Synthetic Fibers in the Apparel Industry

15.1 | Design Project Final
Kelsey Nelsen | 12.10.2021
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PROBLEM STATEMENT

Synthetic fibers from the apparel industry have contributed to some of the highest levels of pollution in the global ecosystem in recent decades. Microplastics from these textiles, predominantly polyester fibers, are not only found in our waterways, but they are also in our soil, food, and the air we breathe.

“Two-thirds of all textile fibers are synthetic, and more than half are made from oil-based polyester”[1]

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Discovery

Exercise A: Research

OVERVIEW

This work explores the issue of synthetic fibers in the apparel industry in order to understand the environmental, economic, and behavioral impacts that have resulted from the fast fashion industry – and how to turn the apparel industry on its end to mitigate future risk and encourage healthier tendencies for people and the planet.

Image Source: Soren Funk via Unsplash

RESEARCH

Throughout the world there are organizations working to offer solutions to curb fast fashion and pollution derived from the textile industry. In the United States Fibershed[2] is focused on land regeneration through equitable fiber and dye systems and in South America the group Hechos por Nosotros focuses on sustainable practices through textile research in the camelid fiber value chain.

Last year, according to Fashion Revolution[3], a French politician was the first to pass microfiber legislation pushing washing machine manufacturers to include microfiber filtration in new machines by 2025. While an excellent example, this legislation does not target the main issue of why there are microplastics in our clothing in the first place.

The once Kickstarter shoe brand, Allbirds is making waves as a sustainable fashion leader with their recent initiatives like investing in materials innovation, focusing on their own carbon footprint, and implementing their plan “Reversing Climate Change”, showcasing their goal of achieving carbon neutrality by 2030.

Until Allbirds released their Sustainability Lifecycle Analysis tool in April of 2021[4], so much of the textile and fashion industry has been overshadowed by proprietary information, secrets, and competition. It’s time for more industry leaders (not just startups) to take bold leaps and get more organizations on board as the ecosystem is suffering from current methodologies.

Exercise A: Research

STRATEGY

This research began with a focus on consumer behavior (*see appendix A)* , but instead worked backward to understand the origin of the issue which lies in the hands of specifiers. By dissecting these two viewpoints, this research dove deeper into the specifier's role in the resulting microplastics in our ecosystem.

STAKEHOLDERS

- RETAILERS
- DESIGNERS
- CONSUMERS
- EDUCATORS
- MANUFACTURERS
    - FIBER
    - TEXTILE
    - APPAREL/FINISHED GOODS
- FARMERS
- NGO'S/POLICYMAKERS
- THE ENVIRONMENT AND *ALL* ECOSYSTEMS
- ***ALL*** OF EARTH'S INHABITANTS

	SPECIFIER LENS	CONSUMER LENS

ISSUES	• Pressure of competition
	  • Keep costs low
	  • Labor
	  • Overhead
	  • Raw materials
	  • Development
	  • Launch new designs/collections quickly
	  • Accessibility
	  • Inventory
	  • Maintain stock levels; often resulting in overbuying
		• Falling victim to marketing trends (i.e. "retail therapy")
		  • Apparel is seen as single use or "disposable"
		  • Quick satisfaction
		• Lack of understanding of the impact of fast fashion
		  • Not "relatable" due to overseas manufacturing
		  • Victims of greenwashing
		  • Environmental impacts

OPPORTUNITIES	• Changing the apparel industry narrative
	  • Encourage higher quality materials and garments that will last
	  • Define material specifications
	  • Select materials with better intention
	  • Create incentive programs
	  • Buyback
	  • Resell
	  • Encourage connection
	  • Through experiences
	  • Storytelling
	  • Transparency
		• Sustainability Education
		  • Knowledge sharing
		• Awareness
		• Creating connection
		• Stopping microfibers from entering our waterways
		  • Washing machine filters
		  • Education for proper garment care → reducing quantity of fibers entering waterways

Exercise C: Analyze

SWOT ANALYSIS

The SWOT Analysis (strengths, weaknesses, opportunities, threats) analyzes the existing situation to gain useful insights into the next steps of design and development in this project: synthetic fibers in the apparel industry.

STRENGTHS

Data supporting harmful effects of synthetic fibers, destruction of the ecosystem, and harmful waste from the fashion industry

Data regarding microplastics specifically

Environmental groups advocating for better policies

Growing awareness/curiosity

Urgent need for change

WEAKNESSES

Adoption of natural fibers/abandonment of synthetics by specifiers

Adoption by consumers (higher prices, etc.)

Total disruption of the fashion industry

OPPORTUNITIES

Companies like Allbirds sharing data/encouraging cooperation

More studies about environmental hazards of the industry

Build domestic infrastructure for natural fibers

Knowledge sharing

Understanding consumer behavior

Challenge specifiers to find solutions to the "polyester problem" – research more sustainable options to make polyester obsolete

Global classification of microplastics

THREATS

Large apparel companies

Oil companies that have a hand in the apparel industry

Misinformation/Greenwashing

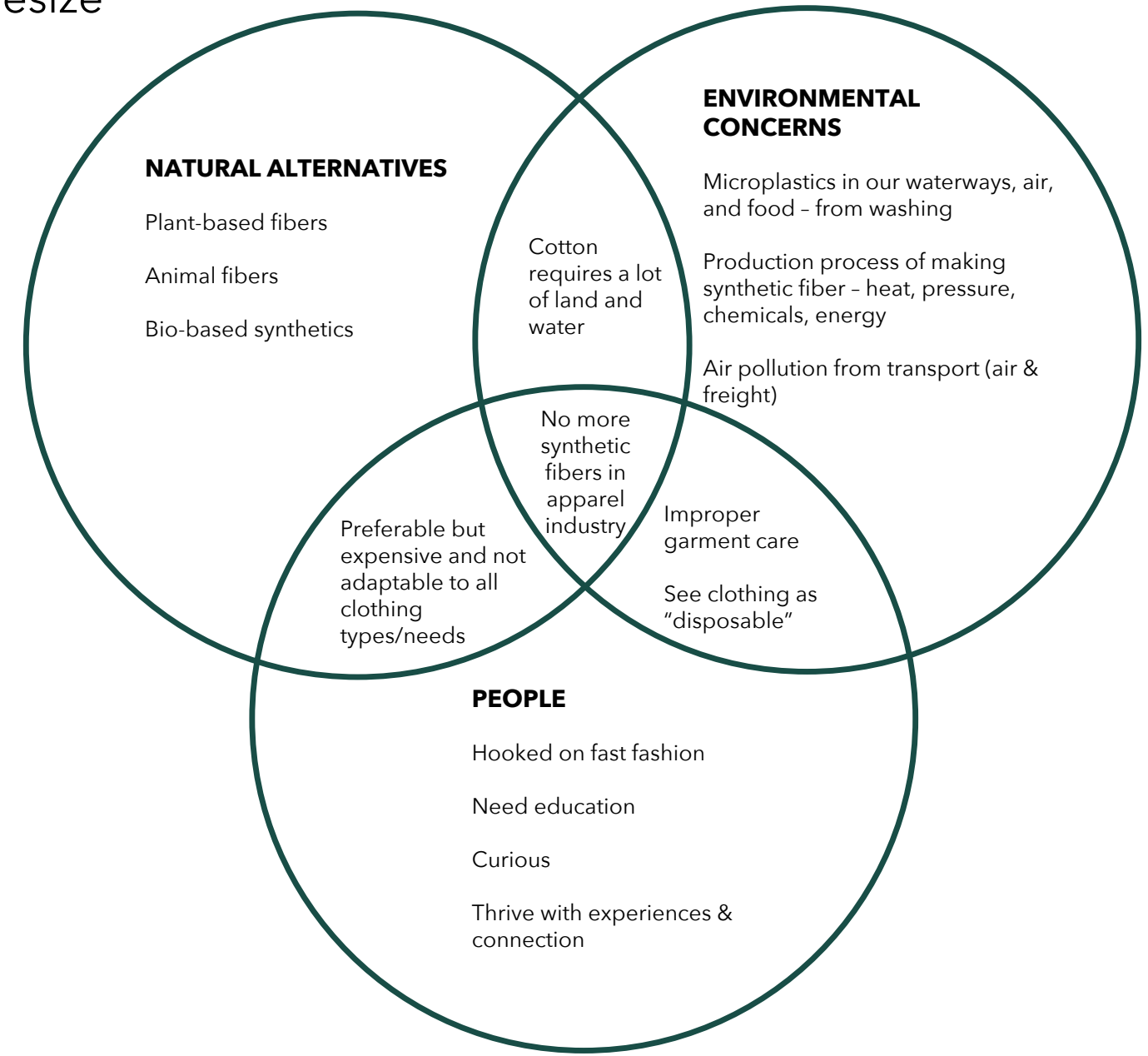
Organizations or manufacturers without resources or the knowledge of more sustainable options

Capitalism

Exercise D: Organize & Synthesize

VENN DIAGRAM

This diagram is used to organize the key components to the implications of synthetic fibers and how to address and identify alternatives. Each set overlaps with other sets within the diagram to show relationships.



Defining the Problem

Exercise E: Describe

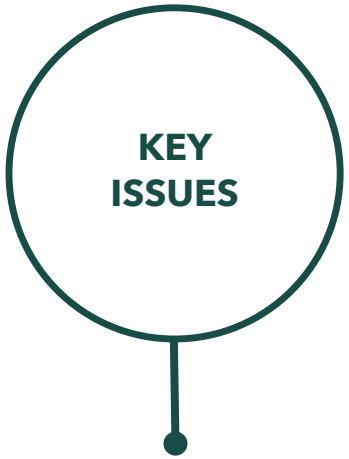
PROBLEM STATEMENT

Synthetic fibers from the apparel industry have contributed to some of the highest levels of pollution in the global ecosystem in recent decades. Microplastics from these textiles, predominantly polyester fibers, are not only found in our waterways, but they are also in our soil, food, and the air we breathe.

KEY DESIGN OBJECTIVES

1. Everything is connected. Acknowledge that the planet is a complex living system and that humans are part of that system. We are subject to its laws and everything we do or make must respect and operate within the system, within the system's limits and according to its laws.
2. Consider the planet and all that inhabits it as a key stakeholder in any project.
3. Employ whole-system thinking (nested systems, patterns, diversity, feedback loops, etc.).
4. Seek integrated design solutions.
5. Employ an integrated design process, including key partners and stakeholders early and often.
6. Collaborate across disciplines (10xE Design Principles; Lovins, RMI).
7. Design for future generations; design for the seventh generation; design for all the children of all species for all time. (Various, c2c, Indigeneous).
8. Apply the Precautionary Principle; don't create new problems by your solution.
9. Remember this is work worth doing (Dawn Danby, Autodesk).

(*Source*: Whole Systems Design Frameworks)



Climate Change
Waste / Overproduction
Microplastics
Specifier Decision-making
Consumer Behavior
Policy

Corporations/Investors
Retailers
Designers
Educators
Manufacturers (at all levels)
Farmers
NGO's/Policymakers
Consumers
The environment and ***all*** ecosystems
All of Earth's inhabitants

Education/knowledge share among stakeholders
Establishing global microplastic specification/standards
Encouragement of specifiers to choose natural vs. synthetic
Influence consumer behavior
Consumers are curious and want to do the right thing, do no harm, etc.

Exercise E: Describe

POTENTIAL STRATEGY

Synthetic fibers in the textile industry must be addressed from multiple angles. From government to corporations, supply chain to consumers, it is a broad and complex issue. Ultimately the industry must shift from manufacturing synthetic fibers to only using natural fibers. In order to see the true benefit, we must also establish a globally-respected definition of the classification of microplastics[4].

Once fibers are measured consistently across the world, we can set concrete rules and regulations to be enforced at the production level, resulting in better process management and progress. Simultaneously, policymakers will need to create legislation that holds textile manufacturers accountable for their methods. Targeting the source of the issue at the development level we can make better choices, educate consumers, and enforce accountability at scale.

Until this happens, it is up to specifiers to push for change within their organizations and ultimately push their CEOs to get on board with driving this change. Roger Lee, CEO of TAL Apparel, was quoted in an interview saying, "*Our industry is highly competitive (and) sharing secrets about how we do things will give one company advantage over another, but CEOs need to say: OK, what's more important ... a profit now or ... a planet in the future. And I think planet in the future.*"[5]

Brainstorm

How Might We...?

PROBLEM STATEMENT

Synthetic fibers from the apparel industry have contributed to some of the highest levels of pollution in the global ecosystem in recent decades. Microplastics from these textiles, predominantly polyester fibers, are not only found in our waterways, but they are also in our soil, food, and the air we breathe.

KEY ISSUE #1

Specifiers have a responsibility in choosing materials for the products they develop.

HOW MIGHT WE...

- Educate specifiers of the adverse effects of synthetic fibers?
- Empower specifiers to shift the apparel industry narrative from fast/disposable fashion?
- Emphasize the magnitude of this responsibility regarding human and environmental health?
- Mitigate financial loss and incentivize the use of natural fibers?

KEY ISSUE #2

Specifiers have an opportunity to steer material trends away from polyester.

HOW MIGHT WE...

- Encourage the use of higher quality AND naturally-derived fibers?
- Provide solutions to more sustainable fiber choices?
- Promote selecting materials with intention and full understanding of the products lifecycle?
- Incentivize materials developers to consider alternatives?

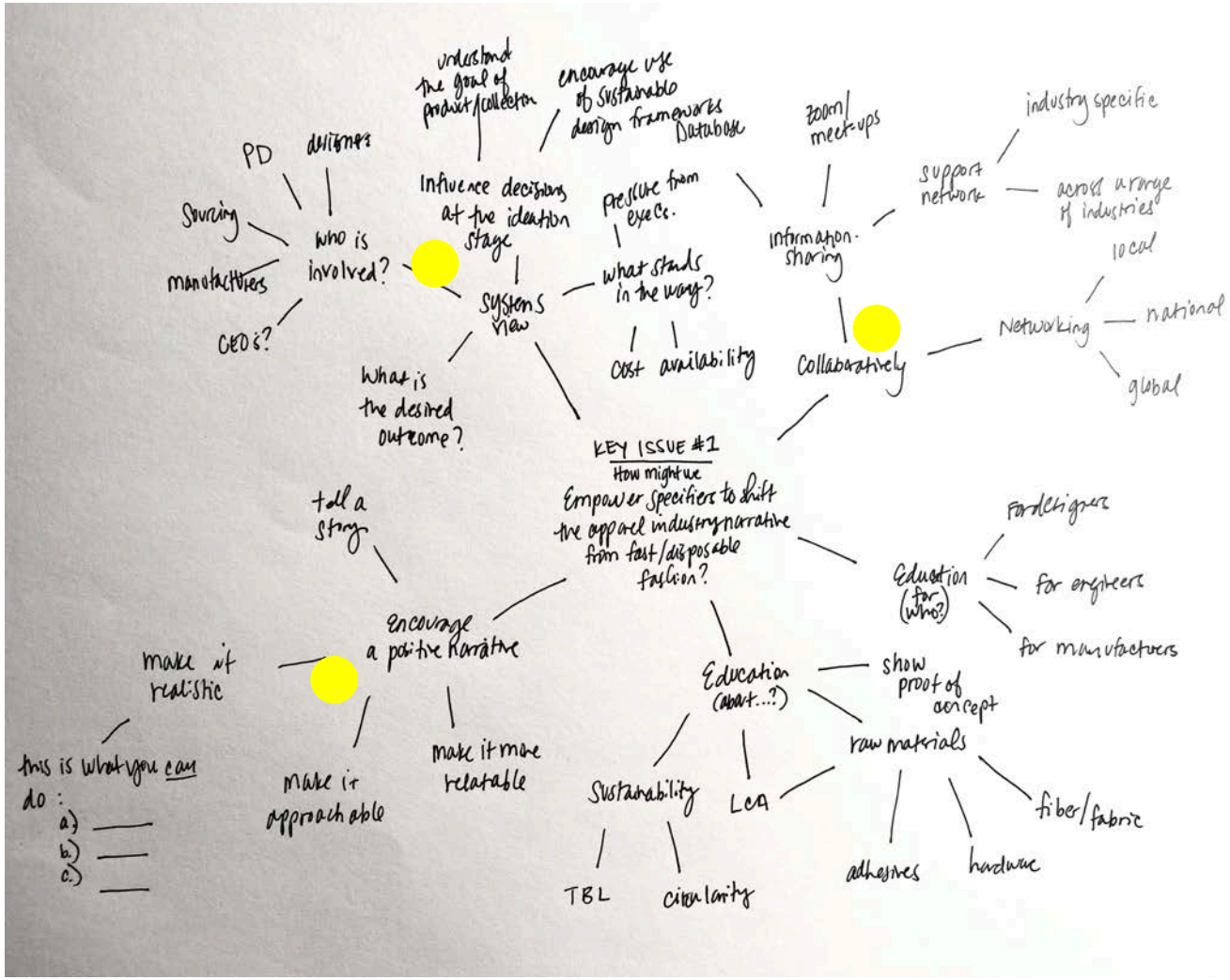
Brainstorm

1 TECHNIQUE - **MIND MAP**

From Key Issue #1

HOW MIGHT WE...

Empower specifiers to shift the apparel industry narrative from fast/disposable fashion?



INDICATES KEY IDEAS

Brainstorm

2 TECHNIQUE – **POWERS OF TEN**

From Key Issue #1

HOW MIGHT WE...

Educate specifiers of the adverse effects of synthetic fibers?

BABY STEPS

Communication

- One on one consulting
    - Project/program specific
- Grab coffee with a colleague/friend in the industry IRL
- Individualized presentation deck/pitch deck
- Chat with an individual or small group via phone or video call, give basic overview

Content

- Impact of individuals material choices
    - Introduction to LCA
- Share datasheets and research applicable to similar product
- Run tests (wash test, abrasion tests, chemical tests, etc.)
- Overview of examples presented in an open forum

GO BIG

Communication

- Zoom to the masses
- Connect with corporations
    - Develop content based on their departmental needs
- Design Conferences
- Trade shows
- Campaign on social media

Content

- Connect with researchers to develop a database of harmful materials used in clothing
- Create a full action plan on how to select more responsible fibers/avoid the bad
- Establish a database of vetted material manufacturers
- Dig deeper into the source of the issue (fossil fuels and supply chain to create/develop synthetic fibers)

INDICATES KEY IDEAS

Brainstorm

3 TECHNIQUE – **GAP FILLING**

From Key Issue #2

HOW MIGHT WE...

Encourage the use of higher quality AND natural fibers?

The Good

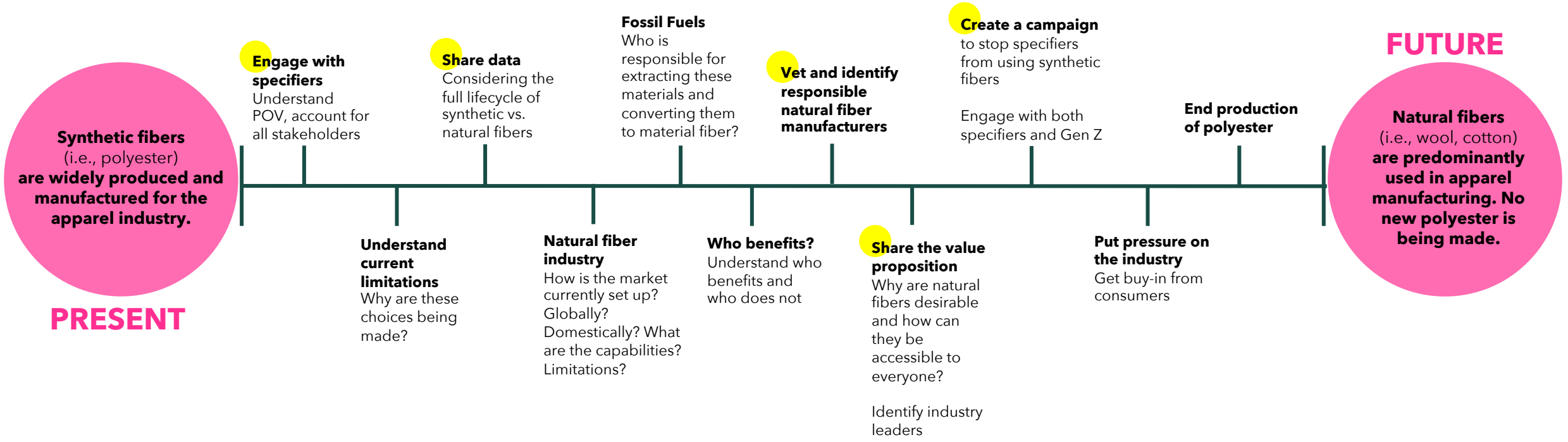
Sustainable Fashion

- There is a general understanding that fast fashion is bad
- More and more studies are exposing issues due to microplastics in all of earths systems

The Challenge

Capitalism

- We have lived during the height of industrialization and consumerism
- Specifiers choose materials based on price, availability, pressure (to meet deadlines and budgets)



INDICATES KEY IDEAS

Brainstorm

4 TECHNIQUE – **THE SKY'S THE LIMIT**

From Key Issue #1

HOW MIGHT WE...

Empower specifiers to shift the apparel industry narrative from fast/disposable fashion?

Specifiers would *always* design and source with sustainability in mind

Specifiers *shared* resources
Cooperation over Competition

Specifiers would be taxed for using unrenewable resources

All humans would thrive on the connection to their belongings, care for them, and treat the land that they came from with respect

Instead of (or in combination with) stores, you could bring fiber in for processing to a mini/boutique manufacturer who could convert your own fiber into something you need

Specifiers would have the necessary tools to make informed decisions about the materials they choose

Specifiers would tell an (honest) story about where the materials are from and encourage others to get to know their own landscapes

Specifiers would understand and encourage connection with the environment

There would be programs aiding people to set up their own farms
localization

Community apparel network?

Specifiers would understand the impact of their choices

Everyone would see value in renewable resources that can be used to make clothing, like cotton, wool, hemp, etc.

DESIGN AWAY FROM POLYESTER
(no new polyester)

Find a solution for all excess material as a safe alternate fuel source, or perform reverse chemistry (magic) and turn it back into fossil fuels to be pumped back into the ground

INDICATES KEY IDEAS

Organize & Capture Results

Organize & Capture Results

A recap of key ideas developed during brainstorming

KEY ISSUE #1

Specifiers have a responsibility in choosing materials for the products they develop.

Much of the focus for brainstorming around specifiers and their responsibility to choose safe materials comes down to education and awareness. There is so much at stake here, but sustainability has not been integrated in design curriculum until recent decades and often, not at all.

Additionally, we are all inhabitants of this planet, so a stronger, more thoughtful connection is needed. How to encourage this is not yet clear, but additional research may shed light on an opportunity in this space.

KEY ISSUE #2

Specifiers have an opportunity to steer material trends away from polyester.

In order to move specifiers away from polyester we need to understand their point of view and then share data with them so that they can consider the full lifecycle of these fibers. It would be useful to specifiers as well to have a well vetted list of responsible manufacturers.

With a strong campaign and the buy-in from some key specifiers and the power of Gen Z, this campaign for “No New Polyester” can be realized.

Life Cycle Diagrams

Life Cycle Diagrams

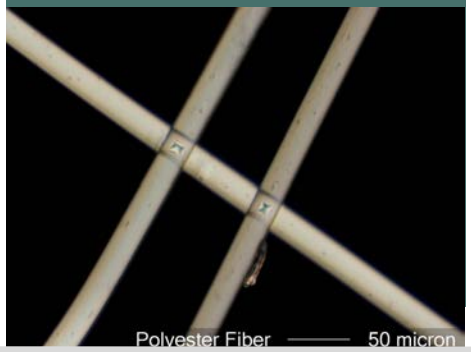
KEY OBJECTIVE

To encourage specifiers to shift away from using polyester in apparel design by sharing data, materials science, and providing education.

3 MATERIALS TO EXPLORE

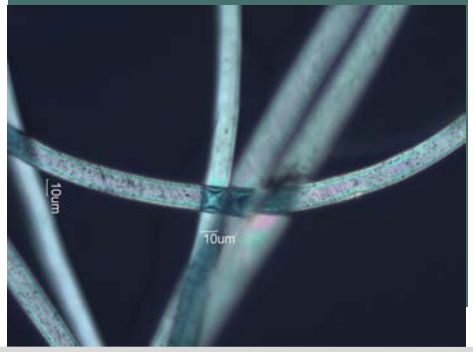
POLYESTER

One of the most abundant fiber types seen in the apparel industry today. Derived from crude oil it is plentiful, inexpensive, durable, and desirable to companies in *fast fashion*.



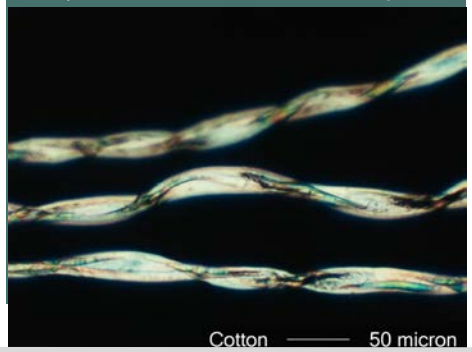
RECYCLED POLYESTER

While it may seem like the solution to our problems, recycling PET bottles into clothing may just result in production of more plastic bottles, resulting in even more microplastics circulating in the biosphere.



CONVENTIONAL COTTON

As the most predominant natural fiber, cotton has gotten a bad wrap for requiring a lot of land and water to process. How does that really add up when its full lifecycle is considered and how can these natural fibers be produced more sustainably?



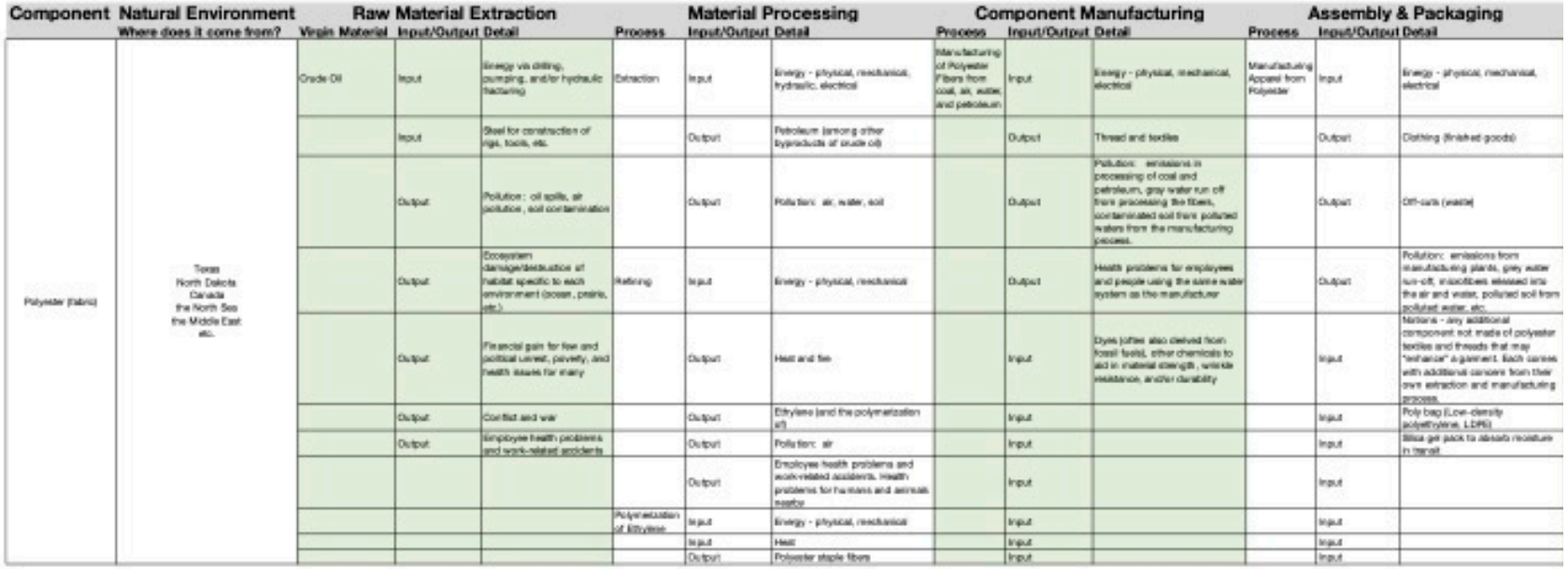
http://www.microlabgallery.com/ClothingFiberFile.aspx

Life Cycle Diagrams

POLYESTER

One of the most abundant fiber types seen in the apparel industry today. Derived from crude oil it is plentiful, inexpensive, durable, and desirable to fast fashion brands.

Through the life cycle diagram, we can see that there are many levels at which the environment and living organisms are impacted by the production of polyester. From extraction of crude oil, to the polymerization of petroleum, to the microfibers that are impacting our waterways, polyester is a dangerous substance that we are only beginning to see the full impacts of its damage on the biosphere.



Component	Natural Environment	Raw Material Extraction				Material Processing			Component Manufacturing			Assembly & Packaging		
	Where does it come from?	Virgin Material	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail
Polyester (fabric)	Texas North Dakota Canada the North Sea the Middle East etc.	Crude Oil	Input	Energy via drilling, pumping, and/or hydraulic fracturing	Extraction	Input	Energy - physical, mechanical, hydraulic, electrical	Manufacturing of Polyester Fibers from coal, air, water, and petroleum	Input	Energy - physical, mechanical, electrical	Manufacturing Apparel from Polyester	Input	Energy - physical, mechanical, electrical
			Input	Steel for construction of rigs, tools, etc.		Output	Petroleum (among other byproducts of crude oil)		Output	Thread and textiles		Output	Clothing (finished goods)
			Output	Pollution: oil spills, air pollution, soil contamination		Output	Pollution: air, water, soil		Output	Pollution: emissions in processing of coal and petroleum, gray water run off from processing the fibers, contaminated soil from polluted waters from the manufacturing process.		Output	Off-cuts (waste)
			Output	Ecosystem damage/destruction of habitat specific to each environment (ocean, prairie, etc.)	Refining	Input	Energy - physical, mechanical		Output	Health problems for employees and people using the same water system as the manufacturer		Output	Pollution: emissions from manufacturing plants, grey water run-off, insecticides released into the air and water, polluted soil from polluted water, etc.
			Output	Financial gain for few and political unrest, poverty, and health issues for many		Output	Heat and fire		Input	Dyes (often also derived from fossil fuels), other chemicals to aid in material strength, wrinkle resistance, and/or durability		Input	Notions - any additional component not made of polyester textiles and threads that may "enhance" a garment. Each comes with additional concerns from their own extraction and manufacturing process.
			Output	Conflict and war		Output	Ethylene (and the polymerization of)		Input			Input	Poly bag (Low-density polyethylene, LDPE)
			Output	Employee health problems and work-related accidents		Output	Pollution: air		Input			Input	Silica gel pack to absorb moisture in transit
						Output	Employee health problems and work-related accidents. Health problems for humans and animals nearby		Input			Input	
					Polymerization of Ethylene	Input	Energy - physical, mechanical		Input			Input	
						Input	Heat		Input			Input	
						Output	Polyester staple fibers		Input			Input	

Transport/Distribution/Purchase			Construction/Installation			Use Phase			Maintenance/Upgrading			End of Life Scenarios		
Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail
Sending Samples to Buyer	Input	Energy - energy to make the physical sample, energy to pack the sample, energy of humans, energy of freight, electrical, and mechanical.	Listing/Displaying Product for Resale	Input	Energy - physical (set up display)	End User Wears the Garment	Input	Energy - physical	Tailoring	Input	Energy - physical, mechanical, electrical	Landfill	Input	Garment ends up at a landfill
	Output	Pollution: air, water, soil		Input	Marketing / signage, hang tags, labels		Output	Microplastics: due to abrasion, wash cycles, and drying		Input	Thread, patches, etc.	Reuse	Input	Garment is re-used as a cleaning cloth
Distributing Product to Retailer	Input	Energy - human energy, electrical energy, mechanical energy		Output	Waste created from marketing materials via landfill or incineration		Output	Emissions: due to use of gas dryers		Output	Repaired garment	Other	Input	Garment is broken down by organic materials, water, heat, pressure, and time (hundreds of years)
	Input	Diesel for transport vehicle		Input			Output	Possible health issues for the wearer	Upcycling	Input	Energy - physical, mechanical, electrical	Incineration	Output	Disposal
	Output	Pollution: CO2 emissions, insecticides from rubber tires, grease from vehicle		Input			Input	Laundering - detergents, dryer sheets, water		Input	Thread, other textiles	Incineration	Output	Pollution: air, water, soil - microfibers may escape into the air, burning these chemicals may cause lung disease in humans and/or harm wildlife, as ash settles it pollutes the soil.
	Input			Input			Input			Output	Upgraded garment	Remanufacturing	Output	Convert to insulation
	Input			Input			Input					Other	Output	Resale
	Input			Input			Input					Other	Output	Donation
	Input			Input			Input					Other	Output	Take-back programs, reuse (repeat), before end of life.
	Input			Input			Input					Disassembly	Input	
	Input			Input			Input					Disassembly	Input	

KEY OBJECTIVE

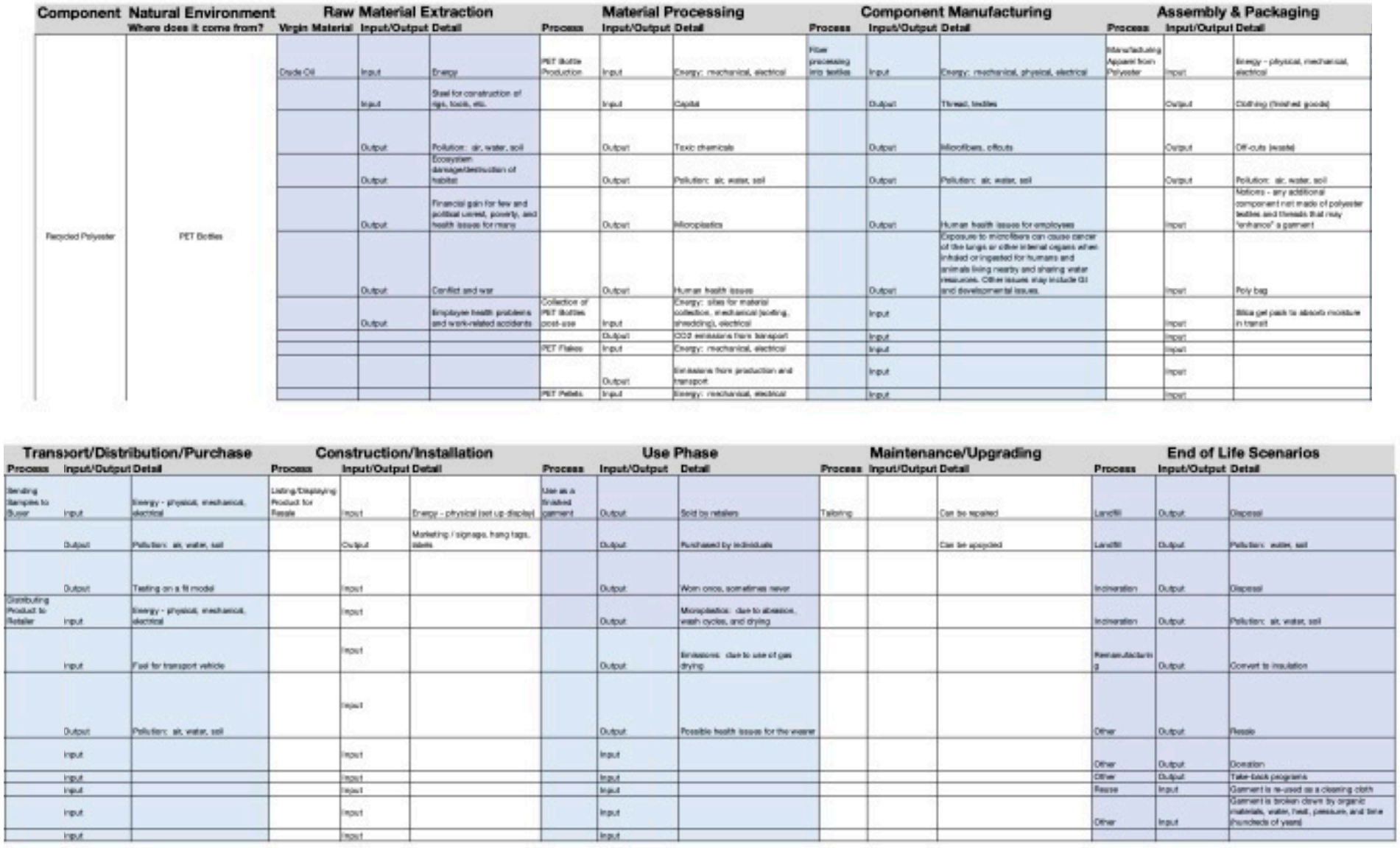
To encourage specifiers to shift away from using polyester in apparel design by sharing data, materials science, and providing education.

Life Cycle Diagrams

RECYCLED POLYESTER

While it may seem like the solution to our problems, recycling PET bottles into clothing may be just another way to break down polymers and release microplastics into our air, waterways, and soils.

Through this life cycle diagram, we can see that recycled polyester differs from virgin polyester, however both the processing of virgin polyester needs to be understood along with all of the additional processes of recycled polyester. Therefore, is recycled polyester offering a solution or creating a new problem? Is it simply an excuse for the beverage industry to produce more plastic bottles?



Component	Natural Environment	Raw Material Extraction				Material Processing			Component Manufacturing			Assembly & Packaging		
	Where does it come from?	Virgin Material	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail
Recycled Polyester	PET Bottles	Crude Oil	Input	Energy	PET Bottle Production	Input	Energy: mechanical, electrical	Fiber processing into textiles	Input	Energy: mechanical, physical, electrical	Manufacturing Apparel from Polyester	Input	Energy – physical, mechanical, electrical
			Input	Steel for construction of rigs, tools, etc.		Input	Capital		Output	Thread, textiles		Output	Clothing (finished goods)
			Output	Pollution: air, water, soil		Output	Toxic chemicals		Output	Microfibers, offcuts		Output	Off-cuts (waste)
			Output	Ecosystem damage/destruction of habitat		Output	Pollution: air, water, soil		Output	Pollution: air, water, soil		Output	Pollution: air, water, soil
			Output	Financial gain for few and political unrest, poverty, and health issues for many		Output	Microplastics		Output	Human health issues for employees		Input	Notions - any additional component not made of polyester textiles and threads that may "enhance" a garment
			Output	Conflict and war		Output	Human health issues		Output	Exposure to microfibers can cause cancer of the lungs or other internal organs when inhaled or ingested for humans and animals living nearby and sharing water resources. Other issues may include GI and developmental issues.		Input	Poly bag
			Output	Employee health problems and work-related accidents	Collection of PET Bottles post-use	Input	Energy: silos for material collection, mechanical (sorting, shredding), electrical		Input			Input	Silica gel pack to absorb moisture in transit
						Output	CO2 emissions from transport		Input			Input	
					PET Flakes	Input	Energy: mechanical, electrical		Input			Input	
						Output	Emissions from production and transport		Input			Input	
					PET Pellets	Input	Energy: mechanical, electrical		Input			Input	

Transport/Distribution/Purchase			Construction/Installation			Use Phase			Maintenance/Upgrading			End of Life Scenarios		
Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail
Sending Samples to Buyer	Input	Energy - physical, mechanical, electrical	Listing/Displaying Product for Resale	Input	Energy - physical (set up displays)	Use as a finished garment	Output	Sold by retailers	Tailoring		Can be repaired	Landfill	Output	Disposal
	Output	Pollution: air, water, soil		Output	Marketing / signage, hang tags, labels		Output	Purchased by individuals			Can be upcycled	Landfill	Output	Pollution: water, soil
	Output	Testing on a fit model		Input			Output	Worn once, sometimes never				Incineration	Output	Disposal
Distributing Product to Retailer	Input	Energy - physical, mechanical, electrical		Input			Output	Microplastics: due to abrasion, wash cycles, and drying				Incineration	Output	Pollution: air, water, soil
	Input	Fuel for transport vehicle		Input			Output	Emissions: due to use of gas drying				Remanufacturing	Output	Convert to insulation
	Output	Pollution: air, water, soil		Input			Output	Possible health issues for the wearer				Other	Output	Resale
	Input			Input			Input					Other	Output	Donation
	Input			Input			Input					Other	Output	Take-back programs
	Input			Input			Input					Reuse	Input	Garment is re-used as a cleaning cloth
	Input			Input			Input					Other	Input	Garment is broken down by organic materials, water, heat, pressure, and time (hundreds of years)
	Input			Input			Input							

KEY OBJECTIVE

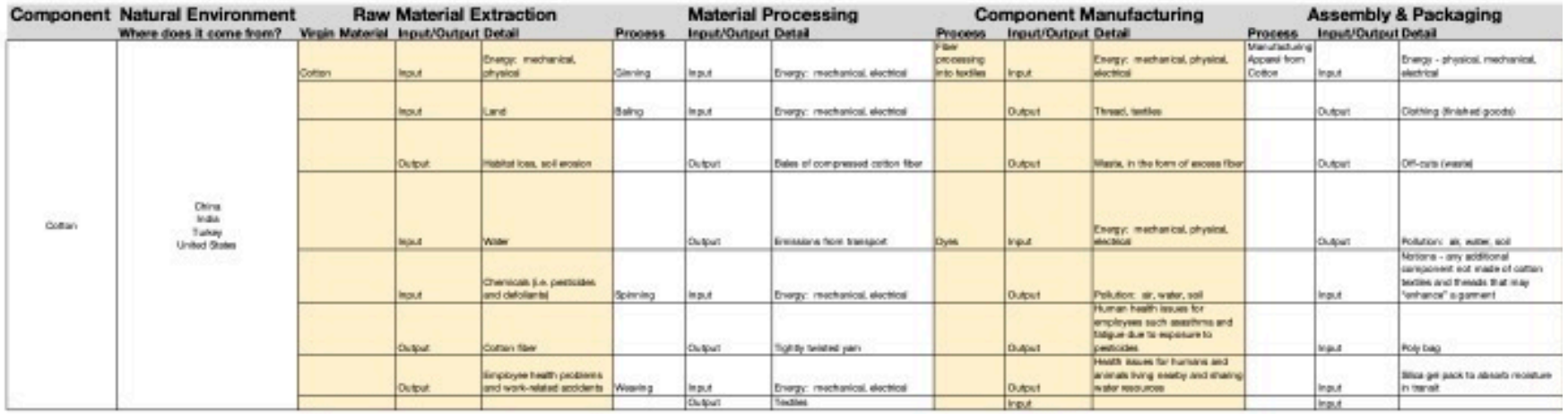
To encourage specifiers to shift away from using polyester in apparel design by sharing data, materials science, and providing education.

Life Cycle Diagrams

CONVENTIONAL COTTON

As the most predominant natural fiber, cotton has gotten a bad wrap for requiring a lot of land and water to process. How does that really add up when its full lifecycle is considered?

Through this life cycle diagram, we see that cotton is to blame for habitat loss, deforestation, and soil degradation, and that doesn't consider the impacts of pesticides that are applied to the plants to aid in farming practices. How can farming of cotton crops be improved? In order to understand this fully, a life cycle analysis would need to be completed for both standard and organic cotton to dive deeper into both types of farming practice.



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	Where does it come from?	Virgin Material	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail
Cotton	China India Turkey United States	Cotton	Input	Energy: mechanical, physical	Ginning	Input	Energy: mechanical, electrical	Fiber processing into textiles	Input	Energy: mechanical, physical, electrical	Manufacturing Apparel from Cotton	Input	Energy - physical, mechanical, electrical
			Input	Land	Baling	Input	Energy: mechanical, electrical		Output	Thread, textiles		Output	Clothing (finished goods)
			Output	Habitat loss, soil erosion		Output	Bales of compressed cotton fiber		Output	Waste, in the form of excess fiber		Output	Off-cuts (waste)
			Input	Water		Output	Emissions from transport	Dyes	Input	Energy: mechanical, physical, electrical		Output	Pollution: air, water, soil
			Input	Chemicals (i.e. pesticides and defoliants)	Spinning	Input	Energy: mechanical, electrical		Output	Pollution: air, water, soil		Input	Notions - any additional component not made of cotton textiles and threads that may "enhance" a garment
			Output	Cotton fiber		Output	Tightly twisted yarn		Output	Human health issues for employees such asasthma and fatigue due to exposure to pesticides		Input	Poly bag
			Output	Employee health problems and work-related accidents	Weaving	Input	Energy: mechanical, electrical		Output	Health issues for humans and animals living nearby and sharing water resources		Input	Silica gel pack to absorb moisture in transit
						Output	Textiles		Input			Input	

Transport/Distribution/Purchase			Construction/Installation			Use Phase			Maintenance/Upgrading			End of Life Scenarios		
Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail	Process	Input/Output	Detail
Sending Samples to Buyer	Input	Energy - physical, mechanical, electrical	Listing/Displaying Product for Resale	Input	Energy - physical (set up display)	Use as a finished garment	Output	Sold by retailers	Tailoring		Can be repaired	Landfill	Output	Disposal
	Output	Pollution: air, water, soil		Output	Marketing / signage, hang tags, labels		Output	Purchased by individuals			Can be upcycled	Landfill	Output	Pollution: water, soil (primarily from dyes and any other fibers spun with the cotton in the fiber manufacturing process)
	Output	Testing on a fit model		Input			Output	Worn once to hundreds of times				Incineration	Output	Disposal
Distributing Product to Retailer	Input	Energy - physical, mechanical, electrical		Input			Output	Microfibers: due to abrasion, wash cycles, and drying, these tiny particles can alter ecosystems where they are not naturally produced (ingested by fish, then humans, etc.)				Incineration	Output	Pollution: air, water, soil
	Input	Fuel for transport vehicle		Input			Output	Emissions: due to use of gas drying				Remanufacturing	Output	Convert to insulation
	Output	Pollution: air, water, soil		Input								Other	Output	Resale
	Input			Input			Input					Other	Output	Donation
	Input			Input			Input					Other	Output	Take-back programs

KEY OBJECTIVE

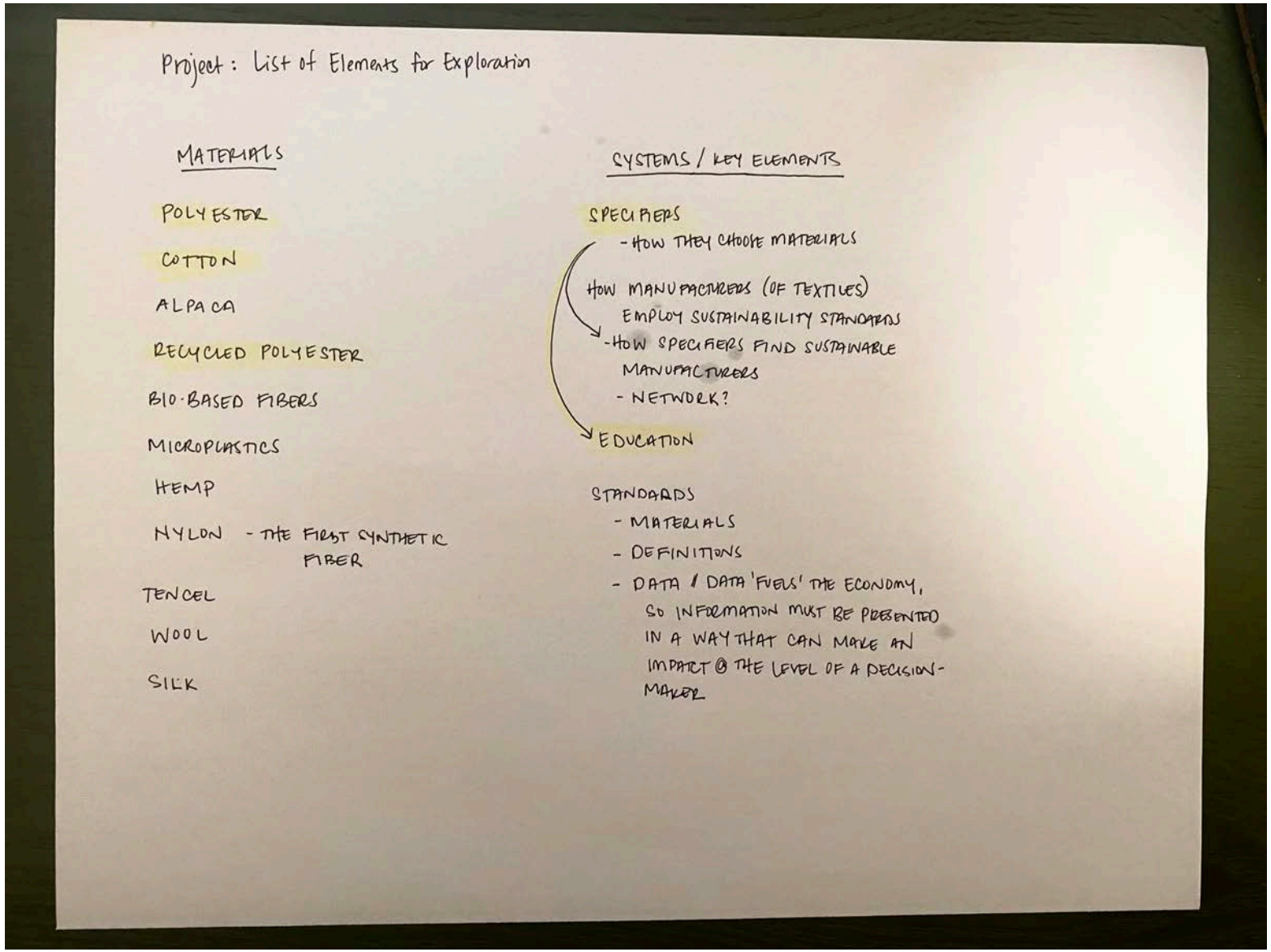
To encourage specifiers to shift away from using polyester in apparel design by sharing data, materials science, and providing education.

Life Cycle Diagrams

Sketches and diagrams developed during the ideation phase

PROCESS OF SPECIFIYING PRODUCT MATERIALS

The intended outcome of this brainstorm was to identify the three elements/materials for exploration in this assignment. The three choice materials for this exercise are Polyester, Recycled Polyester, and Cotton.

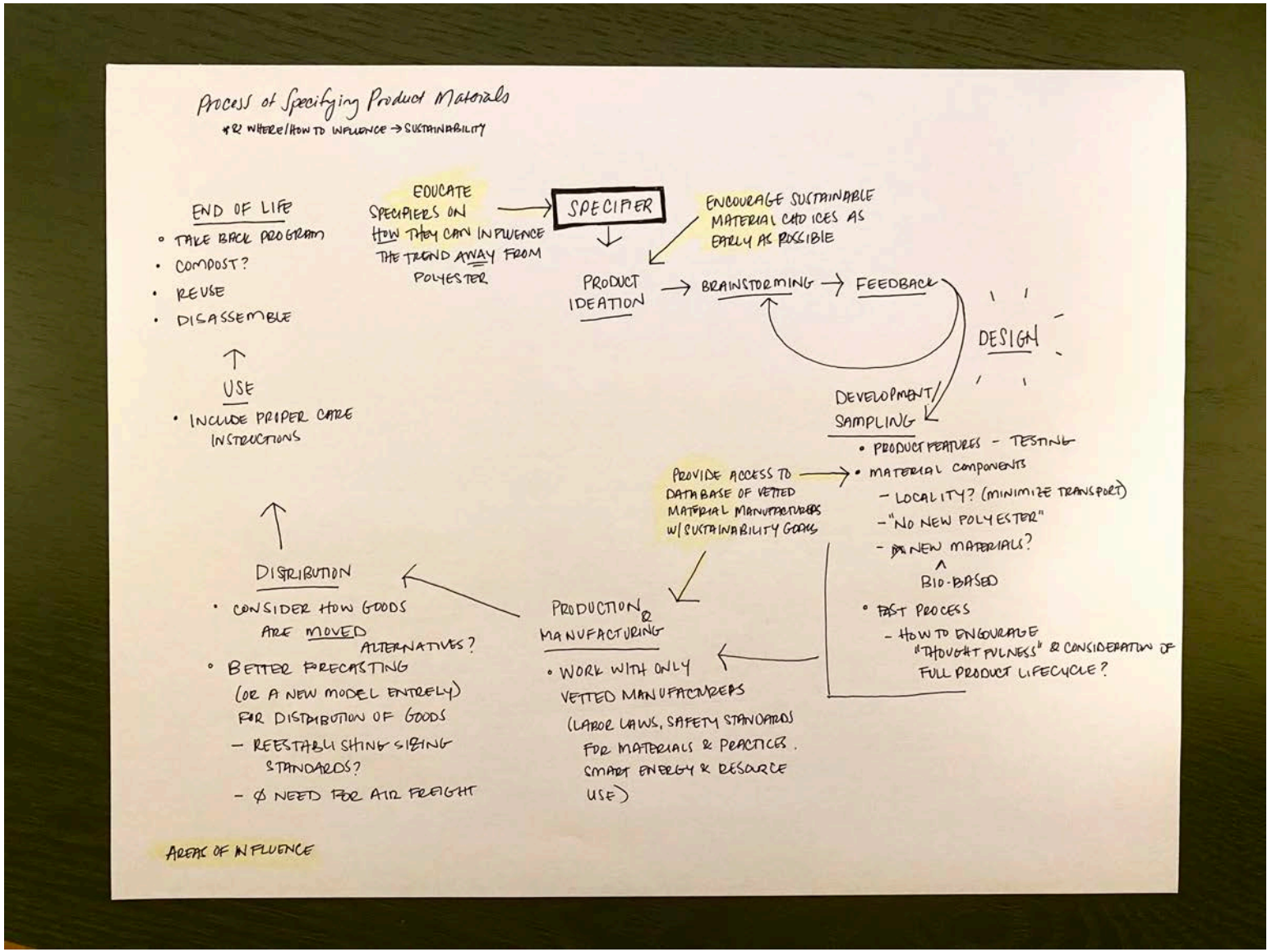


Life Cycle Diagrams

Sketches and diagrams developed during the ideation phase

PROCESS OF SPECIFIYING PRODUCT MATERIALS

In this diagram, the process a specifier may take to make decisions about material specifications was followed. As the process developed, areas where a specifier could benefit from shared knowledge and how education can influence these decisions early on are noted by yellow highlighter.

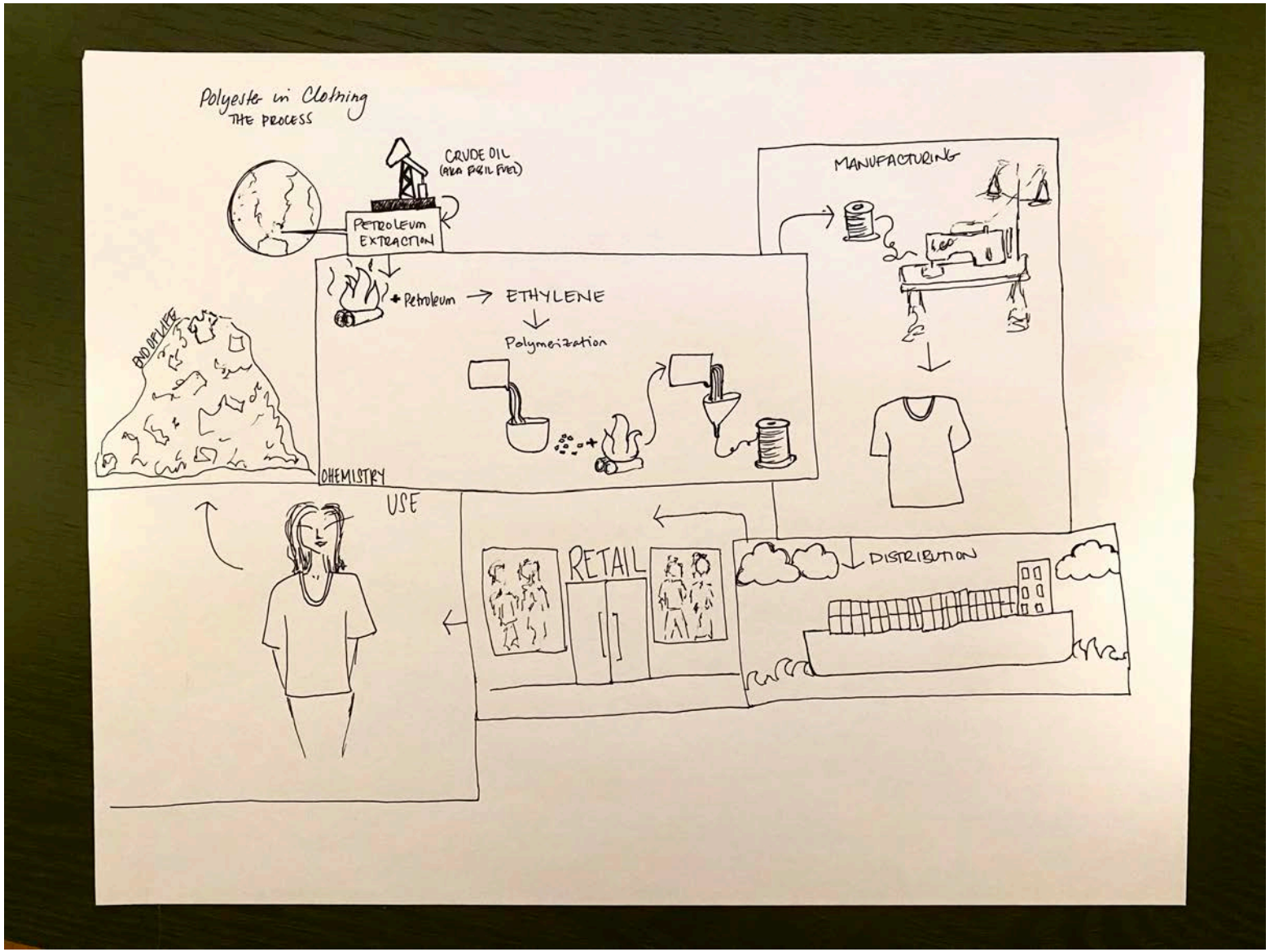


Life Cycle Diagrams

Sketches and diagrams developed during the ideation phase

LIFE CYCLE OF POLYESTER

In this diagram shows an illustrative approach to the lifecycle of polyester from initial extraction as crude oil to end use of a polyester t-shirt in a landfill.

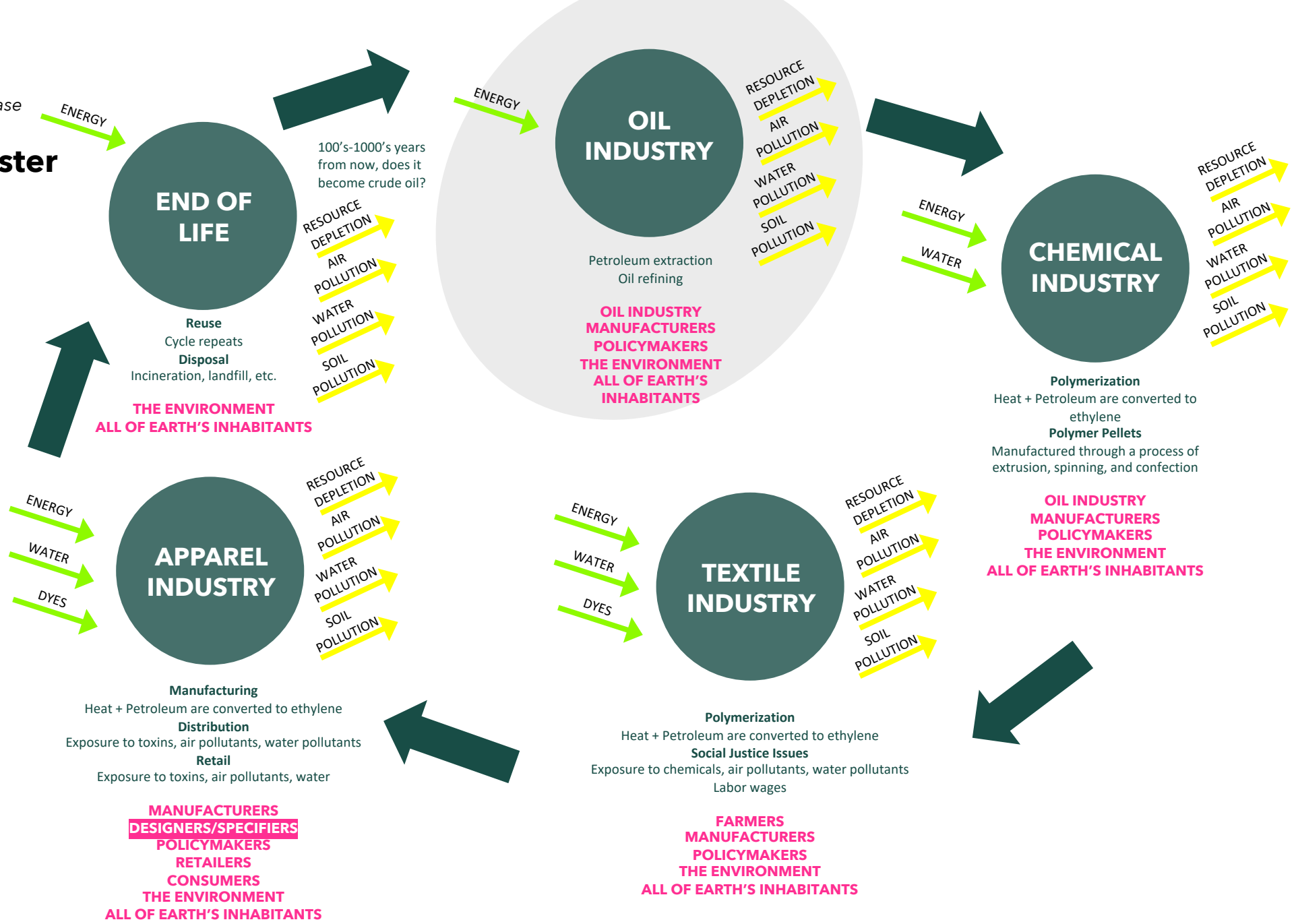


Life Cycle Diagrams

Diagrams developed during the ideation phase

The Life Cycle of Polyester

EXPANDED DIAGRAM



INPUTS

OUTPUTS

STAKEHOLDERS

Step 6:

Life Cycle Assessment

Life Cycle Assessment

Okala Impact Assessment

Assessment #1

100% Polyester T-Shirt - Imported

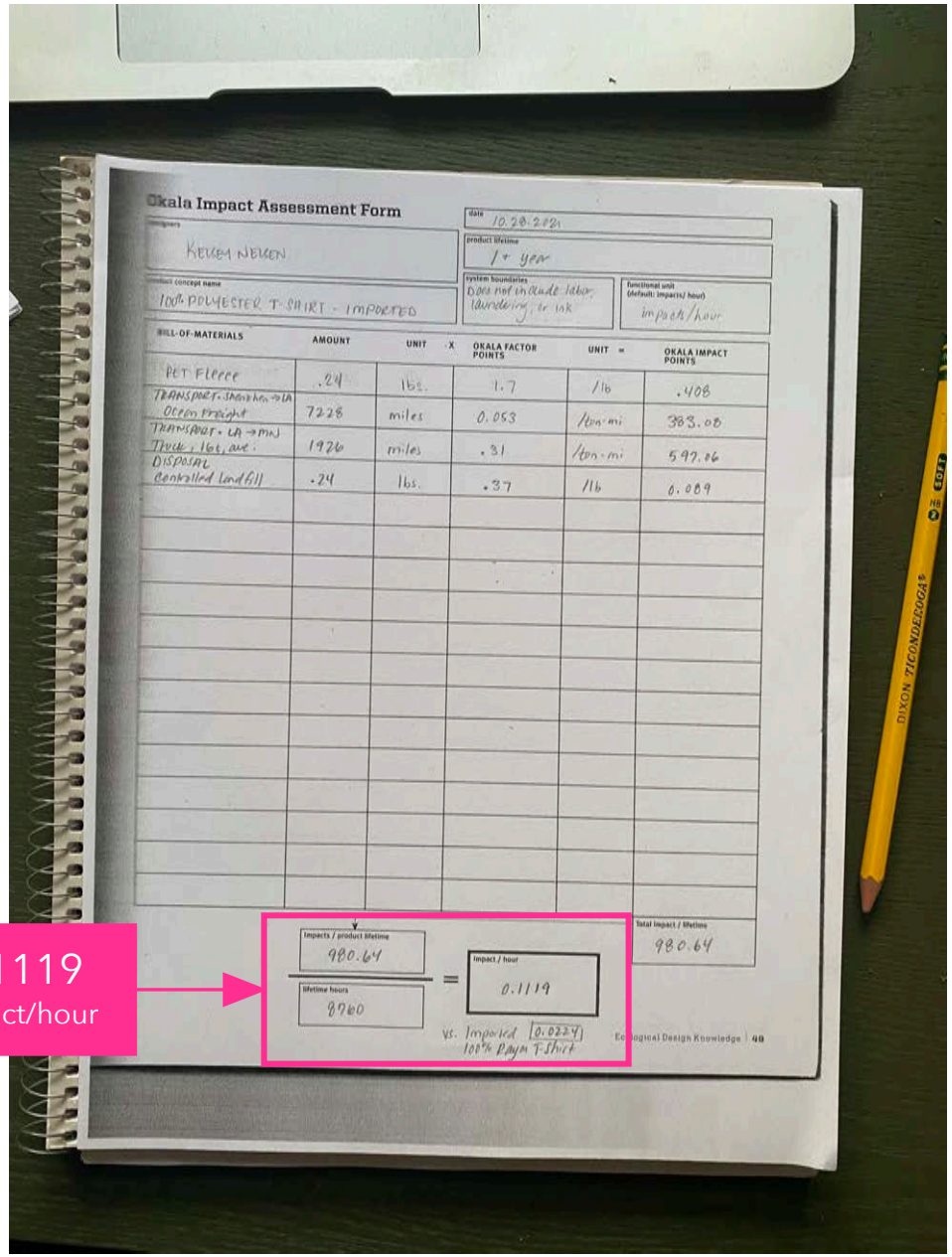
A polyester t-shirt is the first example in this assessment as the microplastics of concern are often from poly and poly-blend clothing.

The Assessment

To keep this assessment simple, we will assume that the garment is entirely made of polyester, including any tags, and we are not going to factor any processing using inks, dyes, labor, or laundering.

We will also assume that:

- Size - Women's Medium
- Lifespan – 1 year
    - Lifespan deduced from clothing in my own closet
- Imported from Shenzhen, China to Los Angeles, California, USA via shipping freight
- Transported from Los Angeles to Minneapolis via ground transport



0.1119
impact/hour

Life Cycle Assessment

Okala Impact Assessment

Assessment #2

100% Rayon T-Shirt - Imported

For this second assessment, rayon is the fiber of interest.

The Assessment

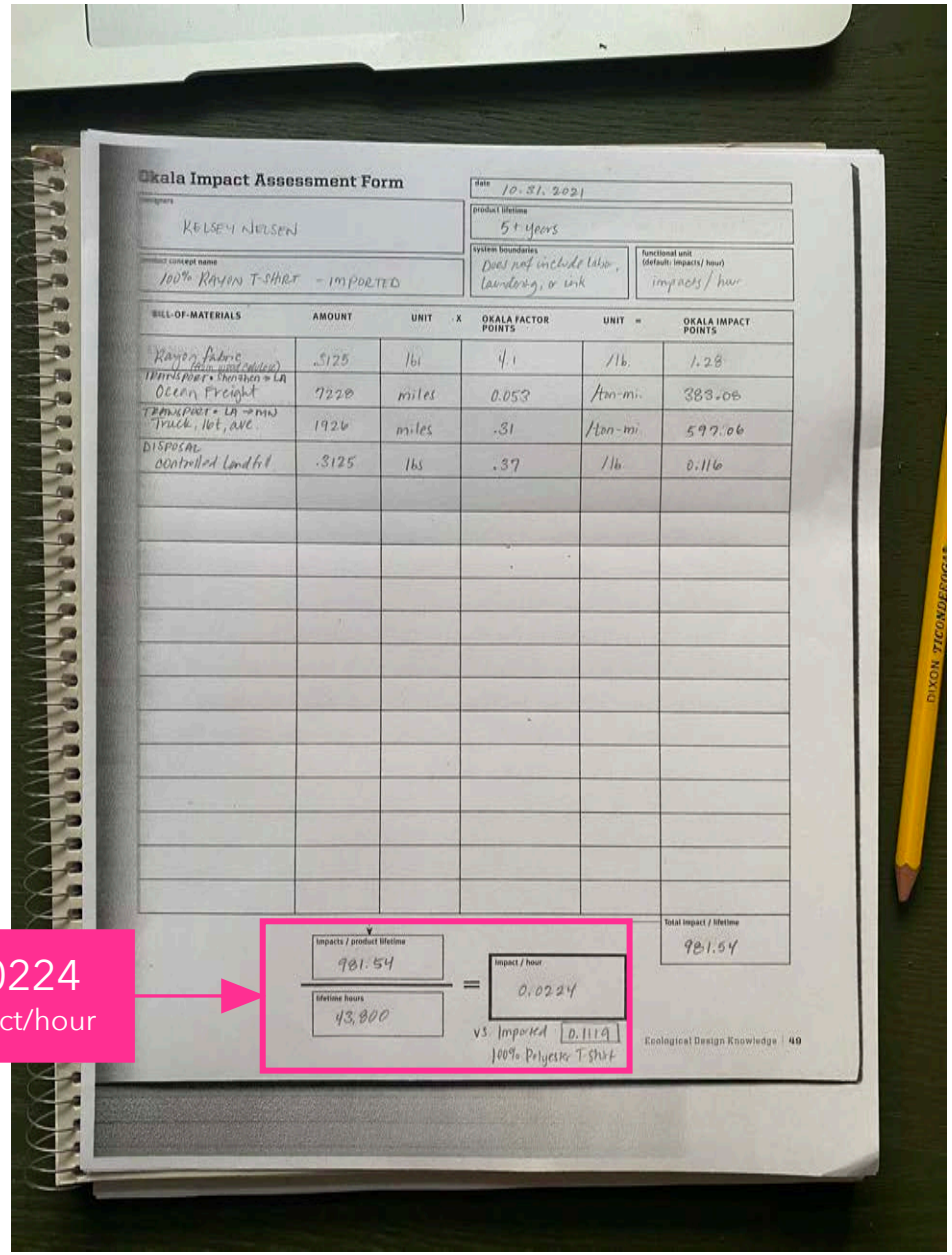
To keep this assessment simple, it can be assumed that the garment is entirely made of rayon, including any tags, and we are not going to factor any processing using inks, dyes, labor, or laundering.

Additional factors:

- Size - Women's Medium
- Lifespan – 5 years
- Imported from Shenzhen, China to Los Angeles, California, USA via shipping freight
- Transported from Los Angeles to Minneapolis via ground transport

Additional Thoughts

Working through the assessment, it was realized that time plays an important role, so it may be more useful to estimate the actual number of hours worn within the lifespan of the garment. However, for this example from manufacturing → consumer → end of life. Because of the factor of timing, it is not surprising that rayon has a lower rate of impact per hour.



Life Cycle Assessment

Okala Impact Assessment

Assessment #3

100% Cotton T-Shirt - Domestic

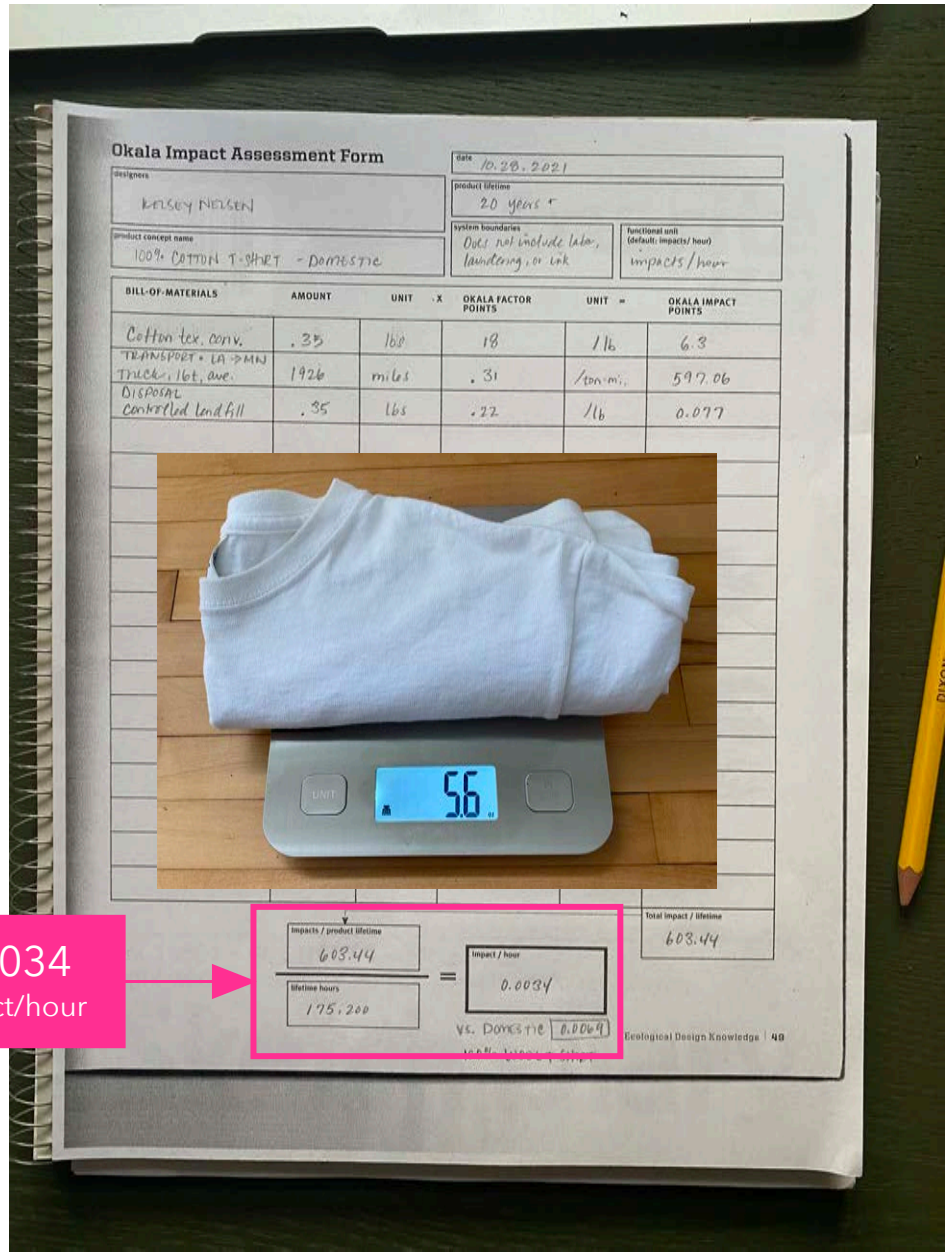
The sustainability of cotton has been scrutinized for decades, especially by producers of poly-based materials. Cotton uses a lot of water to grow and manufacture, but one can also argue that it is durable and maintains its form much longer than polyester or fabric blends.

The Assessment

To keep this assessment simple, we will assume that the garment is entirely made of cotton, including any tags, and we are not going to factor any processing using inks, dyes, labor, or laundering.

Additional factors:

- Size - Women's Medium
- Lifespan – 20 years
- Manufactured in Los Angeles, California, USA
- Transported from Los Angeles to Minneapolis via ground transport



0.0034
impact/hour

Additional Thoughts

While a cotton t-shirt may be used for many years, we tend to accumulate an incredible number of them. In a middleclass community in the Midwest for a teenager who plays sports, it is common to receive a t-shirt with every tournament played, every race run, or every season of said sport or activity. There are creative ways that people repurpose them, but there are far more t-shirts around than people to wear them.

Life Cycle Assessment

Okala Impact Assessment

Assessment #4

100% Wool T-Shirt - Domestic

For this final assessment, the assessment highlights another domestically produced fiber option: wool. While wool isn't the traditional choice for a t-shirt material, it is useful to compare it with cotton. Wool has several desirable properties for athletic wear, including being moisture-wicking and breathable.

The Assessment

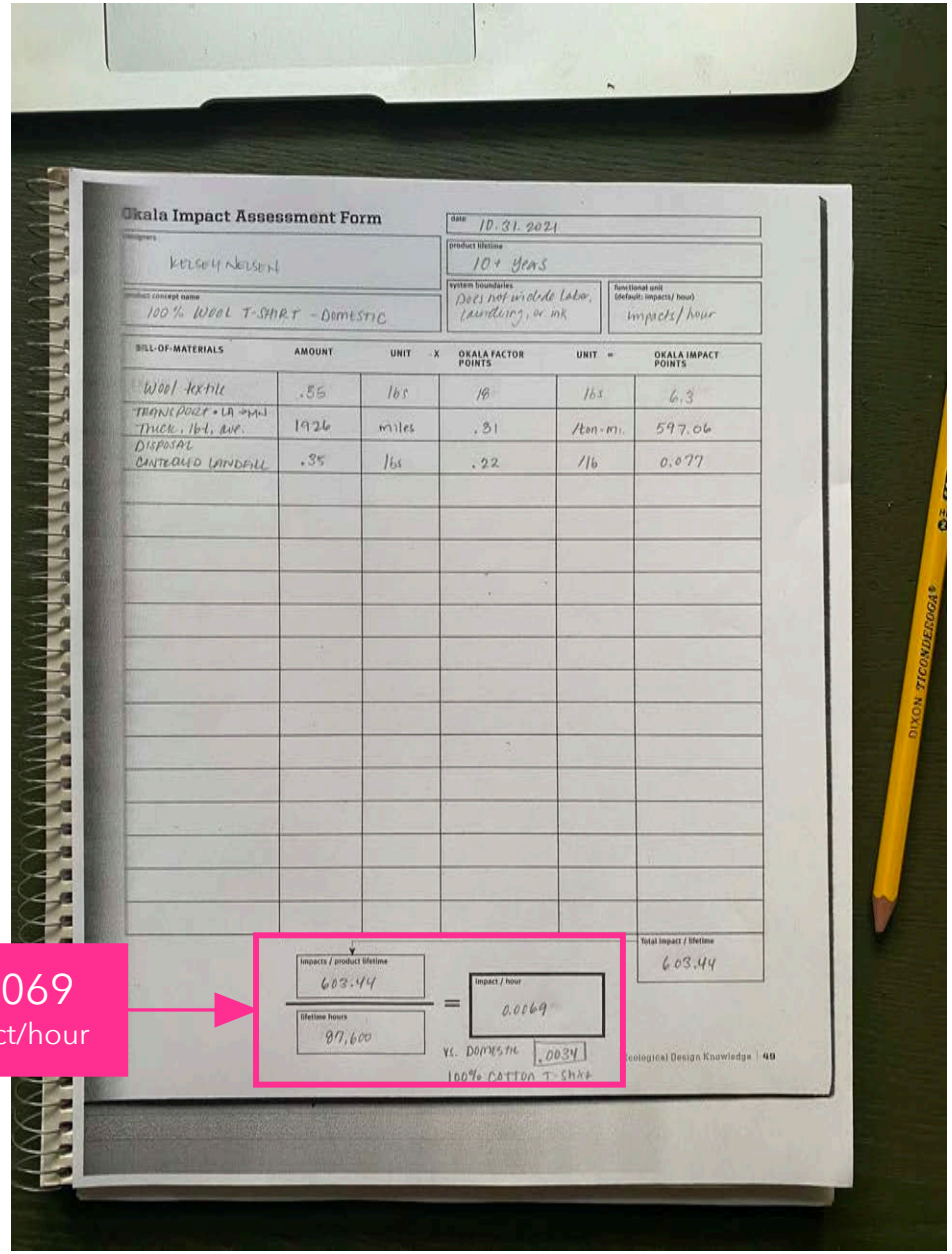
To keep this assessment simple, it can be assumed that the garment is entirely made of wool, including any tags. No other processing using inks, dyes, labor, or laundering will be considered for this assessment.

Additional factors:

- Size - Women's Medium
- Lifespan – 10 years
- Manufactured in Los Angeles, California, USA
- Transported from Los Angeles to Minneapolis via ground transport

Additional Thoughts

It was not surprising to see that wool had a higher rate of impact/hour because of the estimated lifespan of the garment.



Life Cycle Assessment

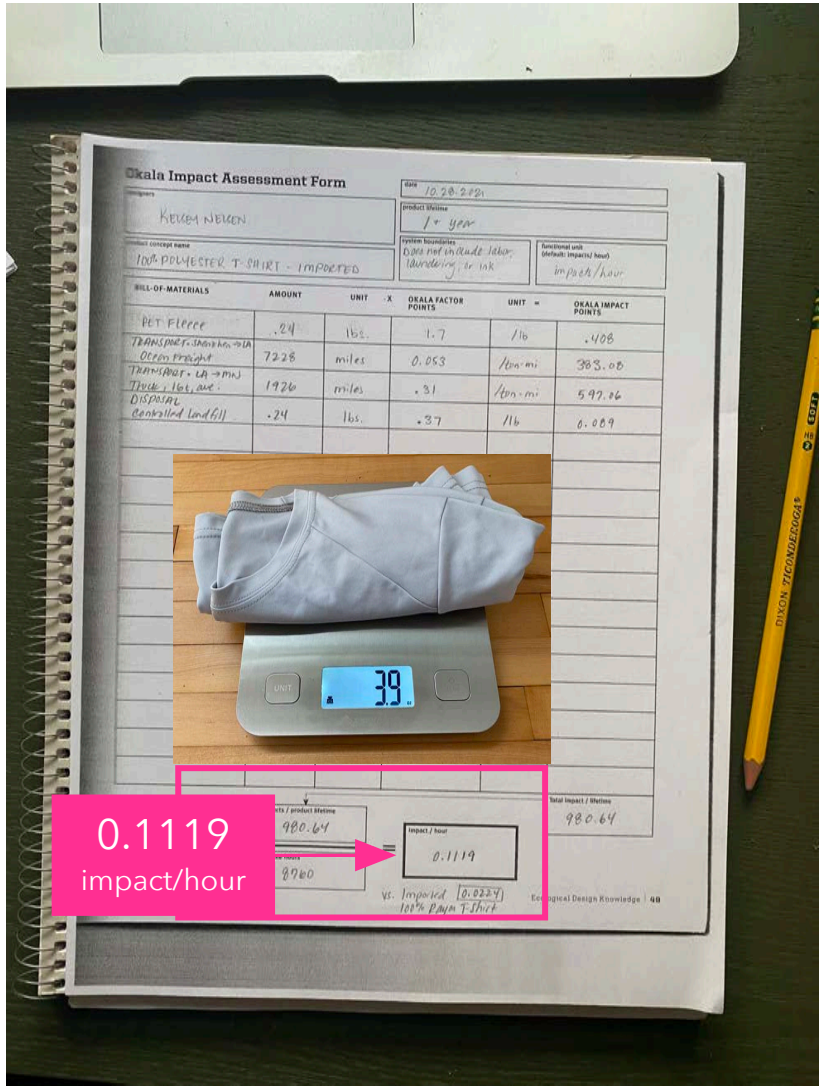
Okala Impact Assessment

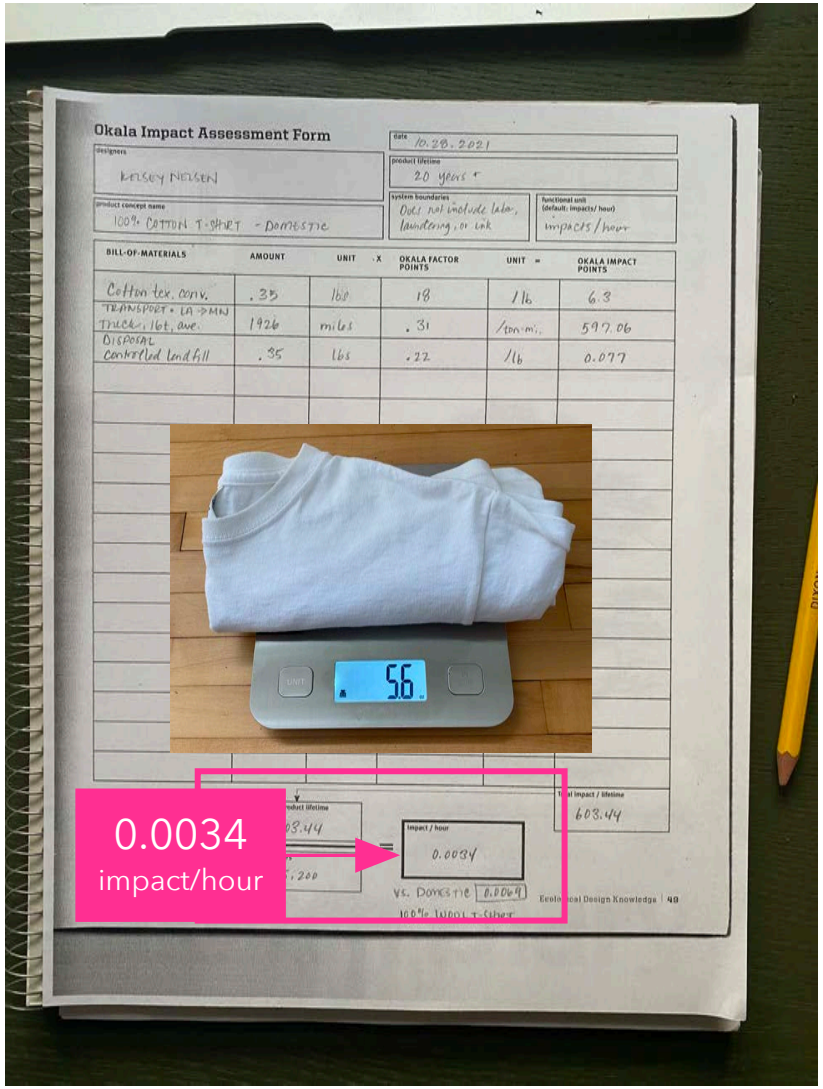
CLOSING THOUGHTS

Bringing this assessment full circle and looking at the two most common fabric choices for t-shirts, we see that **while cotton uses a lot of water, it also lasts a lot longer and has fewer impact/hours**.

It is important to note that with more regenerative agricultural practices coming to light, there is opportunity for an even bigger impact (or quite the opposite, less impact/hour) if we consider the *way* we grow and process cotton. Advancing the industry could be beneficial in many ways, including domestic agriculture and more domestic growth in manufacturing.

Working through this assessment sheds light on other areas of apparel manufacturing through dyeing processes, fiber blends, and options for more domestic and smarter agriculture.





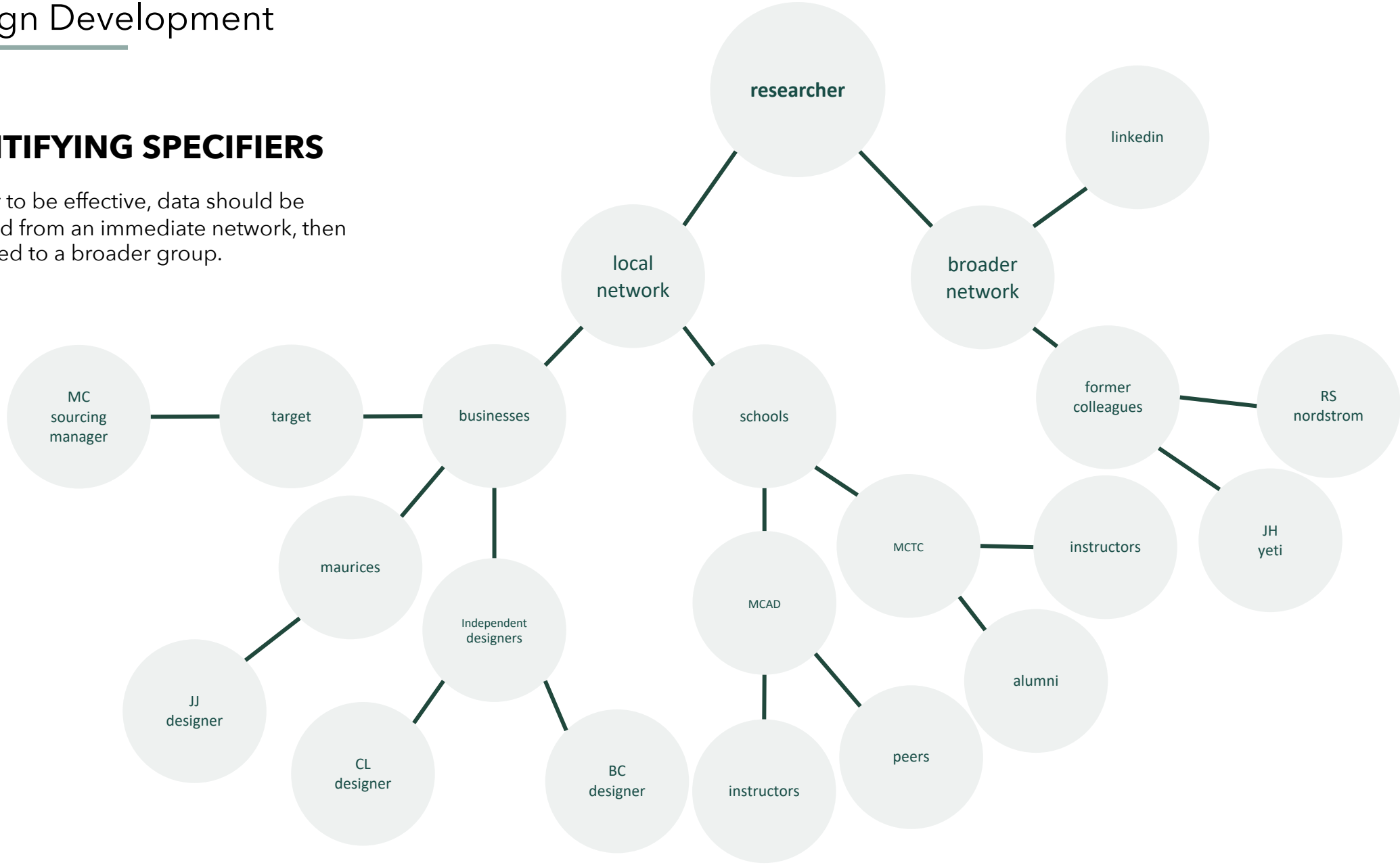
Step 7:

Design Development

Design Development

IDENTIFYING SPECIFIERS

In order to be effective, data should be collected from an immediate network, then expanded to a broader group.



Design Development

IDENTIFYING THE METHOD

Working out the best method of knowledge-sharing with specifiers.

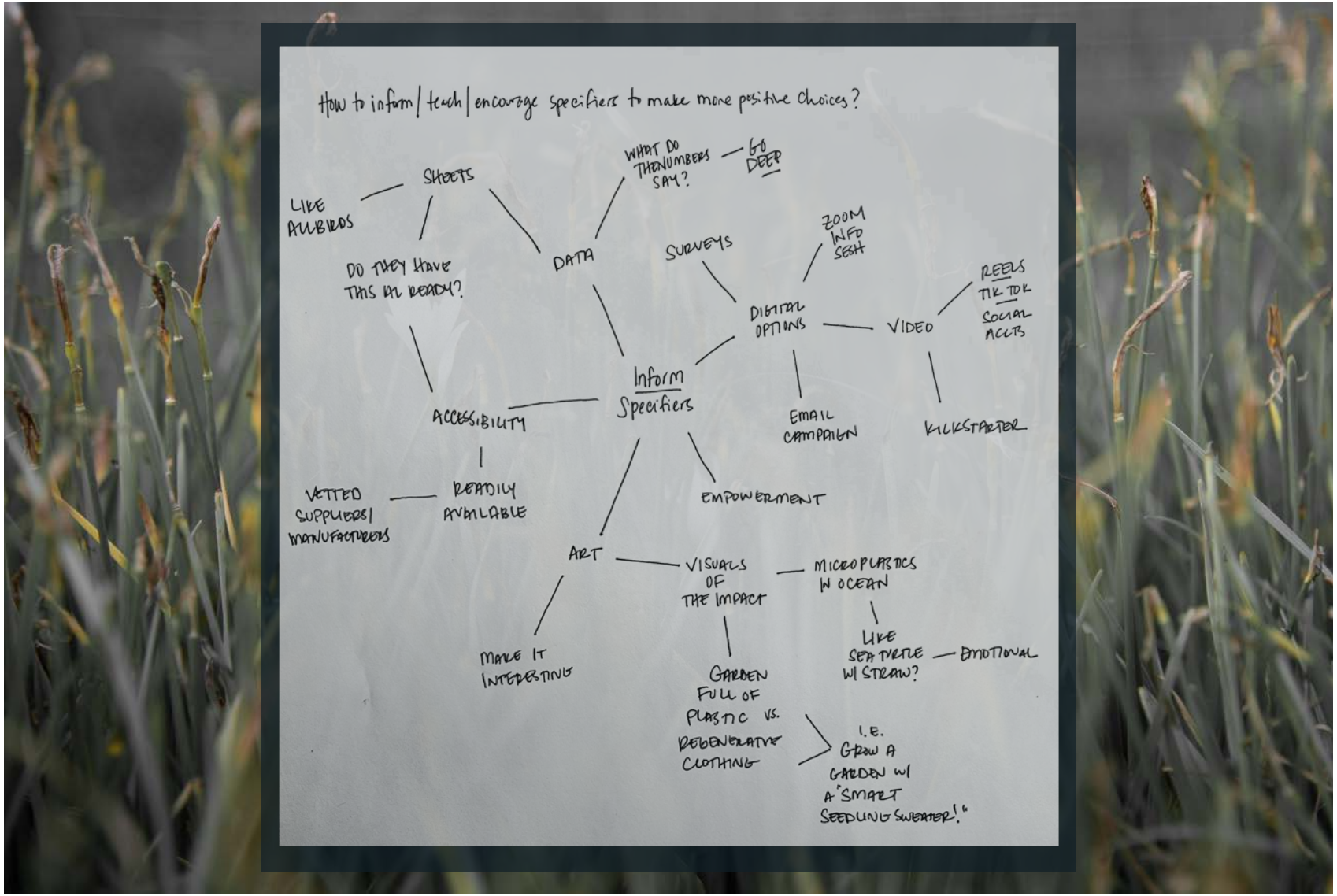
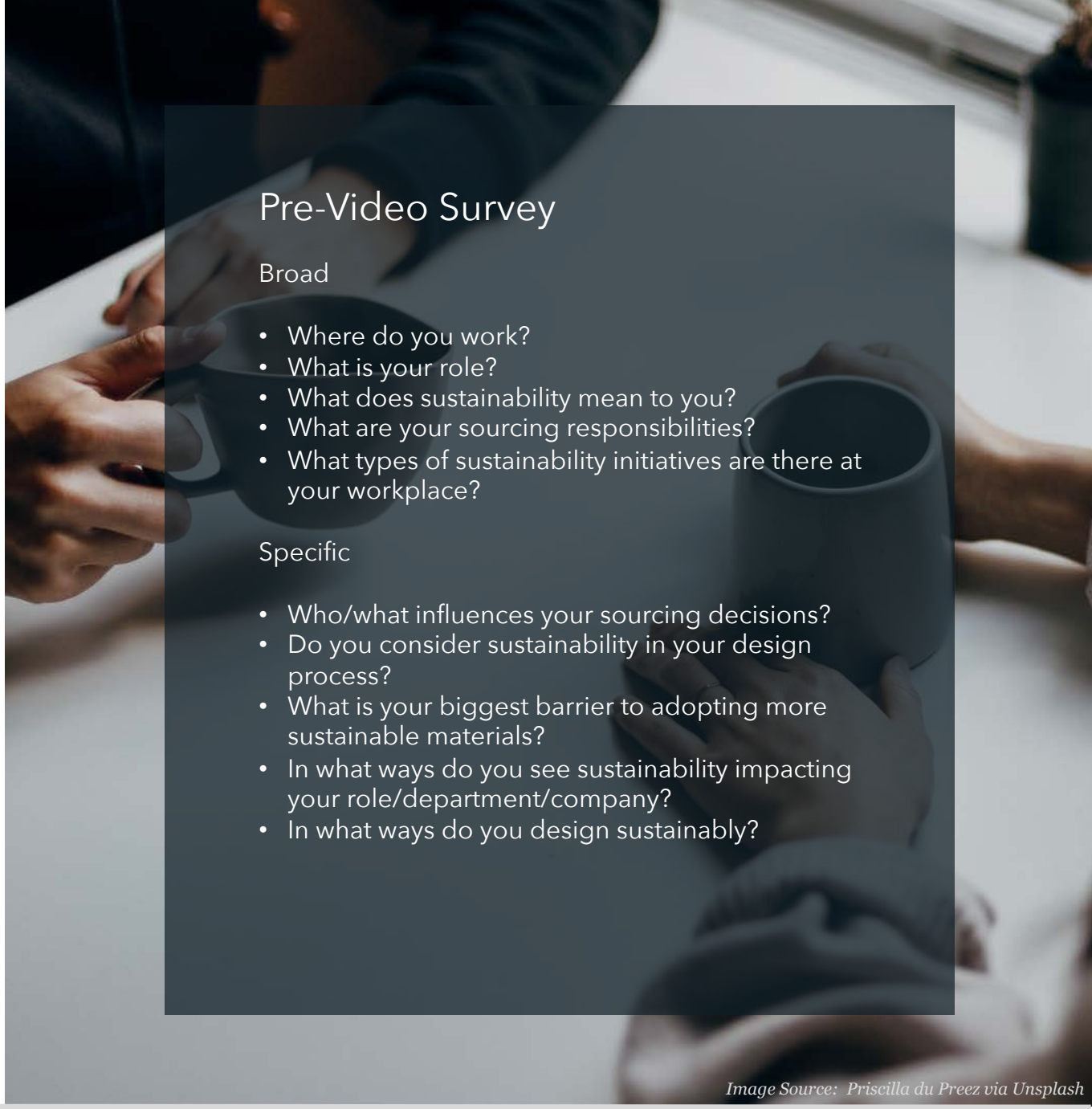


Image Source: Arisa Chattasa via Unsplash

Design Development

DISCUSSION

Interviewing specifiers may help to understand their design process and how they choose to work with specific materials. A series of questions will give background to resources (catalog, vetted manufacturers, etc.) each specifier has available to them, how they consider materials choices, and what influences these decisions. These questions may also shed light on the challenges they face when pursuing more sustainable options.



Pre-Video Survey

Broad

- Where do you work?
- What is your role?
- What does sustainability mean to you?
- What are your sourcing responsibilities?
- What types of sustainability initiatives are there at your workplace?

Specific

- Who/what influences your sourcing decisions?
- Do you consider sustainability in your design process?
- What is your biggest barrier to adopting more sustainable materials?
- In what ways do you see sustainability impacting your role/department/company?
- In what ways do you design sustainably?

Image Source: Priscilla du Preez via Unsplash

PLAN & DESIGN CONCEPT

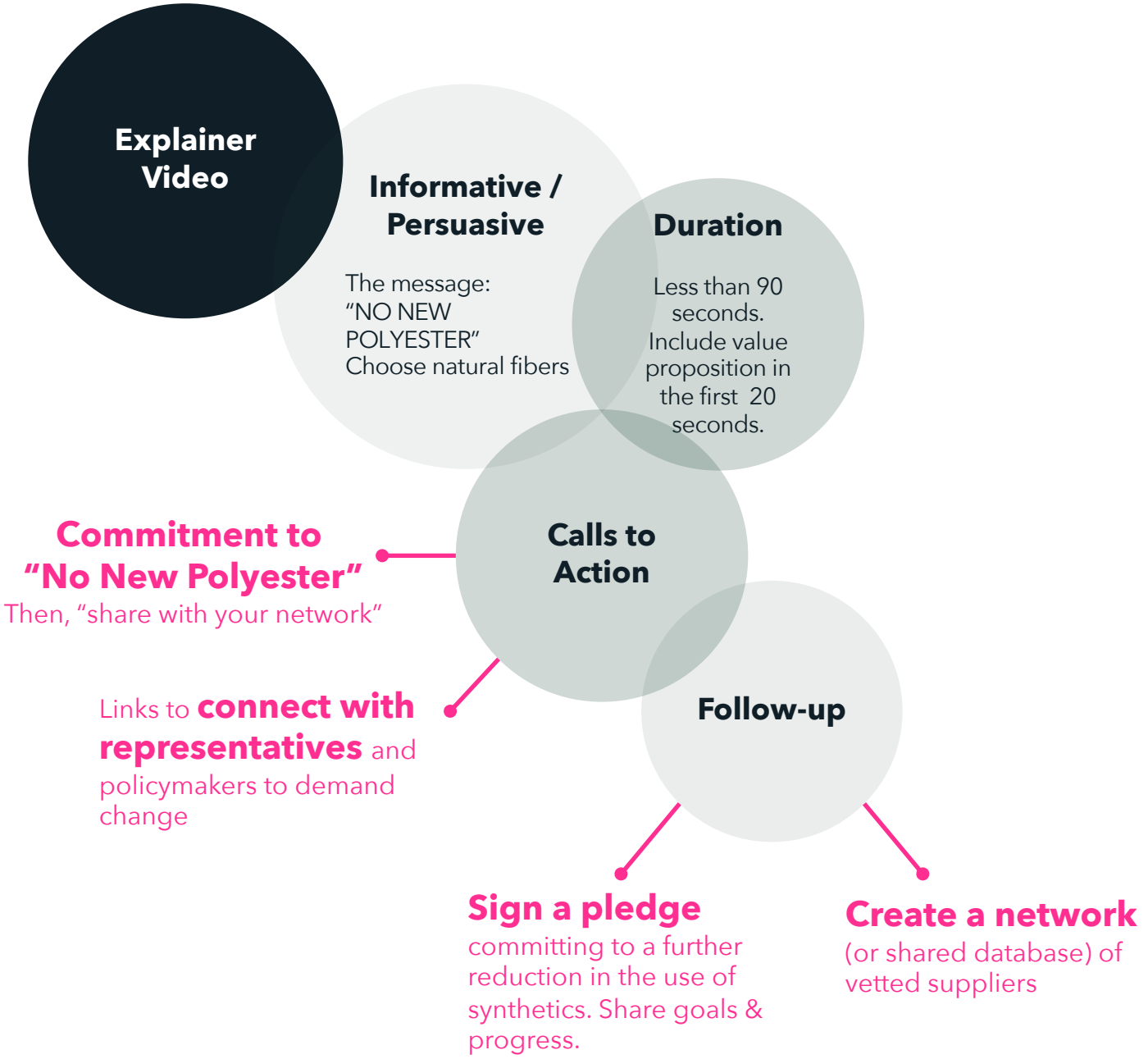
An Explainer Video that encourages specifiers to source away from synthetic fibers. Why an Explainer Video? This idea comes from other impactful videos done by big brands and research groups alike. From AirBnB to The Story of Stuff, videos can be used to explain concepts and ideas in short, meaningful bursts of information.

The goal is to build momentum for natural fibers in the apparel industry. Demand would increase supply, and this shift would encourage more domestic fiber infrastructure. This shift would improve the economy, foster better land management practices, and shift the apparel industry away from *fast, disposable* clothing.

A quick survey presented at the beginning of the video with questions about the specifier's current practices (similar to p. 37), followed by a survey at the end of the video to measure the specifier's intent in changing course.

The video will be shared on platforms like LinkedIn, targeting the specifier audience, but also on larger social platforms, like YouTube and Instagram, to establish a greater reach and engage consumers.

Success will be measured by the metrics gathered from the surveys at the beginning of the video, the end of the video, and sign-up for the shared network of vetted suppliers.



PLAN DESIGN & CONCEPT

A video presentation that encourages specifiers to choose natural fibers over synthetics.

1

Introduction: How can specifiers make the biggest impact?

Opening scene: a field of sheep in the USA, happy farmer, sunshine, healthy soil, etc.

2

Introduction: Specifiers & their role and responsibility in the industry. Pressure from bosses/CEO to make cheap products using cheap materials.

Empathize with them. Describe the problems/hurdles they face when choosing sustainable fabrics. Why is this challenging? What can we do?

3

Introduction: What if we challenged these norms? How could these changes improve the system?

Use natural fibers.

4

Lifecycle: Side-by-side - ORIGIN

Lifecycle of natural fiber on the left, synthetic fiber on the right.

Natural Fiber
Need to choose fiber animal or plant
- Field
- Shearing or harvesting

Synthetic Fiber
- Oil Field
- Ocean drilling

5

Lifecycle: Side-by-side - PROCESSING & MANUFACTURING

Natural Fiber
- Textile &garment manufacturing
- Fiber properties
- Energy Usage
- Labor
- Domestic Distribution

Synthetic Fiber
- Textile &garment manufacturing
- Fiber properties
- Energy Usage
- Labor
- Overseas Distribution

6

Lifecycle: Side-by-side - CONSUMER

Natural Fiber
- Connection to garment
- Comfort
- Use
- Care
- Laundering / natural microfibers

Synthetic Fiber
- Connection to garment
- Comfort
- Use
- Care
- Laundering / synthetic microfibers

7

Lifecycle: Side-by-side – END OF LIFE

Natural Fiber
- Connection to garment
- Upcycling?
- Recyclability?
- Biodegradability

Synthetic Fiber
- Connection to garment
- Microfibers
  - Ocean
  - Soil
  - Air

8

Call to Action
- Share this video
- Pledge: "No New Polyester"

Other things you can do:
- Pledge: Reduction of synthetics
- Call your representatives
  - Demand better domestic agriculture/infrastructure

Link to Survey

Design Idea

Design Idea

1

Image Source: Karl Wiggers via Unsplash

Scene 1

INTRODUCTION
Why natural fibers?

IMAGERY
A field of cotton

TIME
10 seconds

Script

"This field of cotton is being grown for its fiber, fiber that will be converted into textiles, and textiles into clothing.

Designers and Product Developers, we've got a huge opportunity to create change. Shift from fast fashion to a purpose-driven design, design for our future."

2

Image Source: Emmanuel Boldo via Unsplash

Scene 2

WHO
Specifiers & their role

IMAGERY
Designers at work: sketching, prototyping, decision-making

TIME
10 seconds

Script

"As designers and product developers, we make decisions for the consumer every day. Shouldn't we be making choices that benefit them? That make them feel good? That keep their well-being in mind?

While we make these decisions every day, we also receive a lot of pressure to meet the requirements of our employers; to meet our budget, our timelines, and our bottom line."

Design Idea

3

Image Source: Jukan Tateisi via Unsplash

Scene 3

WHAT
Challenge

IMAGERY
A challenge

TIME
5 seconds

Script

"What if we challenged these norms? How could these changes improve the system?"

4

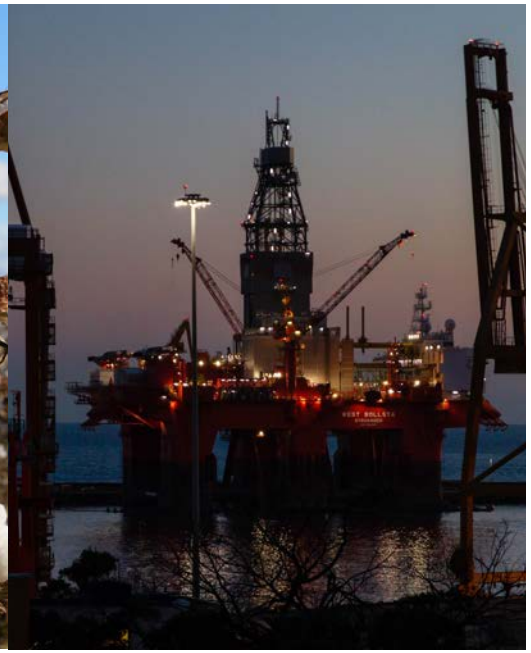


Image Source: Trisha Downing & Maria Lupan via Unsplash

Scene 4

SIDE BY SIDE
Origin Story

IMAGERY
Cotton fiber vs. oil rig, show charts from life cycle assessments

TIME
10 seconds

Script

"Let's begin by looking at the lifecycle of two of the most common fiber sources in apparel: cotton and polyester. Both have gotten a bad wrap from either sides of the industry.

Cotton for being land- and water-intensive, often grown using pesticides.
Polyester for being a fossil fuel and shedding microfibers."

Design Idea

5

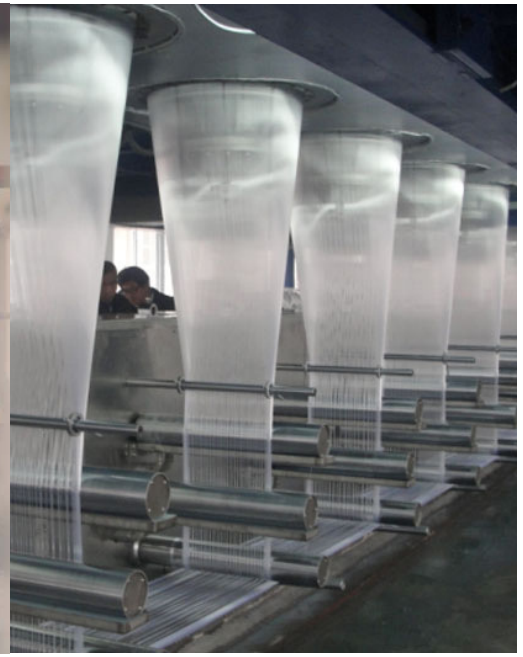


Image Source: Janko Ferlic via Unsplash & EcoTextile News

Scene 5

SIDE BY SIDE
Manufacturing

IMAGERY
Cotton spools and polyester spinnerets. Show life cycle diagrams.

TIME
10 seconds

Script

"Cotton yarns are spun from natural staple fibers, while polyester is made using extreme pressure and heat to melt plastic pellets and extrude them through tiny spinnerets.

Textile factories are major contributors to both air and water pollution. That's why it is important to ask questions and properly vet our suppliers."

6

Image Source: Mukuko Studio & freestocks via Unsplash

Scene 6

SIDE BY SIDE
Consumer relationship

IMAGERY
Cozy, favorite cotton sweater & shopping spree

TIME
10 seconds

Script

"How we interact with our clothing is important. Why do we consume excess clothing when we have our one favorite sweater that we wear over and over? Its those pieces that allow us to build a connection to our closets.

We should be designing *these* products. Products that feel good, products that are good for us."

Design Idea

7

Image Source: Ethan Bodner & Soren Funk via Unsplash

Scene 5

SIDE BY SIDE
End of Life

IMAGERY
Deadstock cotton fabric and plastic ocean pollution

TIME
10 seconds

Script

"When we design, we focus on designing the use case for each garment, but what happens after a consumer is finished with it? What happens in the fabric's end of life?

- Deadstock fabric
- Microfibers
- Plastic pellets (nurdles)

8

Image Source: Jon Tyson via Unsplash

Scene 6

CALL TO ACTION

IMAGERY
Inspirational

TIME
10 seconds

Script

"Take action.

Pledge "NO NEW POLYESTER" and encourage others to do the same.

For more information and announcements, follow us on social media.

Your feedback counts, please take this survey."

Design Idea

AFTER THE VIDEO

Reconnect with specifiers once they have watched the video and ask them follow up questions to assess their reaction, identify key takeaways, and discuss areas and resources of interest.

Post-Video Survey

Broad

- Where do you work?
- What is your role?
- What does sustainability mean to you?

Specific

- What is your initial reaction following the video?
- How might you consider sustainability in your design process moving forward?
- What resources would help you to design and source more sustainably?
- In what ways do you now see sustainability impacting your role/department/company?
- How might you change your design process after watching the video?
- Will you take the “No New Polyester” pledge and encourage your network to do the same?

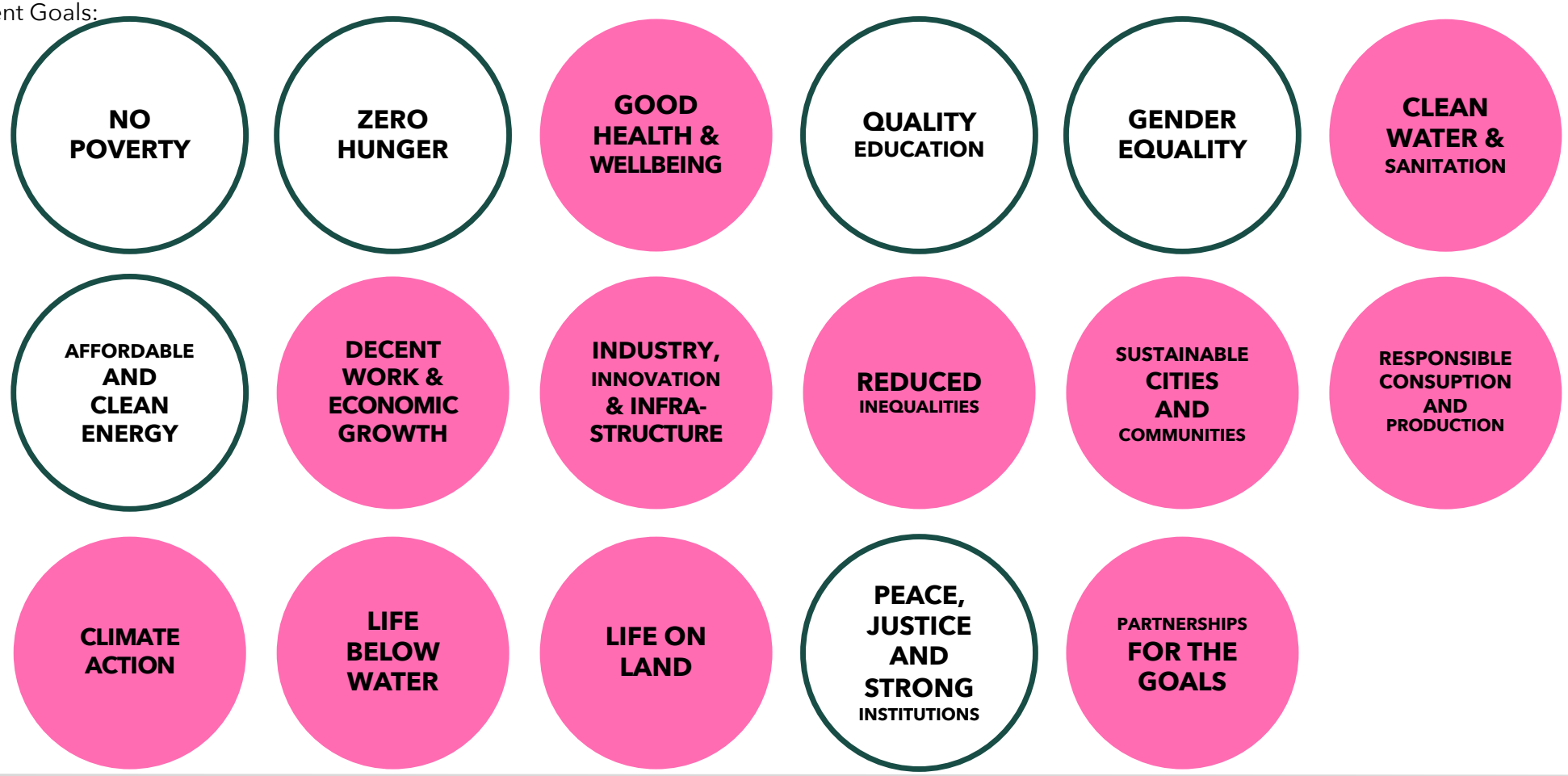
Image Source: Priscilla du Preez via Unsplash

Reflection

UN Sustainable Development Goals

UN Sustainable Development Goals + NO NEW POLYESTER

Circulating the Specifier Explainer Video and creating a network of specifiers willing to commit to *No New Polyester* has the potential to impact the following UN Sustainable Development Goals:



UN Sustainable Development Goals

PEOPLE

GOOD HEALTH & WELLBEING

Reduce and/or eliminate the risk of new microplastics from entering our biosphere.

SUSTAINABLE CITIES AND COMMUNITIES

Improve livelihood of the communities near the manufacturing facilities.

REDUCED INEQUALITIES

Fewer chemicals in textile manufacturing could promote safer working conditions.

PLANET

CLEAN WATER & SANITATION

Reduction of synthetic fibers could prevent microplastics from entering our waterways through laundering or water runoff.

LIFE ON LAND

Cleaner air by eliminating the need to incinerate unused/unwanted textiles.

LIFE BELOW WATER

Discourage oil drilling and mitigate risk of oil spill.

CLIMATE ACTION

Benefit our biosphere and inhibit the production of "forever textiles."

PROFIT

RESPONSIBLE CONSUPTION AND PRODUCTION

Encouraging thoughtful production of clothing could foster stronger connections to a wardrobe.

DECENT WORK & ECONOMIC GROWTH

"No New Polyester" could eliminate the exposure to chemical processing of crude oil for the apparel industry.

INDUSTRY, INNOVATION & INFRA-STRUCTURE

"No New Polyester" could create more domestic jobs in agriculture and manufacturing

PARTNERSHIPS FOR THE GOALS

This movement could create strong, transparent relationships between designers and farmers.

Conclusion

Synthetic fibers are problematic to our biosphere. Microfibers from textiles are becoming more and more abundant in our soil, waterways, the air we breathe. This research focuses on the life cycle of polyester as it compares to cotton. While the durability of polyester is desirable, that inability to breakdown during and at the end of use is what makes it dangerous for our ecosystem. Cotton, meanwhile, requires extensive resources to grow and harvest, but is capable of biodegradability. How then, can specifiers be informed of these differences and encouraged to lean more heavily on natural fibers, given their ability to biodegrade, while removing polyester from their fabric assortment?

An Explainer Video is a viable tool that will capture the attention of specifiers in the apparel industry. Calling attention to the full lifecycle of polyester versus natural fibers via life cycle assessments will highlight the benefits for using natural fibers in apparel production. Designers and product developers can utilize their network to engage, encourage transparency, and foster cooperation across the industry.

The goal of this video is to create a network of industry professionals united to stop the use of synthetic fibers, beginning with "No New Polyester." By committing to ending the use of new polyester fibers, specifiers have an opportunity to set the pendulum toward no synthetics. Incorporating sustainability frameworks, a variety of brainstorming techniques, "how might we?" questions, and comparing these goals to the UN Sustainable Development Goals change can produce change more quickly across the industry.

This project does not end there. Questions arose along the way, like "if recycled polyester is okay, does that encourage beverage companies to produce more plastic bottles to then fuel the apparel industry?" This first step is not a fool-proof solution. In order to be truly meaningful, more research will need to go into the follow-up from the video. How will specifiers network? Where can they find vetted suppliers of natural fiber textiles? How might they persuade their leaders to commit to these changes as well? How else might specifiers act to shift the trend from fast fashion?

Works Cited

Works Cited

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APPENDIX A: Exercise B - *Observe*

OTHER STRATEGIES EXPLORED

As I began my research, I considered the consumer's perspective when it comes to shopping for apparel. In this specific scenario, I asked a series of questions to the guests at my wedding about how they chose what they wore. I had though that perhaps consumer shopping habits could provide insight into where the propensity of synthetic fibers occurred, but in subsequent weeks it became apparent that understanding **specifiers** choices would have a greater impact on this project and help potential to impact the industry.
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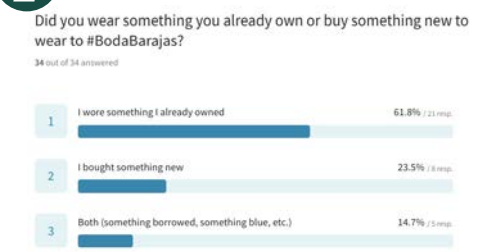
A Quick Survey | What Did You Wear to #BodaBarajas?

With the due date for this assignment during the weekend of my wedding, I chose to observe my guests. To do this, I sent a short survey inquiring about their choices of attire for the event with the intent to understand their shopping habits and whether fiber content is important to them. Most of these questions are playful while still shedding some light on why and how they shop.

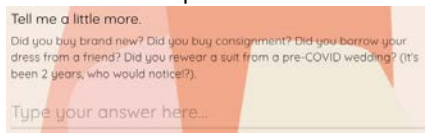
The majority of the questions in this survey were multiple choice with the option to select multiple responses, along with some short answer, and yes/no questions. Of 75 guests, I have received 34 responses thus far. I did not request personal information from guests but gave an option to leave an email address if they were interested in learning more about my thesis work. Of the 34 who responded, 16 women and 8 men provided their email addresses.

Note: This survey was sent after the event to ensure the questions didn't alter the guests wardrobe choice.

1 61.8% wore something they already owned

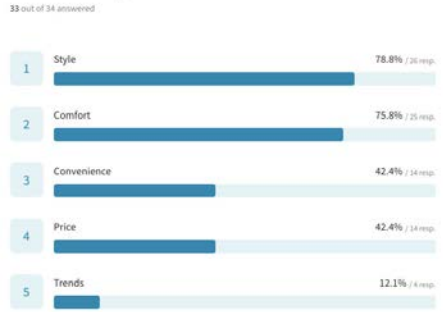


2 I asked for a little more detail, here are some of the responses:

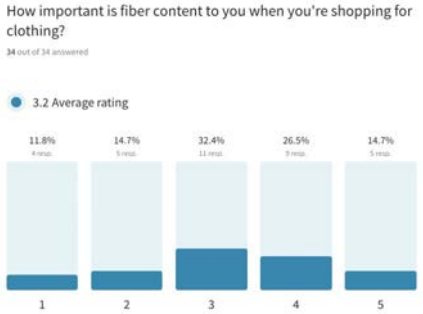


- "I wore it to a wedding 5 years ago."
- "Rewore a dress I had to purchase as a bridesmaid dress 6 months prior"
- "I got it from StitchFix and hadn't worn it yet."
- "Bought new shirt, pre covid ones don't fit anymore"
- "Bought from Poshmark, used once but in excellent condition"
- "Borrowed from Rent the Runway"
- "Brand spanking new."
- I wore my favorite pants that i had bought pre-Covid as well as a shirt/tie that i have owned for awhile.

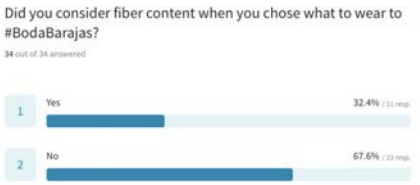
3 78.8% dressed for style, many also dressed for comfort



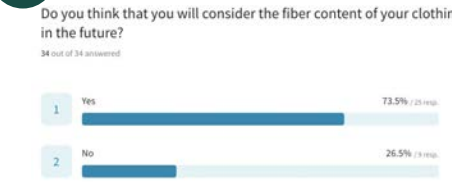
4 Fiber content is moderately important to my wedding guests on a scale of 1 to 5 (*1 – not important, 5 – very important)*



5 67.6% of guests did not consider fiber content when they chose what to wear to my wedding.



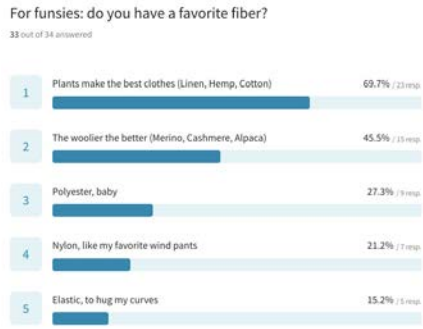
6 Although 73.5% of guests said they would consider fiber content in the future.



**This would have been a great opportunity to ask more about why they would consider fiber choice in the future. Was I asking leading questions? Did they feel guilt for not considering fiber choice initially?*

Some thoughts to consider for future questionnaires.

7 To end the survey, I asked about fiber content preferences and most people prefer natural fibers.
69.7% Plant-based fibers
45.5% Animal-derived fibers



Feedback from friends/family who took the survey:

"Maybe suggest and add a 'wanna learn more?' link to more information for people who haven't thought about fiber content before and/or an introduction to what that means."

"The one thing I would add is that we consider fiber based on what activity the clothing will be used for. For example, for hiking we generally prefer wool socks, wool t-shirts. But prefer cotton for everyday underwear."

"Add an option for rentals!"

Thank you.