Glass Crusher for the Maa Trust

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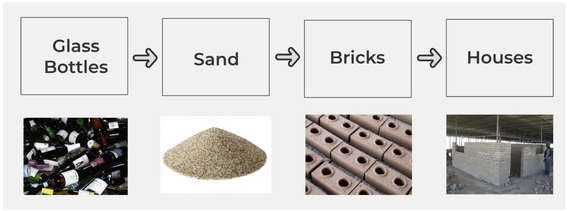
Project Motivation

The Maa Trust is an organization that aims to develop its local community by providing jobs and educating youth. One way this mission is taking form is through the research and creation of a glass crusher that converts recycled glass bottles into fine sand to be repurposed into bricks for construction.



We are creating an effective design that accommodates conditions and circumstances in the Maasai Mara and contribute to the goal of improving the livelihood of the Maasai people.

Our project is aimed at two components of the Maa Trust Initiative:

Education and Skills

Sustainable Livelihoods

While glass crushing machines do exist, the Maa Trust required one that was: 1. Smaller in size 2. Convenient and portable
3. Built with parts that are easily replaceable.

Ideation

Overview: Two part crushing mechanism powered by diesel or mechanically

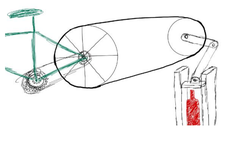
CRANK SLIDER

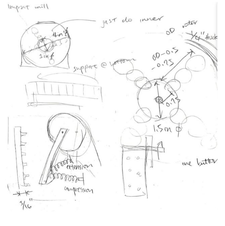
Technical Requirements:

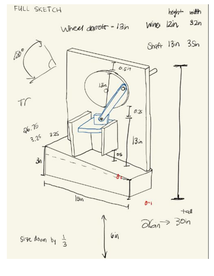
- Effectively crush glass bottle into smaller pieces to go into impact mill
- Have reliable motion
- Multiple ways of powering the device

Development Phases

1. Creating a proportionally dimensioned CAD Assembly to be laser printed
2. Creating device to crank slider at varying angles
3. CURRENT: Bike powered crank slider







IMPACT MILL

Technical requirements:

- Effectively crush small pieces of glass into fine sand
- Have a simple design that is durable and easy to repair

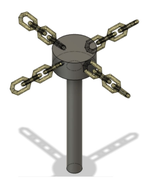
Development Phases

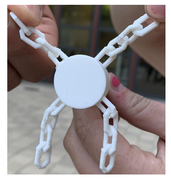
1. Creating a preliminary foam core prototype to test the motion
2. Creating a PLA prototype powered by a motor
3. Creating a prototype with real chains to test breaking ability

Design

Prototyping the Impact Mill

Foam Core Chains + Body → 3D Printed Chains + Body → Steel Chains + 3D Printed Body





Final Prototype Design Features:

- Steel chains attached to a PLA centerpiece
- PLA body
  - Cut out inlet for insertion of material to be crushed
- Acrylic lid secured to body with screws and nuts
  - Cut out outlet to allow crushed material to exit
- Mesh over outlet
  - Regulate size of crushed material

Design Validation and Testing Results

Crank Slider – Bike Analysis

Gear (difficulty)	*Speed Ratio*	*Mechanical Advantage*	*# of Rotations in 10 minutes*
Low Gear	.882	1.13	529.4
Mixed Gear	1.92	.52	1152
High Gear	4.18	.239	2509

- To test the feasibility of the bike powered crank slider, we decided to do an analysis of the speed ratio and mechanical advantage of different gear configurations to account for different biking abilities using our current planned dimensions
- **LOW GEAR**: produces more force out than the force put in, however, this would require longer periods of pedaling in order to have more impacts on the bottle
- **HIGH GEAR**: produces less force out that the force put in, however, shorter periods of biking would result in more impacts on the bottle
- **MIXED GEAR**: the most realistic setting as you get a middle ground for the mechanical advantage and number of impacts

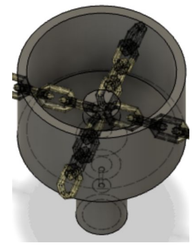
Impact Mill

- Metrics of success: Impact mill can **crush a potato chip into fine sand → success**
- The initial prototype was constructed using PLA chains, however, force analysis revealed that the PLA chains were not strong enough to support the centrifugal force from the motor
  - Based on this analysis, the prototype was modified to use metal chains, as these are stronger and more durable
- Learnings from testing:
  - The depth of the body must match the chain assembly to optimize the crushing area
  - Around ¼ of the last chain link should overlap with the walls of the body when fully extended

Challenges and Reflections

Our biggest challenges happened in the ideation phase of our project as we were stuck between several different designs that each had their own strengths and weaknesses. Additionally, we had some difficulty 3D printing the chains as they were a relatively complex construct to print.

Looking back, we should have spent more time finding and consulting experts, especially those in Kenya (like Kirumba), as this was a big turning point in the project as it validated our current plans.



Future Work

Impact Mill

- Finalizing dimensions of Impact Mill
- Creating metal prototype of impact mill and testing with glass
- Continue developing and adapting operations sequence

Crank Slider

- Begin testing with actual bike crank
- Test amount of force needed to break wine bottle
- Continue analysis of gears with considerations of amount of force needed, height of crank slider wheel, weight of sliding arm

General

- Begin considering the body of both the impact mill and crank slider
- Ideate ways to safely transfer glass from the crank slider to impact mill
- Find optimal diesel powered motor to balance power usage and effectiveness

Acknowledgements

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