Recycle It! Barcode Bag

Final Report D-LAB II

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1. Design Brief

Our client is Irina Mkrtchyan, a Humphrey fellow from Armenia, who works with Innovative Solutions for Sustainable Development on Communities (ISSD) to promote community-based programs focusing on waste management, agriculture, and education. The 'Recycle It!' initiative aims to incorporate waste sorting and recycling into the culture of Armenia. The aim of this project is to reduce the use of plastic bags by creating reusable barcode bags. As an approach to mitigating plastic pollution and creating a recycling culture amongst the community, the barcode will be connected to the rewards system of local grocery stores. These barcode bags will be used in place of a traditional rewards card that unlocks member offers. As the customer presents the reusable barcode bag to the cashier, they will cumulate bonus points with every scan.

The scope of this project includes selecting an environmentally friendly material for the bag, designing a graphic to make the bag aesthetically pleasing, and selecting optimal locations for the barcode to be placed on the bag. The goal for designing the bag is for it to be an alternative to single use bags that Armenians regularly use. As these are a symbol of freedom from Soviet Rule [TED], the new bags should entice customers. The reusable barcode bags are designed for communities in Armenia to promote waste sorting and create a recycling culture.

2. Design Process and Methodology

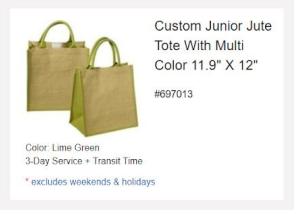
The design process began with an evaluative matrix identifying five main categories for the overall design requirements for the bag. These five main categories were: performance requirements, ergonomics/aesthetic preferences, environmental impact, economic constraints, and social impact. The focus of our research was based on the environmental impacts. We did not want the bag to be more harmful than a single use plastic bag as this would defeat the purpose of the project. The next aspect critical to our design was ergonomics and aesthetics. Even if the bag is environmentally better than a single use plastic bag, there must be interest from users to develop a culture around using the bags. This category was broken down into design of the bag material and style, and the design of the graphic that will be on the front of the bag. Finally, the bag design we choose must be comparable to the characteristics of a single use plastic bag. The values in the design matrix for this category come from the properties of a single use plastic bag since the reusable bags must be an improvement to the existing bag options. Our client was not concerned with the social factors. Our client is interested in purchasing mass produced bags of around 10,000. She provided us with an ideal selling value between $1.50 and $15.00. This is something that we found would be easily achievable with any bulk distributor.

A detailed table of the criteria, objective function, testing procedure, target value and functional unit can be found in Appendix A. We developed a second evaluative matrix to

examine potential fabrics and materials to make the bags out of. This material matrix is in Appendix B.

After research and feedback from our client, we went on to purchase and construct prototypes of the bags (detailed in table X below). Tests were conducted in the form of a relay race. Students were told to load and unload the different bags and race a set distance. Afterwards they were asked to complete a survey detailing their opinions about the bags.

Below are the costs of the bags, based on the bulk order and customization website AnyPromo. Pictures of the bags described are included as well. These costs do not include shipping and other international fees.



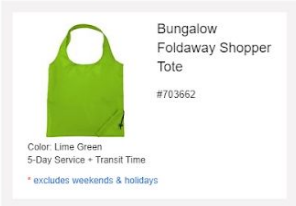


Table 1: Costs of printing on bags

Bag	Quantity	Cost per bag (1 print)	Cost imprint front / bag		Cost imprint Back / bag	Cost Imprint Pouch / bag
Jute	10000	3.76	0		.66	n/a
Corner bungalow	10000	2.70	.01	.52 2nd color	n/a	n/a
Corner latitudes	10000	3.18	1 / color		1 / color	.01
Separate Pouch	10000	2.37	0		n/a	n/a

Table 2: Costs for color variations on bag

	Single Color Front, Single color back	Double color front, Single Color Back	Single Color Front, No back	Double color front, No Back
Jute	4.42	----------	3.76	----------
Bungalow	----------	----------	2.71	3.22
Latitudes (with pouch design)	5.19	6.19	4.19	5.19
Latitudes (without pouch design)	4.19	5.19	3.19	4.19
Separate pouch	----------	----------	2.37	----------

3. Results and Discussion

We documented the relay race participants' comments and provided the client with a summary for each bag. The relay race times for each bag were very similar so we concluded that bag style does not significantly impact loading and unloading. Also, neither of the styles slowed down the participants. We shared the comments and feedback from our peers' evaluations of the bags in Table 4 below.

Table 3: Participant feedback

Bag Type	**Comments/Feedback**
Canvas and Jute	People found this design to look the nicest of the four bags, but thought it could benefit from longer handles.
Corner Fold Polyester	People found it to have better handles for carrying than the pouch style, but found it more difficult to load and unload with groceries. They found the drawstring closure design more time consuming to close but liked that it was more secure.
Pouch Fold Polyester	People found it easy to load and unload with groceries but had difficulty carrying it on their shoulder due to the handle locations. People overall liked this pouch design, though one person felt it could easily come out the top and preferred the following corner bag foldable design.
Burlap	The shape and handle length received positive feedback through one person found the fabric itchy. It can be a difficult material to sew and our prototype was easy to tear at the seams.

Though this information was helpful, we recognize that we used a very small sample size and that our client's opinion is the most important. We shared the information with Irina and found that what she cared about most was if the bag was foldable or not. She also did not like the pouch design and told us that the most important factor moving forward was to have a good graphic design. We decided on the foldable corner polyester bag and focused on making a good graphic. The first couple rounds of graphics provided by our contracted graphic designer, Karin Debach can be found in Appendix A.

A number of critical failures have been identified that would offset the purpose of the project. The manufacturing and production process for the material for the reusable bag may harm the environment more than single use plastic bags. The bags that will be produced and distributed may never be attached to the grocery rewards system, thus failing to fulfill the client's wishes. The design of the bag could be outcompeted by better designs, or a design disliked by customers could lead to lower bag purchases and negatively affect the reputation of ISSD. Customers purchasing the bags may continue to use plastic bags, furthering negative environmental impacts. Only a few grocery stores may accept this idea, thus never scaling up would result in the project having a low impact.

4. Conclusion

Compiling results from user feedback surveys showed that the design and length of the bag handles were critical when it came to the comfort of the bag. Out of the bags we had people test, the bags with longer handles were more comfortable to use.

Following the client's recommendations on prior art, our team designed a number of graphics with a similar style and topic shown in Appendix D. The client specified that she wanted a pouch design and liked the idea of having a tree as a graphic.This narrowed the design of the bag down to having a green background with brown ridges, and a silhouette of a tree or leaf printed onto the corner pouch the bag will fit into.

5. Next Steps

We are currently deciding which bag design we would like to use as our final prototype. Based on the feedback we got from other D-lab students, we provided our client with possible modifications. We will work to develop a new survey to evaluate our top 3 bag designs and top 3 graphic designs. From then we hope that our client administers the surveys to locals in Armenia so that we can gain culturally relevant information in regards to bag ergonomics, convenience and graphics options. We also would like the bag survey administered in grocery stores so that cashiers can give their feedback on which bag would be efficient for them to load. We will process the survey data and use that to fill out an additional column on our decision matrix. We will send this to our client, and allow her to modify the weight of each criterion if she is not happy with the outcome.

Below is a list of suggested modifications for the bag designs. Due to our client's plan to bulk order from the cheapest place, these modifications may or may not be feasible. We will send the original versions of the bags as well as a modified version of the pouch foldable bag. Depending on where she orders from, she can see if these modifications are possible to make.

Table 4. Suggestions for modifications to bag design.

Corner Bag	none
Pouch	Create a pullover “lid” to ensure the bag stays closed when stuffed in pouch
Canvas/Jute	Lengthen handles
Jute	Use a different material – strap can be itchy for sleeveless shirts

Ultimately, she will order the bags in bulk and have unique barcodes/QR codes sewn onto the bag depending on the store’s system. We plan to have a survey for stores to tell us what they feel about the bag design in terms of convenience for the check out process. If the project is a success and our client expands the project, we can take these considerations into account.

As we move forward with this project, we will continue corresponding with our client through email. We want to get feedback on the designs from the client so that we can further develop the designs and turn them into vector graphics. We will then get the graphic printed onto stickers that we will attach to the bags as prototypes. Irina said that we could either send her the bags or she has contacts in Armenia we could send them to. We will be developing a survey to get feedback to evaluate the bags upon.This summer all three of us will be in Northern California and can continue to work on this project.

6. Bibliography

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7. Appendices

Appendix A: Decision Matrix

Criteria	Objective Function	Testing Procedure	Target Value	Functional Unit
Performance	Weight	Literature, Scale	*7.7*	kilograms
	Uses	Research	varies	uses/bag
	Volume	Literature, Testing	20	Liters
Ergonomics/Aesthetic	Ergonomics (interactions between consumer and product, comfort)	Consumer Surveys	80%	overall response on each question
	Convenience (when not in use)	Consumer Surveys	80%	overall response on each question
	Consumer Satisfaction	Consumer Surveys	80%	overall response on each question
Environment	Embodied Impacts/use	LCA Research	Varies material chart	uses / bag to = single use plastic bag
Economics	Number of Units	N/A	10,000	Bags
	Retail price	N/A	1.5- 15	USD
Social	Fair Trade	Certification	0	
	Jobs Created	Numerical	0	
	Local Capacity			

Appendix B : Material Matrix

Material	**Polyester**	**Nonwoven Polypropylene**	**Cotton/ Canvas**	**Heavy Duty LDPE**	**Nylon**	**Jute**
Price per Bag ($USD)	0.3-0.5	0.10-0.26	0.50-1.00	0.01-0.15	0.5-1.0	0.25-0.65
Carrying capacity (kg)	10-12	10-12	13-17	18-20	9	18-20
Weight of Bag (g)	115	110-125	80-230	30-40	100	500
# reuses to be environmentally better than single use bag	8	50	131	4	11	100
Volume (L)	16	17 - 22	17-33	19 - 24	10	29
Potential Designs	Stuffed into shapes / pouches (strawberry), folded	Tote bag, foldable tote bag	Typical tote bag shape	Foldable	Foldable	Stiff tote bag shape
Other Notes	-Machine washable -Water resistant	-Water resistant -Antibacterial -Gloss & Matte options	-Washable - Energy-intensive processing leads to ecotoxicity / water pollution.	-Durable, -Waterproof -Lightweight - Stiff and keeps its shape (similar to material used for tarps)	-Machine Washable -Lightweight -Waterproof	-100% jute fabric -Durable

Appendix C : Graphic Designs from Karin Debach

Appendix D : Graphic designs from D-Lab Pro II team.

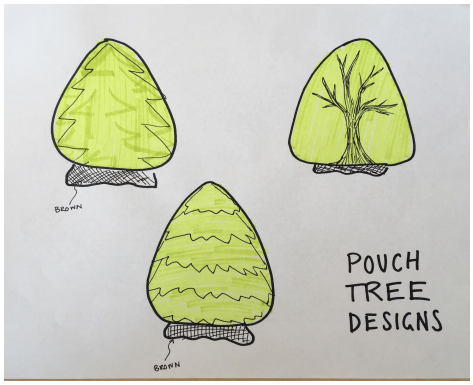
Yerevan city skyline behind leaf
by Lauren Chew and Rujuta Munshi

World map Tree Graphic by Lauren Chew

Plastic Bag Graphic by Lauren Chew

Tree Designs by Ziqra Raza

Skyline with Trees by Rujuta Munshi



Corner Pouch Tree by Rujuta Munshi and Lauren Chew

Appendix E: Course deliverables from Design Notebook.

Deliverable 2: Initial Design Brief

Recycle It : Lauren Chew, Rujuta Munshi, Ziqra Raza

• **Who is the client and what is their business?** Irina Mkrtchyan is a Humphrey fellow from Armenia working with Innovative Solutions for Sustainable Development on Communities. This NGO promotes community-based programs, focusing on waste management, agriculture and education and the Recycle It initiative hopes to make reusable bags widely used in the area.

• **What is the Project Goal Statement?** We will work with the client to define our design space and constraints and design, build, and test ideas for reusable, barcoded bag.

• **What are the specific project goals? Why?**The primary goal is to define the design space and research prior art. From this, we will have a better idea of how to go about building a prototype.

• **Who is the target market/customer?** Stores willing to scan and use the bags/ implement the point system. Customers who are willing to buy bags and get rewards from using them.

• **Any known benchmarks?** None.
Possible benchmarks: Frequency of people using reusable bags at certain shops (or tracking with barcode) , Number of stores willing to offer the program.

• **What is the approximate budget**? Unknown

• **What is the approximate timeline?**

Week 2 - contact Irena and gather all background information she currently has
Week 3 - in class project, research prior art for bags
Week 4 - research barcode systems based on needs
Week 5 - Have bag designs ready, Design Review
Week 6 - 7: work on prototypes, update Irena
Week 8 - 9: test prototypes and make improvements
Week 10: decide on final options

• **What are the final deliverables?**

The final deliverable will possibly be a demo bag for the client (still awaiting detailed needs and requirements from client).

Project Goal Statement Elevator Pitch

We are a team of 3 engineering students working on a project to improve the Recycling culture of Armenia. Our client is a Humphrey fellow from Armenia named Irina. We are planning to design a reusable bag with a barcode that allows users to connect with a store's rewards system. The objectives of this project will be to determine the fabric, design, and graphic of the bag to create an appealing bag to promote the use of reusable bags.

Deliverable 3 : Expanding the Design Brief and Brainstorm Project Considerations

Who is the client? Who are you designing the technology for?
Irina Mkrtchyan, a UC Davis Hubert H. Humphrey Fellow and co-founder of the NGO, ISSD is the client. The reusable barcode bags are designed for communities in Armenia to promote waste sorting and create a recycling culture.

Who is the target customer? Who will actually be using the device? Be specific
The target customers will be people shopping at stores, the stores involved, companies part of the rewards system and other organizations that are involved with the reusable barcode bag project.

What are the specifications if any given for the technology?
The current specifications are a barcode on a bag as a system to track customers bag usage to provide appropriate rewards such as coupons and discounts for not using plastic bags.

What are the technical, social, environmental and financial considerations?
Technical:

- Functional bag and bag distribution
- Working barcode
- Appropriate rewards system

Social:

-Community acceptance: may be slow to adopt and acquaint themselves with bringing own bags

Environmental:

- Fighting against plastic pollution by using reusable bags made from environmentally friendly materials

Financial:

-Need to consider cost effective environmentally friendly materials that can be used to make bags

What are other existing designs?
Four major supermarkets in Singapore have teamed up with the Singaporean Environment Council to reduce plastic wastage by introducing a reusable bag featuring a barcode that tracks the use of the bag. Shoppers who spend more than $50 can redeem the reusable bag, and can enter a lucky draw to win $3000. Source: https://www.straitstimes.com/singapore/environment/four-supermarket-chains-launch-campaign-to-reduce-plastic-bag-use

Some grocery stores (San Jose Target) gave a 10 cent discount for bringing your own bag for about a year before the government passed legislation forcing a 10 cent fee on paper bags.

What will a successful design do?
A successful design will promise some return for the customers. There must be an incentive that will satisfy the customer, thereby driving them to use the bag even more. If the use of plastic bags decreases in the targeted stores by 25% in the first 3 months of implementing this we know it is working.

What is the timeline?
7 weeks

What is the project budget? What is the cost and quantity of products needed?
Unknown

What is the end deliverable?
Recyclable bag and plan for implementing the points system

What skills and informations will you need to design a successful product?
-Community surveys to determine what would be a good rewards system to implement
-Information about local recyclable materials that can be used to make bags
-Information about markets that are willing to participate (how many are participating, how big are they, how many customers to they receive, what do they sell)

Brainstorm design considerations and write down 10-20 of them

- Who will fund the bags? (Recycling company? Households?)
- How much are people willing to spend on a bag? Do they currently cost money?
- Will the bags be standardized or can people attach barcodes to their own bags?
- Education component to show people the existing problem
- Stakeholder involvement all along supply chain (policy makers, recyclers, vendors, households)
- Who will manage the digital component and data storage?
- Should the government play a role? (Ban on plastic bags?)
- What is the expected life cycle of bag? How many reuses should we design for?
- Will stores still have plastic bags for individual vegetables? Does that system exist in Armenia? Or are we making bags in different sizes for individual vegetables as well as carrying all the groceries?
- What materials are readily available? Should we opt for cloth or reusable bags made from recycled plastic? What industries are common in the area - sewing or textiles?

Deliverable 4: Specific Design Criteria and Metrics

We have a video call with our client scheduled for 4/19. We expect to get more information about our project then.

Important design considerations:

- Built in bar-code
- Recyclable material for bag
- Affordable material
- Aesthetically pleasing (graphic design)
- Durable. Preferred to single-use bags

Quantitative design evaluation:

Track Number of stores participating in project
Number of barcodes scanned per store per day
Number of bags reused based on scanner

Qualitative design evaluation:

Customer feedback and surveys
Feedback from the store and companies that contribute to the rewards system

Criteria	Qualitative/Quantitative	Testing Procedure	Target Value	Metric
Functioning bar code	Qualitative	Barcode scanner	>50	Number of scans
Recyclable material	Qualitative	Research local facilities to determine recyclability	<2	Number of raw materials used (should be primarily recycled material)
Low-cost	Quantitative	Compare local market values	<10	dram
Aesthetics	Qualitative	Customer feedback and surveys	--	--
Durability	Quantitative	Recording and bookkeeping	>2	Number years the bag lasts

Deliverable 5: Brainstorming for Design Concepts

New information: Understood more about the existing barcode/ QR code/ card with magnetic strip system for membership cards in stores. The idea is to replace plastic bags with reusable bags or some other carrying objects that function similar to a membership card to keep track of uses and encourage customers to bring back their bags. Our client suggested we focus on the design of the bag and ensure there is some place for a QR code or barcode to be added. The final design

Brainstorm on Bag Ideas

1) Drawstring backpacks
- Concern with this is lack of space → instead of two pieces of fabric, add a base and sides to the drawstring bags.

2) and 3) Bags that can be stuffed into a shape (ex - strawberry)
- Different themes
- Shape can be on the corner or in the center

- Have designs that represent Armenian culture (bags with flags, celebrities, national sports, etc. - are exciting to customers)

4) Bag that folds into separate pouch

5) Paper bag design made from more durable materials
6) Crates
- Hard because most people walk for groceries

7) Personal Shopping Cart
-fine enough mesh to not need bags

8) Multiple shopping bags in one

9) Upcycled bags (may encourage upcycling culture).
Trade in system - bring a pair of old jeans
and get a bag for X dollars?
Otherwise, pay more for the bag?

10) Foldable bag wallet

11) Feature local art on bags (potential art competitions)

12) Metal Mesh

13) grocery backpack

14)Woven basket

15) insulated crate (like food delivery companies use)

16) bento bag

17) Woven bag with tag for scanning

18) compartmentalized Bag

19) Bucket Bag

20) Recycled Feed Bags

Brainstorm on Materials to Use For Bags

<u>In similar products</u>

"Made from 99% recycled plastics"
Cotton
Nylon
Canvas

<u>Low environmental impact Materials</u>

Recycled polyester
Leftover textiles
Bamboo Cloth
Soy cashmere
Wool
Tencel
Hemp
Jute
Burlap

Deliverable 6: Proposed Design concepts, Idea Evaluation, Project Timeline, and Budgets

Top design considerations:

- Cost
- Capacity
- Ease of carrying
- Durability
- Sizes
- Cloth vs plastic materials

Top Three Bag Designs

	Pros	**Cons**	**Notes**
Foldable Bag	-Cheap - Can bulk orders with same screen printed design -can incorporate a theme/fun	-Since so flimsy will need barcode that is flexible and won't chip off Uses virgin material	-Durability depends on material - rayon will break faster than cotton. Can size up -Client suggested this and likes it
Upcycled Tote from recycled Textiles	-Durable. -Uses local material that would be wasted -Promotes reuse/ upcycling culture -More likely to be unique	-Do not know of existing manufacturers -May be more labor intensive since not mass produced	-Could get people involved by donating old clothes/jeans and giving them a discount
Drawstring Bag	- Can bulk orders with same screen printed design	-Does not hold as much, difficult to carry multiple at a time	-Requires more than one material

Deliverable 7: Prior Art Survey

Ziqra I. Raza

Annotated Bibliography

Fletcher, K. (2012). *Sustainable fashion and textiles: design journeys*. Routledge.

This book looks at nylon as textile which can be useful for knowing the usefulness for nylon as a material for a reusable bag. The approach it takes however is an analysis of the production and manufacturing of the material and its environmental impact. Production of nylon results in the release of nitrous oxide which is a greenhouse that has a significant contribution to global warming. Emissions from a single UK nylon plant in the 1990s were thought to have a global warming impact equivalent to more than 3% of the UK's entire carbon dioxide emissions. Is it not suited to natural dyes and the lowest impact chemical dyes (process of coloring the fiber) creates significant water pollution. More nylon being produced in countries with weaker environment protections in place makes nylon a significant contributor to water pollution.

Hart, S. L., & Milstein, M. B. (1999). Global sustainability and the creative destruction of industries. *MIT Sloan Management Review*, *41*(1), 23.

This research paper highlights that nylon is three time more energy intensive than cotton to produce. Nylon also on average takes about 30-40 years to break down. Nylon manufactured also creates nitrous oxide, which is a greenhouse gas that is 310 times more potent than carbon dioxide. Thus the manufacturing process is very energy-intensive. It is made from petroleum and is often given a permanent chemical finish that can be harmful. It is also very water intensive processing-wise and is generally non-biodegradable.

John, J., Mani, R., & Bhattacharya, M. (2002). Evaluation of compatibility and properties of biodegradable polyester blends. *Journal of Polymer Science Part A: Polymer Chemistry*, *40*(12), 2003-2014.

This research paper delves into the biodegradability of nylon with an introduction to the science of nylon and its properties. Nylon is a fiber forming polymer and is the largest group of long chain synthetic polymers. It is very resistant to wear and tear, temperature and chemical changes. It was first used in the fiber industry in 1935 and could be found in everything ranging from clothing to parachutes. Cheap artificial materials during the industrial age induced the creation f nylon. Pulped fiber from wood led to cellophane when then developed into nylon. There was hunger for artificial materials and nylon was the new synthetic substance.

Muthu, S. S., Li, Y., Hu, J. Y., Mok, P. Y., Mao, Y. F., Li, Q. H., & Wu, X. X. (2013). Assessment of eco-functional properties of shopping bags. *International Journal of Clothing Science and Technology, 25*(3), 208-225. doi:http://dx.doi.org/10.1108/09556221311300228

This paper looks at the development of a testing instrument that can be used to quantify the eco-functional properties for shopping bags. It defines a criterion that can be used to evaluate the ecological and functional properties as well as the reusability of shopping bags. Some of the factors it takes into account are impact strength and weight holding capacity of a shopping bag. The findings in the paper are that plastic bags outscore paper bags in the single use category and woven bags top the reusable bags category.

Norum, P. S. (2003). A comparison of apparel garment prices by national, retail, and private labels. *Clothing and Textiles Research Journal*, *21*(3), 142-148.

Nylon is a common fiber used for carpets because of its strength and long lifespan. The paper reports that nylon has a higher fiber content (more than 60%) than polyester. It is however the most expensive synthetic fiber available. It can cost $8-$45 per square yard whereas polyester can cost around $6 to $15 per square yard. Nylon is more durable however its manufacturing process is also not environmentally friendly and the material is not biodegradable. Nylon does have a better stretching property, around 7-10% WLL whereas polyester is 2-3% WLL. This allows nylon to stretch more when lifting a load with little potential for it to 'snapback'. Nylon is not as well suited for delicate loads compared to polyester.

Lauren Chew

Annotated Bibliography

Arzumanyan, G. (2004). *Municipal Solid Waste Management in Armenia Current Trends and Steps Forward.* (Master of Science in Environmental Management and Policy), The International Institute for Industrial Environmental Economics, Lund, Sweden.

- Though a little outdated, this paper gives information on the values and policy trajectory in Armenia when it comes to municipal solid waste and the environment.

Butler, P. R. (2008). *Composition of Solid Waste in the Berd Municipal Dump in Tavush Marz, Armenia*.

- Gives information on how big of a problem plastics are in Armenia. They make up 37% of trash by volume. Also provides background on Armenia with descriptions of the resources and sociopolitical history that produced the current situation.

Hsiou-Lien Chen, L. D. B. (2006). Environmental Analysis of Textile Products. *Clothing and*

Textiles Research Journal, 24(3), 248-261. doi:10.1177/0887302X06293065

- This article evaluates the processes used to produce polyester and other materials and measures their potential environmental impacts.

Manoukian, E. (2018). Banning Single-Use Plastics: Can Armenia Take Out the Trash for Good? *The Armenian Weekly*.

- Gives background on plastics in Armenia. This is important for understanding the cultural and political background to our project. It also informs us of what technologies are being pursued. Tells us that it is on the national radar - likely competitive. One important note is that plastic bags were attractive because of convenience, perceived luxury and abundance. There is a cultural draw to plastic because reusability is associated with hardships and scarcity of Soviet life.

Subramanian Senthilkannan Muthi, Y. L., J.Y. Hu, P.Y. Mok. (2012). Quantification of Environmental Impact and Ecological Sustainability for Textile FIbres. *Ecological Indicators, 13*(1), 66-74.

- This article examines how various textiles impact the environment during manufacturing. It measures environmental impact through a life cycle impact assessment tracking greenhouse gases, land use, use of chemicals, energy consumed, recyclability, and biodegradability.

Rujuta Munshi

Annotated Bibliography

Bisinella, V., Albizzati, P. F., Astrup, T. F., & Damgaard, A. (Eds.). (2018). Life Cycle Assessment of grocery carrier bags. *The Danish Environmental Protection Agency,1985*. Retrieved April 30, 2019, from https://www2.mst.dk/Udgiv/publications/2018/02/978-87-93614-73-4.pdf.

The key take away from this study is that if a plastic bag is used once and disposed of, how many times would an alternative need to be used to be better. Reusable polypropylene bags - 37 reuses, paper bags - 43 reuses, cotton bags - 7,100 times. The surprising thing is that in terms of energy paper needs to be used more than once. It's important to keep in mind that some factors may be weighted differently - plastic in the ocean is more dangerous than paper in the ocean. Cotton is a resource intensive product to grow, and for

this project should only be used as a material if it is being upcycled. By upcycling, I mean that it should be used here if the textile would otherwise be disposed.

Chaffee, C., & Yaros, B. R. (n.d.). Life Cycle Assessment for Three Types of Grocery Bags - Recyclable Plastic; Compostable, Biodegradable Plastic; and Recycled, Recyclable Paper. Retrieved April 29, 2019, from https://plastics.americanchemistry.com/Life-Cycle-Assessment-for-Three-Types-of-Grocery-Bags.pdf

This article goes into a detailed LCA of three different types of bags, under different post use conditions. The three bags used were a "traditional grocery bag made from polyethylene, a grocery bag made from compostable plastics (a blend of 65% EcoFlex, 10% polylactic acid or PLA, and 25% calcium carbonate), and a paper grocery bag made using at least 30% recycled fibers." The results showed that based on proper use and disposal (assuming compostable bags are composted, recycled ones are recycled, and so on. For the same carrying capacity as 1000 paper bags, polyethylene (single-use plastic bags) had the least energy, water, and fossil fuel use along with the least municipal waste and greenhouse gas emissions. This is helpful for us because it helps us realize that many options that seem better for the environment are not actually better than single-use plastic bags.

Diringer, Jeremy Alan, "Evaluation of Durability of Nonwoven Polypropylene Grocery Bags Under Routine Use" (2016). All Theses. 2476.

The portion of water used, even if just added into an existing load has an environmental cost higher than single-use plastics. The bags were tested by undergoing walk tests (175 feet with groceries and 125 cycles per bag) with washes at every 25 to determine if washing the bags had an impact on the lifespan. The walk tests were later determined as an inaccurate representation since testing until failure took too long and the variation in load cycles was not represented. When testing our bags for ergonomics, we should know how far the typical person in Armenia walks carrying groceries. The load test (ATP 001) to test for breaking is done with an evenly distributed concentrated mass rather than clumps of uneven masses which could better represent groceries. Over 75% of these test led to failures at the seams, usually the upper corners. The non-woven polypropelyne (NWPP) bags all broke at the seams, rather than by creating tears in the material, which is something our client should understand is a manufacturing quality that may be hard to modify is she chooses to import in bulk.

Greene, Joseph. (2019). Life Cycle Assessment of Reusable and Single-use Plastic Bags in California.

The overall recommendation of this paper is that a reusable bag with the lowest environmental footprint should be as light as possible and be made from recycled material. Due to a lack of recycling infrastructure, the US cannot make bags from 100% post-consumer resin (PCR), but the best alternative is a polyethylene-based reusable bag with 40% PCR. From this, it is important to look into the the recycling infrastructure in Armenia and help our client understand that importing does have environmental costs.

Waxer, C., & Waxer, C. (2019, April 12). Eco-friendly initiatives focus on plastic gift cards. Retrieved April 30, 2019, from https://www.creditcards.com/credit-card-news/eco-friendly-green-gift-cards-plastic-1273.php

This article talks about the environmental impacts of plastic gift cards, which are similar in material to the membership cards used for rewards in Armenia. 17 billion cards are produced worldwide annually, which soon end up in the landfill. The plastic used in the produces carcinogens during the manufacturing process. This is an added element to the LCA when we compare the impact our barcode bag is making.

Deliverable 8: Design Review

Project Background

1. Client: Irina Mkrtchyan, a Humphrey fellow from Armenia but currently based out of DC. She is working on an initiative called "Recycle it!" where they are trying to promote waste sorting and recycling
2. Culture Context: Plastic bags are widely used and accepted throughout Armenia. They are associated with the coming of the free market and the end of the scarcity caused by Soviet rule. People currently don't use them because they are "ashamed" and think they are not convenient. She says that there are a few different organizations actively working on increasing public awareness about zero waste, sorting, recycling, etc and so the time to change these high-waste behaviors is now.
3. Purpose(identified by the client): to decrease the consumption of single use plastic bags by 40% within 1-2 years. Wants to produce 10,000.
4. Project Goal: To provide a bag design (material, shape, logo) with a barcode that can be linked to store's rewards system that she can send to interested companies

Design Process

Relevant Prior Art (brainstorm and research)

1. Points Tracking systems: loyalty cards, phone numbers, separate barcode held at the register
2. Considerations and Table with Criteria and Evaluation Methods

   Explain printout → waiting on confirmation from client

   We decided to not include social criteria such as being fair trade during these first stages of design.

Proposed Design Concepts

1. Materials for Bags - evaluated by carrying capacity, the number of times it needs to be reused to have less environmental impact than a single use bag. Also took note of how convenient it is to carry when not in use by considering the weight of the bag and how small it can be folded up.

   Explain Matrix

   Our top 3 → checking with client to see what she thinks
   a. Jute: environmentally friendly, not foldable, so would require a nice print design, recommended to spot treat or hand wash
   b. Heavy Duty LDPE: needs nice print on it, easy to clean, can be wiped down
   c. Polyester: Can create foldable design, logo does not stay on when washed,
2. Bag structure:
   d. continuous bag to handle with all one lightweight material (polyester)
   e. separate pieces, can have one or two materials (Lightweight LDPE or Jute)

Timeline

Week 6: D-lab graphic designer working on logos/ possible graphics for the bag, decide specifics of materials, get client feedback.

Week 7-8: purchase and test 3 different bags, potentially buy material and sew our own/ modify bags based on wear they experience as we test them.

Week 9: create mockups of bag + design to show the client