



Design



Compostable
Rating



Packaging

NPC UK cotton + corn

Collaborative Product Design // Final Presentation



Materials and
Manufacturing



Marketing



Cost
Viability

PRESENTED BY

MCAD

Masters of Arts in Sustainable Design Program Candidates



ALLISON
HENDRICKS



OLIVIA
PEDERSEN



AOIFE
FAHEY



AJDA
MESIC

NPC UK cotton + corn



A STEP IN THE RIGHT DIRECTION



FIRST EVER

NPC UK Cotton + Corn is USDA Certified Biobased.



MADE WITH THINGS THAT GROW

100% cotton upper. Corn based sole.



WRAPPED WITH CARE

100% recycled packaging.

SYSTEMS MAP





DESIGN BRIEF

SCOPE: Materials | Packaging | End of Life

FUNCTIONAL UNITS: 18 Months - lifetime of a shoe

Sustainable Objectives:

- Sustainable colorways - Natural dyes
- Hit Compostable rating (90 days)
- Packaging Upgrades

Non-Sustainable Objectives:

- Performance enhancements
- Silhouette improvement

PRIORITIES

Our client is keen for us to think ‘out of the box’ when it comes to finding solutions to make the NPC UK Cotton+Corn shoe even more sustainable and improve its compostability timeline. To do this we are focusing on alternate materials to make the upper and lower of the shoe.

Additional colorway options are also an aspect our client wanted us to look into.

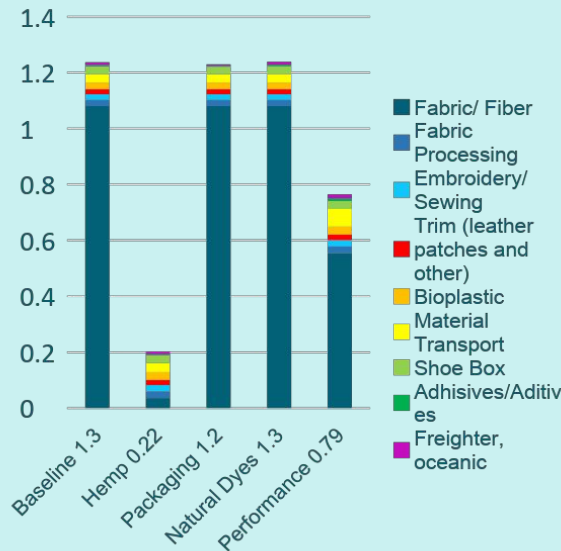
Currently, the packaging is 100% recycled, however, we are looking at using alternative materials or less packaging all together - which was also a specific request from Reebok.

DECISION MATRIX *Weight Key: 5 = High impact | 1= Low Impact*

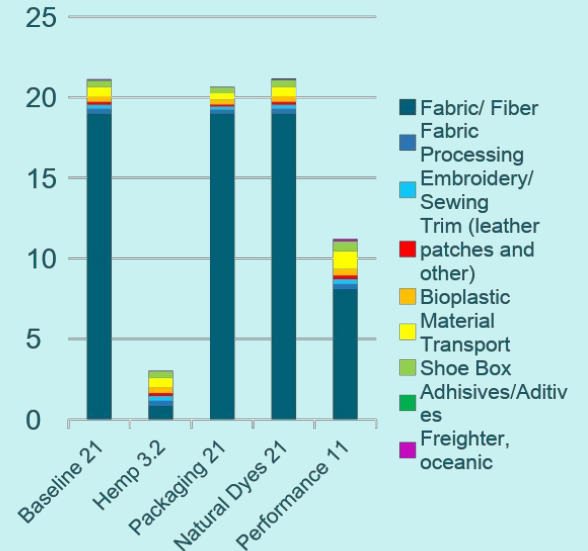
Priority	Weight	Metric	Why
Alternative materials	5	Compostable in 90 days in backyard	Find ways to allow shoe to compost faster
Increase Performance	4	Improved Ergonomics	Reach more customers, advance what is possible
Packaging	4	Impact of materials used	Reduce impact, this area was requested by Reebok
Natural Dyes	4	Durability, scalability, and environmental output	More color options appeals to more people therefore takes more conventionally made shoes out of market
Alternative Constructions	3	Optimized adhesive and/or sewn	Increase compostability or ability to deconstruct
Price * Unlimited Budget	1	Cost increase or decrease	Need to know how this will impact ability to produce even if this is not a deal breaker

SUMMARY GRAPHS

Impacts by SBOM inputs: Total [mPts/func unit]



Impacts by SBOM inputs: Carbon footprint [CO2 eq. kg/func unit]



NPC UK cotton + corn – simple LCA

SCOPE: MATERIALS | MANUFACTURE/ VENDOR MATRIX | END OF LIFE

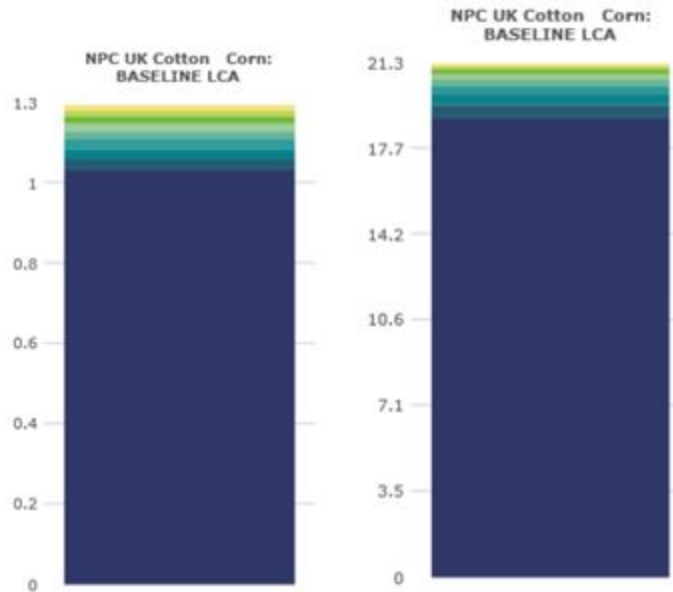
OBJECTIVE: Create a more sustainable model of the Reebok NPC UK cotton + corn by focusing on materials, vendor sourcing, and end of life breakdown of the shoe.

FUNCTIONAL UNITS: 18 Months - lifetime of a shoe

This concept: [Edit overview](#) [Copy](#)
 Declare as: [Final](#)
 Created: October 6, 2018



Total impacts by impact category

We completed the simple Life Cycle Assessment online using the Sustainable Minds software.

From this assessment we can see that the materials create the biggest impacts. Working with the Future team at Reebok provided us with the exciting opportunity of looking at new materials and what the shoe could look like in alternative, innovative materials in the future.

We also wanted this project to provide some benefit and useful information to our client which is why we chose to add the C2C material. This product is a great candidate for becoming C2C certified if Reebok decides this investment is worthwhile.

Natural dyes add additional materials and processes to the impact but it will also provide more options for customers. If more compostable choices are on the market then it will hopefully reduce the number of conventional shoes being bought.

Total = 21 CO ₂ eq. kg/func unit			Total = 1.3mPts/func unit		
Input	CO ₂ eq. kg/func unit		Input	mPts/func unit	
Weaving, cotton	19.0		Weaving, cotton	1.08	
Paperboard 100% Recycled	0.588		Transport, combination truck, average fuel mix	0.0292	
Weaving, cotton	0.395		Paperboard 100% Recycled	0.0281	
Transport, combination truck, average fuel mix	0.328		Corn, at farm	0.0242	
Paperboard 100% Recycled	0.294		Weaving, cotton	0.0225	
Cotton fabric (eco)	0.240		Cotton fabric (eco)	0.0201	
Corn, at farm	0.185		Leather, cow	0.0180	
Freighter, oceanic	0.142		Paperboard 100% Recycled	0.0141	
Soap	0.0594		Freighter, oceanic	0.00997	
Yarn, cotton	0.0267		Soap	0.00494	

Impact category	%
Ecological damage	
Acidification	6.04
Ecotoxicity	5.24
Eutrophication	1.98
Global warming	24.37
Ozone depletion	0.01
Resource depletion	
Fossil fuel depletion	4.26
Human health damage	
Carcinogenics	37.55
Non carcinogenics	9.48
Respiratory effects	6.49
Smog	4.57

NPC UK cotton + corn Best Design Ideas

Provide C2C Assessment Assistance



Based on the feedback from our clients providing a clear process of what the C2C certification entails would be very valuable.

Print Compost Me Inside the Shoe



A simple but constant reminder to remember to compost the shoes once they are unwearable. This is not normal behavior so some persuasive actions are required.

Algae Foam Soles



A carbon-capturing non-food feedstock alternative that does not require pesticides could be an option in the future. It is not currently biodegradable but that is being worked on.

Linen Uppers



It's approx 30% stronger than cotton and it is also more breathable and hygroscopic. Flax plants are resilient and can grow in poor soil which helps with material diversity.

The New Materials List



Providing a contact list for all the new materials we have come across during this project was flagged by our clients as being useful.

Circular Knit Uppers



Engineer one piece upper and eliminate material waste. Reduce number of production steps as well as the need for laces.

Thinner Durable Sole



Constructing soles that use less materials would reduce the overall impact during manufacturing as well as expedite the decomposition period since there is less to biodegrade.

Natural Dyes



All-natural dyes were used for thousands of years. They are derived from plants, minerals and invertebrates. The client is interested in exploration of plant based, non toxic and renewable colorants.

LCA Results

Scope:

Materials | Packaging | End of Life

Functional Units:

18 Months - lifetime of a shoe

Sustainable Objectives:

- Hit Compostable rating (90 days)
- C2C Certification
- Sustainable colorways - Natural dyes
- Packaging Upgrades

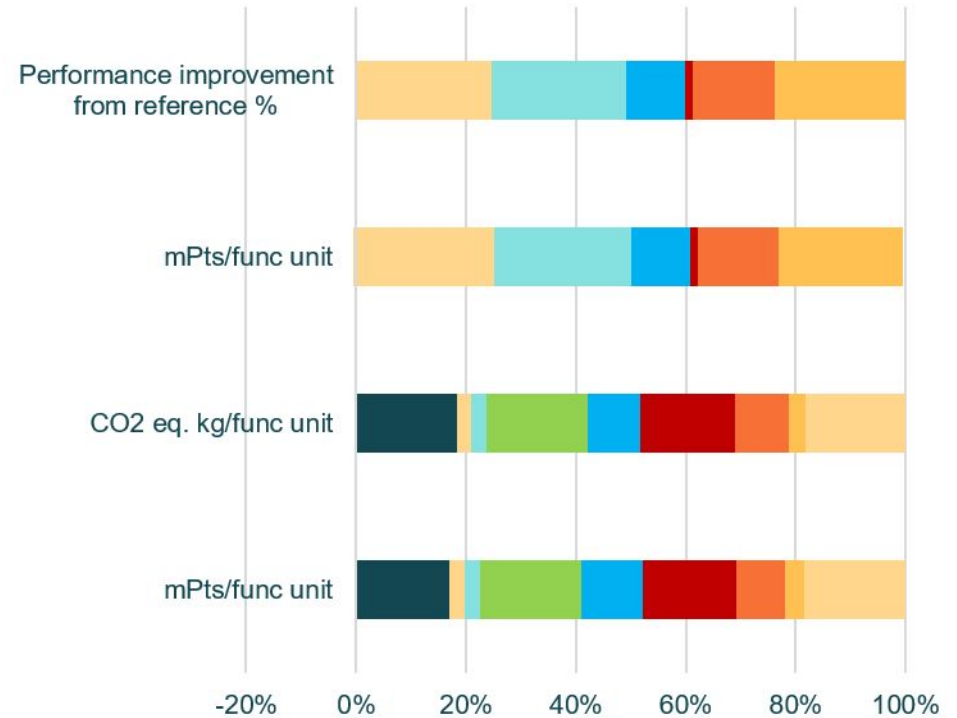
Non-Sustainable Objectives:

- Performance enhancements
- Silhouette improvement

Assumptions:

The use of natural dyes deviates from the baseline by 0.08% however it is in line with Reebok's ask to provide their consumers with a variety of color options. Once the final design is chosen and adjustments are made, the LCA for those design(s) can be assumed to be just 0.08% lower. New materials provide performance improvement of up to 84%, utilizing natural dyes would take it down to 83.02%.

*** Actual LCA improvements for C2C would be assumed equal to the best and final design option(s) Reebok chooses to proceed with. C2C is not directly tied back to an LCA, rather the commitment to sustainable stewardship in the footwear industry.



	mPts/func unit	CO2 eq. kg/func unit	mPts/func unit	Performance improvement from reference %
■ Baseline	1.2	21		
■ C2C ***	0.2	3.1	1.1	84%
■ New Materials	0.2	3.1	1.1	84%
■ Compost Me Printed Insoles	1.3	21	-0.0094	-0.08%
■ Circular Knit Uppers	0.79	11	0.47	37%
■ Algea Foam Upper	1.2	20	0.062	4.80%
■ Thinner Durable Sole	0.62	11	0.64	51%
■ Linen Upper	0.25	3.5	1	81%
■ Natural Dyes	1.3	21	-0.0094	-0.08%

DECISION MATRIX

PRIORITY	Weight	#1 Complete the C2C Assessment	#2 New Materials	#3 "Compost Me" Printed Insole	#4 Circular Knit Upper	#5 Algae Foam Upper	#6 Thinner Durable Sole	#7 Linen Upper	#8 Natural Dyes
Alternative Materials	5	4 = 20	5 = 25	4 = 20	2 = 10	5 = 25	2 = 10	4 = 20	5 = 25
Increase Performance	4	2 = 8	4 = 16	0	4 = 16	3 = 12	4 = 16	3 = 12	0
Packaging	4	4 = 16	5 = 20	0	0	0	0	0	2 = 8
Natural Dyes	4	4 = 16	4 = 16	4 = 16	0	0	0	1 = 4	5 = 20
Alternative Construction	3	3 = 9	3 = 9	0	4 = 12	2 = 6	2 = 6	3 = 9	1 = 3
Cost	1	1	2	4	2	2	3	3	3
LCA Impact	5	5 = 25	5 = 25	4 = 20	5 = 25	4 = 20	4 = 20	2 = 10	5 = 25
Awesome Factor	5	5 = 25	5 = 25	3 = 15	3 = 15	5 = 25	2 = 10	2 = 10	5 = 25
Compostable In 90 Days	5	5 = 25	4 = 20	5 = 25	1 = 5	5 = 25	4 = 20	4 = 20	5 = 25
TOTAL	-	145	158	100	85	115	85	88	134



Cradle to Cradle

The C2C[®] mark provides validation of a manufacturer's commitment to highest standards of sustainability.

Based on our research into Reebok and their parent company - the Adidas Group, we found that the organization meets the Bronze level for Cradle to Cradle certification. We believe it is possible with future improvements and proper documentation that Reebok could achieve Silver or possibly Gold certification as a result of corporate initiatives outlined for 2020.



CRADLE TO CRADLE CERTIFIED^{CM} PRODUCT SCORECARD

QUALITY CATEGORY	BASIC	BRONZE	SILVER	GOLD	PLATINUM
Material Health			✓		
Material Reutilization			✓		
Renewable Energy	✓				
Water Stewardship		✓			
Social Fairness			✓		
Overall Certification Level		✓			



New Materials List

The Reebok Future team works on projects that are years into the future, so we thought it would be fitting to compile a list of potential materials that could be used for these future projects.

We have done extensive research and provided a new materials list for innovative and sustainable materials that use alternative feedstocks and help maintain a diversity in material choice which is an important and often overlooked factor in sustainability choices.

ZOA - <http://www.modernmeadow.com/>
ZOA is the first bioleather that has been engineered through biofabrication by Modern Meadow. They design and engineer the material to deliver the right structural and aesthetic properties.
Contact: Susanne Lee
partnerships@modernmeadow.com

Bolt Thread - <https://boltthreads.com/>
Microsilksilk

Bolt thread are another biofabrication company that work with the DNA of materials. The first material they developed was inspired by spider silk. They develop proteins inspired by the spider's natural silks and through bioengineering put genes into yeast and ferment them

Myco
This is another alternative leather material using mycelium and corn stalks. It was developed in collaboration with Ecovative.
Contact: Dan Widmaier

Mango Materials - <http://mangomaterials.com/>
Mango Materials produces a naturally occurring biopolymer from waste biogas (methane). Their fully biodegradable biopolyester fibers are a sustainable alternative to petroleum-based polyester.
Contact: Molly Morse



Algiknit <https://www.algiknit.com/>

Algiknit is still under active development. They are creating biopolymers using kelp. They are creating durable yet rapidly degradable yarns.

Co-founders:
Tessa Callagan
Aaron Nesser
Aleks Gosiewski



Photo Credit: Forbes

Bloom - <https://bloomfoam.com/>

A carbon-capturing non-food feedstock alternative that does not require pesticides could be an option in the future. It is not currently biodegradable but that is being worked on.

Bloom foam is a product of algix:

<https://algix.com/>

Contact: Michael Van Drunen

CRAiLAR FIBERS

“A kilogram of CRAiLAR, using current flax sources, requires less than 97 percent less of the life-cycle water of a kilogram of cotton. This soft natural fiber, nearly indistinguishable from cotton, does not sacrifice on consumer experience or performance. It will provide all of the environmental benefits without the premium pricing that unfortunately characterizes sustainable products at retail today because of its agronomic flexibility and price.”

Contact: Jay Nalbach

Pond - <https://pond.global/>

Pond produces bio resin systems which are 100 % bio-based and fully biodegradable in nature. They are suitable to bind many types of natural fibers such as flax, hemp, pineapple, palm leaves, cotton, banana and jute – resulting in making fully biodegradable products.

Contact: Thomas Brorsen Pedersen

Honey Bee Silk -

<https://www.launch.org/innovators/tara-sutherland/>

While Bolt Thread used spiders as inspiration for their microsilks, Australian researchers at CSIRO, used honey bees to develop their silk using DNA.

Contact: Tara Sutherland

QMilk -

<https://www.qmilkfiber.eu/?lang=en>

Qmilk uses milk casein in a zero waste process to produce compostable, silk-like fabrics. Qmilk is the only natural fibre which has thermo-bonding properties.

Contact: Felix Puller

Faber Futures

<https://www.faberfutures.com>

Bio-pigments for textiles is one of research projects at Faber Futures where they are exploring different ways of using synthetic biology to create sustainable processes for future materials.

Contact: Natsai Audrey Chieza

PACKAGING

Ecovative - <https://ecovatedesign.com/>
Using mycelium and farm waste, Ecovative have developed materials that are an alternative for plastic. Their most common biomaterials are an alternative for styrofoam but they are also partnering with Bolt Threads to develop Mylo, the bioleather.

Contact: Eben Bayer



“Anything you can imagine that is thermoformable, our design team can grow into a custom shape” - Ecovative

OTHER RESOURCES

The Better Shoes Organization is an information hub which aims to promote sustainable development and practices across the global shoe industry by providing an open-source platform where people can be inspired by the advances others are making. There are helpful maps listing suppliers and factories around the globe, brands and innovative techniques.

<http://www.bettershoes.org>

List of materials is here:

<http://www.bettershoes.org/home/material-selection>



Image Credit: [bettershoes.org/home/material-selection](http://www.bettershoes.org/home/material-selection)



Natural Dyes

All natural dyes were used for thousands of years. They are derived from plants, minerals, and invertebrates.

With our clients' interest in the exploration of plant-based, non-toxic and renewable colorants we researched the best natural dyes that can be made from food waste. While there are several edible plants that can make natural dyes, the following five give the most vibrant and consistent color among all. They are cranberries, blueberries, pomegranates, avocado and spinach.

While natural dyes can remove and recycle food waste into dyes, the dyes also emit minimal waste and no toxins are discharged in wastewater.



DYEING PROCESSES AND NATURAL DYE SUPPLIERS

Colorifix

<http://www.colorifix.com/Colorifix/page.php>

Colorifix dyes are biologically produced, adhering to strict safety guidelines. One of the key features of the dyeing technology is that the dyes produced, deposited and fixed onto fabrics without the need for heavy metals, organic solvents or acids.

Contact: Dr David Nugent

Nano-Dye

<http://nano-dye.com/>

This is a patent pending, nanotechnology process to improve cotton dyeing processes. Currently it is still under development.

Contact: Lon Negrin

Rubia

<https://www.rubia-nc.com/>

Rubia 100% Natural Colours produces natural colour agents from a renewable, natural source. The company operates within the business to business market and in this way, it helps producers to realize durable processes and products

Rubia 100% Natural Colours is market leader in the market for natural colouring of threads, fabrics, leather, paper and cosmetics. The CO2-footprint of Rubia 100% Natural Colours is positive and the Product Life Cycle of Rubia 100% Natural Colours is C2C.

Earth Colors by Archroma

<http://www.bpt.archroma.com/earthcolorsbyarchroma/>

EarthColors® is Archroma's patented new method of synthesizing dyes to produce warm shades from nature.

Archroma's EarthColors® technology creates fully traceable biosynthetic dyes derived from natural waste products of the agriculture and herbal industries; leaving the edible part still available for food consumption.

DYEING PROCESSES AND NATURAL DYE SUPPLIERS CON'T

Couleurs de Plantes

A company at the heart and the service of the environment.

<http://www.couleurs-de-plantes.com/index-en.html>

The company cultivates dye plants and produces various innovative natural dyes in powder or liquid form for industrial applications in the field of cosmetics, textiles, coloring of eco-materials, paints.... but also for applications related to creative and artistic activities. Couleurs de Plantes@ has developed a range of products that are used in dyeing or textile printing on all types of natural fibers (silk, wool, cotton, hemp, linen, bamboo)

AMA Herbal Laboratories Private Limited

<http://www.amaherbal.com>

AMA Herbal is one of the world Leaders in Natural Textile Dyes and is one of only a few successful and commercialized company dealing in extract form of natural dyes formulation and have been saving the environment from the use of chemical. Their herbal products are the result of dedicated and professionalized in-house R&D team who is responsible for making eco friendly and trusted products for their consumers.

ALR Dying

<https://www.alrdyeing.com>

Dubbed the fashion worlds artisanal dyer by the NYTimes. Audrey Louise Reynolds uses right and left-brained instincts to create her dyes. All-natural ingredients, foraged and sourced from daily life, travels, and unexpected encounters. Everything from minerals, seaweed, squid ink, coral, shells, plankton, flowers, earth, can find its way into her boiling pot. Her clientele range from indie labels like Kaelen and The Elder Statesman to veritable giants like Nike and J.Crew, and she now has her own line of gorgeous, completely scalable dyes carried at Whole Foods, various fashion retail stores and her own online shop.

THANK YOU!
