in different countries, often in developing nations

<sup>35</sup> Transparency and Traceability in the Textile and Clothing Supply Chain - Scientific Figure on ResearchGate. Available from: [https://www.researchgate.net/figure/The-Textile-and-Clothing-Supply-Chain-own-illustration-based-on-Appelbaum-and-Gereffi\\_fig2\\_308376425](https://www.researchgate.net/figure/The-Textile-and-Clothing-Supply-Chain-own-illustration-based-on-Appelbaum-and-Gereffi_fig2_308376425) [accessed 21 Apr, 2023]

where labor is cheaper. This has led to concerns about exploitative labor practices and poor working conditions in the fashion industry's supply chain (Choi et al, 2015).

**Problem description.** Jeans are a ubiquitous clothing item. Examining the supply chain of this relatively simple piece of clothing proves a complex investigation. This paper will trace the supply chain starting at a cotton farm, through global production of denim into jeans as well as the delivery process using the lens of dynamic system modeling. Our Causal Loop Diagram investigates this supply chain and looks at the relationship between process and the resulting environmental impacts. There are a number of positive and negative impacts to the environment. For example cotton pulls carbon emission out of the environment, but is outweighed by the carbon emissions put back into the atmosphere from industrial farming practices. The transportation to the textile mill and the processing of the cotton into denim produces a greater amount of carbon emissions than the original benefit of cotton to the overall carbon footprint. Using our modal investigations we will alter and manipulate various factors and run simulations to gauge the resulting outcome to carbon emissions.

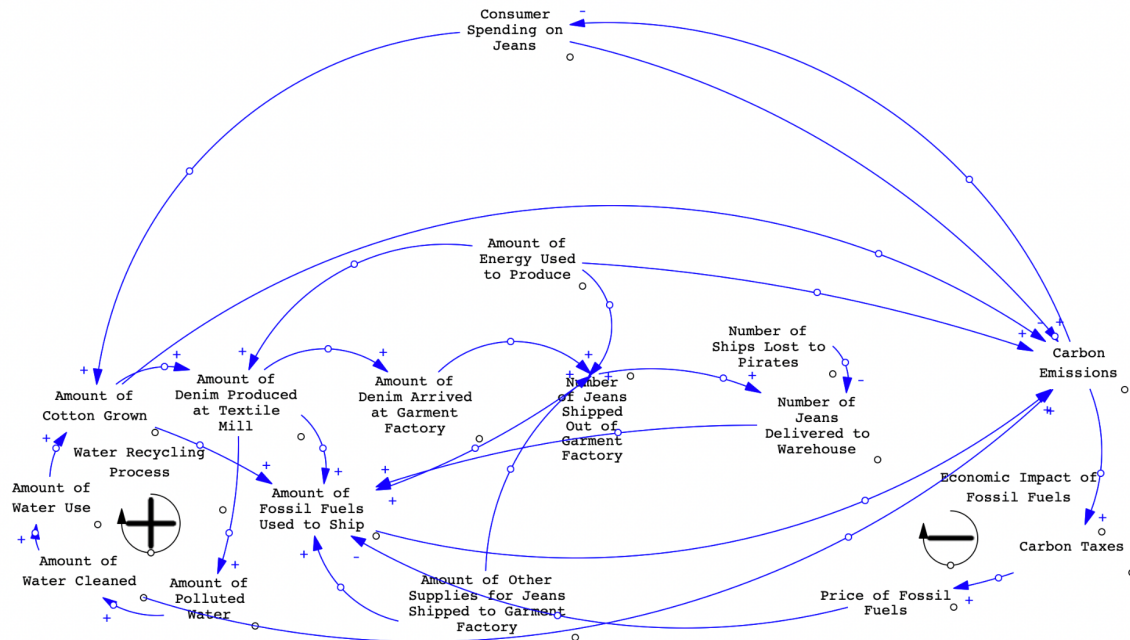
## Hypothesis

**Initial Hypothesis:** The amount of cotton grown has a direct negative impact (decreases) on carbon emissions due to industrial farming practices and its positioning within the global supply chain in relation to denim jeans production. However a positive indirect impact (increases) on carbon emissions through the denim industry, and the positive indirect impact will be higher in magnitude than the direct negative impact.

**Revised Hypothesis:** Because the amount of cotton grown reduced carbon emissions due industrial farming practices and its positioning within the global supply chain in relation to denim jeans production, consumer spending on jeans will increase. However, the carbon emissions produced from the denim industry will negatively impact (decreases) consumer spending on jeans because of social and environmental awareness, which will positively impact (decreases) the amount of cotton grown, and this effect will be stronger than the former.

## Method

### Causal loop diagram



**Figure 1. Causal loop diagram of Denim production**

The amount of cotton grown negatively impacts the amount of carbon emissions because cotton pulls carbon emissions out of the environment. The amount of cotton grown increases the amount of denim produced at the textile mill because there is more cotton to use, which increases the amount of denim arrived at the garment factory, and subsequently the number of jeans shipped out of the garment factory (as long as the amount of other supplies for jeans shipped to garment factory is sufficient) and ultimately the number of jeans delivered to the warehouse (as long as all of the ships are not lost to pirates). Cotton growing, textile mill production, garment factory production, and shipping jeans from the warehouse all increase the amount of fossil fuels used to ship. Textile mill and garment factory production both depend on the amount of energy used. The amount of cotton that can be grown depends on the amount of water used, and the amount of water that can be used depends on the amount of polluted water cleaned. The amount of denim produced at the textile mills positively impacts the amount of polluted water, creating a reinforcing causal loop (positive loop) of the water recycling process. The amount of fossil fuels used to ship positively impacts the amount of carbon emissions, which positively impacts the number of carbon taxes (if countries increase carbon taxes in response to more carbon emissions), and therefore, positively impacts the price of fossil fuels

and ultimately, the amount of fossil fuels used to ship, creating a balancing causal loop (negative loop) of the economic impact of fossil fuels.

### Fuzzy Cognitive Map

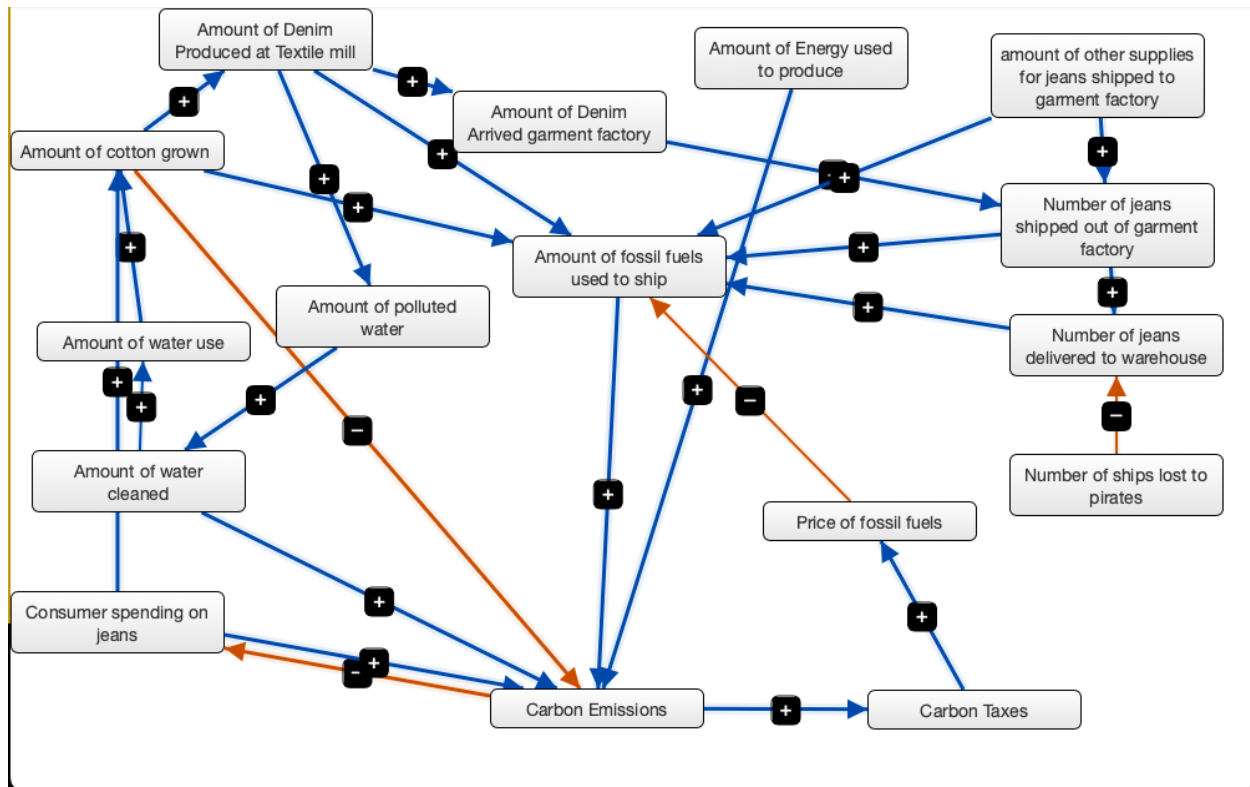


Figure 2. Fuzzy Cognitive Map

### Fuzzy Cognitive Map Relationships Description:

We thought through how much of an effect each of the relationships would have on each other and determined the strength of the relationship. We used 0.75 for strong relationships, 0.5 for moderate relationships, and 0.25 for weak relationships. The blue arrows represent positive relationships and orange represents negative relationships. The detail on each relationships strengths are described in Appendix 1.

### Scenario Testing

Increase Amount of Cotton Grown (to 1) - since the amount of cotton grown impacts a lot of the other variables and is at the start of our fuzzy cognitive map, we decided to see how increasing this would impact the rest of the variables

1. Increase Amount of Water Use (to 1) - since the amount of water use also impacts a lot of other variables and is impacted by a lot of variables, including via the water recycling process loop, we decided to see how increasing this would impact the rest of the variables

2. Increase Price of Fossil Fuels (to 1) - since fossil fuels are an important part of our fuzzy cognitive model, we decided to see how increasing this impacts the other variables via the amount of fossil fuels used
3. Decrease Amount of Energy Used to Produce (to -0.5) - since the amount of energy used to produce is important for producing jeans, we decided to see how decreasing this would impact the other variables
4. Decrease Amount of Other Supplies for Jeans Shipped to Garment Factory (to -1) - since the amount of other supplies for jeans shipped to garment factory is needed to produce the jeans, we decided to see how decreasing this would impact the other variables

### ***Nonlinearity***

#### **Explanations:**

1. The more carbon emissions, the less consumers spend on jeans because they want a smaller carbon footprint, but it is not linear because it is a delayed oscillation and once consumers reach a certain carbon footprint, they stop caring as much about their carbon footprint (hopeless factor). An additional explanation could be that due to innovation, throughout the supply chain the total carbon footprint could account for the nonlinear relationship between increased amount spent on denim and the decrease in the carbon footprint. Less carbon emissions are produced per pair of jeans, while consumers are increasing the number of pairs purchased. Thus, in 2021 the carbon emissions goes down but the growth in the denim market rises. Data inputs are provided in Appendix 2.
2. The more consumers spend on jeans, the more cotton grown because there is a response in supply to demand, but it is not linear because it is a delayed oscillation between supply and demand. Data inputs are provided in Appendix 3.

### ***Delays***

We modeled a manufacturing delay in the supply chain process from the amount of jeans produced at the garment factory to the number of jeans shipped out. Since manufacturing delays are random, we used the PULSE function to create random delays. The manufacturing delays impact how many orders can be fulfilled, which impacts the number of jeans shipped out of the garment factory. Data inputs for delays are provided in Appendix 4.

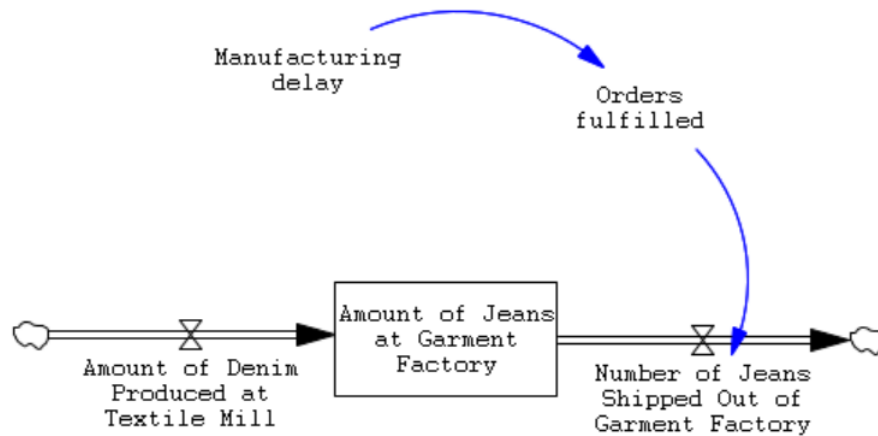
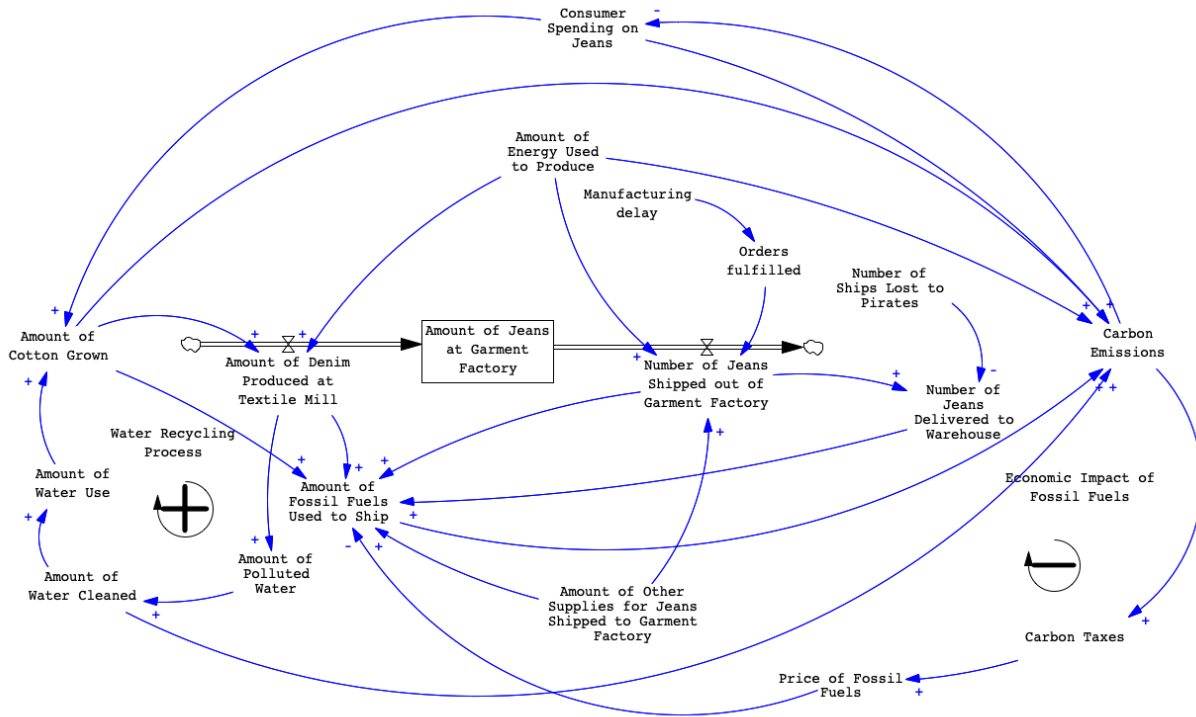


Figure 3. Stock and Flow diagram

The model above is structured to demonstrate the stock and flow nature of materials flowing into the garment manufacturing factory and the finished garments being shipped from the factory as completed mass production orders. Manufacturing delays can take many forms; materials shortages, labor shortages, or mechanical breakdowns just to name a few. With the goal of

simplifying these delays into one category we have grouped all delays with the view only to its relation as an interrupter to garment construction. As the model depicts the fulfillment of orders on a mass production scale, and not the completion of piece goods “orders fulfilled” references large orders written by clothing brands which are only considered fulfilled when fully completed and in transport out of the factory.

The ability of our modeled factory stood at 300,000 pairs of jeans a month. This capacity, therefore became the basis of the amount of the denim being ordered from the textile mill and subsequently put into production. It takes an average of 2 yards of denim for each pair of jeans.

### ***Sensitivity Analysis***

#### **Model Outcome Sensitivity:**

The number of jeans shipped out of garment factories has an impact on the carbon emissions. This is because the shipping of materials and supplies to make jeans to each site utilizes a lot of energy. Therefore, we want to see how the different number of jeans shipped out of garment factories will have an impact on carbon emissions. Data inputs and equations for model outcome sensitivity is in Appendix 5.

#### **Uncertainty Sensitivity:**

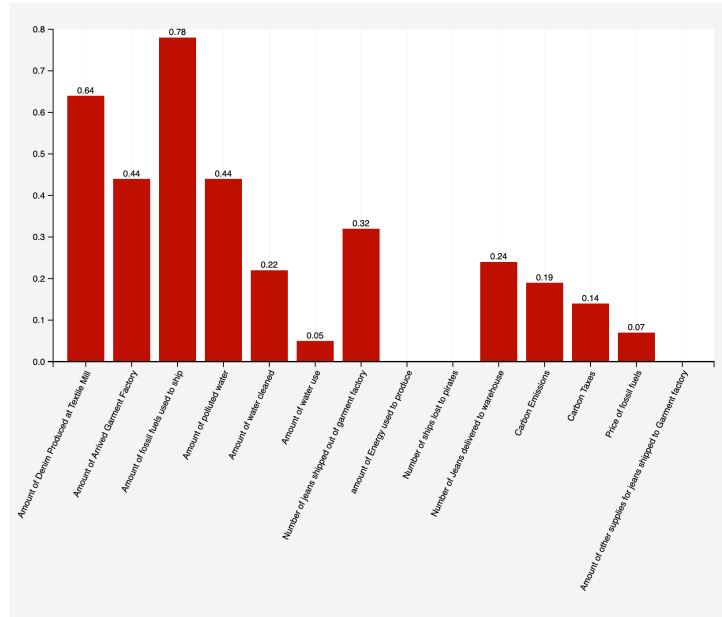
Manufacturing delays can be caused by a number of factors, these delays can be related to the supply chain, machinery, power grid, or labor. Given the wide variance in not only the nature of delays, but also the delays themselves, delays can come without warning, have small to catastrophic impacts on operations, and persist in duration from days to months.

## **Results**

### ***Scenario Testing***

#### **Scenario 1**

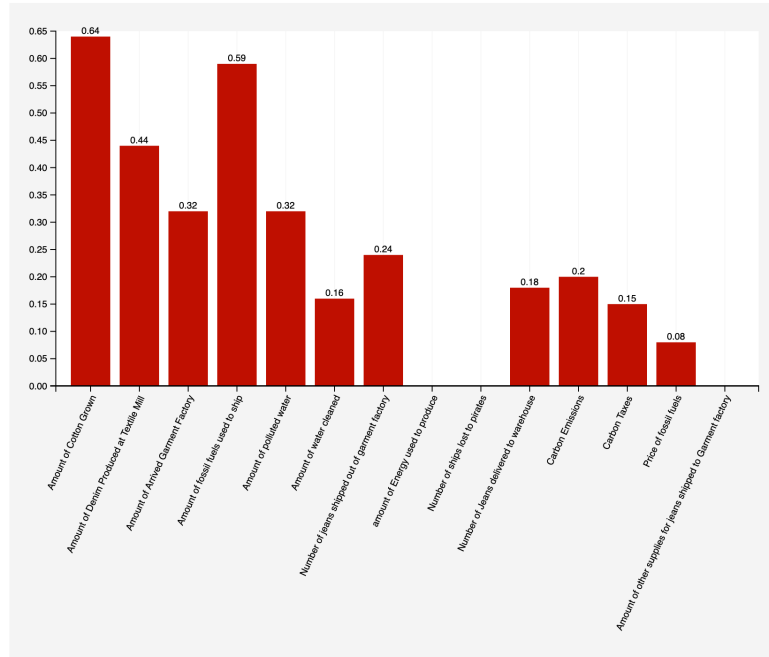




**Figure 4. Scenario 1: Increase cotton grown to 1**

Cotton, the start of our fuzzy cognitive map, has a complex relationship with carbon emissions. On one hand, as a plant, cotton can absorb carbon dioxide when growing. On the other hand, cotton is raw materials for the production of other products which emit carbon dioxide in every manufacturing process and transportation. Therefore, cotton has a positively weak relationship with carbon emissions that the increase of 1 unit of cotton causes the increase of 0.19 unit of carbon emissions.

## Scenario 2



**Figure 5. Scenario 2: Increase the amount of water use to 1**

We assume that the waste water produced by textile mill would be treated and then reused for watering cotton, as a way to recycle water. Increasing water use would cause the rise in the amount of cotton and subsequently other products which would increase carbon emissions. Also, the increase of water use would increase the amount of polluted water produced by textile mill, which require higher electricity consumption for water treatment, resulting in the rise in carbon emissions again. Therefore, water use also has a positive relationship with carbon emissions.

### Scenario 3

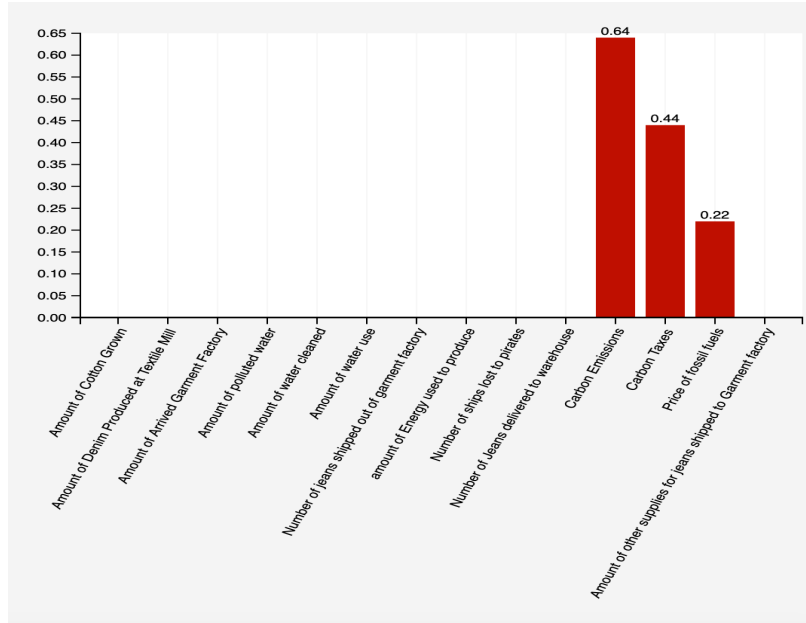
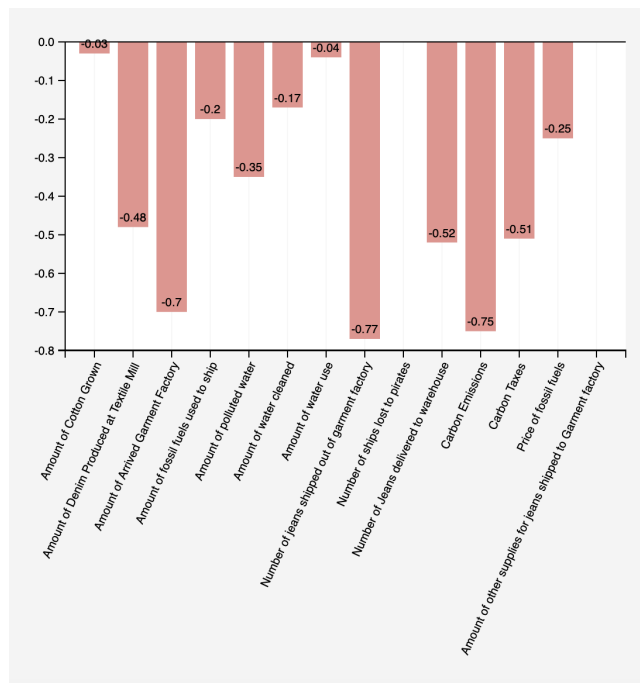


Figure 6. Scenario 3: Increase the amount of fossil fuels used to ship to 1

The amount of fossil fuels used to ship has positively strong impacts on carbon emissions as burning fossil fuels would emit a large amount of carbon dioxide. But once there is a carbon tax, it would increase the cost and price of fossil fuels. Then, the amount of fossil fuels would drop. Therefore, the positively strong impacts from fossil fuels on carbon emissions would be weakened by a carbon tax.

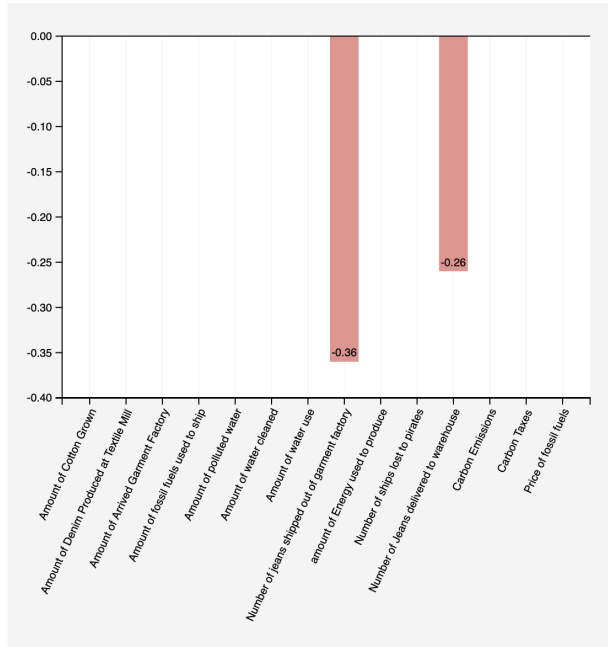
Scenario 4



**Figure 7. Scenario 4: Decrease the amount of energy used to produce to -1**

Energy is essential for producing jeans. The reduction of energy usage would decrease the production of each product and then shipment. Thus, the carbon emissions would decline sharply. Carbon tax would also decrease due to the reduction of carbon emissions.

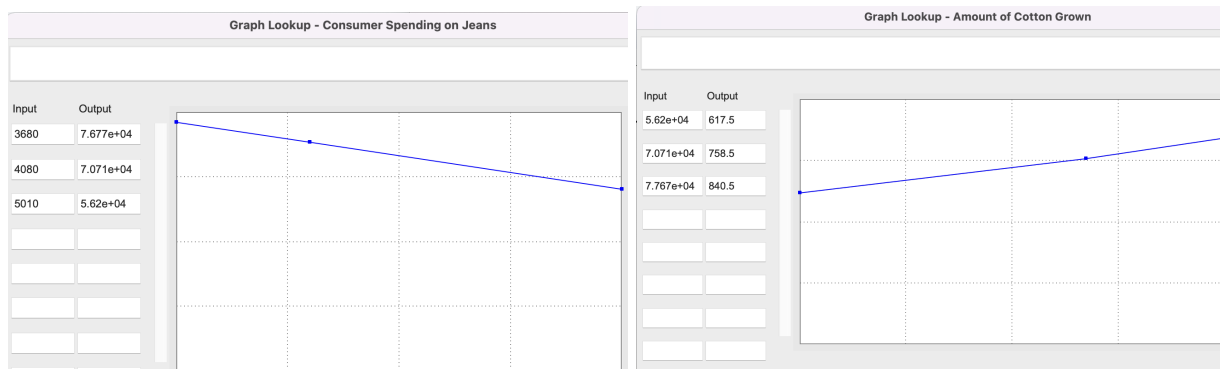
Scenario 5



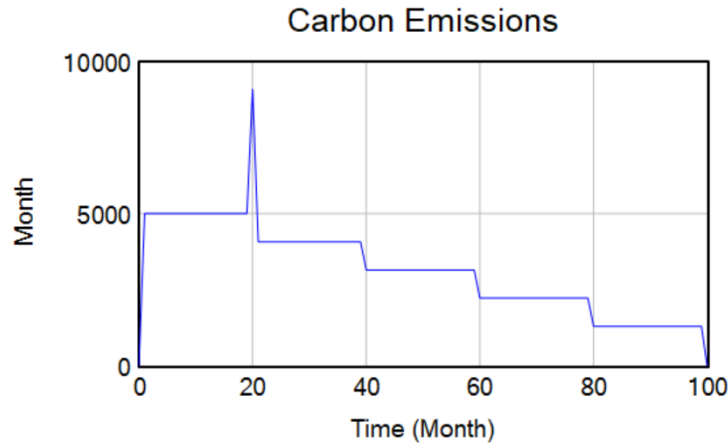
**Figure 8. Scenario 5: Decrease the amount (-0.5) of other supplies for jeans shipped to Garment factory**

Other supplier for jeans is not a key variable in our supply chain model. The decrease of this variable only leads to a weak drop in the number of jeans produced by garment factories and the number of jeans delivered to warehouses.

**Nonlinearity**

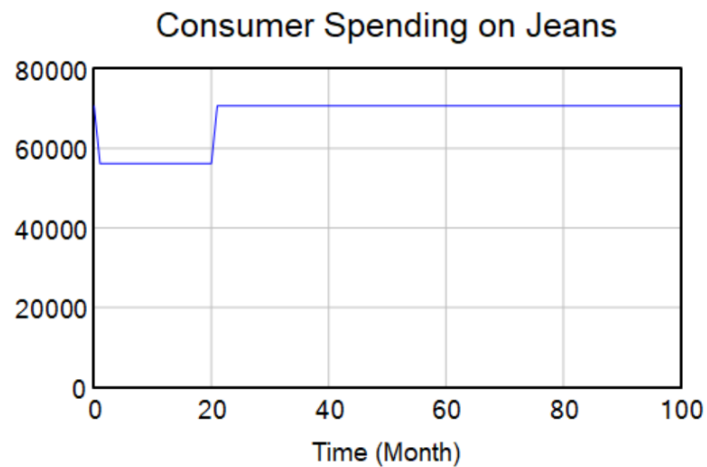


**Figure 9. Graphical function screenshots**



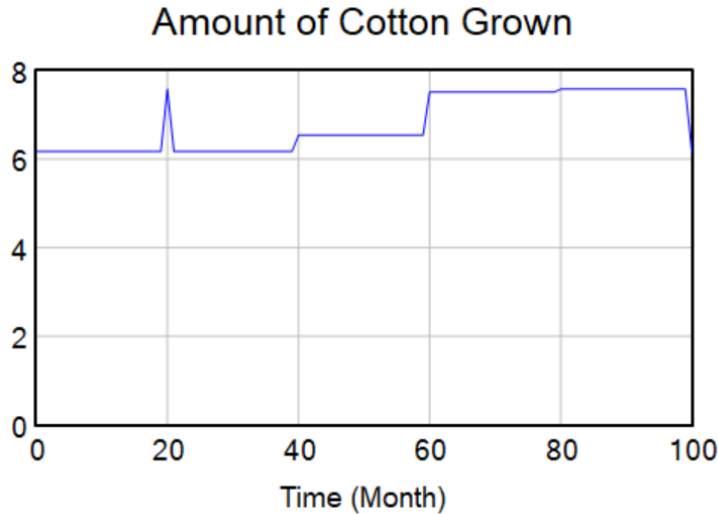
**Figure 10. Decreasing carbon emissions levels**

Figure 10. was created selecting projected step decreases by 930 tons of carbon. The graph models the decrease over time. This projection was based on the decrease in carbon emissions between the years 2020 and 2021. The decrease reported in that year was repeated at the same rate to model the projected carbon emissions over time.



**Figure 11. Influence of carbon emissions on consumer spending**

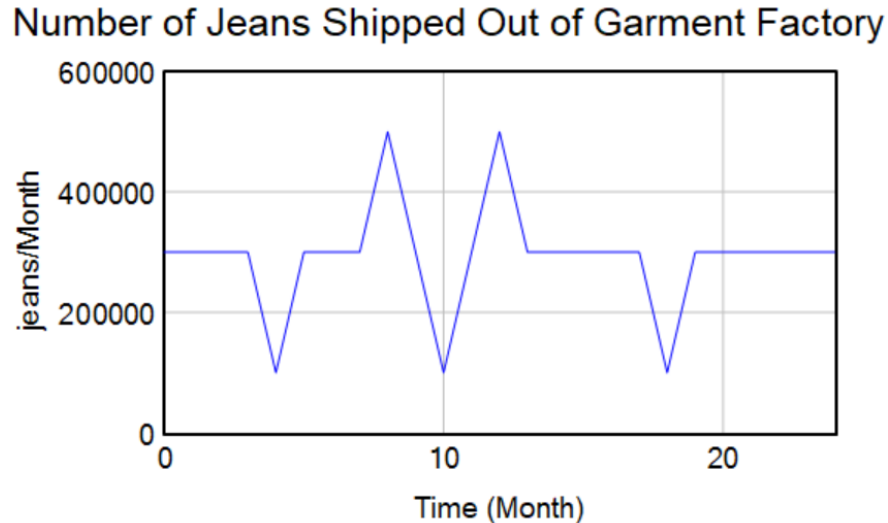
Figure 11. shows the models the relationship between consumer spending and carbon emissions. As the carbon emissions decrease consumers feel confident as the behavior exhibits in an increase in spending. The increase in spending results in a higher number of goods being produced. Thus, even though the carbon emissions are lower per piece good the increased number of goods once again inflates the carbon emissions. The hypothesis is that if there are additional data points injected into the system that this line will show variance. The model will shift from a flat line to an oscillating line and the reported cotton growth. That gap shows a vulnerable point in the market supply chain.



**Figure 12. Relations of consumer spending and cotton**

Figure 12. shows the amount of cotton grown over time in units of millions of pounds. The graph variation models the relations between the consumer spending and the post spend cotton grown as a projection on the market demand. As spending increases the demand on cotton is anticipated to increase, but there is a lag between the consumer spend.

### **Delays**



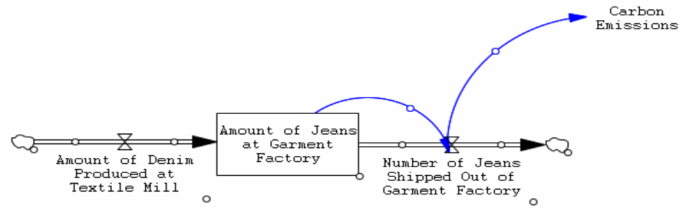
**Figure 13. Manufacturing delay effects**

Figure 13. shows a realistic nature of production in a factory floor necessary to successfully fulfill orders. If there is a delay in production which causes capacity to drop below the max of 300,000 and the orders to be fulfilled are written on this capacity, then measures must be taken to push production past the maximum capacity. A facility in terms of capacity, as one cannot push past a maximum capacity, this clearly demonstrates the volatile and insatiable nature of writing and accepting or booking orders based on the maximum capacity of your manufacturing

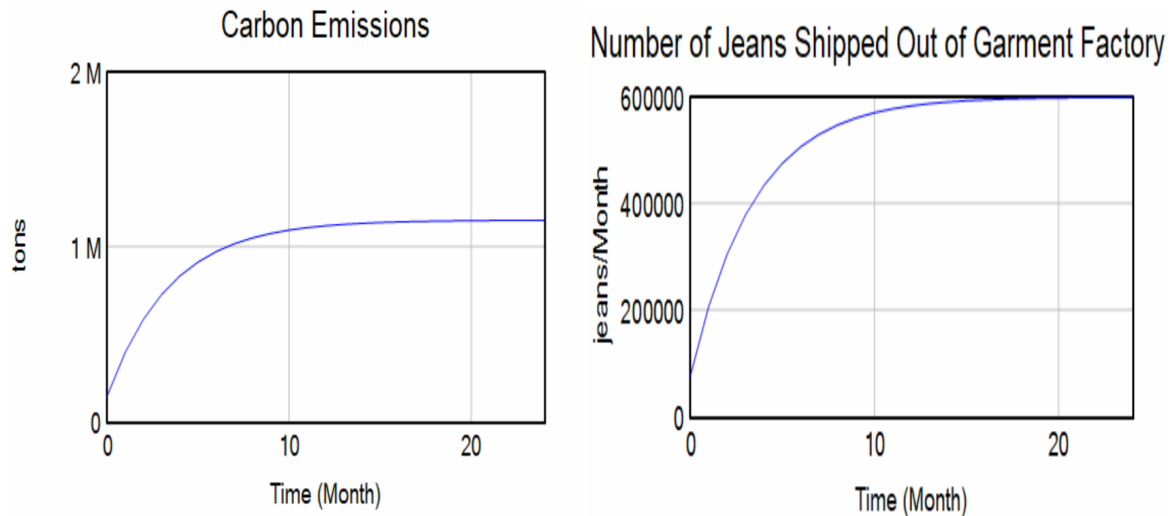
facility. What is clearly modeled in the graph below is not only a vulnerable and unstable structure in the manufacturing process but also a predictive market indicator of shifts throughout the supply chain.

**Sensitivity analysis**

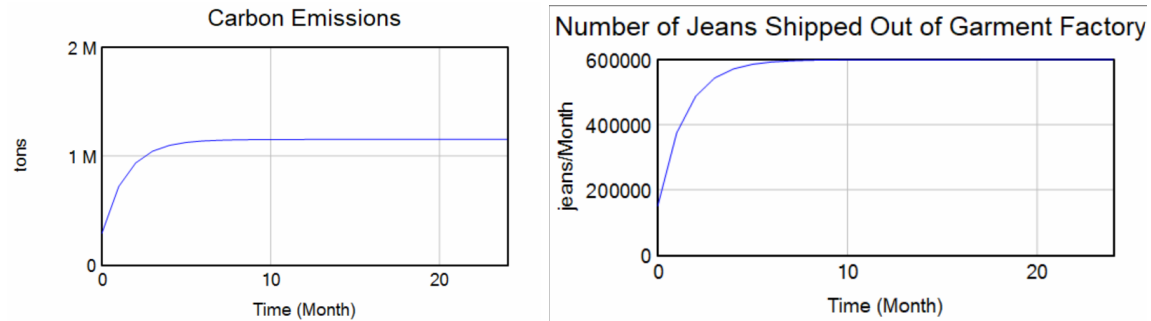
Model Outcome Sensitivity



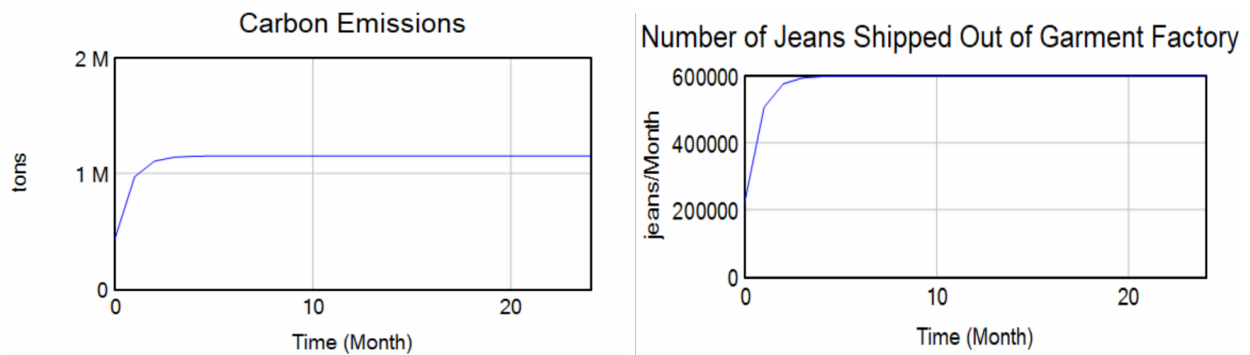
**Figure 14. Stock and flow diagram of model outcome sensitivity**



**Figure 15. Scenario 1 with 25% of total pairs of jeans**



**Figure 16. Scenario 2 with 50% of total pairs of jeans**



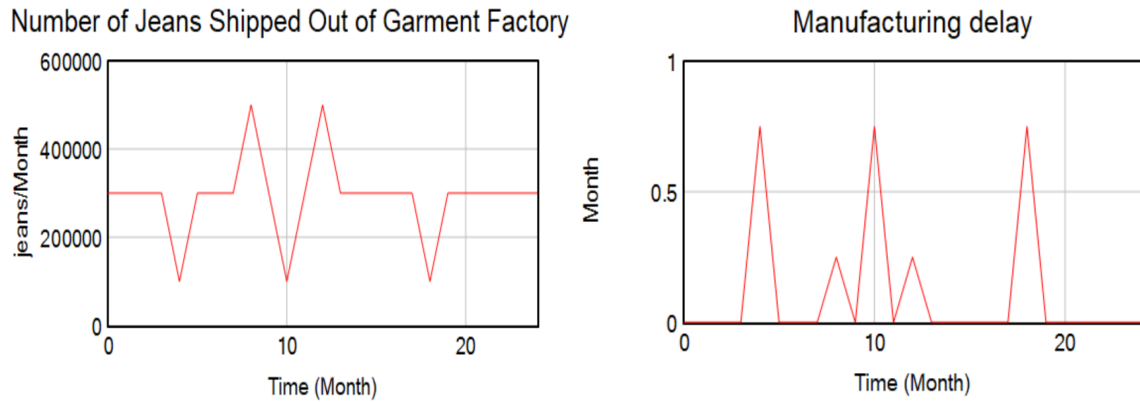
**Figure 17. Scenario 3 with 75% of total pairs of jeans**

We tested how the number of jeans shipped out of the garment factory impacted the carbon emissions. The number of jeans shipped out of the garment factory is a function of the number of jeans produced in the garment factory. We tried shipping out a small proportion of the total number of units (pairs of jeans) first (25% of the amount), then a larger proportion (50% of the amount), and finally the largest proportion (75% of the amount). Since the amount of jeans shipped out of the garment factory reaches an equilibrium around 600,000 jeans per month, the different proportions just impact at which month the system reaches this equilibrium. Therefore, the carbon emissions reach equilibrium a bit quicker with the higher proportions. Overall, changing the proportions of the amount of jeans shipped out of the garment factory from the amount of jeans produced in the garment factory does not have much of an effect on the model outcome of carbon emissions. Equations for these scenarios are provided in the Appendix 6.

### Uncertainty Sensitivity

Scenario 1:

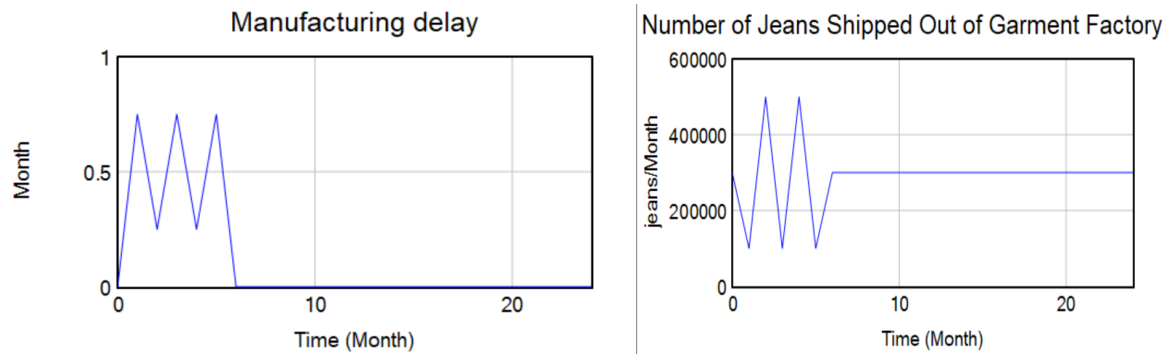




**Figure 18. Scenario 1 of uncertainty sensitivity**

Our baseline assumption of manufacturing delay is that it would occur on the 4th, 8th, 10th, 12th and 18th month. The first month refers to the beginning of operations and each consecutive month continues to measure the time of operations for production. The equations are provided in Appendix 4.

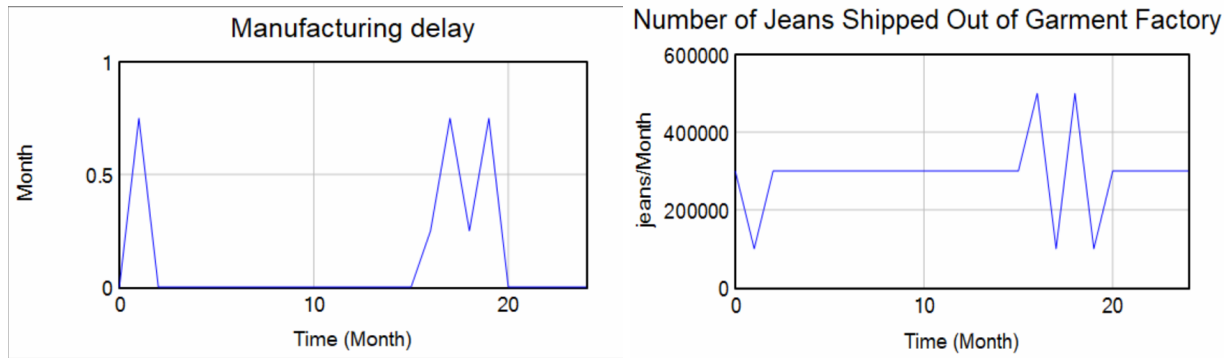
Scenario 2:



**Figure 19. Scenario 2 of uncertainty sensitivity**

In scenario 2 the model reflects a manufacturing delay in months 1-5, however the delays oscillate to the same upper and lower threshold. The number of jeans shipped out of a garment factory has the same range but its oscillation rate occurs in months 1-5, which is different from that in scenario 1.

Scenario 3:



**Figure 20. Scenario 3 of uncertainty sensitivity**

Scenario 3 sets the manufacturing delay in month 1 and months 16-19 with the same upper and lower threshold of oscillation. This doesn't change the highest and lowest number of jeans shipped out of a garment factory, but changes the time when these highest and lowest numbers occur. When the manufacturing delay occurs in the production process does not impact the amount of goods produced. The number of pairs of jeans produced is only impacted by the delay itself.

## Discussion

Although the denim industry has generated a reported value of 64.5 billion USD in 2022<sup>36</sup>, it consumes large amounts of energy, leading to substantial emissions of greenhouse gasses like CO<sub>2</sub> (Karthik & Murugan, 2017). An environmental impact occurs at each stage in the life cycle of garments, from the transportation of cotton to the various manufacturing processes and the transportation at each stage. Denim production has both (incremental) positive and (significant) negative impacts to the carbon emissions as shown in the causal loop diagram and fuzzy cognitive map. Our hypothesis was that as the carbon emissions increases in the denim industry, consumers will spend less as they become more socially aware of the environmental issues. We tested different scenarios to see how the production of denim would affect the carbon emissions. Based on the results, we can conclude that consumer spending behavior has an impact on the carbon emissions of the denim jeans production.

When more consumers spend on jeans, more cotton will be needed to produce, then more fossil fuels will be used to ship out the supplies, and more energy will be used to make the jeans to meet the demand. Therefore, in order to reduce the emissions, consumers should practice reducing, reusing and recycling. Rather than discarding used jeans, they can donate or sell them in the secondhand market and consider purchasing used clothing instead of always buying new. Producers can also contribute to creating more sustainable denim clothing by combining cotton with other natural fibers such as hemp, as cotton requires a substantial amount of water

<sup>36</sup><https://www.statista.com/statistics/734419/global-denim-jeans-market-retail-sales-value/#:~:text=The%20global%20denim%20jeans%20market%20was%20forecast%20to%20be%20worth,billion%20U.S.%20dollars%20in%202022.>

to grow. Additionally, using recyclable denim to manufacture new denim jeans can be an effective method of reducing emissions.

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A number of references cited in this document were taken from personal interviews collected by Niki Fairchild Azevedo in the summer of 2022. Film documentation and translations of interviews are available as unpublished research in progress, and can be viewed through a google drive. Please do not distribute or share the following material as it is in the process of publication review.

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## Appendix

### Appendix 1. Fuzzy Cognitive Map relationships strengths

All of the strong positive relationships (0.75 on MentalModeler):

1. Amount of Water Use to Amount of Cotton Grown
2. Amount of Cotton Grown to Amount of Denim Produced at Textile Mill
3. Amount of Denim Produced at Textile Mill to Amount of Denim Arrived at Garment Factory
4. Amount of Denim Arrived at Garment Factory to Number of Jeans Shipped Out of Garment Factory
5. Number of Jeans Shipped Out of Garment Factory to Number of Jeans Delivered to Warehouse
6. Amount of Denim Produced at Textile Mill to Amount of Polluted Water
7. Amount of Other Supplies for Jeans Shipped to Garment Factory to Number of Jeans Shipped Out of Garment Factory
8. Amount of Energy Used to Produce to Carbon Emissions
9. Amount of Fossil Fuels Used to Ship to Carbon Emissions
10. Carbon Emissions to Carbon Taxes

All of the moderate positive relationships (0.5 on MentalModeler):

1. Amount of Energy Used to Produce to Amount of Denim Produced at Textile Mill
2. Amount of Energy Used to Produce to Amount of Denim Arrived at Garment Factory
3. Amount of Energy Used to Produce to Number of Jeans Shipped Out of Garment Factory
4. Amount of Cotton Grown to Amount of Fossil Fuels Used to Ship
5. Amount of Denim Produced at Textile Mill to Amount of Fossil Fuels Used to Ship
6. Amount of Denim Arrived at Garment Factory to Amount of Fossil Fuels Used to Ship

7. Number of Jeans Shipped Out of Garment Factory to Amount of Fossil Fuels Used to Ship
8. Number of Jeans Delivered to Warehouse to Amount of Fossil Fuels Used to Ship
9. Amount of Polluted Water to Amount of Water Cleaned
10. Amount of Water Cleaned to Carbon Emissions
11. Carbon Emissions on Price of Fossil Fuels

All of the weak positive relationships (0.25 on MentalModeler):

1. Amount of Water Cleaned to Amount of Water Use

All of the moderate negative relationships (-0.5 on MentalModeler):

1. Amount of Cotton Grown to Carbon Emissions

All of the weak negative relationships (-0.25 on MentalModeler):

1. Price of Fossil Fuels to Amount of Fossil Fuels Used to Ship
2. Number of Ships Lost to Pirates to Number of Jeans Delivered to Warehouse

### Appendix 2. Nonlinearity data 1

1. 50.1 billion tons of carbon dioxide emitted in 2020
2. 1/10 of carbon dioxide emitted is from textile industry
3.  $50.1 * 0.1 = 5.01$  billion tons of carbon dioxide from textile industry in 2020
4. \$56.2 billion spent on jeans in 2020
5. 5.01 billion tons of carbon dioxide emitted led to \$56.2 billion spent on jeans in 2020
6. 40.8 billion tons of carbon dioxide emitted in 2021
7.  $40.8 * 0.1 = 4.08$  billion tons of carbon dioxide from the textile industry in 2020
8. \$70.71 billion spent on jeans in 2021
9. 4.08 billion tons of carbon dioxide emitted led to \$70.71 billion spent on jeans in 2021
10. 36.8 billion tons of carbon dioxide emitted in 2022 (assumption)
11.  $36.8 * 0.1 = 3.68$  billion tons of carbon dioxide from the textile industry in 2022
12. \$77.67 billion spent on jeans in 2022
13. 3.68 billion tons of carbon dioxide emitted led to \$77.67 billion spent on jeans in 2022
14. Three data points: (5010, 56200), (4080, 70710), (3680, 77670) (all in million)

### Appendix 3. Nonlinearity data 2

15. \$518.7 million of cotton grown in 2020
16. Cotton is \$0.84 per pound
17.  $\$518.7 \text{ million} / \$0.84 = 617.5$  million pounds of cotton grown
18. \$56.2 billion spent on jeans in 2020
19. \$56.2 billion spent on jeans led to 617.5 million pounds of cotton grown in 2020
20. \$637.1 million of cotton grown in 2021
21.  $\$637.1 \text{ million} / \$0.84 = 758.45$  million pounds of cotton grown
22. \$70.71 billion spent on jeans in 2021
23. \$70.71 billion spent on jeans led to 758.45 million pounds of cotton grown in 2021
24. \$77.67 billion spent on jeans in 2022
25. \$706.02 million of cotton grown in 2022 (assumption)
26.  $\$706.02 \text{ million} / \$0.84 = 840.5$  million pounds of cotton grown
27. \$77.67 billion spent on jeans led to 840.5 million pounds of cotton grown in 2022
28. Three data points: (56200, 617.5), (70710, 758.45), (77670, 840.5) (all in million)

**Appendix 4. Delay data and equation**

1. Amount of denim produced at textile mill (yards/month) = 600000
2. Amount of jeans at garment factory initial value (jeans/month)= 300000
3. Amount of jeans at garment factory = Amount of denim produced at textile mill - Number of jeans shipping out of garment factory
4. Number of jeans shipped out of garment factory = orders fulfill
5. Orders fulfill = IF THEN ELSE(Manufacturing delay=0.75, 100000 , 300000) + IF THEN ELSE(Manufacturing delay=0.25, 200000 , 0)
6. Manufacturing delay =  $0.75 * \text{PULSE}(4, 1) + 0.25 * \text{PULSE}(8, 1) + 0.75 * \text{PULSE}(10, 1) + 0.25 * \text{PULSE}(12, 1) + 0.75 * \text{PULSE}(18, 1)$

**Appendix 5. Model Outcome sensitivity data and equation**

Jeans cost in 2021 = \$27 per pair on average

Amount of spent on jeans in 2021 = \$70.71 billion

Jeans produced in 2021 = 2,596,296,296

Total Carbon emissions in 2021 from the textile industry = 5,010,000,000 tons

Carbon emissions per pair of jean = 1.93 tons \*(This amount is artificially high due to the data that was available was only for the textile industry as a whole and there is no way to calculate the amount of jeans as a percentage of the global textile industry as a whole.)

Scenario 1: Number of Jeans Shipped Out of Garment Factory =  $0.25 * \text{Amount of Jeans at Garment Factory}$

Scenario 2:

Number of Jeans Shipped Out of Garment Factory =  $0.5 * \text{Amount of Jeans at Garment Factory}$

Scenario 3:

Number of Jeans Shipped Out of Garment Factory =  $0.75 * \text{Amount of Jeans at Garment Factory}$

**Appendix 6. Uncertainty sensitivity data and equation**

Scenario 1:

Manufacturing delay =  $0.75 * \text{PULSE}(4, 1) + 0.25 * \text{PULSE}(8, 1) + 0.75 * \text{PULSE}(10, 1) + 0.25 * \text{PULSE}(12, 1) + 0.75 * \text{PULSE}(18, 1)$

Scenario 2:

Manufacturing delay =  $0.75 * \text{PULSE}(1, 1) + 0.25 * \text{PULSE}(2, 1) + 0.75 * \text{PULSE}(3, 1) + 0.25 * \text{PULSE}(4, 1) + 0.75 * \text{PULSE}(5, 1)$

Scenario 3:

Manufacturing delay =  $0.75 * \text{PULSE}(1, 1) + 0.25 * \text{PULSE}(16, 1) + 0.75 * \text{PULSE}(17, 1) + 0.25 * \text{PULSE}(18, 1) + 0.75 * \text{PULSE}(19, 1)$

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