

Design Problem

Duke researchers want a more efficient way to collect and isolate mast for research purposes. Our solution is a device which will collect falling mast in the Duke Forest and separate them from other debris (eg. twigs, leaves, pine needles).

Background and Motivation

Fig. 1 Mast Genus in Duke Forest



Hickory mast Red Oak mast Beech tree mast

Mast play an integral role in forest ecosystems as a primary food source and as a key reproductive mechanism, so knowledge of masting patterns is essential. Our device will:

- Aid collection process for Duke researchers conducting studies on masting cycles
- Serve as a mechanism for public outreach in the Duke Forest

Design Criteria

Design Objective	Target Value
Filtering accuracy	Filter out debris from collected materials with $\geq 80\%$ accuracy
Collection accuracy	Collect $\geq 80\%$ of mast that fall from the canopy
Durability	≥ 3 months (1 season) without critical failure
Low maintenance	≥ 2 weeks with no maintenance
Low cost	$\leq \$500$
Easy to set-up	≤ 30 minutes for 2 people to set-up

Final Solution

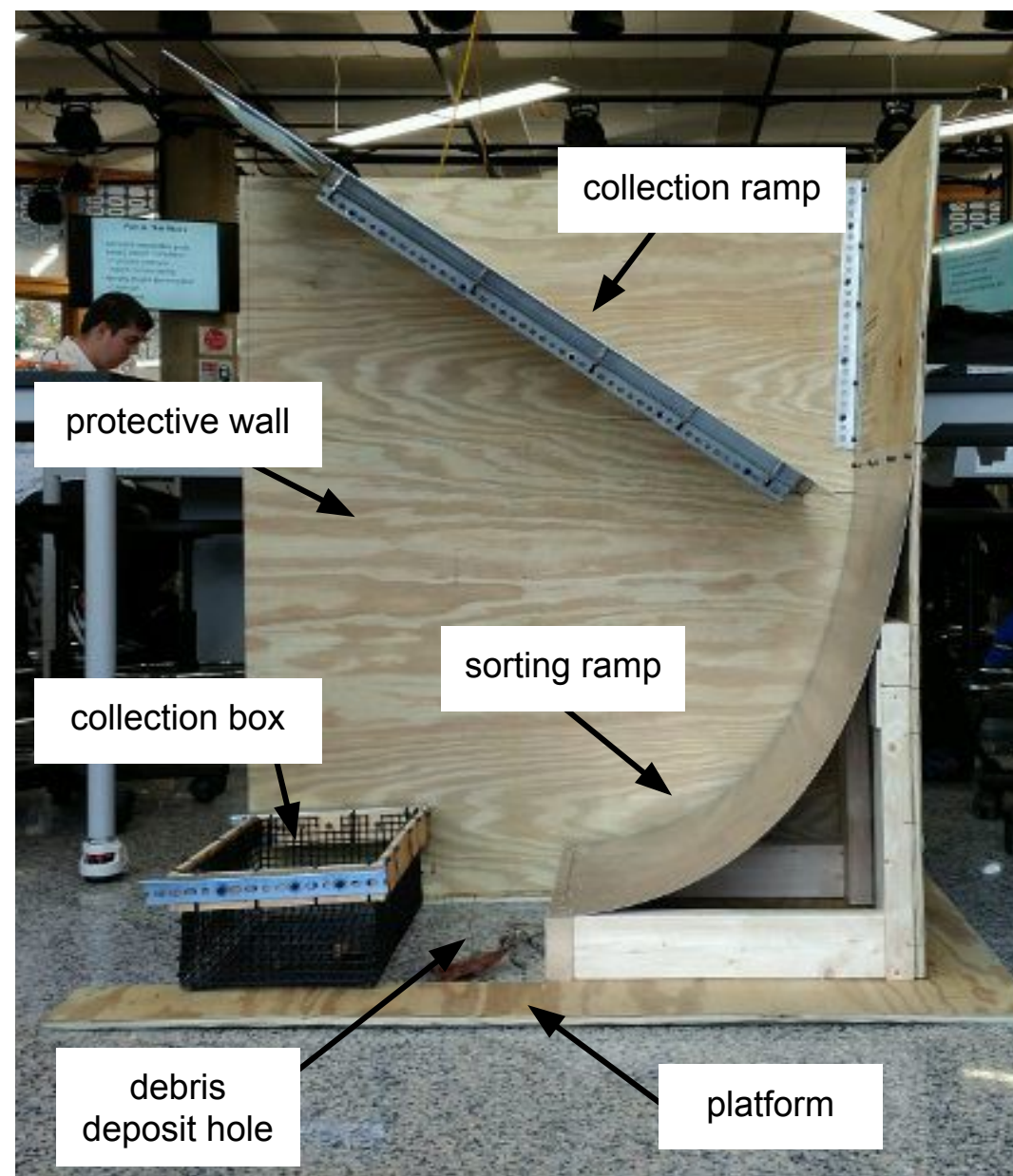


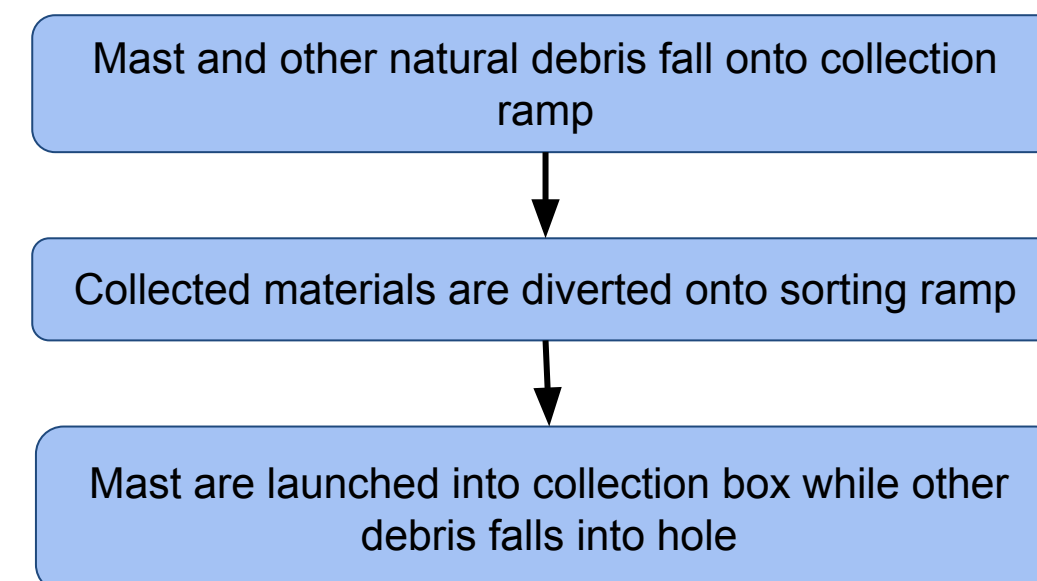
Fig. 2 Inside of final solution

Simulation for Prototyping:

A range of distances for the collection box was obtained through a Python model which simulates the behaviors of mast and debris in the device. The model also helped inform the device's dimensions

Device Sorting Mechanics:

Our final prototype uses the greater kinetic energy and momentum of rounder mast to sort them from irregularly-shaped debris:



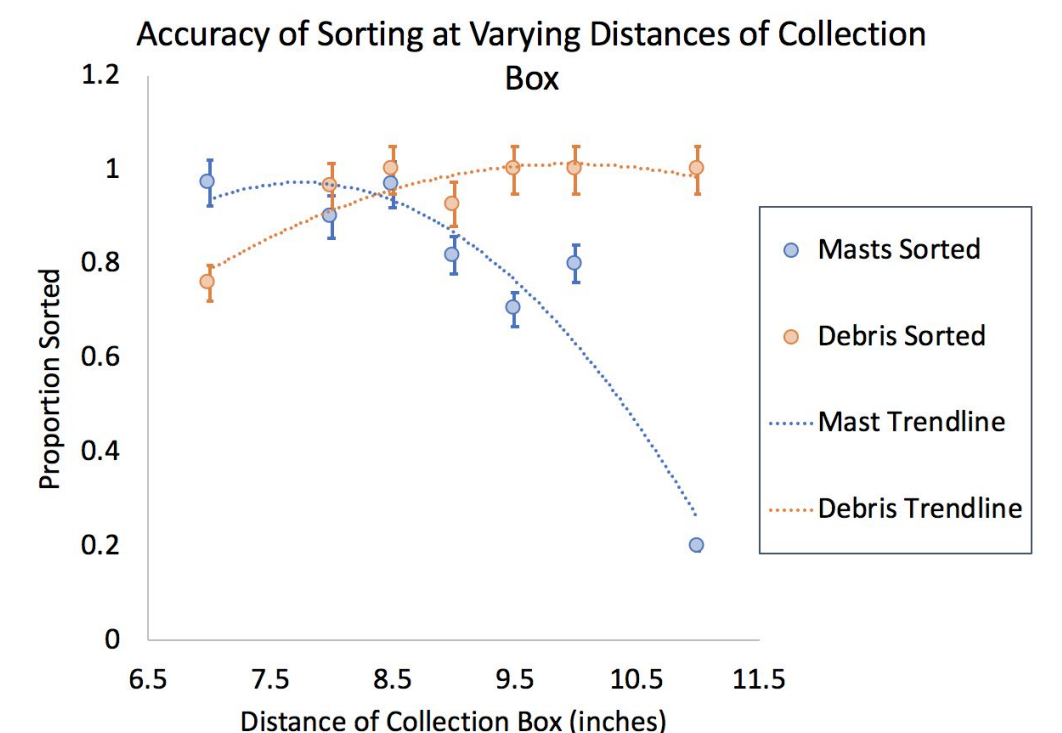
Device Mode of Display:

A panel of acrylic on the front of the prototype (not pictured) will allow visitors to view the sorting process. The sorted masts will be visible through the wire mesh collection box.

Testing

Design Objective	Test	Results
Filtering accuracy	Drop debris into device	$\sim 97\%$ at 8.5 in.
Collection accuracy	Drop mast into device	100% at 8.5 in.
Durability	Spray with water; drop branches	TBD
Low maintenance	Drop high volume of debris into device	0 masts/debris caught
Low cost	Client consult regarding cost	\$323.61
Easy to set-up	Have 2-person team set up device	TBD

10 masts and 10 sticks were dropped from ~ 10 feet in each trial shown below. We chose 8.5 in. to maximize filtering and collection accuracy.



Conclusion

The final design prototype fulfills the design objectives in terms of accuracy, maintenance, and cost, acting as an accurate and efficient resource for research and educational outreach.

Future Work

- Add components to further sort mast by genus
- Deploy device into Duke Forest

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