

OBJECTIVE

Replace single-use cartridge cover with carbon-neutral re-designs.

BACKGROUND AND VALUE PROPOSITION

HP produces and ships millions of toner cartridges annually. Their disposable cartridge covers are made of Polystyrene, a petroleum-based plastic.

To reduce the impact of these products on the environment, our goal is to provide alternative cover designs that support the use of renewable materials without sacrificing other standards.



KEY REQUIREMENTS

- 90% carbon degraded within 180 days
- Production cost equal to or less than \$0.07/part
- Withstand drop and vibration tests
- Maintain strength properties under humidity and heat treatment
- Improved consumer perception
- Fit within current packaging dimensions

ACKNOWLEDGEMENTS

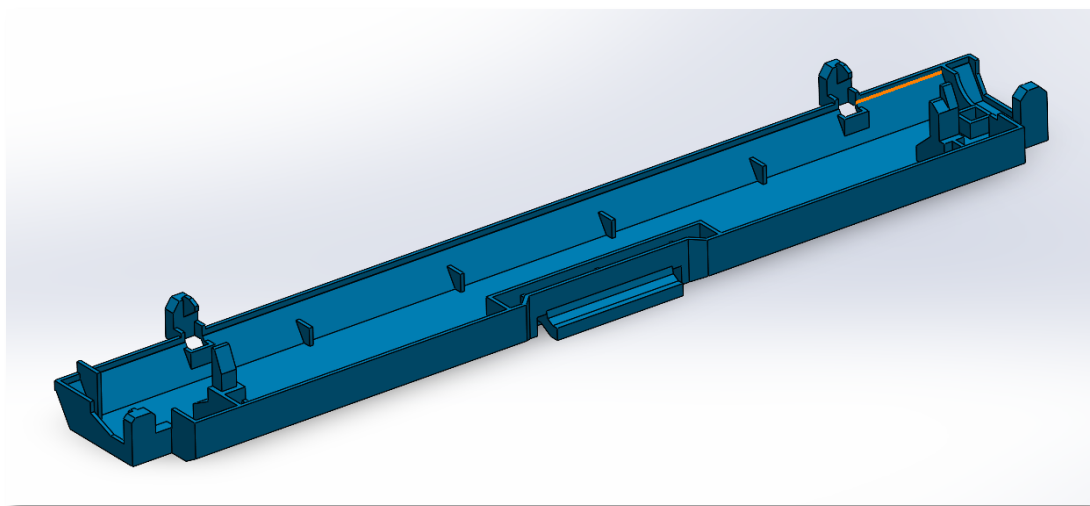
Dr. Matthew Swenson – Instructor, Nagendra Tanikella – Mentor Jeff Frechette, Doug Richards, & Andie Zoeller – HP Clients

TONER CARTRIDGE NATURAL FIBER APPLICATIONS

SKYLAR DAWE, COLIN HAUGSETH, ISAAC LOONEY, JAMES SETTERS

PROTOTYPE PATHS

3D Printing



Alternative plastics in same manufacturing process

PLA, Wood PLA, PHA, PHB

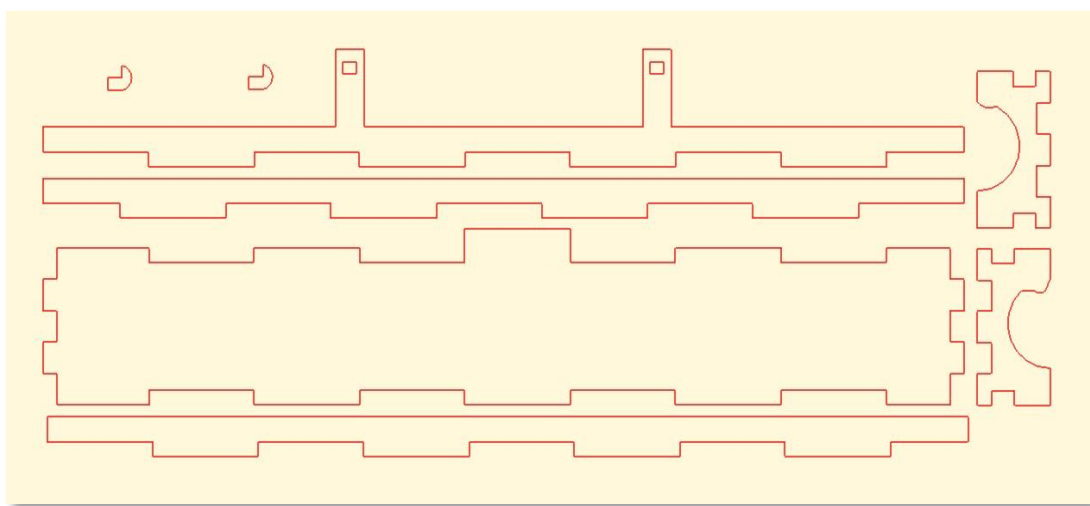
Pulp Foam



Outsource material with complex overhang geometry

Starch, pulp, water, binder

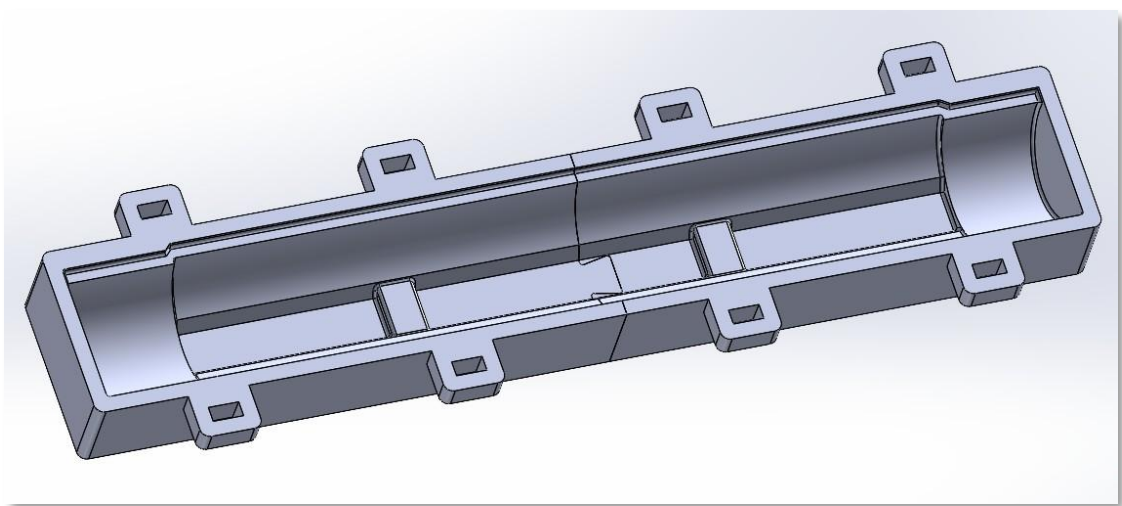
Laser Cut



Design interlaced friction-fitting with custom tabs

Plywood, no glue needed

Pulp Mold



Press pulp blend custom cover mold without tabs

Paper product, rice, pine

FINAL DESIGNS

Pulp Cover Prototypes

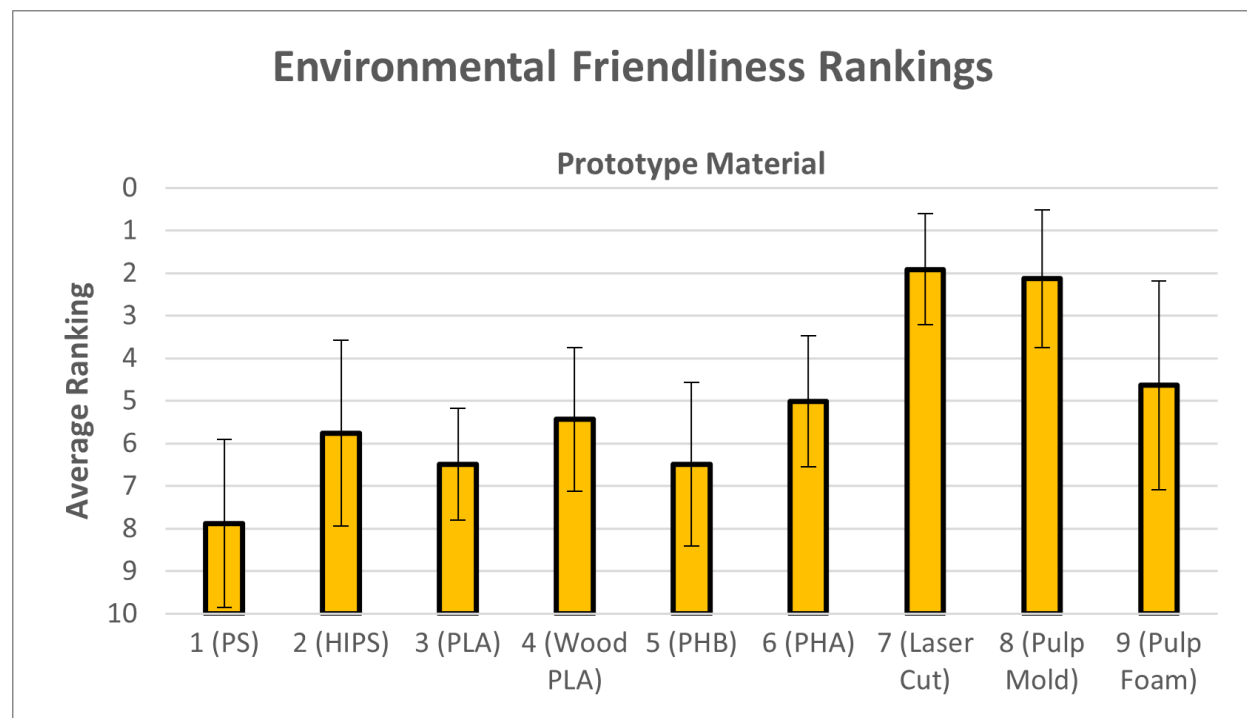


3D Printed Polymer Prototypes



VALIDATION

Requirement	Test	Result
One use cover survive single max-force cycle	Drop test (6ft) to concrete floor	Success: PLA, WPLA, PHA, PHB, Laser cut
Less than 25% change in strength properties during 80% humidity	Humidity chamber for a set period of time then quickly move to stress test (<10 minute)	PLA: Got stronger in high temp high humidity conditions. Did get more brittle but not substantially.
Parts remain within 50% increase in weight per volume	Use scale to measure parts of the same size, one using petroleum plastics, one is sodium silicate wood composite	Success: PLA, WPLA, PHA, Pulp
Less than 25% change in strength properties during 32C	Temperature chamber for a set period of time then quickly move to stress test (<10 minute)	Success: PLA, PHA, WPLA, PHB
Biodegradable within 2 years.	Research life of each material	All prototypes except PLA meets the environmental requirement.
Customer's perceive it as a more environmentally friendly solution than Polystyrene.	Conduct survey in multiple different populations to compare their perception of each samples vs polystyrene.	57 total surveys from University of Idaho and University of Graz
Total cost per Part	Implementation Cost Modeling	PM/PF - \$0.05, PIM - \$0.13, PHB/PHA - \$0.16, LASER CUT - \$0.06, PLA - \$0.08



RECOMMENDATION

A decision matrix determines which carbon-neutral replacements are viable without sacrificing other factors. When highly weighting environmental friendliness, a pulp mold solution is suitable.

	Weight	Scale	Pulp Mold	Weighted Score
Enviromental Friendliness	4	2	8	32
Manufacturing Cost	5	50	42.5	212.5
Packaging Tests	2	10	0	0
Treated Strength Properties (MPa)	2	3.25	0.76923077	1.538461538
Consumer Perception	3	1	6.865	20.595
Ease of Implementation	4	1	5	20
Total Score				286.6334615

