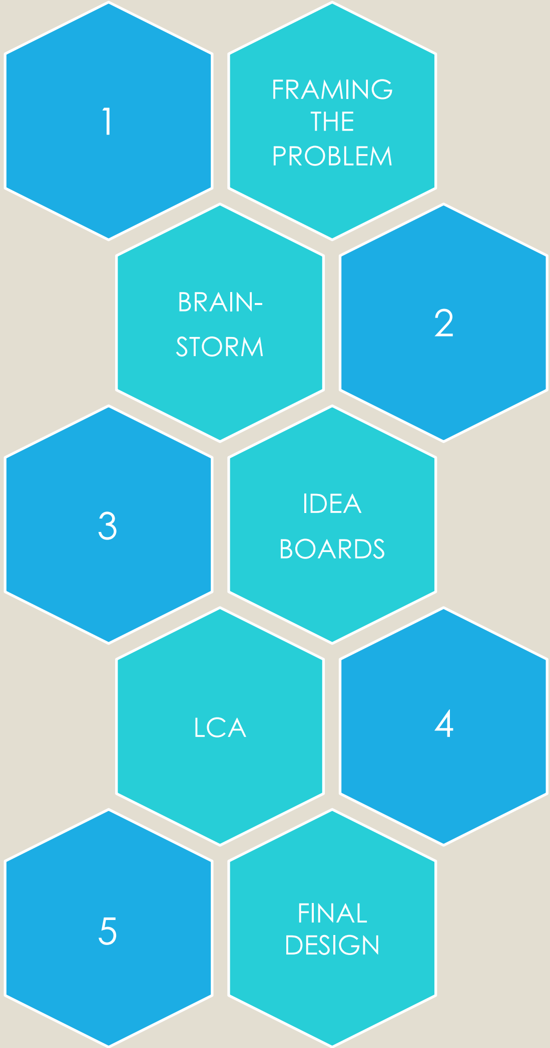
WEARING OUR CLOTHING LONGER

Michelle Dunn

SD-7620-10-F23
Practice of Sustainable Design

12.10.23

OUTLINE


1
FRAMING THE PROBLEM
BRAIN-STORM
2
3
IDEA BOARDS
LCA
4
5
FINAL DESIGN

FRAMING THE PROBLEM

Discovery:

The Sustainability Minded Fashionista

The Industry:

Issues in the fashion industry): The fashion industry is well known for being one of the biggest creators of waste to the planet. This industry is under scrutiny for "fast fashion" where cheap clothes are output into the world due to constantly changing trends. Users buy and throw away garments carelessly to keep up with trends.

Reason for being: Fashion isn't all bad, as it is an outlet for people to show personal artistic expression. This is an important need from people in certain cultures to thrive in their societies. Some people bond and communicate through their fashion expression.

Gaps/Unmet needs: There is a need to allow those to express themselves via fashion, in a not so detrimental way to the environment. There exist those who care about expressing themselves through fashion, but also are conscious of the environmental impacts.

Opportunities: There is an opportunity to address this gap. So one does not have to choose between expressing themselves, and being kind to the planet.

Deficits: Current solutions in the fashion industry to try and address sustainability are mainly through the use of "green" materials. However, this does not address the issue of putting out more and more products to keep up with the ever changing trends.

The Client:

Discovery:

The Sustainability Minded Fashionista

Who is the client/user? Anyone who wants to feel stylish and look good when wearing fashions. However this user also cares about their carbon footprint. This client is torn between wanting to be fashionable and wear the latest trends, while also being mindful of the impact of the fashion industry.

What do they think? This user thinks about expressing themselves through fashion. They like to be viewed as stylish, or simply just looking good in their clothes, and like to be looked to for their great sense of fashion and style.

What values to they hold? This user is also conscious of their environmental impact. They are well aware of how the fashion industry puts a strain on the planet due to its wasteful practices such as fast fashion. This user values wearing fashion that limits this impact.

What do they actually do? Although this user is aware of the impacts of this industry, it does not keep them from wearing the latest fashions. They still care about being viewed as trendy. Therefore, they make an effort to avoid certain brands, and make an effort to wear rented or resale clothes.

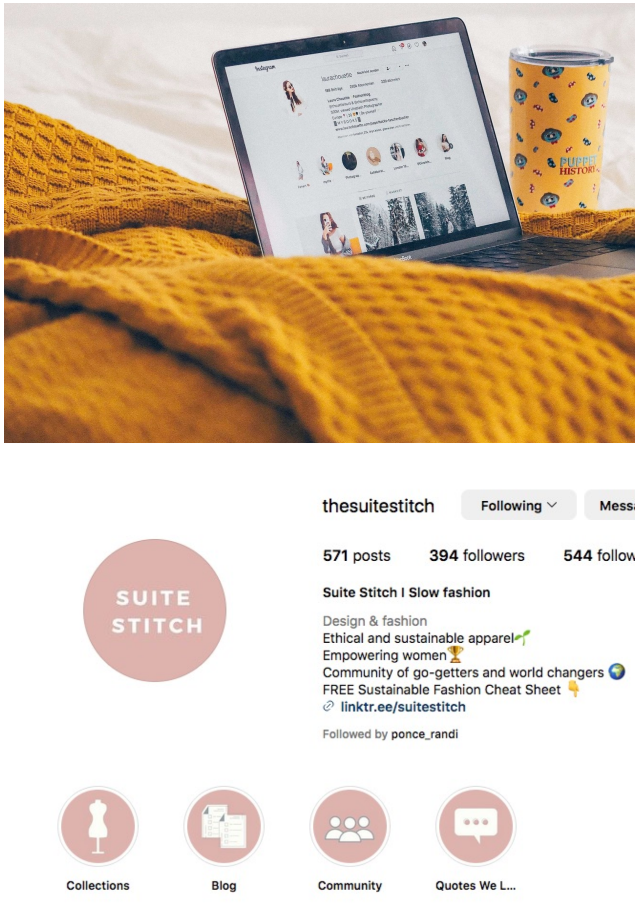


Figure 1: The Suite Stitch, Screen Capture

Observe:

How People View Fashion Trend via Web & Mobile Apps

What are people doing? looking for insight to the latest trends

How are they doing it? via social media and social media influencers. Turning to those around them who are admired.

Why are they doing it that way to get their motivations? social media offers quick access to the latest trends (rather than waiting to see what works with those around you). It expands your circle of influence.

Who has the best experience? Those who are complimented and admired for their fashion choices

Who has the worst experience? Those who want to be known for their fashion choices, but are constantly looking for the right thing. Therefore are consistently buying and getting rid of clothes to keep up with trend.

What are the true functions my product should have? An ability to show what the user is wearing is trendy, while also being aware of negative environmental impacts.

What has similar functions to my product? Brand names/tags on clothes. Brands that are well known for being trendy and/or environmentally friendly. This label then becomes an identifier into the wear's values.

What do I want my experience to be like? *The goal is to have the user* want to feel proud to wear their clothes, Proud to be viewed as both trendy and environmentally friendly.

PROBLEM STATEMENT

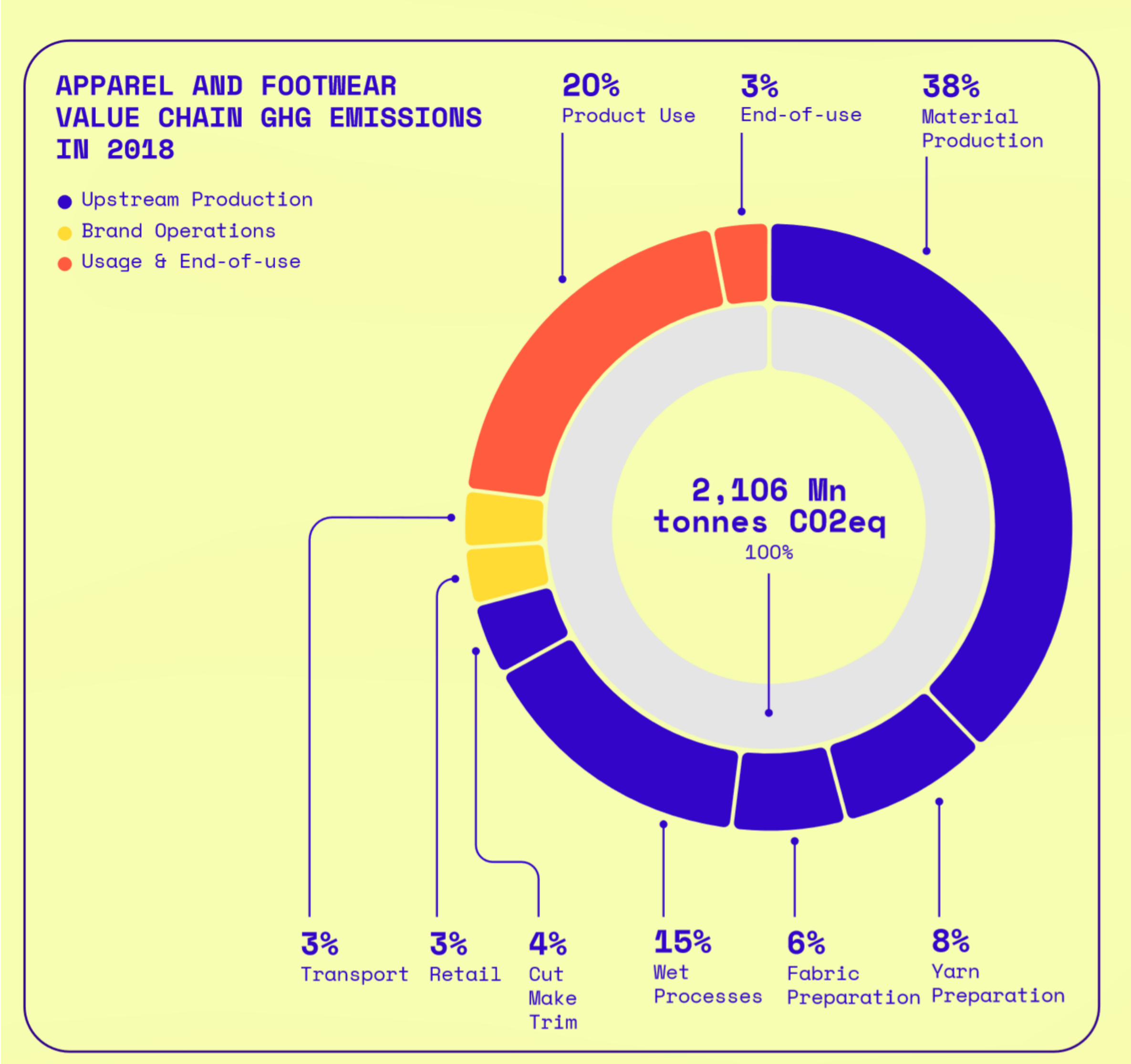
The problem is to reduce the amount of clothes wasted and sent to the landfill by keeping clothes in circulation for longer. To keep clothes in the closets of the consumer longer, the aim is to make the longevity of clothes appreciated and valued in a cultural sense.

Clothing Waste

Every year, 85% of textiles produced end up in the landfill- most of which cannot biodegrade

The fashion industry is still responsible for 10 % of annual global carbon emissions

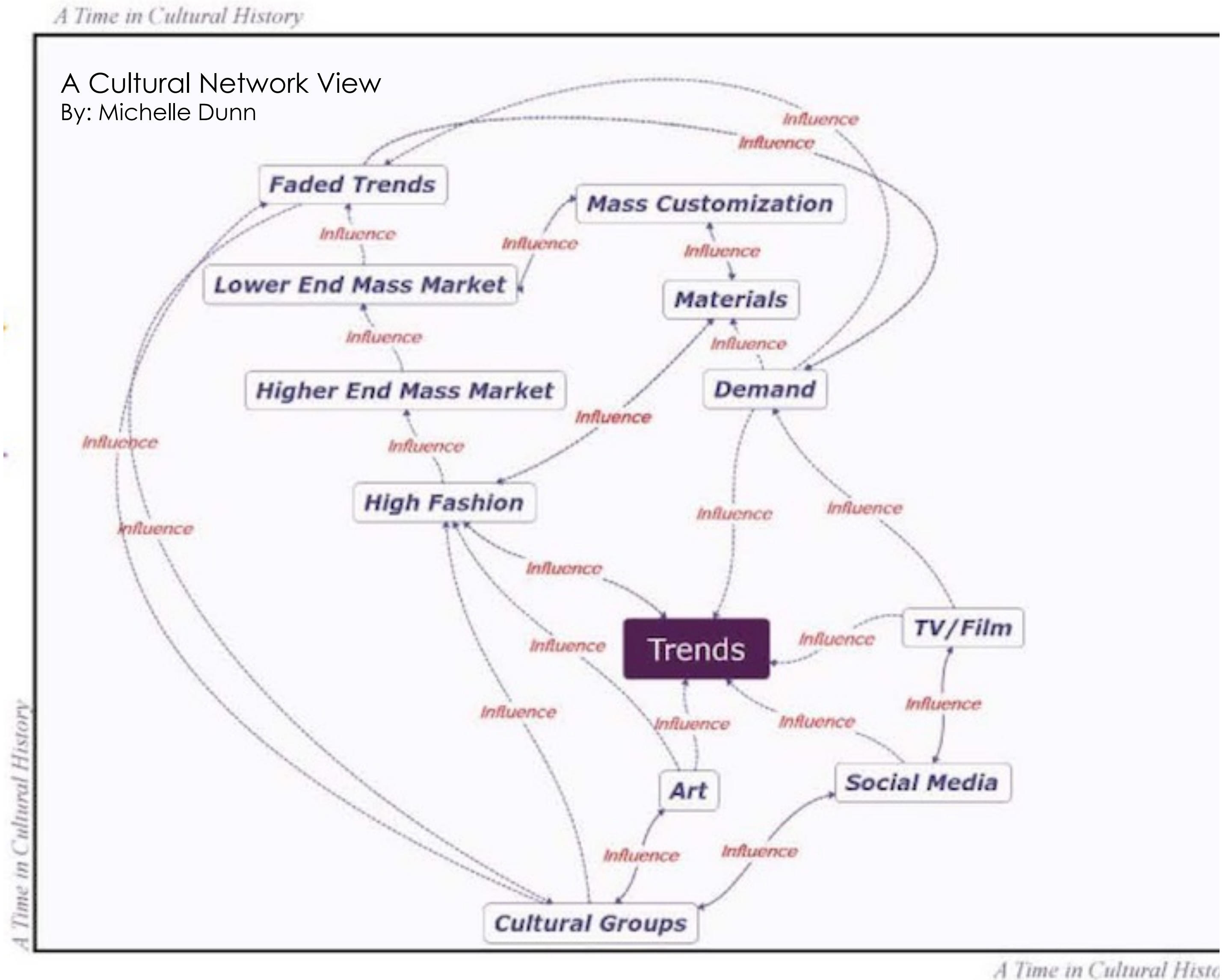
Figure 2: McKinsey, *The Next Normal*



Analyze:

SWOT Analysis
of Sustainable Fashion Trend Through Social Media Influencers

Strengths	- Gets people onboard with ideas just because someone popular is - Spread of information quickly - Can inspire good change	- Can spread incorrect or incomplete information - Trends can easily change - Usually still pushing products with a paid agenda	Weaknesses
Opportunities	- Trend doesn't always have to mean pushing new products. It can be pushing new ideas or changing ideas (such as what does "trendy" mean. Such as trendy doesn't necessarily have to be "new" it can be those who are most sustainable)	- Brands with the most dollars can often pay influencers to push trends. Therefore its not really a trend but a company with the most dollars.	Threats



Organize & Synthesize

What is Trend?

Key Takeaways:

- Trends create, and are influenced by many factors in our cultural and economic lives and are very interconnected

Defining the Problem

Overall Problem Statement

Those who care about being fashionable need an opportunity to also be sustainable in their fashion choices. How can we **leverage** the idea of **trend** to influence sustainable choices? By **increasing the interest in wearing clothes longer, therefore diverting from the landfill**

Stakeholders

1. The biosphere
2. Those who follow trends
3. Those who want to be sustainable
4. Fashion brands (both those who care about sustainability and those who do not)
5. Trend influences
6. Workers in the industry

Key Issues

1. Impacts of Overconsumption
2. Stress on the supply chain and resource use
3. Creating clothing and resource waste and reducing waste
4. Freedom of expression via fashion
5. Constantly changing trends
6. Encouraging sustainable behavior
7. Redefining Trend

Key Design Drivers

1. Credibility of the influencer or labels of the products
2. Competing brands
3. Partnering brands
4. Sustainability influence and educed resource use as a result of the new idea
5. Adoptability and scalability of the new idea
6. Financial gain

Key Design Objectives & Strategies

1. Consider future generations > designing for the 7th generation
2. Create green jobs > buy from green companies/vendors
3. Design to encourage low consumption behavior > incentivize to encourage desired behavior
4. Optimize performance > design for use
5. Be cost effective > align costs with target market
6. Create quality forms and designs > design for human use/human centric
7. Optimize resources > encourage recycling of products and materials
8. Cycle resources > design for reuse

12/10/23

BRAINSTORMS

How Might We....?

Key Issue #1

Overconsumption of Resources for Clothing

- How might we encourage people to wear their clothes longer?
- How might we encourage this behavior to reuse clothes to be considered the stylish choice by the wearer, and become a symbol of good style?

Key Issue #2

High Amount of Waste Created in the Clothing Industry

- How might we enlighten the average consumer to knowledge about their own, and the industry's wasteful practices?
- How might we encourage more sustainable behaviors from the end user?

Key issue #3

Constantly Changing Trends in the Clothing industry

- How might we encourage freedom of personal expression elsewhere in our lives (outside of clothing).
- How do we make sure people feel accepted (without use of clothing)?

Brainstorm #1

List Making; words and phrases

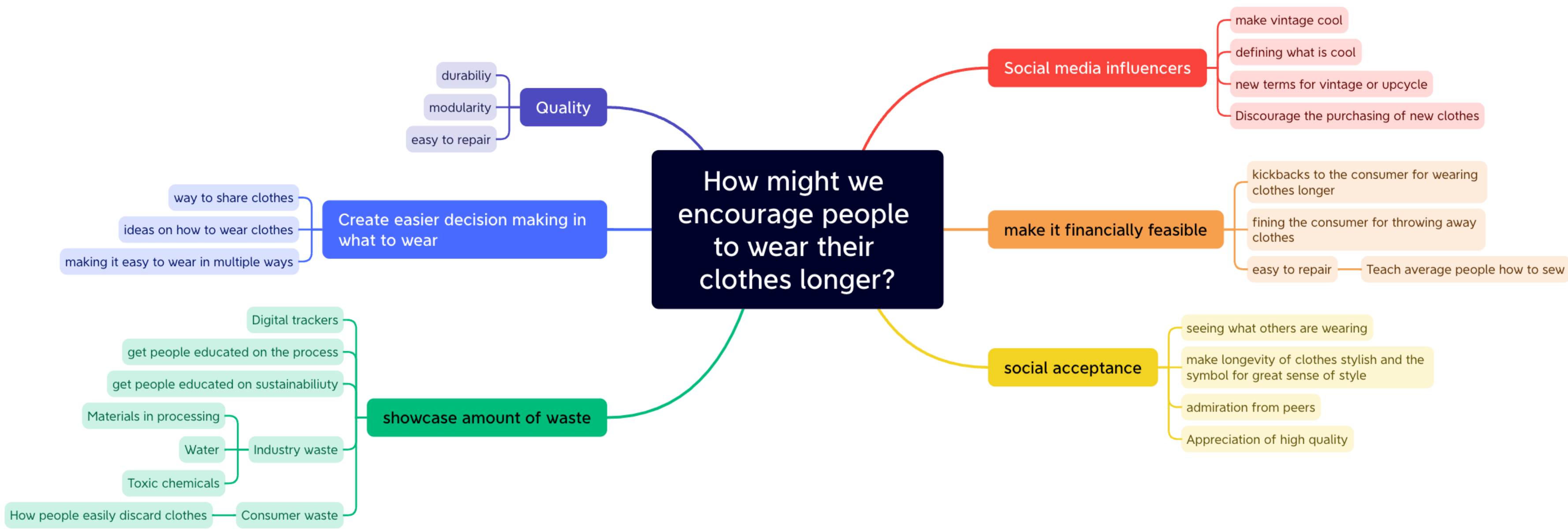
- Vintage
- Cool
- Trend
- Timelessness
- Reuse
- Sustainability
- Waste
- Expression
- Inclusion
- Number of wears
- Dressing up
- Dressing down
- Environmental
- Upcycling
- Recycling
- Fashion
- Art
- Consumption
- Consumerism

- Renewable
- Influencers
- Social
- Society
- Feeling good
- Looking good
- Uniqueness
- Heirlooms
- Hand me downs
- Little black dress
- Cyclical
- Colors
- Materials
- Silhouettes
- Modular design
- Sharing
- Stylist
- Advise

- Capitalism
- Profits
- Never ending growth
- Quality
- Fast fashion
- Throw away fashion
- Slow fashion
- Corporations
- Sewing
- Repairs
- Longevity
- Markets
- Supply and Demand
- Purchasing
- Outdated

Key Takeaways:

- How to we marry sustainability and trend? How can we make timeless and longevity, a desired social outcome?

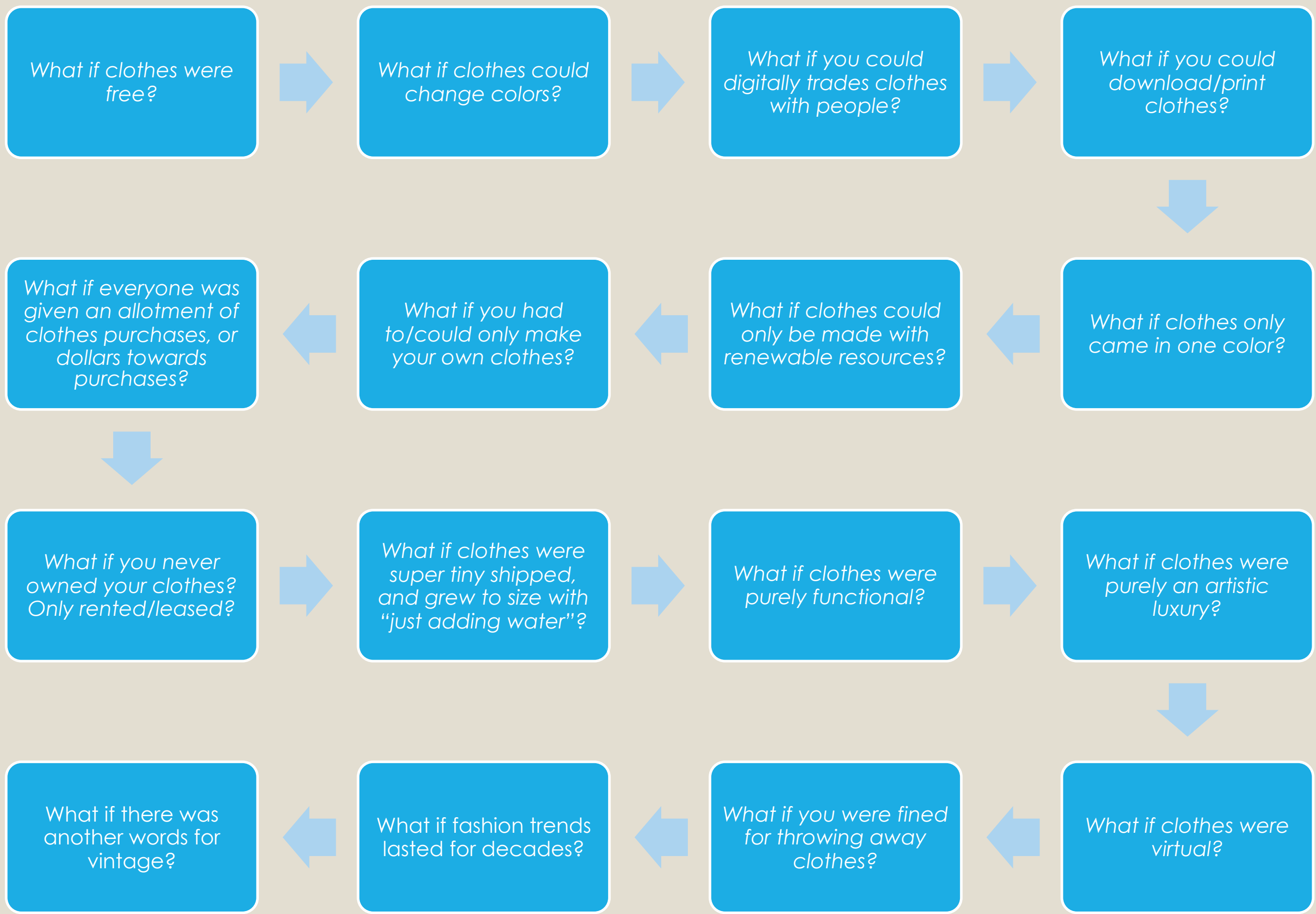


BRAINSTORM #2

Mind Mapping

12/10/23

Michelle Dunn - SD-7620-20-F23 The Practice of Sustainable Design



Brainstorm #3

Changing Assumptions & Attributes

Key Takeaways:

- How bold can we be in rethinking our clothes? If ideas are stretched far, then what becomes truly important to us in regard to our clothes?

ORGANIZE & CAPTURE RESULTS

- Design
- Behavior
- Technology

A digital tracker to see how long your reuse garment is kept from the landfill with every use

A platform where you can see how others are wearing their clothes

Digital platform to share clothes

Cool points for wearing your clothes longer

A wearable tag to show the product age

A wearable tag that is like a product odometer for how many wears

Companies getting kickbacks for designing clothes to last longer

Clothes that can we worn multiple ways (dressed up or dressed down

Clothes designed to be modular

Clothes designed for easy repair

Designing clothes only with renewable sources

Cool points for wearing your clothes longer

Redefining trend

Influencers getting kickbacks for support sustainable fashion or slow fashion trends

Charging money for disposal of clothes

Encouraging slow fashion and reuse

Coming up with a new terminology- not vintage, not upcycled but…

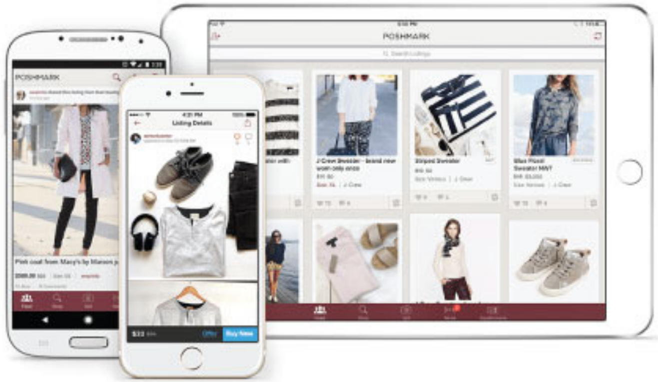
12/10/23

IDEA BOARDS

POSSIBLE SUSTAINABLE DESIGN STRATEGIES

- The Natural Step
- Natural Capitalism
- Provide a service rather than product
- Design for sustainable behavior change
- Design to encourage low consumption behavior
- Design for longevity
- Focus on what people ultimately desire, not the creation of artifacts
- Feedback loops from the whole system and track results
- Seek radical simplicity (in clothing design)
- Design for multifuction/multiuse

Clothes Sharing App

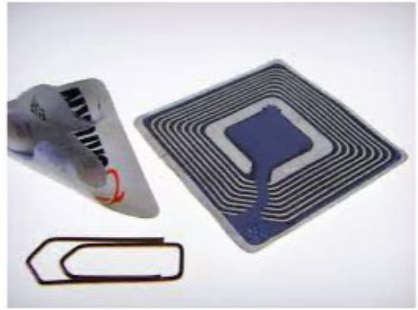


A vintage clothes sharing app, similar to Poshmark, or rental companies such as Nuuly

Through the use of social media influencers, they can help make vintage "cool". Placing emphasis on classic styles that can be worn over and over

However this app platform provides user sharing of "how to wear" to give style guidance.

Odometer for Your Clothes



Made up of a flexible material similar to this thermometer, that consists of a scanable RFID tag

A wearable clothing tracker, similar to a pedometer

When you purchase an item is begins its “tracking”. This can be scanned at the retailer via your smartphone

Tags be in any location on the garment- what’s important is that its visible for all to see how long you’ve helped keep this item from the landfill

Your smartphone app linked to the tag can also show data on how you’ve helped reduce materials from the landfill

Clothing Odometer:

Analog Ticker

In this idea, an analog type odometer was proposed in an effort to reduce the amount of raw materials used from an electronic version. Eliminating laminate processes in circuit boards, batteries, etc.

Clothing Odometer:

Partnerships with second-hand stores

In this idea, one can only get their "odometer" if it was from a garment that came from a second hand store, such as Goodwill. These companies have a key to be able to set it to its 0000 or more.

This allows for the simple analog counter to work, as only certain retailers have the ability to adjust the count.

Clothing Odometer:

Years of “Service” Stripes

In this idea, the uniqueness of the garment’s age is given via a visible detail, similar to military “years of service” stripes.

These details do not have to be a standard stripe detail, they can fit to the design of the garment, be bold, or subtle.

Stripes can be given every 5 years, by the manufacturer, or a second-hand store

Clothing Odometer:

Incentivizing Clothing Brands

In this idea, rather than the consumer getting their odometer from a second- hand store, it comes from the clothing manufacturer itself with a purchase.

These will come on specially designed products that are designed with intention to be repaired or have classic style.

The manufacturer can make money from registering the item, or repairing, etc.

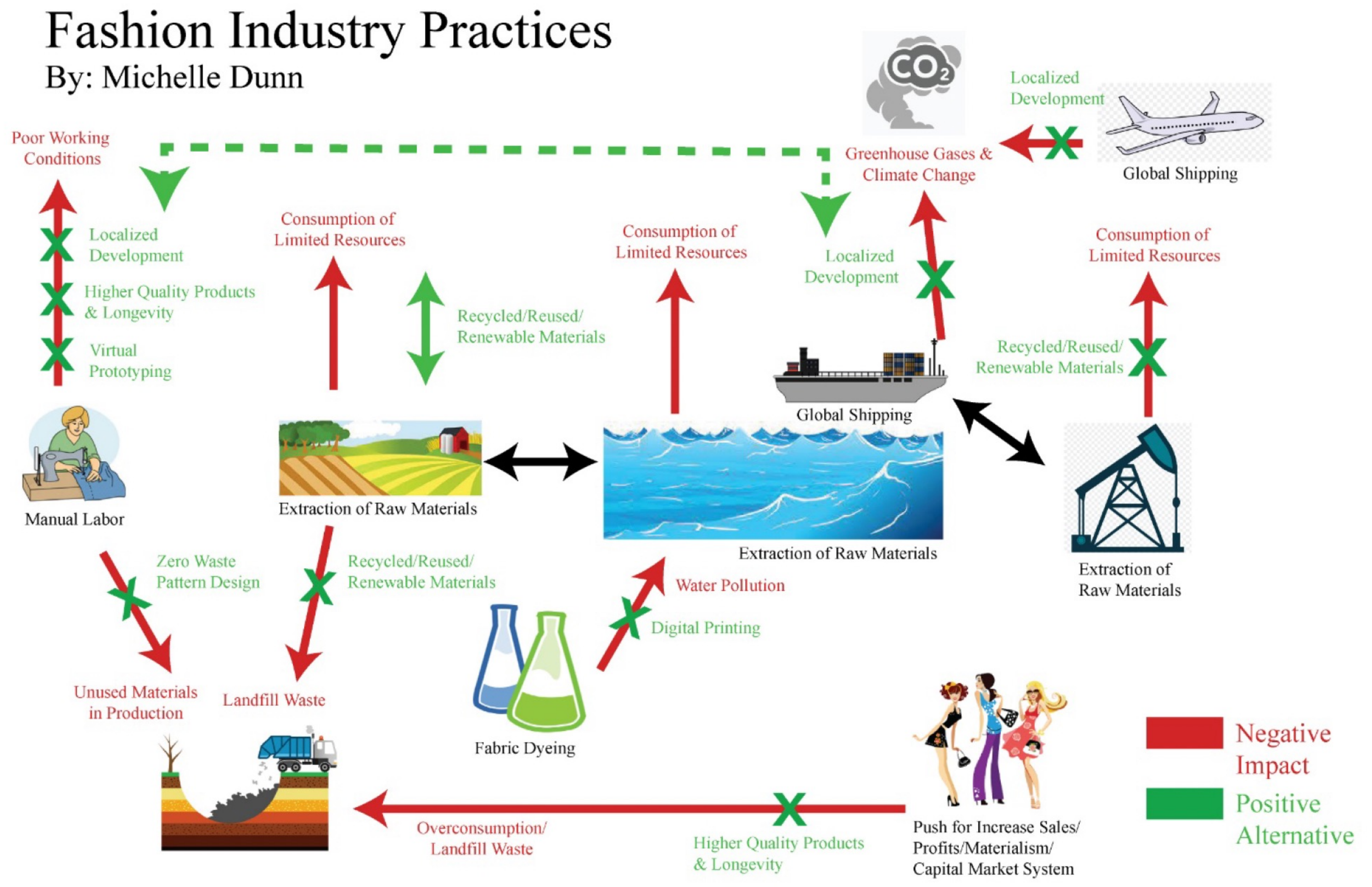
12/10/23

LIFECYCLE ASSESSMENTS

LIFECYCLE FLOW DIAGRAM

OF FASHION INDUSTRY PRACTICES

One of the many ways to improve the negative impacts of the fashion industry is to reduce the amount of clothing sent to the landfill by increasing its wear longevity



12/10/23

Components to Evaluate

Creation of a new "pedometer" for clothes

Electricity/internet usage with the creation of a new app

Output of clothing waste today

See Appendix A for Component Details

LCA: CONCEPT 1

Base: Leather Jacket, disposed of after 1 year.

See Appendix B for SBOM

Sustainable Minds
Design greener products right, from the start

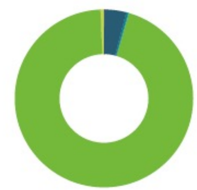
Project: Vin-tag
Concept: Leather Jacket - 1 Year life
Methodology: SM 2013

Scorecard

	Reference
	Leather Jacket - 1 Year life
	Image not provided
Impacts per functional unit	3.1×10^3 mPts per 1 year of use
Total amount of service delivered	1 x 1 year of use
Impacts of total service delivered	3.1×10^3 mPts
Assessment level	Estimate
Greatest impacts	
SBOM input	Leather, finished cow, chrome tanned
Impact category	Carcinogenics
Life cycle stage	Manufacturing

This concept is the reference for this project. The reference is a baseline to which other concepts in this project will be compared.

Total impacts by impact category



Impact category	%
Ecological damage	
Acidification	0.06
Ecotoxicity	3.96
Eutrophication	0.35
Global warming	0.13
Ozone depletion	0
Resource depletion	
Fossil fuel depletion	0.04
Human health damage	
Carcinogenics	94.81
Non carcinogenics	0.61
Respiratory effects	0.04
Smog	0.01

A leather jacket was chosen for this exercise, as leather jackets are highly resource heavy, however if taken care of, the product could last a few decades

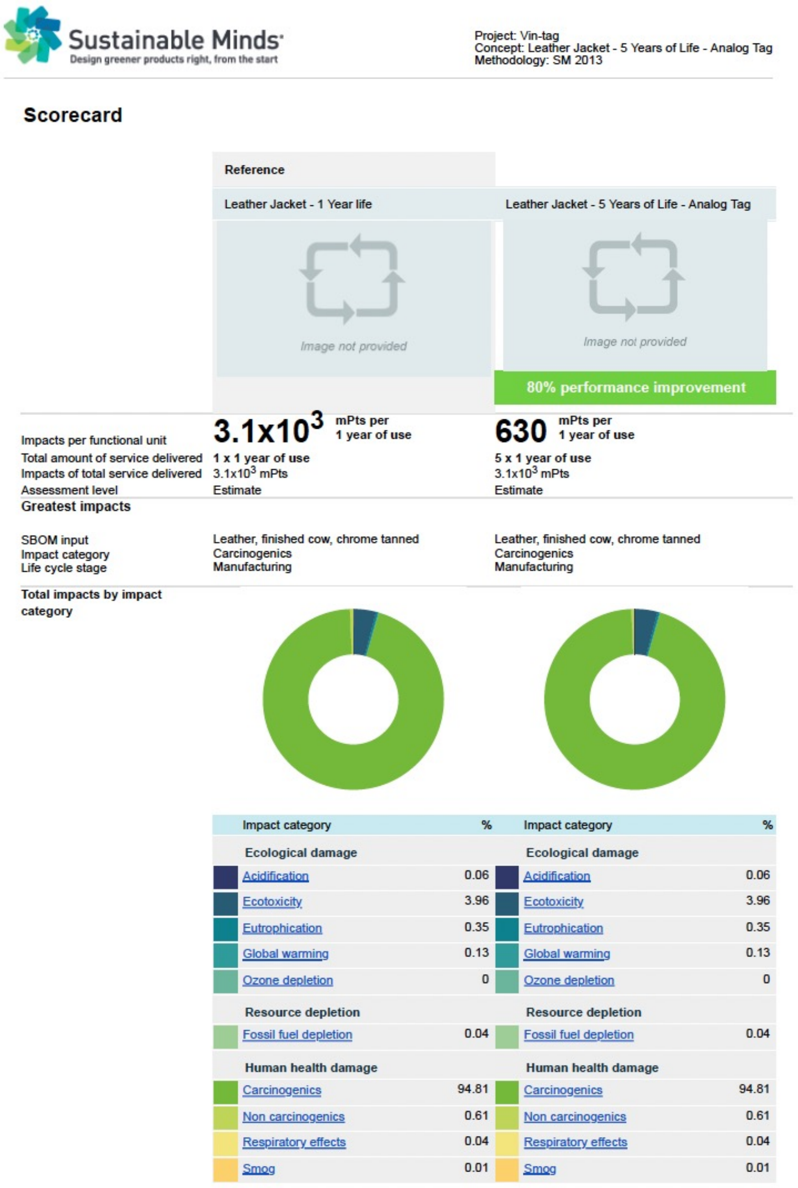
LCA: CONCEPT 2

Leather jacket, disposed of after 5 years. However, used an analog clothing "odometer"

Odometer materials include:

- Plastics
- Circuit boards
- Lithium battery

See Appendix B for SBOM


Sustainable Minds
Design greener products right, from the start

Project: Vin-tag
Concept: Leather Jacket - 5 Years of Life - Analog Tag
Methodology: SM 2013

Scorecard

	Reference: Leather Jacket - 1 Year life	Leather Jacket - 5 Years of Life - Analog Tag
	Image not provided	Image not provided 80% performance improvement
Impacts per functional unit	$3.1x10^3$ mPts per 1 year of use	630 mPts per 1 year of use
Total amount of service delivered	1 x 1 year of use	5 x 1 year of use
Impacts of total service delivered	$3.1x10^3$ mPts	$3.1x10^3$ mPts
Assessment level	Estimate	Estimate
Greatest impacts		
SBOM input	Leather, finished cow, chrome tanned	Leather, finished cow, chrome tanned
Impact category	Carcinogenics	Carcinogenics
Life cycle stage	Manufacturing	Manufacturing
Total impacts by impact category		

Impact category	%	Impact category	%
Ecological damage		**Ecological damage**	
Acidification	0.06	Acidification	0.06
Ecotoxicity	3.96	Ecotoxicity	3.96
Eutrophication	0.35	Eutrophication	0.35
Global warming	0.13	Global warming	0.13
Ozone depletion	0	Ozone depletion	0
Resource depletion		**Resource depletion**	
Fossil fuel depletion	0.04	Fossil fuel depletion	0.04
Human health damage		**Human health damage**	
Carcinogenics	94.81	Carcinogenics	94.81
Non carcinogenics	0.61	Non carcinogenics	0.61
Respiratory effects	0.04	Respiratory effects	0.04
Smog	0.01	Smog	0.01

This option turned out to be the least impactful of the three choices. However, extending the life of the jacket to even 5 years still increased its score by 80%

Result: 80% better than base concept

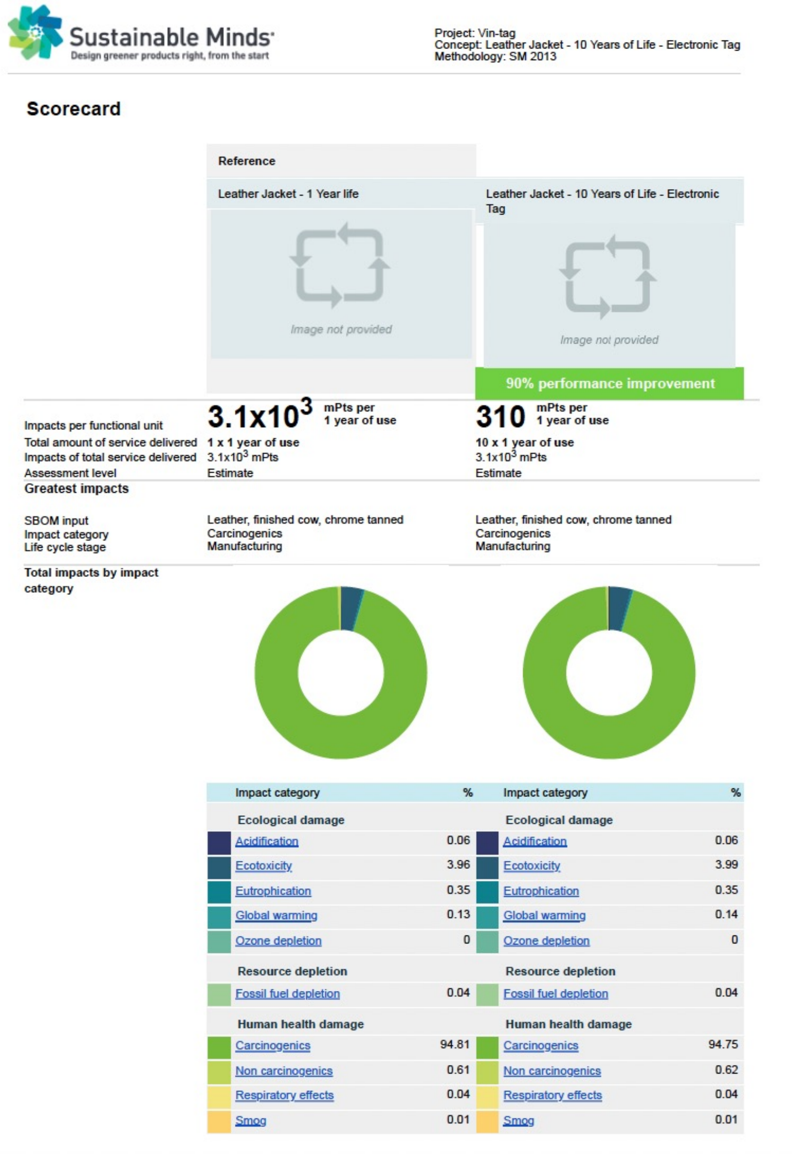
LCA: CONCEPT 3

Leather jacket disposed of after 10 years, however using an electronic clothing "odometer"

Odometer materials include:

- Plastics
- Circuit boards
- Lithium battery

See Appendix B for SBOM



Sustainable Minds
Design greener products right, from the start

Project: Vin-tag
Concept: Leather Jacket - 10 Years of Life - Electronic Tag
Methodology: SM 2013

Scorecard

	Reference: Leather Jacket - 1 Year life	Leather Jacket - 10 Years of Life - Electronic Tag
	Image not provided	Image not provided
		90% performance improvement
Impacts per functional unit	$3.1x10^3$ mPts per 1 year of use	310 mPts per 1 year of use
Total amount of service delivered	1 x 1 year of use	10 x 1 year of use
Impacts of total service delivered	$3.1x10^3$ mPts	$3.1x10^3$ mPts
Assessment level	Estimate	Estimate
Greatest impacts		
SBOM input	Leather, finished cow, chrome tanned	Leather, finished cow, chrome tanned
Impact category	Carcinogenics	Carcinogenics
Life cycle stage	Manufacturing	Manufacturing
Total impacts by impact category		

Impact category	%	Impact category	%
Ecological damage		**Ecological damage**	
Acidification	0.06	Acidification	0.06
Ecotoxicity	3.96	Ecotoxicity	3.99
Eutrophication	0.35	Eutrophication	0.35
Global warming	0.13	Global warming	0.14
Ozone depletion	0	Ozone depletion	0
Resource depletion		**Resource depletion**	
Fossil fuel depletion	0.04	Fossil fuel depletion	0.04
Human health damage		**Human health damage**	
Carcinogenics	94.81	Carcinogenics	94.75
Non carcinogenics	0.61	Non carcinogenics	0.62
Respiratory effects	0.04	Respiratory effects	0.04
Smog	0.01	Smog	0.01

This option was created to see if using the metals, and lithium ion battery resource would turn out to offset increasing the lifespan of the jacket. It did not, and overall the electronic device still increased the score by 90%

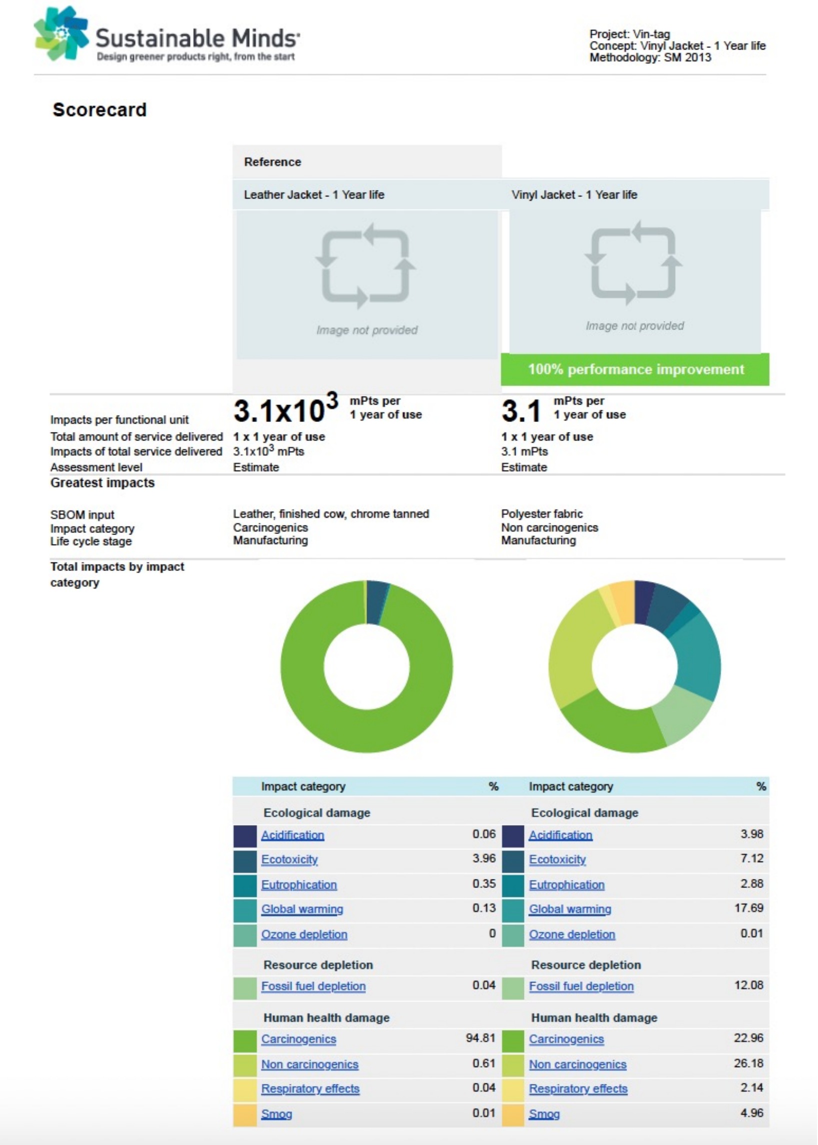
Result: 90% better than base concept

LCA: CONCEPT 4

Vinyl Jacket, disposed of after 1 year.

This is assuming no other factors, such as, are the cows bred for leather also used for meat production?

See Appendix B for SBOM



Sustainable Minds
Design greener products right, from the start

Project: Vin-tag
Concept: Vinyl Jacket - 1 Year life
Methodology: SM 2013

Scorecard

	Reference: Leather Jacket - 1 Year life	Vinyl Jacket - 1 Year life
	Image not provided	Image not provided
		100% performance improvement
Impacts per functional unit	$3.1x10^3$ mPts per 1 year of use	3.1 mPts per 1 year of use
Total amount of service delivered	1 x 1 year of use	1 x 1 year of use
Impacts of total service delivered	$3.1x10^3$ mPts	3.1 mPts
Assessment level	Estimate	Estimate
Greatest impacts		
SBOM input	Leather, finished cow, chrome tanned	Polyester fabric
Impact category	Carcinogenics	Non carcinogenics
Life cycle stage	Manufacturing	Manufacturing
Total impacts by impact category		

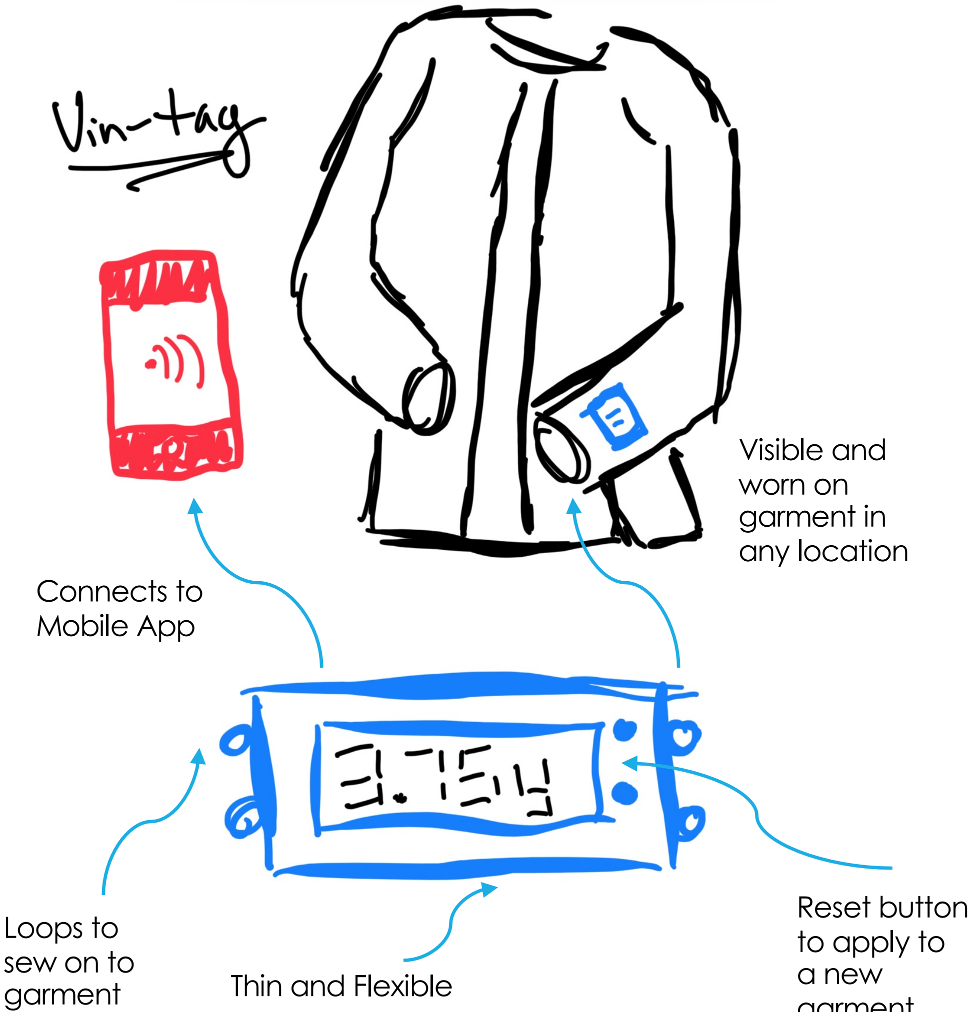
Impact category	%	Impact category	%
Ecological damage		Ecological damage	
Acidification	0.06	Acidification	3.98
Ecotoxicity	3.96	Ecotoxicity	7.12
Eutrophication	0.35	Eutrophication	2.88
Global warming	0.13	Global warming	17.69
Ozone depletion	0	Ozone depletion	0.01
Resource depletion		Resource depletion	
Fossil fuel depletion	0.04	Fossil fuel depletion	12.08
Human health damage		Human health damage	
Carcinogenics	94.81	Carcinogenics	22.96
Non carcinogenics	0.61	Non carcinogenics	26.18
Respiratory effects	0.04	Respiratory effects	2.14
Smog	0.01	Smog	4.96

Vinyl being a petroleum based product, has heavy impacts, and as a clothing item is not as durable as leather. The goal was to see how this compared to the leather jacket after 1 year. This score is significantly better, as leather is still very resource heavy

Result: 100% better than base concept

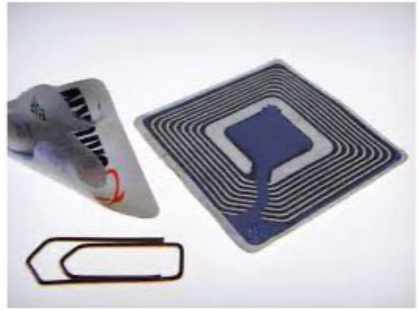
12/10/23

FINAL DESIGN


Vin-tag
Connects to Mobile App
Visible and worn on garment in any location
Loops to sew on to garment
Thin and Flexible
Reset button to apply to a new garment

THE *VIN-TAG*

The VIN-TAG



Made up of a flexible material similar to this thermometer, that consists of a scanable RFID tag

A wearable clothing tracker, similar to a pedometer

When you purchase an item is begins its "tracking". This can be scanned at the retailer via your smartphone

Tags be in any location on the garment- what's important is that its visible for all to see how long you've helped keep this item from the landfill

Your smartphone app linked to the tag can also show data on how you've helped reduce materials from the landfill

SUSTAINABLE DESIGN STRATEGIES

What Sustainable Design Strategies is the Vin-tag using?

Reflection:

By using the Vin-tag the main sustainable design strategies used are as follows:

- Design to encourage low consumption behavior
- Design for behavior change
- Design for longevity
- Focus on what people ultimately desire, not the creation of artifacts
- Feedback loops from the whole system and track results
- Seek radical simplicity (in clothing design)
- Design for multifuction/multiuse

The Vin-tag creates a culture where the longevity of a garment is stylish, and addresses what people ultimately desire, which is to be accepted in cultural groups, rather than the product itself. Therefore, clothes that are purchased by the user will likely be garments that are easy to mix and match, wear for multiple occasions, have multi-use or multifuction. This may mean a "radical simplicity" in the garment itself- no crazy colors, difficult to launder fabrics etc. As users appreciate the longevity of garments, and seek to find garments that meet those needs, the results will be tracked and shared among the cultural group, encouraging further low consumption behavior.

UN Sustainable Development Goals Addressed:

The Vin-tag as a product is created to address and influence the behaviors of the user. The change in behavior is meant to encourage the user to be interested in wearing their clothes longer, as it is intended to be viewed as "trendy" to do so. This then will address the 12th Sustainability Goal, by encourage responsible consumption from the consumer as they will be encouraged to purchase clothes that will last longer. Additionally this will encourage clothing manufacturers to produce higher quality goods, if the demand for them increases.

SUSTAINABLE DESIGN STRATEGIES

UN Sustainable Development Goals

Works Cited

1. Cho, Renee | June, Renee Cho, and Jeanne Luddeni. "Why Fashion Needs to Be More Sustainable." State of the Planet, December 16, 2021. https://news.climate.columbia.edu/2021/06/10/why-fashion-needs-to-be-more-sustainable/.

2. Gwilt, Alison. *A Practical Guide to Sustainable Fashion*. London: (Bloomsbury Publishing, 2020), whole book.

3. Muter-Hamilton, Jodi. 2019. *Fashion and Mental Health.* Janurary 27. https://otherday.co.uk/magazine/2019/1/27/fashion-and-mental-health-appearances-can-be-deceptive

4. Pointing, Charlotte. January. "Recycled Polyester Doesn't Fix Fast Fashion's Over-Production Problems." *Good on You.* 2023 19. Accessed 2023. https://goodonyou.eco/recycled-polyester-fast-fashion/.

5. Atkin, Zoe. 2018. "Three ways to drive greater creativity in innovation." *Inventium.* April 27. Accessed August 2023. https://www.inventium.com.au/three-ways-to-drive-greater-creativity-in-innovation/.

6. "The Myth of Sustainable Fashion." Harvard Business Review, January 14, 2022. https://hbr.org/2022/01/the-myth-of-sustainable-fashion.

7. "Ten Reasons People Resist Change." Harvard Business Review, September 26, 2018. https://hbr.org/2012/09/ten-reasons-people-resist-chang.

8. Amory Lovins, Hunter Lovins, and Paul Hawken. 1999. "Natural Capitalism: Creating the Next Industrial Revolution." Chapter 4. Little, Brown & Company

9. Wicker, Alden. 2019. "Fashion's growing interest in recycling clothing." *Vogue Business.* August 21. Accessed 2023. https://www.voguebusiness.com/companies/fashion-brands-recycling-upcycling-resale-takeback-sustainability

10. Kellogg, Katherine. 2022. "Upcycled Clothing Ideas for a Zero Waste Lifestyle." *Going Zero Waste.* March 23. Accessed 2023. https://www.goingzerowaste.com/blog/upcycled-clothing-ideas-for-a-zero-waste-lifestyle/.

11. "Fashion on Climate - Mckinsey & Company." Accessed August 19, 2022. https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf.

12. Gwilt, Alison. *A Practical Guide to Sustainable Fashion*. London: (Bloomsbury Publishing, 2020), 73. .

13. https://superfund.arizona.edu/resources/learning-modules-english/copper-mining-and-processing/processing-copper-ores#:~:text=Oxide%20ores%20are%20generally%20processed,%2C%20solvent%20extraction%2C%20and%20electrowinning.

14. https://nap.nationalacademies.org/read/18985/chapter/11#47

15. https://thisisplastics.com/plastics-101/how-are-plastics-made/#:~:text=Plastics%20are%20made%20from%20raw,refined%20into%20ethane%20and%20propane.&text=Ethane%20and%20propane%20are%20then,them%20into%20ethylene%20and%20propylene.&text=These%20materials%20are%20combined%20together%20to%20create%20different%20polymers.

16. https://www.mckinsey.com/featured-insights/the-next-normal/fashion

APPENDIX

APPENDIX A:
LIFECYCLE COMPONENTS

Component 1

Component	Natural Environment	Raw Material Extraction			Material Processing		
	Where does it come from?	Virgin Material	Input/Output	Detail	Process	Input/Output	Detail
Clothing "pedometer" materials (plastics, metals, battery)	Copper; North, South and Central Americas, Lithium batteries; Australia, Chile, China, Plastics; Arctic, Persian Gulf, Gulf of Mexico	Copper	Input	Machines & labor to extract minerals	Copper oxide refining (hydrometallurgy)13	Input	water, acid, electricty
			Output	Degradation of the environment, reducing non renewable resources		Output	Pure copper, processing waste
		Oil	Input	Machines & labor to extract oil	Cracking 15	Input	heat
			Output	Degradation of the environment, reducing non renewable resources		Input	Plastic polymers
		Lithium	Input	Machines & labor to extract minerals	lithuim battery cell creation	Input	polymer binders, conductive additives, solvents14
			Output	Degradation of the environment, reducing non renewable resources		Output	lithuium battery

Component Manufacturing			Transport/Distribution/Purchase		
	Input/Output	Detail		Input/Output	Detail
Printed Circuit Boards	Input	Chemicals, silkscreen, machine labor, electricty, other metals, heat	Fossil Fuel use	Input	transportation of raw mateirals to refineries, materials to manufaacturers, manufactured products to retail stores, final product to end consumer
	Output	electronic system to be used, metals can be extracted and recycled		Output	CO2
Shaping of Plastics	Input	machine labor, molds, chemical processing, heat	Use	Input	can be used as long as the life of the battery. The goal is to last several decades
	Output	Plastics for specific use. May or may not be able to recycle		Output	keeping clothing in peoples closets, diverting from landfills
Final Assembly	Input	human and machine labor, glues, heat, electricty	End of life	Input	metals can be recycled. Plastics may be able to be recycled, heat, energy to extract
	Output	a final product to help increase longevity of clothing		Output	waste, carbon emissions
Packaging	Input	trees, heat, water, laminates, glues		Input	
	Output	cardboard that can likely be recycled		Input	
				Input	

Component 2

Component	Natural Environment	Raw Material Extraction		
	Where does it come from?	Virgin Material	Input/Output	Detail
Electricity/Internet usage (using an app)	Fossil Fuels; coal mines, persian gulf, gulf of mexico	Fossil Fuels	Input	Machines & labor to extract oil
	Metals for the power grid/internet usage; metals mined globally		Output	Degradation of the environment, reducing non renewable resources
		Solar	Input	sun energy
			Output	clean energy
		Wind	Input	wind energy
			Output	clean energy
		Nuclear	Input	toxic materials
			Output	unsafe conditions, difficult to dispose of

Component Manufacturing			Transport/Distribution/Purchase/Use		
	Input/Output	Detail		Input/Output	Detail
Wind Turbines	Input	metals extraction for turbin building, land space to put the turbines	Transportation of parts	Input	transportation of turbines, transportation of metals to build infrastructure, transportation of solar panels
	Output	larger structures generating clean energy, needs grid infrastructure to utilize		Output	CO2 emissions
Solar Panels	Input	metals and silcon extraction to create solar panels, land space to put the panels	Power grid	Input	Metals for infrasture, land use, fossil fuels
	Output	larger structures generating clean energy, needs grid infrastructure to utilize		Output	CO2 emissions, the ability to use electronics
Cellular Devices	Input	metals, electricity, plastics, battery	Data Servers	Input	Metals, land space for infrastuture
	Output	a device that enables the use of the internet		Output	ability to acces the internet, ability to have knowledge and social connection at our fingertips
Processing of fossil fuels	Input	oil refinereies, power plants to turn fossil fuels into electricity, use of a non renewable source			
	Output	CO2 emissions			

Component 3

Component	Natural Environment	Raw Material Extraction			Material Processing		
	Where does it come from?	Virgin Material	Input/Output	Detail	Process	Input/Output	Detail
Clothing waste	farmlands for natural fibers, gulf of mexico, persian gulf for petroluem based fibers	Wool	Input	grasslands, food, water	Weaving	Input	electricity, raw materials turned into yarn, chemicals to treat the fabrics
			Output	renewable source of wool to shear		Output	fabrics knitted or woven ready to be sewn
		Cotton	Input	farmland, labor, water	Sewing	Input	elecricity, human labor
			Output	cotton plants to create cotton fiber		Output	scrap waste, clothing to be sold and worn
		Polyester/Nylon	Input	drilling of crude oil, degradation of land	Dyeing	Input	water, electricity, chemicals to create dyes, heat
			Output	petrolum based pellets to be extruded into fibers		Output	colored yarns or fabrics, water pollution, toxic chemicals

Component Manufacturing			Transport/Distribution/Purchase		
	Input/Output	Detail		Input/Output	Detail
Packaging	Input	Plastic bags, silcone pellets, cardboard boxes for shipping	Use of Fossil Fuels in Transportation	Input	transportation of raw materials to weavers, fabric mills to manufacturing, final product to stores, final products to end consumer
	Output	Plastic waste, cardboard can be recycled		Output	CO2 emissions
Clothing waste	Input	Old or discarded clothes due to end of useful life of end of "trend" life	Retail Stores	Input	electricty, water, staff
	Output	mixed materials going to second hand sellers, or into landfills		Output	products out to consumers to wear untill products end of life

12/10/23

APPENDIX

APPENDIX B:
LCA SBOM

Project: Vin-tag
Concept: Leather Jacket - 1 Year life
Methodolog SM 2013
Date: 29-Oct-23
Created by:
Total Amour 1 x 1 year of use

Item	Stage	Row type	Part ID	Name	Description	Qty	Material/prc	Amount	Units	Measureme	Total (mpts)	Acidification	Ecotoxicity (r	Eutrophicati	Global warm	Ozone deple	Fossil fuel de	Carcinogenic	Non carcinog	Respiratory (	Smog (mpts)	CO2 Equivalent (kgs)
0		concept		Leather Jacket - 1 Year life							3130	1.83	124	11	4.04	0.00145	1.1	2970	19	1.16	0.375	280
1		Life cycle stage																				
1.1		Part		Leather		1		4	yd2													
1.1.1		Material		Leather			Leather, finis	4	yd2	Estimate	3400	1.78	124	11	3.92	0.00133	1.03	2970	18.2	1.11	0.318	272
1.2		Part		Metal Zippe	Metais used	1		1	lbs													
1.2.1		Material processing		Process			Contour, bra:	1	lbs	Estimate	0.893	0.00337	0.00755	0.000458	0.0113	7.06E-06	0.00421	0.0469	0.0311	0.00302	0.00155	0.783
1.2.2		Material		Metal Zipper			Brass, produ	1	lbs	Estimate	2.39	0.0189	0.124	0.00252	0.0187	1.45E-05	0.00886	0.165	0.717	0.0304	0.00823	1.3
2		Life cycle stage																				
2.1		Power use		Power			Electricity, 2	3	kWh	Estimate	1.67	0.00282	0.00271	0.0048	0.023	1.39E-05	0.00757	0.0248	0.00579	0.00322	0.00225	1.59
3		Life cycle stage																				
3.1.1		End of life		Recycling		1	Leather, finis	4	yd2	Estimate	0	0	0	0	0	0	0	0	0	0	0	0
3.1.2		End of life		Landfill, sanitary, generic		1	Brass, produ	1	lbs	Estimate	0.00267	9.01E-06	3.09E-06	6.33E-06	3.62E-05	5.30E-08	2.92E-05	3.35E-05	5.16E-06	1.22E-05	2.05E-05	0.00251
4		Life cycle stage																				
4.1		Transportation - Assembled product																				
4.1.1		Transportation - Assembled product				1	Freighter, oc	6880	miles	Estimate	0.062	0.000492	7.62E-05	0.000176	0.000835	1.21E-06	0.000671	0.000712	0.000131	0.000336	0.000623	0.058
4.2		Transportation - Subassemblies and parts																				
4.2.1.1.1		Transportation - Part		Leather		1	Train, freight	3000	miles	Estimate	4.62	0.0172	0.0107	0.0123	0.0607	9.01E-05	0.0496	0.181	0.0204	0.0148	0.0432	4.21
4.2.1.2.1		Transportation - Part		Metal Zippe	Metais used	1	Train, freight	3000	miles	Estimate	0.128	0.000478	0.000296	0.000342	0.00169	2.50E-06	0.00138	0.00502	0.000567	0.000412	0.0012	0.117

Data values contained in this spreadsheet are based on intermediate calculations from within the Sustainable Minds Software. Values are for informative purposes only. Modifications to contained data values may invalidate the results

SBOM: CONCEPT 1

Project:	Vin-tag
Concept:	Leather Jacket - 5 Years of Life - Analog Tag
Methodolog	SM 2013
Date:	29-Oct-23
Created by:	
Total Amour	5 x 1 year of use

Item	Stage	Row type	Part ID	Name	Description	Qty	Material/prc	Amount	Units	Measureme	Total (mpts)	Acidification	Ecotoxicity (r	Eutrophicati	Global warm	Ozone deple	Fossil fuel de	Carcinogenic	Non carcinog	Respiratory (	Smog (mpts	CO2 Equivalent (kgs)
0		concept		Leather Jacket - 5 Years of Life - Analog Tag							626	0.366	24.8	2.2	0.81	0.000293	0.222	594	3.8	0.233	0.0754	56.1
1		Life cycle stage																				
1.1		Part		Leather		1		4	yd2													
1.1.1		Material		Leather			Leather, finis	4	yd2	Estimate	680	0.357	24.7	2.2	0.784	0.000265	0.206	593	3.65	0.222	0.0636	54.4
1.2		Part		Metal Zippe	Metais used	1		1	lbs													
1.2.1		Material processing		Process			Contour, bra	1	lbs	Estimate	0.179	0.000673	0.00151	9.16E-05	0.00226	1.41E-06	0.000843	0.00937	0.00621	0.000604	0.000311	0.157
1.2.2		Material		Metal Zipper			Brass, produ	1	lbs	Estimate	0.478	0.00379	0.0248	0.000504	0.00374	2.89E-06	0.00177	0.0329	0.143	0.00608	0.00165	0.26
1.3		Part		Analog Counter		1		0.5	lbs													
1.3.1		Material processing		Process			Enamelling,	0.5	ft2	Estimate	0.12	0.000308	0.000246	0.000122	0.00165	9.05E-07	0.00053	0.00192	0.000464	0.000339	0.000187	0.115
1.3.2		Material		Analog Counter			Aluminium, s	0.5	lbs	Estimate	0.0232	5.54E-05	0.000122	1.19E-05	0.000309	3.70E-07	0.000229	0.000409	0.000451	6.44E-05	3.76E-05	0.0215
2		Life cycle stage																				
2.1		Power use		Power			Electricity, 2	3	kWh	Estimate	0.334	0.000564	0.000542	0.00096	0.00459	2.77E-06	0.00151	0.00496	0.00116	0.000644	0.00045	0.319
3		Life cycle stage																				
3.1.1		End of life		Recycling		1	Leather, finis	4	yd2	Estimate	0	0	0	0	0	0	0	0	0	0	0	0
3.1.2		End of life		Landfill, sanitary, generic		1	Brass, produ	1	lbs	Estimate	0.000533	1.80E-06	6.18E-07	1.27E-06	7.24E-06	1.06E-08	5.84E-06	6.70E-06	1.03E-06	2.44E-06	4.10E-06	0.000502
3.1.3		End of life		Incineration, aluminum		1	Aluminium, s	0.5	lbs	Estimate	0.00184	8.22E-06	4.86E-06	5.02E-06	2.38E-05	5.88E-08	2.81E-05	8.45E-05	7.41E-06	5.97E-06	2.13E-05	0.00165
4		Life cycle stage																				
4.1		Transportation - Assembled product																				
4.1.1		Transportation - Assembled product				1	Freighter, oc	6880	miles	Estimate	0.0186	0.000148	2.29E-05	5.27E-05	0.000251	3.64E-07	0.000201	0.000214	3.93E-05	0.000101	0.000187	0.0174
4.2		Transportation - Subassemblies and parts																				
4.2.1.1.1		Transportation - Part		Leather		1	Train, freight	3000	miles	Estimate	0.924	0.00344	0.00213	0.00246	0.0121	1.80E-05	0.00993	0.0361	0.00408	0.00297	0.00864	0.842
4.2.1.2.1		Transportation - Part		Metal Zippe	Metais used	1	Train, freight	3000	miles	Estimate	0.0257	9.55E-05	5.92E-05	6.84E-05	0.000337	5.00E-07	0.000276	0.001	0.000113	8.25E-05	0.00024	0.0234
4.2.1.3.1		Transportation - Part		Analog Counter		1	Train, freight	3000	miles	Estimate	0.0128	4.78E-05	2.96E-05	3.42E-05	0.000169	2.50E-07	0.000138	0.000502	5.67E-05	4.12E-05	0.00012	0.0117

Data values contained in this spreadsheet are based on intermediate calculations from within the Sustainable Minds Software. Values are for informative purposes only. Modifications to contained data values may invalidate the results

SBOM: CONCEPT 2

Project:	Vin-tag	
Concept:	Leather Jacket - 10 Years of Life - Electronic Tag	
Methodology	SM 2013	
Date:	29-Oct-23	
Created by:		
Total Amount	10 x 1 year of use	

Item	Stage	Row type	Part ID	Name	Description	Qty	Material/pro	Amount	Units	Measurement	Total (mpts)	Acidification (	Ecotoxicity (m	Eutrophicatio	Global warmi	Ozone depleti	Fossil fuel dep	Carcinogenics	Non carcinoge	Respiratory e	Smog (mpts)	CO2 Equivalent (kgs)
0		concept		Leather Jacket - 10 Years of Life - Electronic Tag							313	0.19	12.5	1.1	0.439	0.000676	0.124	297	1.93	0.122	0.0426	30.4
1		Life cycle stage																				
1.1		Part		Leather		1		4	yd2													
1.1.1		Material		Leather			Leather, finish	4	yd2	Estimate	340	0.178	12.4	1.1	0.392	0.000133	0.103	297	1.82	0.111	0.0318	27.2
1.2		Part		Metal Zipper	Metais used f	1		1	lbs													
1.2.1		Material processing		Process			Contour, bras	1	lbs	Estimate	0.0893	0.000337	0.000755	4.58E-05	0.00113	7.06E-07	0.000421	0.00469	0.00311	0.000302	0.000155	0.0783
1.2.2		Material		Metal Zipper			Brass, product	1	lbs	Estimate	0.239	0.00189	0.0124	0.000252	0.00187	1.45E-06	0.000886	0.0165	0.0717	0.00304	0.000823	0.13
1.3		Part		Circuit Boards		1		0.125	lbs													
1.3.1		Material		Circuit Boards			Printed wiring	0.125	lbs	Estimate	1.98	0.00586	0.00914	0.00307	0.0262	2.68E-05	0.0103	0.0681	0.0297	0.00484	0.00422	1.82
1.4		Part		Lithium Battery		1		0.125	lbs													
1.4.1		Material		Lithium Battery			Battery, LiIo,	0.125	lbs	Estimate	0.723	0.000862	0.116	0.000393	0.00841	0.000504	0.00261	0.00596	0.00354	0.000968	0.000721	0.583
1.5		Part		Plastic Housing for Electroni		1		0.125	lbs													
1.5.1		Material		Plastic Housing for Electronics			Polycarbonate	0.125	lbs	Estimate	0.0464	5.46E-05	0.000147	2.58E-05	0.000633	8.39E-10	0.000483	0.000696	0.000261	9.80E-05	5.86E-05	0.0439
2		Life cycle stage																				
2.1		Power use		Power			Electricity, 24	3	kWh	Estimate	0.167	0.000282	0.000271	0.00048	0.0023	1.39E-06	0.000757	0.00248	0.000579	0.000322	0.000225	0.159
3		Life cycle stage																				
3.1.1		End of life		Recycling		1	Leather, finish	4	yd2	Estimate	0	0	0	0	0	0	0	0	0	0	0	0
3.1.2		End of life		Landfill, sanitary, generic		1	Brass, product	1	lbs	Estimate	0.000267	9.01E-07	3.09E-07	6.33E-07	3.62E-06	5.30E-09	2.92E-06	3.35E-06	5.16E-07	1.22E-06	2.05E-06	0.000251
3.1.3		End of life		Recycling		1	Printed wiring	0.125	lbs	Estimate	0	0	0	0	0	0	0	0	0	0	0	0
3.1.4		End of life		Recycling		1	Battery, LiIo,	0.125	lbs	Estimate	0	0	0	0	0	0	0	0	0	0	0	0
3.1.5		End of life		Landfill, plastics, mixture		1	Polycarbonate	0.125	lbs	Estimate	0.000538	2.60E-07	4.55E-07	2.63E-06	7.52E-06	3.53E-09	1.59E-06	2.58E-06	3.95E-07	2.86E-07	5.17E-07	0.000522
4		Life cycle stage																				
4.1		Transportation - Assembled product																				
4.1.1		Transportation - Assembled product				1	Freighter, oce	6880	miles	Estimate	0.00853	6.77E-05	1.05E-05	2.42E-05	0.000115	1.67E-07	9.23E-05	9.79E-05	1.80E-05	4.62E-05	8.57E-05	0.00797
4.2		Transportation - Subassemblies and parts																				
4.2.1.1.1		Transportation - Part		Leather		1	Train, freight,	3000	miles	Estimate	0.462	0.00172	0.00107	0.00123	0.00607	9.01E-06	0.00496	0.0181	0.00204	0.00148	0.00432	0.421
4.2.1.2.1		Transportation - Part		Metal Zipper	Metais used f	1	Train, freight,	3000	miles	Estimate	0.0128	4.78E-05	2.96E-05	3.42E-05	0.000169	2.50E-07	0.000138	0.000502	5.67E-05	4.12E-05	0.00012	0.0117
4.2.1.3.1		Transportation - Part		Circuit Boards		1	Train, freight,	3000	miles	Estimate	0.0016	5.97E-06	3.70E-06	4.27E-06	2.11E-05	3.13E-08	1.72E-05	6.27E-05	7.08E-06	5.15E-06	1.50E-05	0.00146
4.2.1.4.1		Transportation - Part		Lithium Battery		1	Freighter, oce	4000	miles	Estimate	0.000451	3.58E-06	5.54E-07	1.28E-06	6.07E-06	8.82E-09	4.88E-06	5.17E-06	9.52E-07	2.44E-06	4.53E-06	0.000421
4.2.1.5.1		Transportation - Part		Plastic Housing for Electroni		1	Train, freight,	5000	miles	Estimate	0.00267	9.95E-06	6.17E-06	7.12E-06	3.51E-05	5.21E-08	2.87E-05	0.000105	1.18E-05	8.59E-06	2.50E-05	0.00244

Data values contained in this spreadsheet are based on intermediate calculations from within the Sustainable Minds Software. Values are for informative purposes only. Modifications to contained data values may invalidate the results

SBOM: CONCEPT 3

Project:	Vin-tag
Concept:	Vinyl Jacket - 1 Year life
Methodolog	SM 2013
Date:	29-Oct-23
Created by:	
Total Amour	1 x 1 year of use

Item	Stage	Row type	Part ID	Name	Description	Qty	Material/prc	Amount	Units	Measureme	Total (mpts)	Acidification	Ecotoxicity (I	Eutrophicati	Global warm	Ozone deple	Fossil fuel de	Carcinogenic	Non carcinog	Respiratory	Smog (mpts	CO2 Equivalent (kgs)
0		concept		Vinyl Jacket - 1 Year life							3.14	0.125	0.224	0.0906	0.556	0.000448	0.38	0.722	0.823	0.0672	0.156	38.6
1		Life cycle stage																				
1.1		Part		Vinyl		1		4	lbs													
1.1.1		Material		Vinyl			Polyester fal	4	lbs	Estimate	35.5	0.094	0.0872	0.0793	0.486	0.000387	0.345	0.444	0.064	0.0257	0.131	33.7
1.2		Part		Metal Zippe	Metais used	1		1	lbs													
1.2.1		Material processing		Process			Contour, bra:	1	lbs	Estimate	0.893	0.00337	0.00755	0.000458	0.0113	7.06E-06	0.00421	0.0469	0.0311	0.00302	0.00155	0.783
1.2.2		Material		Metal Zipper			Brass, produ	1	lbs	Estimate	2.39	0.0189	0.124	0.00252	0.0187	1.45E-05	0.00886	0.165	0.717	0.0304	0.00823	1.3
2		Life cycle stage																				
2.1		Power use		Power			Electricity, 24	3	kWh	Estimate	1.67	0.00282	0.00271	0.0048	0.023	1.39E-05	0.00757	0.0248	0.00579	0.00322	0.00225	1.59
3		Life cycle stage																				
3.1.1		End of life		Recycling		1	Polyester fal	4	lbs	Estimate	0	0	0	0	0	0	0	0	0	0	0	0
3.1.2		End of life		Landfill, sanitary, generic		1	Brass, produ	1	lbs	Estimate	0.00267	9.01E-06	3.09E-06	6.33E-06	3.62E-05	5.30E-08	2.92E-05	3.35E-05	5.16E-06	1.22E-05	2.05E-05	0.00251
4		Life cycle stage																				
4.1		Transportation - Assembled product																				
4.1.1		Transportation - Assembled product				1	Freighter, oc	6880	miles	Estimate	0.31	0.00246	0.000381	0.000879	0.00418	6.07E-06	0.00336	0.00356	0.000655	0.00168	0.00312	0.29
4.2		Transportation - Subassemblies and parts																				
4.2.1.1.1		Transportation - Part		Vinyl		1	Train, freight	5000	miles	Estimate	0.855	0.00318	0.00197	0.00228	0.0112	1.67E-05	0.00919	0.0335	0.00378	0.00275	0.008	0.779
4.2.1.2.1		Transportation - Part		Metal Zippe	Metais used	1	Train, freight	3000	miles	Estimate	0.128	0.000478	0.000296	0.000342	0.00169	2.50E-06	0.00138	0.00502	0.000567	0.000412	0.0012	0.117

Data values contained in this spreadsheet are based on intermediate calculations from within the Sustainable Minds Software. Values are for informative purposes only. Modifications to contained data values may invalidate the results

SBOM:
CONCEPT 4