EWB Human-Powered Sorghum Press

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Abstract

A sorghum press extracts a nutritious syrup from the stalks of sweet sorghum plants that can be processed to produce a molasses-like sweetener. Through this syrup production, business opportunities are created for the villagers of Dissan, Mali.

Figure 1 (right): Sorghum ear-heads.

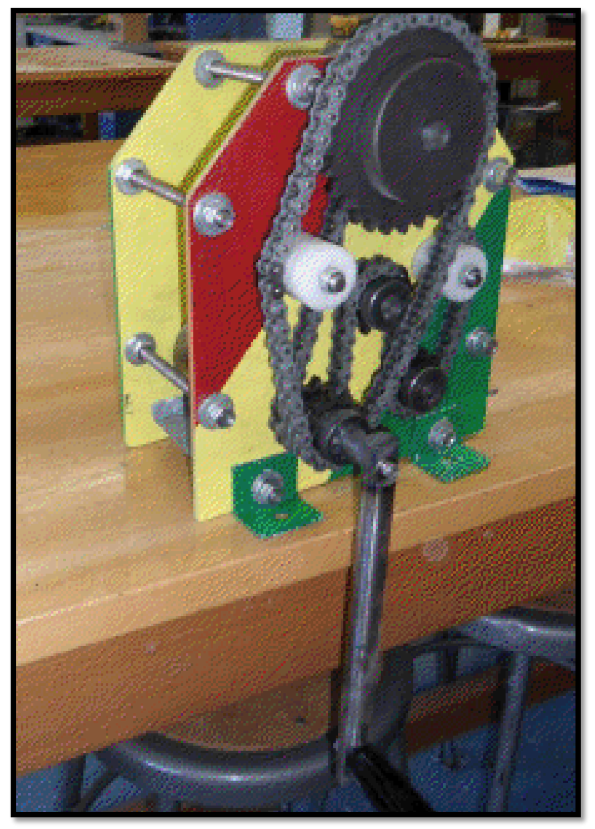

Figure 2: The 2009 EWB press.

A sorghum press design, shown in Fig. 2, was made for this community by the Engineers Without Borders team in 2009. After this prototype was used for a season, the people of Dissan requested a new design that allows for increased sorghum throughput while maintaining ease of manufacturability and low cost.

This year, a fully functional press prototype was made by February and a final press with design iterations was completed by May. The final press was proven to be fully manufacturable in Mali and has a throughput twice that of the 2009 press.

Design Objectives

Feedback from the Malian community and extensive research yielded six important performance criteria.

Performance Criteria	Value to Meet	Value Achieved
Human Powered	Input Torque ≤ 240 N*m	65 N*m
Extracts Sorghum Juice	Crush sorghum to ≤ 5.1 mm	✓
Increased Throughput	Process sugar cane at ≥ 10 cm/s	14.2 cm/s
Fully Manufacturable in Mali	Confirmed by Scott Lacy	✓
Affordable	Retail cost of materials ≤ $550	$381.93

Table 1: Performance requirements with desired and achieved values.

References

Patents: 544972 Aug 20, 1895; 96264 Oct 26, 1869; 31828 Mar 26, 1861.

Figure 3: Final CAD model.

Figure 4: Final press.

Analysis and Testing Results

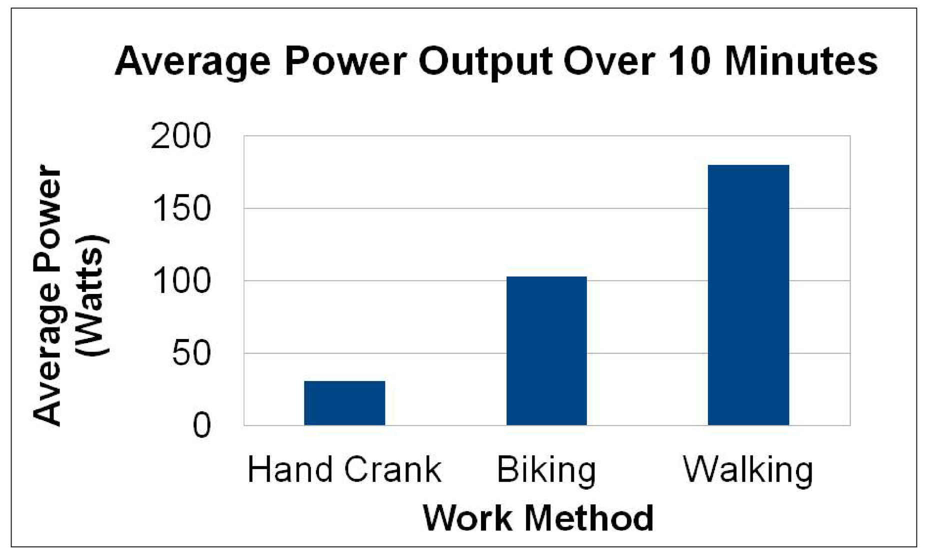

Figure 5. Human power test results.

To determine the best way to harness human power, we tested various power input methods. We found that the walk and push method was best for sustained power output as shown in Fig. 5.

Finite element analysis and testing, shown in Figs. 6 and 7, were performed in order to determine the critical mode of failure for the rollers. After trying different standard materials, a SCH40 steel pipe was determined to be the best choice to combine high strength and low cost.

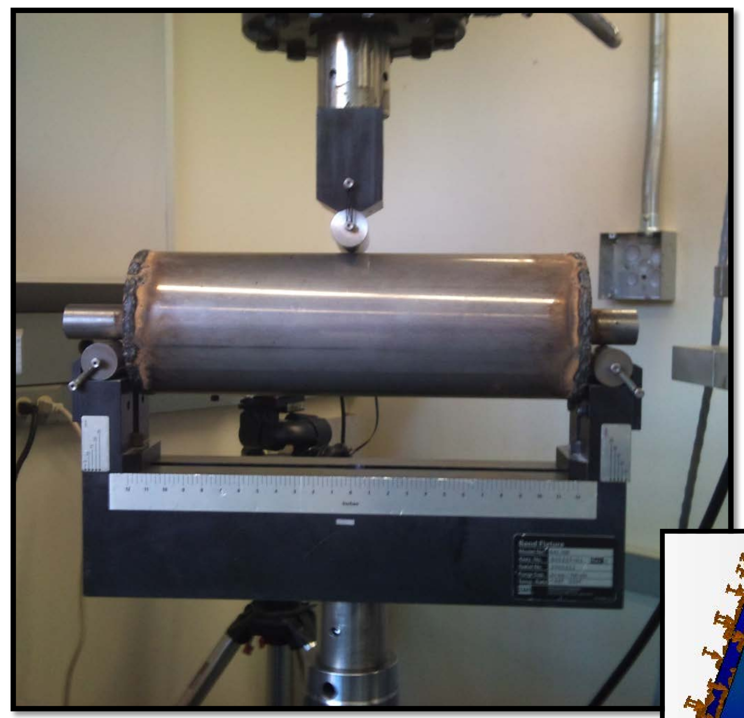

Figure 6: A three-point bend test done on the rollers yielded a safety factor of 5.3.

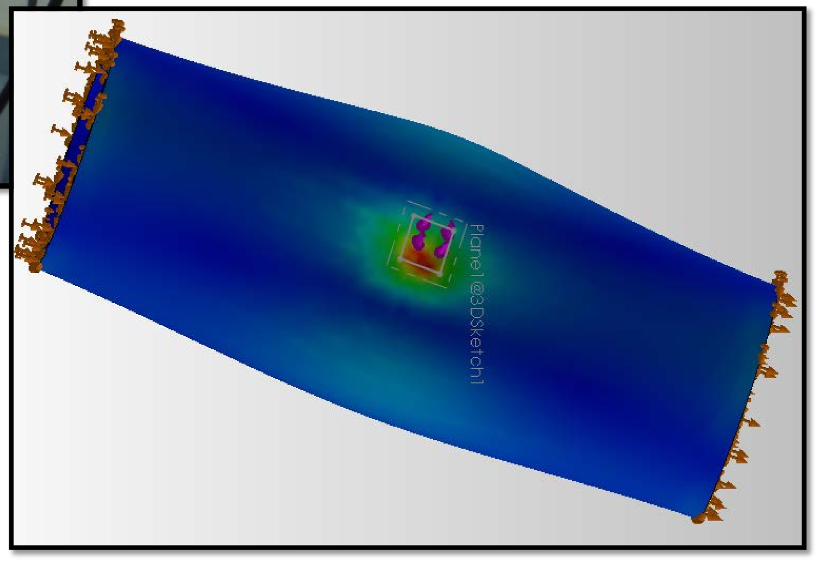

Figure 7: Finite element analyses with various types of loads yielded safety factors ranging from 2.3 to 6.

Prototyping Results

A prototype was constructed and extensively tested in the winter of 2012. Observations made during testing of the prototype resulted in a refined design including the addition of channels, milled longitudinally on the roller surface, to enhance "gripping" of the stalks during feeding.

Figure 8: Prototype in action, Winter 2012.

Manufacturability and Throughput

To verify our design could be fully manufactured in Mali, we had the most complicated component of our press, the gears, made by Malian machinists. These gears, pictured in Figure 9, have been used successfully in our prototypes.

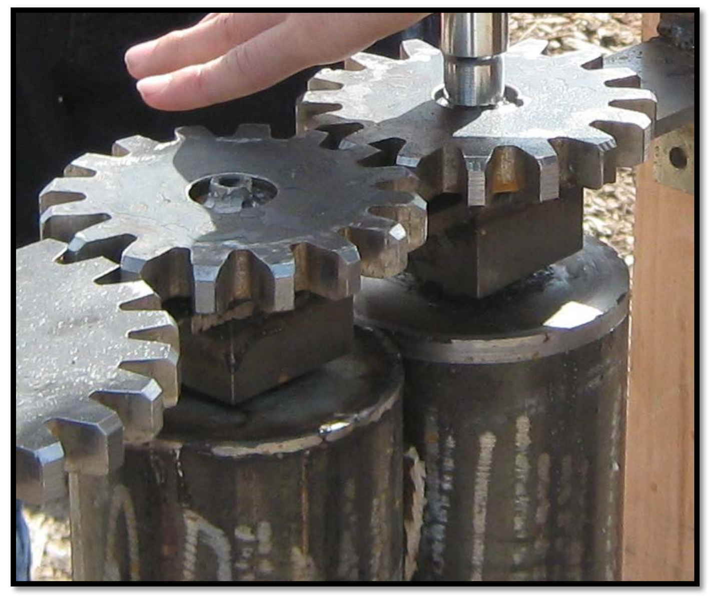

Figure 9: Gears that were manufactured in Mali by a local machinist are successfully being used on the current press.

Testing yielded a throughput of 14.2 cm/s for sugar cane, which is much larger in diameter than sorghum. This value is twice the throughput of the 2009 press, successfully meeting the most important request of the community.

"You knocked this project out of the park…you literally addressed every single concern and request I documented from Dissan farmers who used the first press. You may not fully grasp just how transformative your new press design [will] be. [You have created] an ideal machine to produce and use in Mali!"

---Scott Lacy, Executive Director of African Sky

Acknowledgments

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