TEXTLAST

A Smarter Way To Make Textbooks

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SD-7620-10-W14
The Practice of Sustainable Design
Assignment 12.2 - Final Project
7620_F19_15_1_A_French_121419

Books to the ceiling,
Books to the sky,
My pile of books is a mile high.
How I love them!
How I need them!
I'll have a long beard
by the time I read them.[7]

- Arnold Lobel

Defining The Problem

Learning to read is a profound achievement in a child's development. We learn from a young age that books are a bountiful source of entertainment and knowledge. Once we get to school, we rely on textbooks to expand our minds and grow our intelligence on a vast array of subjects. But what happens to all those textbooks when they're done being used?

Our overall contributions to landfills is continuing to increase, and paper makes up the largest percentage of all solid municipal waste (SMW) each year. Millions of books are among the paper waste being discarded every year, and textbooks are a major contributor.

While book recycling efforts are on the rise, the current systems are flawed and recycling isn't happening at the rate we need it to in order to lower the environmental impact of textbooks.

320 million books are thrown away each year. [7]

The Key Issues

Paper is the #1 contributor to SMW. [25]

While a growing percentage of books do find their way to a proper recycling facility at the end of their life, many are still ending up in landfills - upwards of 320 million books each year. [7]

Recycling isn't perfect.

Recycling requires a lot of energy and resources and isn't a perfect end-of-life solution. It also doesn't do anything to stop the constant production of new books. In addition, there's a serious lack of knowledge around where and how to recycle books depending on the style of book, and an individual's location and local recycling programs.

Textbooks aren't built to last.

In a survey of K-12 schools, it was reported that 78% of textbooks are disposed of because they are damaged beyond repair. [7]

New editions.

About 70% of publishers release a new edition of their book every three or four years,[13] requiring the production and distribution of an entire new batch of books and leaving old versions obsolete.

Deforestation.

14% of all global wood that's harvested is used for the production of paper. Of all paper used, 93% of it is coming from trees. [23]

But aren’t digital books the answer, you might ask?

Bound Textbooks Are Still King

"If you are reading something lengthy – more than 500 words or more than a page of the book or screen – your comprehension will likely take a hit if you're using a digital device. The finding was supported by numerous studies and held true for students in college, high school and grade school." [26]

Less Screen Time = Better Learners

"Kids who spend more time staring at screens perform worse on memory, language and thinking tests than do those who spend less time in front of a device." [18]

E-Readers Aren't Affordable for Most Schools.

"On a per-year basis, the e-textbook is actually more expensive" [6] than a traditional book.

"Do we learn better from printed books than digital versions? The answer from researchers is a qualified yes." [26]

Key Stakeholders

Students	Parents	Book Publishers
Teachers	Communities	Book Printers
Schools	The Planet	Libraries

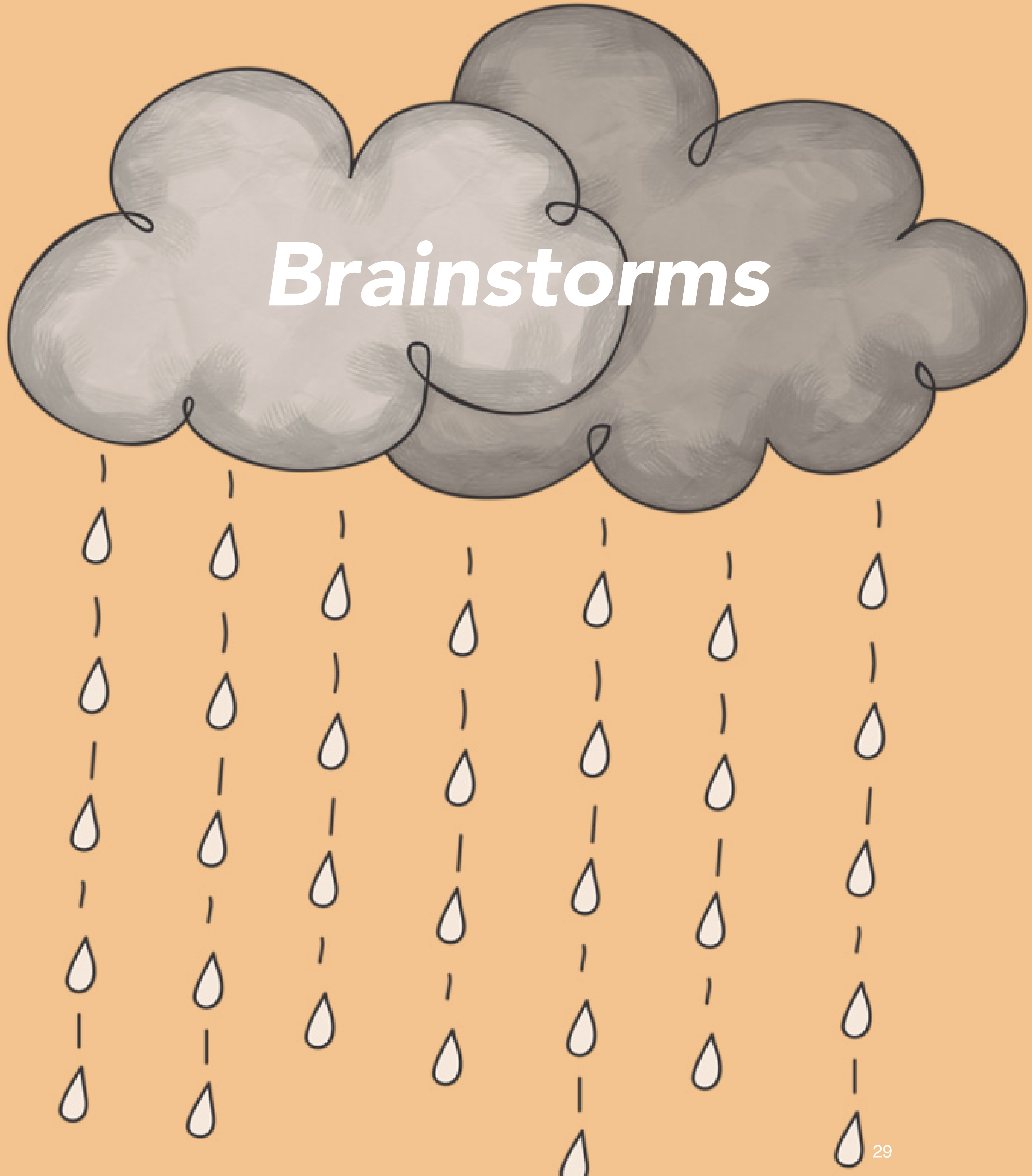
Desired Design Functions

- Last as long as possible
- Be sturdy enough to withstand abuse
- Able to remove/replace pages as needed
- Pages that can be written on and erased
- Provide sense of ownership/responsibility
- Provide connection to production process

Desired Design Outcomes

- Reduce amount of textbooks sent to landfills
- Reduce environmental impact of textbook production
- Increase environmental awareness of students
- Lower cost burden on students and schools
- Decrease environmental impact

Brainstorms



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How Might We...

How might we make textbooks more durable?

How might we design an indestructible book?
How might we create a book that's lightweight?
How might we make a book that's waterproof?
How might we make a book that can be written in repeatedly?

How might we connect readers to the production process of their textbooks?

How might readers get more engaged with their textbook?
How might readers learn best?
How might we address readers from all backgrounds and of all age levels?

How might we get textbook users to treat their books kindly?

How might we create a sense of ownership for the reader?
How might we understand how readers transport their books around with them?
How might we get readers share books with others?

How might we educate textbook users about book recycling?

How might we get more books to recycling facilities at their end-of-life?
How might we connect to a broad audience?
How might we reach as many students as possible?
How might we gauge how interested students are in sustainability?

The Sky's The Limit

If there were no limits to this idea...

All textbooks could be made using this model.

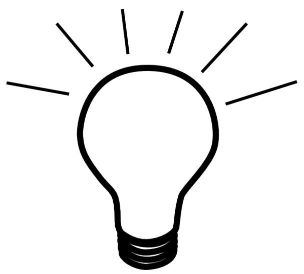
The textbook could be used forever without damage.

Textbooks would be made available and free for everyone.

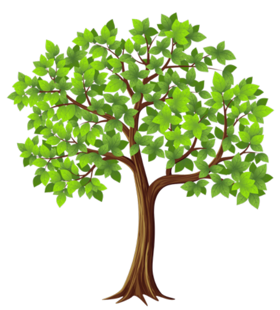
No textbooks would end up in landfill or incinerator.

All students would be educated on sustainability.

The Lifecycle of a K-12 Textbook



1. An author has a brilliant idea, writes a book, and it gets approved for publishing.



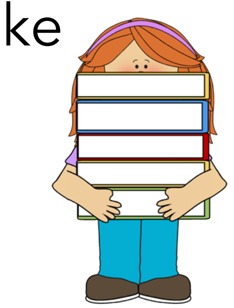
2. A tree is cut down, debarked, made into wood chips, and sent to a paper making plant.

3. Wood chips are combined with water and chemicals to make wood pulp before completing the process of turning the pulp into paper.

4. Paper then gets printed and bound into a book.

5. Finished books are then delivered to publishers where they wait for sales reps to sell the books to schools.

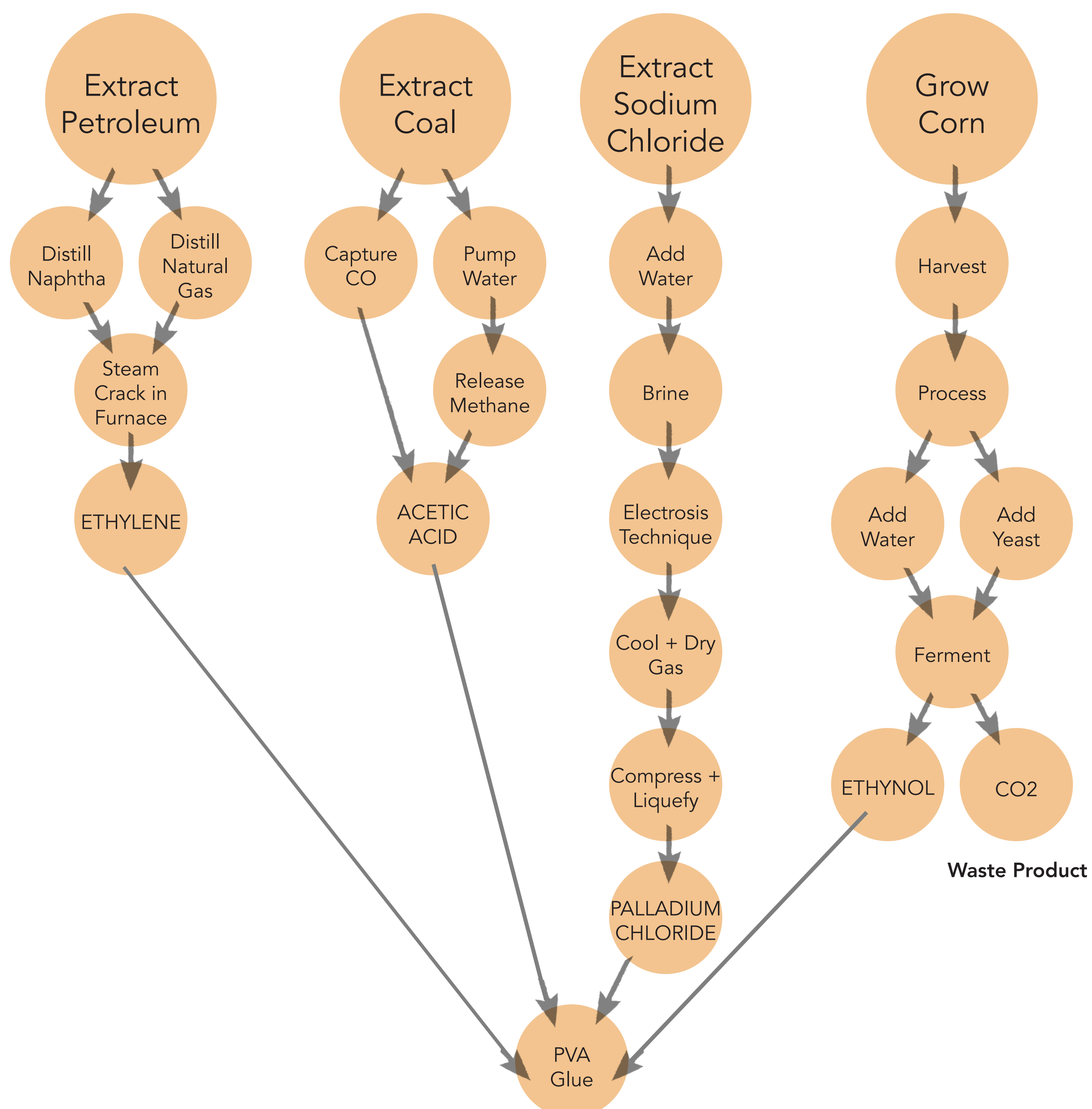
6. The books then make their way to school and into the hands of students.



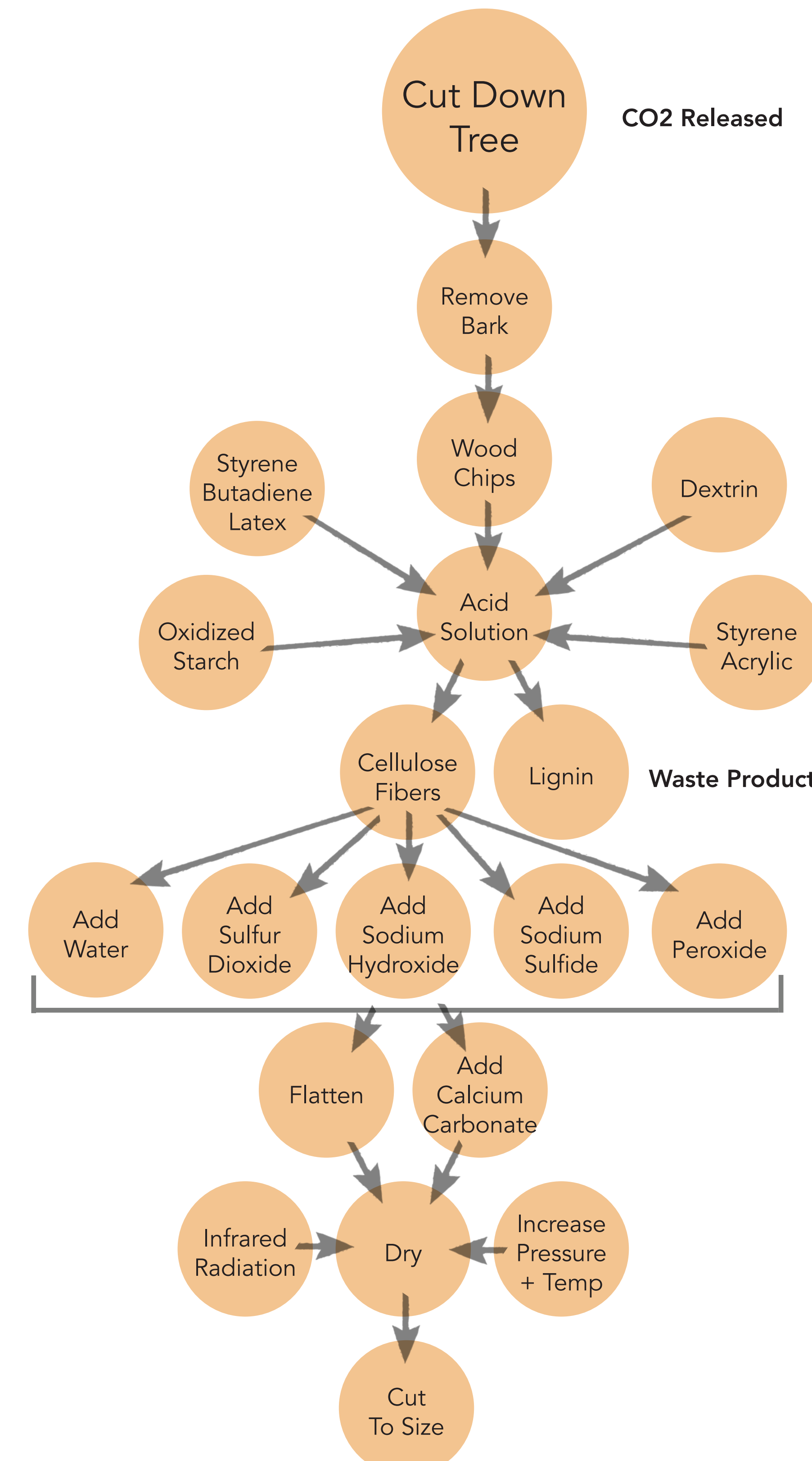
7. At the end of their life, books either end up in: landfill, incinerator, or a recycling facility.

Lifecycle + Flow Diagram

PVA Glue



Paper



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Okala Impact Assessment

Findings

An Okala Impact Assessment was completed based on the primary materials needed to compose a traditional, hardcover textbook.

The first assessment looks at the common materials used for an average hardcover textbook. While some textbooks last a good amount of years before reaching the end of their life, others never make it out of the publisher's storage facility before being pulped. For this assessment, 8 years was the estimated average length of a textbook's life.

The second set of assessment looks at the materials used in a TEXTLAST textbook. Because pages are able to be replaced, exercises pages can be written on and erased endlessly by countless users, and the cover is durable enough to last many years, the average lifespan for a TEXTLAST book was estimated to be 20 years for this assessment. It also utilizes more sustainable options for paper choice, fabric choice, and ink choice.

Conclusion: Due to a reliably longer lifespan and more conscious use of materials, the TEXTLAST book's score surpasses that of an average textbook and is a sustainable alternative.

Okala Impact Assessment

Okala Impact Assessment Form

date: December 1, 2019

designers: Ashley French

product lifetime: ~8 years (70,080 hours)

product concept name: A Standard Bound Book

system boundaries: Based on use of black ink only

functional unit (default: impacts/ hour): impacts/pound

BILL-OF-MATERIALS	AMOUNT	UNIT x	OKALA FACTOR POINTS	UNIT =	OKALA IMPACT POINTS
Wood Chips	0.15	cu.ft.	0.19	lb	0.0285
Water	0.0019	gal	0.04	lb	0.000076
Dextrin	1.3	lb	1.2	lb	1.56
Oxidized Starch	2.6	lb	0.72	lb	1.872
Styrene Butadiene Latex	0.74	lb	1.3	lb	0.962
Styrene Acrylic	0.01	lb	1.1	lb	0.011
Sulfur Dioxide	140	lb	3.9	lb	546
PVC Glue	1.1	lb	1.9	lb	2.09
Ink	48	lb	44	lb	2112
Nylon Fabric	11	lb	22	lb	242
Coated Hardcover	18	cu.ft.	36	lb	648

Total impact / lifetime: **3551.063**

Impacts / product lifetime: **3551.063**

lifetime hours: **70080**

= Impact / hour: **0.05067156107**

Okala Impact Assessment Form

date: December 1, 2019

designers: Ashley French

product lifetime: ~20 years (175,200 hours)

product concept name: TEXTLAST Book

system boundaries: Based on use of black ink only

functional unit (default: impacts/ hour): impacts/pound

BILL-OF-MATERIALS	AMOUNT	UNIT x	OKALA FACTOR POINTS	UNIT =	OKALA IMPACT POINTS
Wood Chips	0.15	cu.ft.	0.19	lb	0.0285
Nature Based Solvents	1.3	lb	1.2	lb	1.56
Ink	48	lb	44	lb	2112
Vegetable Oil Based Ink	1.7	lb	1.8	lb	3.06
Hemp	2.9	lb	3.1	lb	8.99
Biopolymer	0.22	lb	0.2	lb	0.044
Flax	3.1	lb	3.5	lb	10.85
Plastic Resin	82	lb	3	lb	246
Kraft Paper	0.71	lb	0.84	lb	0.5964
Adhesive	0.72	lb	1.3	lb	0.936

Total impact / lifetime: **258.4264**

Impacts / product lifetime: **258.4264**

lifetime hours: **175,200**

= Impact / hour: **0.00147503653**

TEXTLAST: The Design

Design Description

TEXTLAST is a sustainable textbook made to last for years and pass through the hands of many readers.

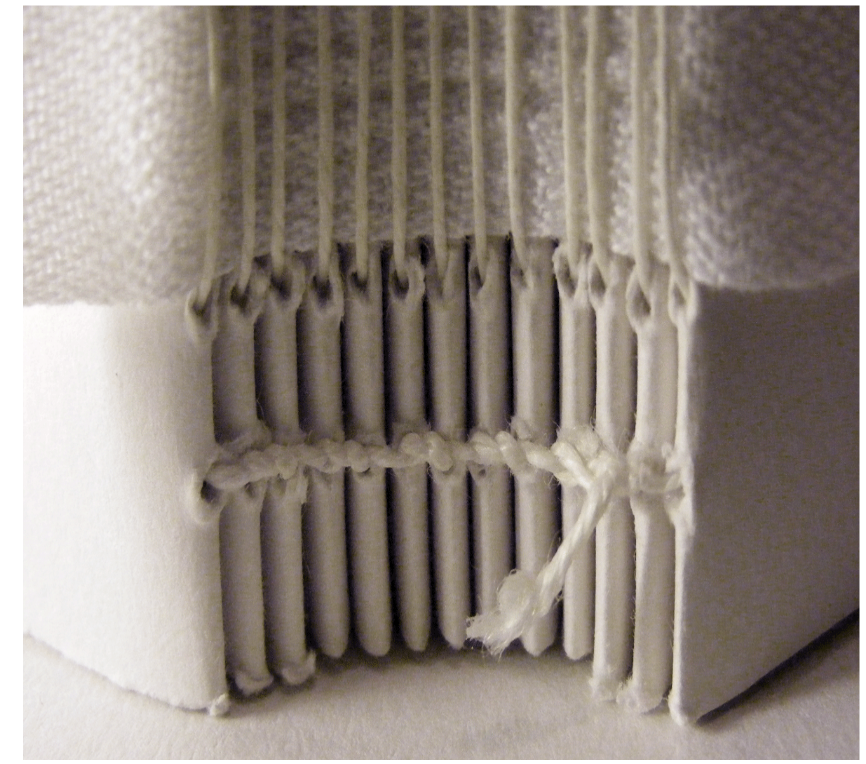
Design Details

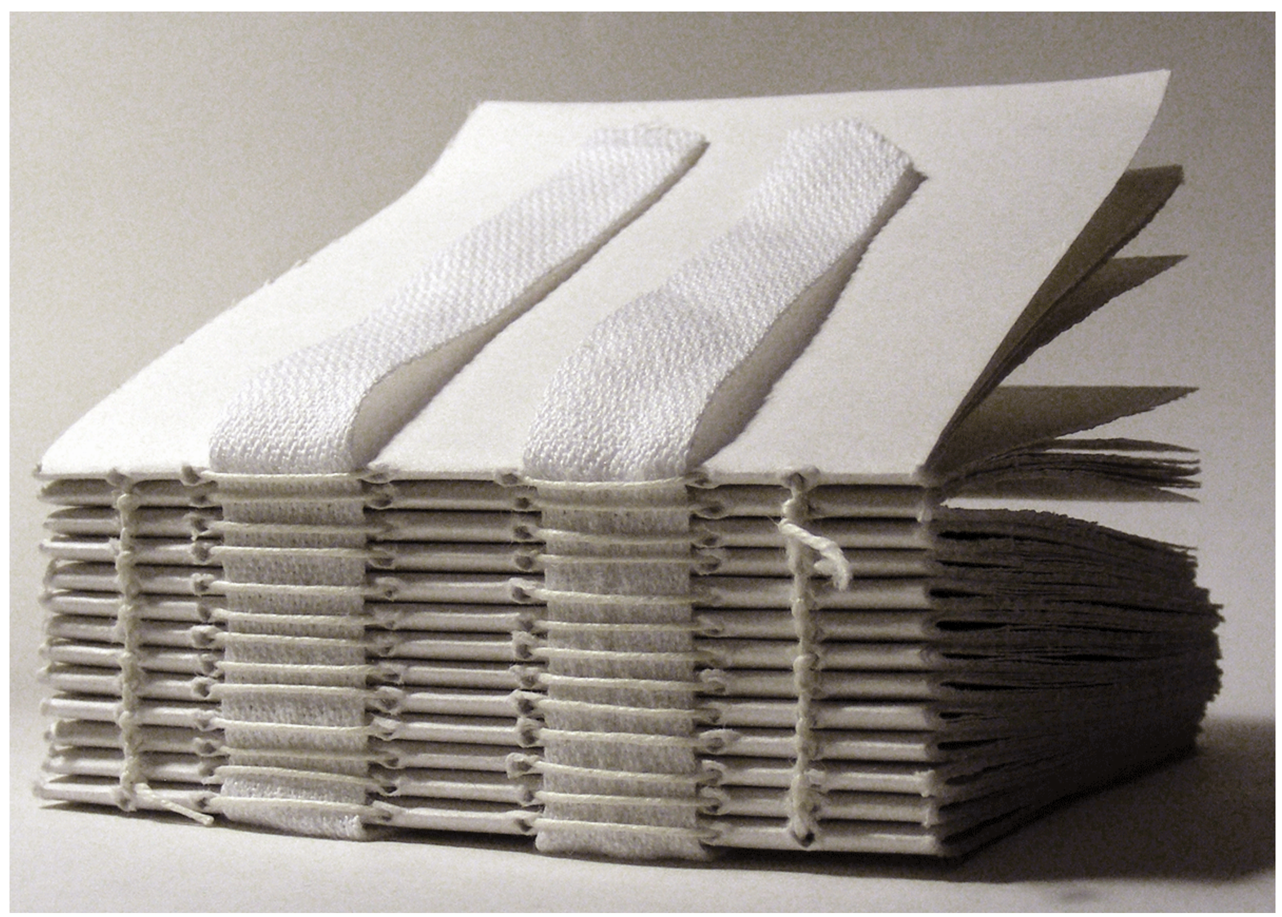
❇ Durable cover made of a biopolymer, flax shive blend
❇ Pages easily added/removed as needed
❇ Binding with unique sewing technique, no glue
❇ Binding with natural hemp fabric
❇ Exercise pages made from plastic resin, capable of being written on and easily erased endlessly
❇ List of names in front of all the book's owners
❇ QR code to engage, learn more, see where book recycling facilities are in your area

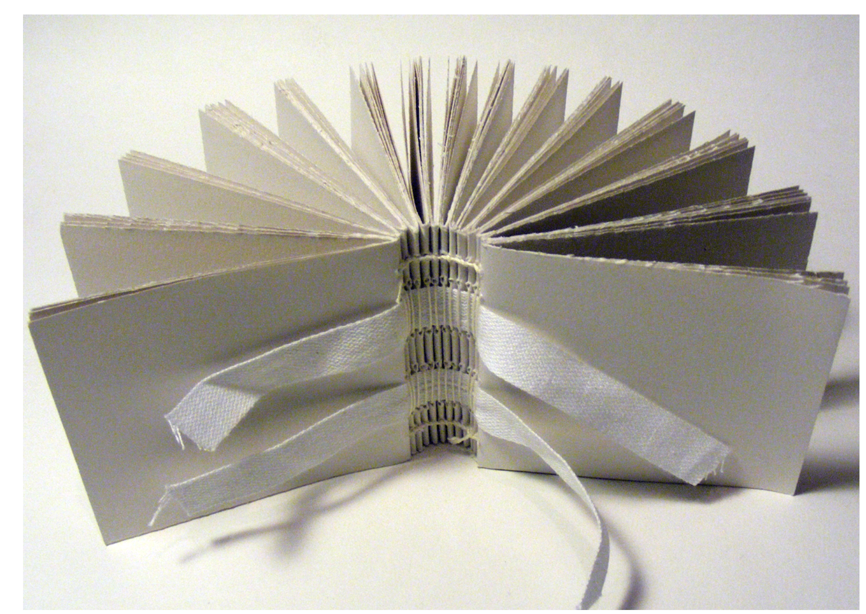
TEXTLAST textbooks have a durable, compostable biopolymer cover that is lightweight, water resistant, and can withstand years of abuse.

Binding

A unique sewing technique is used to hold the pages together tightly without the use of glue. Hemp fabric and string are used as it's natural, sturdy, and biodegradable. Pages can easily be removed by taking out the string. This way, instead of printing an entire new book when a new edition is released, select pages can be replaced.







Cover

Inspiration for the book’s cover comes from the Pela cell phone case made of the same materials: biopolymers and Canadian Prairie flax shive. “100% COMPOSTABLE and free of lead, cadmium, BPA and phthalates.” [14]

The book’s cover is lightweight and flexible, while still being sturdy enough to protect the pages inside the book. It can also be made in a wide variety of colors.

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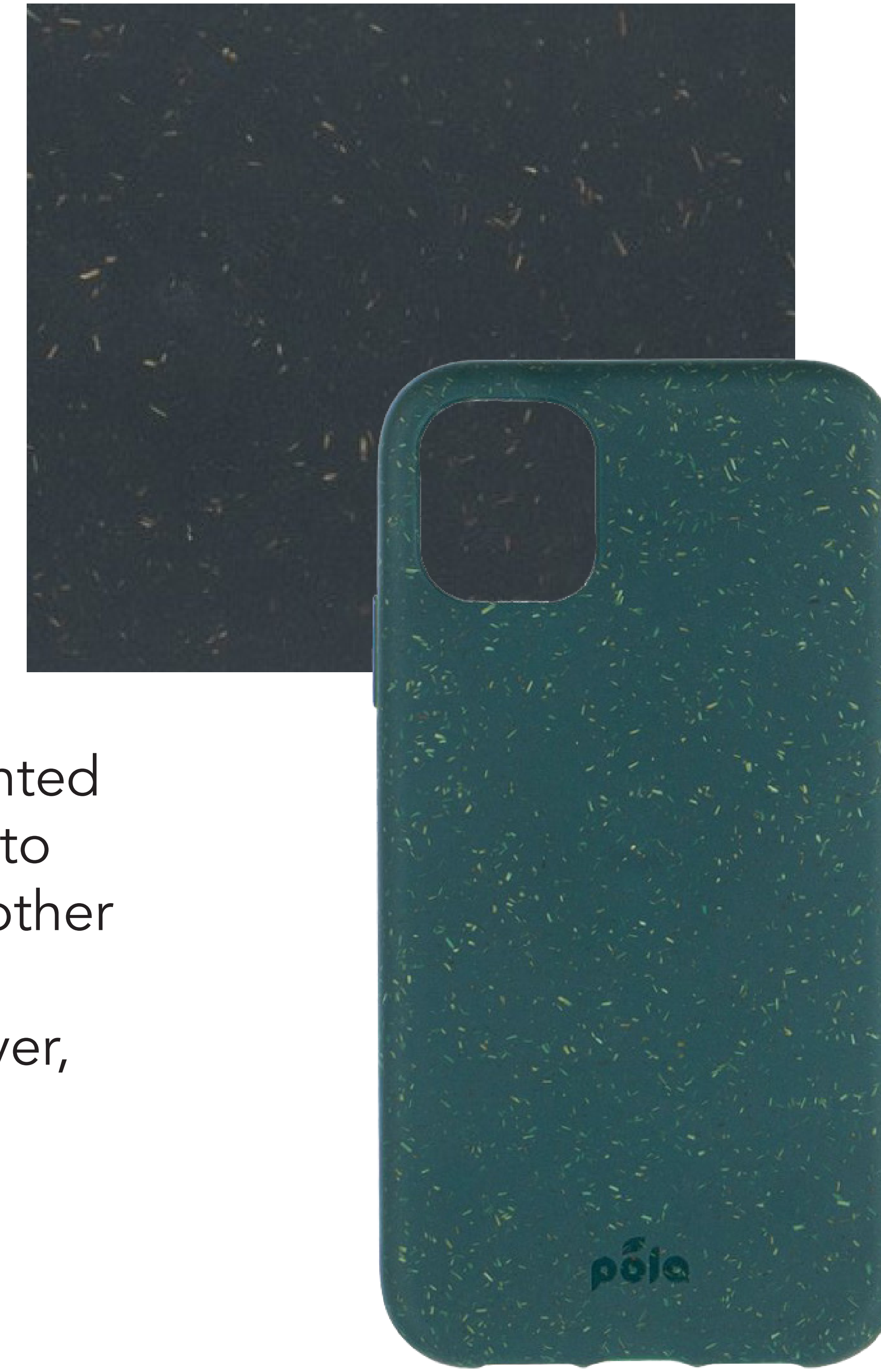
Kraft paper adhesive stickers are printed on and adhered to the book’s cover to provide the cover title, details, and other information. These can be removed later in order to either re-use the cover, or send it on for composting.



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QR Code + Name Log

The QR code available in the front of the book provides the reader with information about how the book was made, and tools for further engagement. It’s a way of connecting the reader to the physical object they have in their hands and helping them understand that there was a complex, multi-step process that went into getting it to them. It’s also a way to start getting students thinking about sustainability and engaging from an early age.

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The Name Log in the front of the book is also a way to give students a sense of ownership. Each student has a space to write their name, and see the names of previous students who have owned the book. This will show them how many students previously used the book, and will help to give them a sense of ownership of the book. With this, they will be more likely to treat the book respectfully and in turn, make the book last longer.

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Appendix

Limited Lifecycle Inventory + Analysis

Measuring The Impact of Paper

Component	Natural Environment	Raw Material Extraction			Material Processing		
	Where does it come from?	Virgin Material	Input/ Output	Detail	Process	Input/ Output	Detail
Paper (for binding into a book)	Softwood Forests	Wood	Input	Energy and resources required to grow and harvest	Growing	Input	Water, sunlight, minerals, time
			Input	Wood pulp is made	Harvesting	Output	Shopped wood
			Output	Deforestation and habitat loss	Pulping	Input	Water
			Output	Carbon, released when tree is cut and during transportation		Input	Chemicals
			Input		Washing, Bleaching	Output	Water, bleaching agents
			Input		Recycled Paper	Input	Water
			Input		Transportation	Output	Gasoline

Assembly & Packaging			Transport/Distribution/Purchase		
	Input/ Output	Detail		Input/ Output	Detail
Book binding	Input	Machine energy	Distribute to factory	Input	Energy
	Input		Transport of raw materials	Input	Energy

Limited Lifecycle Inventory + Analysis

Measuring The Impact of Paper, Cont.

Use Phase		
	Input/ Output	Detail
Wear and tear	Input	Dimishes liklihood of reuse

End of Life Scenarios		
	Input/ Output	Detail
Industrial Recycling	Input	Energy

Limited Lifecycle Inventory + Analysis

Measuring The Impact of Ink

Component	Natural Environment	Raw Material Extraction			Material Processing		
	Where does it come from?	Virgin Material	Input/ Output	Detail	Process	Input/ Output	Detail
Ink (for printing on paper)	Fossils	Petrolium oil	Input	Energy to heat oil to high temperatures	Oil	Input	Energy to heat oil to high temperatures
		Carbon black	Output	Final result of heating process		Output	Oil spills, environmental pollution
		Heat	Input	Heating oil to high temperatures	High temperature gasses	Input	Produced when heating petrolium oil to high temperatures
			Output			Output	Air pollution
			Input			Output	Harm to factory workers' health

Transport/Distribution/Purchase		
	Input/ Output	Detail
Distribute to factory	Input	Energy
Transport of raw materials	Input	Energy

Limited Lifecycle Inventory + Analysis

Measuring The Impact of Glue

Natural Environment	Raw Material Extraction			Material Processing		
Where does it come from?	Virgin Material	Input/ Output	Detail	Process	Input/ Output	Detail
Fossils	Crude Oil	Input	High heat and pressure	High heat	Input	Crude oil and salt combination
	Salt	Input	Added to crude oil		Input	Energy, high heat

Transport/Distribution/Purchase		
	Input/ Output	Detail
Distribute to factory	Input	Energy
Transport of raw materials	Input	Energy

End of Life Scenarios		
	Input/ Output	Detail
Deterioration	Output	Pollution of environmnt

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