PET BOTTLE STRIP CUTTER

VILA NOVA ESPERANCA, BRAZIL

D-LAB II FINAL REPORT

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SUMMARY

Trash is a big problem in Sao Paulo, Brazil. UC Davis students Ryan Pang and Daniel Quinn from D-Lab have worked to design and prototype a PET Bottle Strip Cutter for Miguel Chavez in the Innovation Center-Vila Nova Esperanca. The problem with the existing bottle strip cutter currently used by the center is that the design will not allow for adjustments to be made in the size of the plastic string created and is not set up for different sized plastic bottles. Cutting bottles into strands of plastic is important because the string can then be woven to make items such as chairs, green houses, fencing, and more. These products can generate income to improve the lives of people living in poverty. Additionally, in improving this design we can decrease the amount of plastic trash accumulation by repurposing it to create desirable goods.

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1. DESIGN BRIEF

CLIENT

The Innovation Center at Vila Nova Esperança is a leading makerspace. Established in January 2014, the Innovation Center is a hub for projects that bring technologies, design, and innovations to the favela community outside of São Paulo, Brazil. The Innovation Center's main goal is not just to provide workshops and activities for the community, but to use innovation tools, such as the PET Bottle Strip Cutter, to engage Vila Nova Esperança and other low income communities in the process of building their own way out of poverty.

MIGUEL CHAVES
Direct, IC-VNE
Mentor and advisor
Bi-weekly Skype calls;

PATRICIA DRANOFF
Design Student, Rhode Island School of Design
Partner working on
Plastic strip use
Two Skype calls;
Email collaboration

INTERNATIONAL DEVELOPMENT INNOVATION NETWORK
Offered support and knowledge on similar projects in Different regions

PROBLEM

Excessive garbage waste and low-to-nonexistent incomes are two great challenges in Brazilian favela communities. A PET Bottle Strip Cutter makes use of plastic bottle waste while also producing raw material for users to create new products for income generation. Current cutter designs, however, have limited functionality in the size of bottle and a strip width they are able to accommodate and must be improved.

GOAL

The goal of this project is to improve upon the current cutter design in a way that allows the user to easily adjust the width of strips produced and adapt to different sized PET bottles.

USER

The target users are individual entrepreneurs and organizations, such as recycling cooperatives, who will make new income-generating products out of plastic strips or use strips to replace expensive inputs, such as rope/string, currently used in their business operations. Examples of income generating products include chairs, fencing, baskets, and greenhouse roofing made from woven strips.

Greenhouse with woven plastic strip roofing

Basket from woven plastic strips

SPECIFICATIONS

As per the clients needs, it was determined that the design must make it possible to adjust the width of plastic strips, adapt to different sized bottles, and accommodate bottle that are shaped with varying diameters, as these are most common in Brazil. Additionally, the design should be safe, easy to assemble, and easy to operate.

BENCHMARKS

Although there are many iterations of this design, Russian designer Адвокат Егоров found on Youtube has created an efficient design to strip plastic bottles for all sizes into super strength plastic string.

Dr. David Saiia, a professor of strategic economics and sustainability at Duquesne University has created a solution to strip plastic bottles from a handpowered machine.

METRICS FOR EVALUATION

According to the described design specification, an evaluative matrix was set to guide the design process and ultimately measure the appropriateness of the final design. Evaluation will be based on a total of 6 objectives: (1) Ease of construction; (2) Ease of use; (3) Versatility; (4) Consistency; (5) Use of recycled materials; and (6) safety. Both quantitative and qualitative measures were selected for performance indicators. Most of the evaluation metrics can be tested here in Davis, however, a few require user experience feedback and focus group data to completely measure. These are the metrics pertaining to users perception of ease of use and construction. A complete evaluative matrix and final design performance can be found in the "Results" section.

2. DESIGN PROCESS

ITERATIVE DESIGNS

We started prototyping by "unpacking" the original design (Prototype 1) used in Brazil to find strengths and limitations of the design. The first thing we noticed was the need to replace the round-wood support for the bottle, as it was set to only support one bottle size. The blade was also fixed in place, producing only one width of strip that measured the distance between the cutter base and blade height.

From here, we created a prototype (Prototype 2) that did away with the circular wooden support in favor of a long wood or metal strip with many riveted strips cut into it where the bottle would slip in, being supported at two opposite sides. This solved the problem of using bottles of different diameters, but did not accommodate a single bottle that had a varying diameter shape, and still had a fixed blade. Additionally, we found it was difficult to keep the bottle from skipping out of the "tracks" as it spun.

Rather than having sunken tracks for the bottle, we thought the design could be improved by stretching the bottle between raised metal poles. This led to Prototype 3. Here we faced many of the same problems with the bottle slipping out while in motion unless it was stripped very slowly. It was also hard to operate without two people, as one person was required to place downward pressure on the bottle while the other pulled the strip. We also face challenges securing the razor blade in a safe

fashion between the pipes and abandoned the prototype before resolving the problem of how to secure the razor blades in place.

Prototype 1: Original design from brazil

Prototype 2

Prototype 3

Prototype 3

FINAL DESIGN

Realizing the difficulties of a vertical bottle, we went back to our benchmark research and decided to try a design that held the bottle perpendicular to a vertical cutter at 90 degrees. Thus, the final design is a combination of 3 of our previous designs utilizing an angle iron. The final design accommodates bottle sizes of any size and diameter and has also been cut to feed three different plastic strip widths. More feeds can but cut into the angle iron but the maximum strip width is limited by the 20mm width of the iron. The design does require the user to precut the bottom

of the bottle off to get the stripping process started as the other design did, saving time. Although the user is required to manually cut off the bottom of the bottle, the design can pre-cut the bottom of the bottle to feed through the different length slits. The design also provides a cut out of the angle iron so the bottom of the bottle can feed through without any interference. While using the pre-cut feature, the user must insert a metal dowel into the nozzle of the plastic bottom and slipping the metal dowel over the bolt while moving the metal dowel from a 45 degree angle for the initial cut to a 90 degree angle once the stripping is in process. The results are consistent, the design allows different plastic strip sizes, accommodates different bottle sizes, ability to replace razor blades, and most importantly, it is safe to use.

Final design showing inside of angle iron with blade attachment on right side and cutting strip widths on left.

Outer view of final design. Width of strip is determined by the right hand side width of the three slits shown between the screws.

Materials and tools used to fabricate final product

TOOLS

	Item	Quantity
	Vice	1
	Wrench (11mm)	1
	Hacksaw	1
	Mig welder	1
	Drill press	1
	C-Clamp	At least 2
	Angle Grinder	1

	Sand Paper (course)	Pack

SUPPLIES

Item		Amount
	24” Angle Iron	1
	7/16-20” x ¾” Hex Head Screw	2
	7/16” wing nut	2
	Razor blade	Many
	7/16” washer	2

3. RESULTS

Our result is a simple, easy to construct bottle cutter that meets or exceeds 10 out of 14 of our target performance indicators, with the remaining 4 still to be evaluated based on actually user experience in Brazil. These include performance indicators on perceived ease of construction, perceived ease of use, percent frequency of a continuous and complete bottle "strip", and percent recycled materials. The only one of there remaining indicators to be measured that we do not expect to meet is the target of 80% recycled materials. Ultimately, our designed prioritized an effective tool over the use of recycled materials and we believe that with only 5 relatively inexpensive materials required to built, the final design is still accessible to those with limited incomes. The table below contained the complete results from our testing.

Consideration	Metric(s	Target	Final Result
Ease of Construction	**1. # of materials 2. # time to build 3. # of people to build 4. Perceived ease by builder (likert scale)**	**1. Less than 8 2. Less than 2 hours 3. 1 person 4. Very easy**	**1. 5 materials 2. ~ 1 hour 3. 1 person 4. TBD**
Ease of Use	**1. Time to strip 1 bottle 2. # of people use 3. Perceived ease by user (likert scale)**	**1. Less than 30 seconds 2. 2 or less people 3. Very easy**	**1.~15-30 seconds 2 1 person 3. TBD**
Versatility	**1. Range of bottle sizes that can be stripped (in fl. oz sizes) 2. Range of strips that can be made (in mm)**	**1. From 20oz up to 2 liter 2. From 3mm to 20mm**	**1. Up to 2 liter w/ varying diameter 2. From 8mm to 12mm**

Consistency	**1. Variation of strip width after initial "evening out" 2. % frequency of continuous complete bottle "stripping"**	**1. +/- 1mm 2. 9/10 tries**	**1. < +/- 1mm 2. TBD**
Use of Recycled Materials	**1. % of total materials that are from reused waste material**	**1. 80%**	**1. TBD**
Safety	**1. Exposure of blade 2. # of accidents**	**1. Not exposed 2. Zero**	**1. Not exposed 2.Accident free**

4. CONCLUSION

The IC-VNE is determined to make use of plastic waste and continue experimenting with commercial products made from PET plastic strips. We believe that the final result of this project will be of great benefit to the center and their goals. Overall, we are very pleased with the final design created for the bottle cutter and the design process in general. High quality communication with partners and collaboration between builders led to this success. The final design is simple, easy to construct and use, durable, cheap, and most of all fun to use. The next step will be field-testing in Brazil and we fully expect ultimate success for the design and PET bottle strip activities generally.

5. RECOMMENDATIONS

There are several recommendations for the design of this PET bottle strip cutter moving forward. First, a base should be attached. Currently the design is held in place by a vice, but we realize this is probably not an option for the ultimate user. The cutter could easily be welded to a metal plate so that it can simply be clamped to a tabletop. Further, we'd like to attach a pivoting bar support. We are cutting the bottle at a 45-degree angle to the angle iron to start the cut then placing a bar support and moving to 90-degrees to continue the cut. If the bottle could just easily be placed on a pivoting bar support initially, cut at 45-degrees, and then moved to 90-degrees in one motion, we think this would be an improvement. It may also be

possible to create a spooling mechanism to collect lengths of plastic strip. Finally, if these cutters were to be made at a large quantity, it would be helpful to create a simple jig that can lead to consistent and accurate fabrication.

In addition to recommendations on the design itself, we have several recommendations regarding the project generally. First, we'd recommended a thorough environmental analysis of the plastic waste and strips that are created. How are they being used? How are they ultimately disposed of? Are there any unforeseen addition environmental risks to plastic strips over bottles? These are all questions that should be answered, though outside the scope of this project. Some resources have been provided in the bibliography to start to analyze this topic. We are also interested in the work that others are doing to find creative uses for plastic strips and markets for both the cutter itself and plastic strip products and recommend further study in this area.

6. ANNOTATED BIBIOLOGRAPHY OF BACKGROUND MATERIAL

"Matatas". "PET string cutter (string from plastic bottles)." Instructables. Retrieved 4/29/2015, 2015, from http://www.instructables.com/id/PET-string-cutter-string-from-plastic-bottle/.

This is an instructable website for a PET Bottle Strip Cutter Design. It consists of a cutting blade secured in place by two stacks of washers around a threaded rod held in place by a wing nut. A bottle of various sized is pre-cut and placed between the two threaded rods, which support it's weight. Once in place the pre-cut edge is pulled out as a string, turning the bottle so that the blade continuously cuts through the bottle. Strings of varying width can be made by adjusting the height of the blade from the wood platform.

Beecheno, K. (2013). Recycling and Waste Management in Brazil: Overview Report, University of Essex.

This report provides a comprehensive overview of the issues around waste management and recycling in Brazil.The report begins with a brief summary of the system of waste management in Brazil, highlighting key points to be explored in greater depth later. It describes waste management in a policy context; waste recycling and collection statistics; the role of waste pickers; division of responsibility for waste management, and the moral economy of recycling.

Friedenbach, M. (2011). Tool for cutting used containers of recyclable plastic material into ribbons, Google Patents.

***A patent for a PET Bottle Strip Cutter** tool. The tool includes a toolhead having an opening, a cutting blade housed inside the opening and a slot open above and extending perpendicular to the plane of the blade, downwards through the toolhead a short distance past the blade. The blade has a sharp edge across the slot. The slot receives the edge of the bottle obtained by cutting off the bottle bottom or the funnel and spout thereof. The edge is inserted in the slot and the bottle turned so that the blade cuts through the bottle following a spiral path and producing a ribbon of PET material at an outlet side of the slot.*

O.I Nkwachukwu, C. H. C., A.O. Ikenna, and L. Albert. (2013). "Focus on potential environmental issues on plastic world towards a sustainable plastic recycling in developing countries." International Journal of Industrial Chemistry 4(34): 1-13.

This paper outlines environmental concerns of many plastic products and applications. It outlines the most important mechanisms of degradation of plastics, environmental impacts and recommendations for sustainable development.

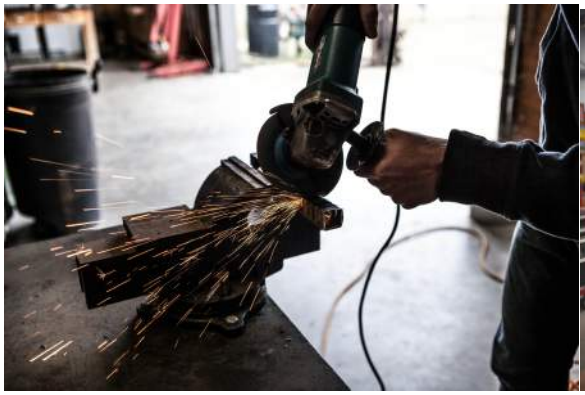
T.M Coelho, R. C., J.A. Gobbo Jr. (2011). "PET containers in Brazil: Opportunities and challenges of a logistics model for post-consumer waste recycling." Resources, Conservation and Recycling 55(3): 291-299.

This paper describes the opportunities and challenges of the logistics model forpost-consumer PET bottle recycling in Brazil, while providing knowledge of its practices along the recycling chain. The results describe the need to educate those directly and indirectly involved in the process; to reduce consumption in order to reduce the amount of waste generated; to structure the post-consumer reverse chain and engage industrial sectors and government, through public policies, to support cleaner technologies along the PET bottle production chain.

7. PHOTO APPENDIX

Concept 1


Concept 2




Concept 3


Final Design