Digital Manufacturing Challenge Proposal

SME Student Chapter S077

Michigan Technological University

Discarded Clothing Reimagined as Dust Collection Solution

Authors:

Jake Mahoney <jamahone@mtu.edu>

Sara Venegas Guerrero <[redacted]>

Abstract

There are many ways that “waste” materials can be re-imagined for new purposes. The way people reuse materials will define the future of waste in cultures and countries. By combining waste materials like textiles with new technologies like additive manufacturing there are countless opportunities to reduce and reuse; ultimately eliminating waste that would go to landfills. The following project is just one example of how combining old and new can lead to cleaner oceans and brighter skies.

Table of Contents

Executive Summary

Every year **34 billion pounds** of used textiles [1] and **62 million tonnes** of E-waste [2] are thrown out in the US alone. With trends towards "disposable quality" objects and short-term purchasing decisions it is less important than ever to design products that can stand the test of time. With such a wide variety of waste in these categories the team was surprised to find very few initiatives to extend the usable life of products with repurposed items.

This SME Student Chapter S077 project will use fabrics from dump-bound pieces of clothing and additive manufacturing to reinstate features in a common power tool: ultimately this process will extend the tools usable life leading to one less piece of E-waste in the dump. With creative ways to maintain the "disposable" items that populate the modern home the team believes that technology like additive manufacturing will have its place in decreasing the amount of waste each person creates.

Industry Overview

The social trend towards "fast fashion" is one of waste. Articles of clothing are mass produced and imported to satisfy consumer demand for a style that is only "relevant" for a short period of time. With a low expected product life, manufactures save money by producing comparatively fragile articles of clothing. The issue is that the "amount of clothing being shipped is far too great and the quality of the textiles sent is too low" [1].

While many initiatives focus on the recycling and donating of these products, the unfortunate truth is that a very small percentage of these textiles make it to "environmentally friendly" final locations. Many of the products that are donated to organizations like salvation army and goodwill are ultimately thrown away or shipped off to foreign countries where they're used, thrown away, or burned [1]. With there are initiatives from companies to refurbish clothing items like "take-back" programs [2], the team believes that there is an opportunity to reuse these types of materials around homes before they ever reach the dump.

Problem Statement

A Bosch orbital sander in Michigan Tech's machine shop has been cast aside due to a missing dust collection bag. The tool is not used without the accessory due to the hazards and inconvenience of excessive airborne dust; both to the operator and equipment like the CNC router. Due to the ovate shape of the dust port the shop's standardized hose adapters are not compatible.

To extend the life of the otherwise functional power tool the team will design and build a new dust collection bag using 3D printed plastics and scrap textiles from goodwill. This project aims to explore the filtration capabilities of discarded cotton and polyester fabrics as a possible implement in dust collection systems.

Proposed Design

A satisfactory dust collection bag must meet the following criteria:

1. Removable, washable dust bag.
2. Tight, locking seal with existing dust port.
3. Filtering capabilities for small and medium particles.

Additional considerations must be made for the ergonomics and durability of the accessory when it is attached to the dust port.

The proposed design is a 3D printed “cage” with a removable discarded textile bag. The cage will handle the interface between the accessory and sander while giving the bag structure; this will keep it from interfering with the operator or workpiece. The bag will be comprised of a 2-stage fabric filter. The 1st stage is constructed from a 100% cotton t-shirt and acts as a medium to large particulate filter. The intent is to capture most of the particles without excessively restricting air flow. The 2nd stage is constructed from a “performance” flannel material that has a finer, lighter weave. The intent is to capture the smaller airborne particles that are accelerated through the first stage. With this combination a filter “sock” is created that seals on the cage.

Additive manufacturing is the ideal manufacturing choice for the cage; for a project of this scale it’s hard to beat the rapid prototyping capabilities of a modern, consumer-grade machine. Figure 1 shows the design of the cage in its printing orientation. The structure consists of a latticed skin that creates a rigid structure with ample air flow to the dust bag. Using design for additive manufacture (DFAM) principals that cage is designed to print with no support material waste. The interface to the dust port utilizes the elasticity of the additive polymers and an oversized dimple to lock onto pre-existing dust port geometry.

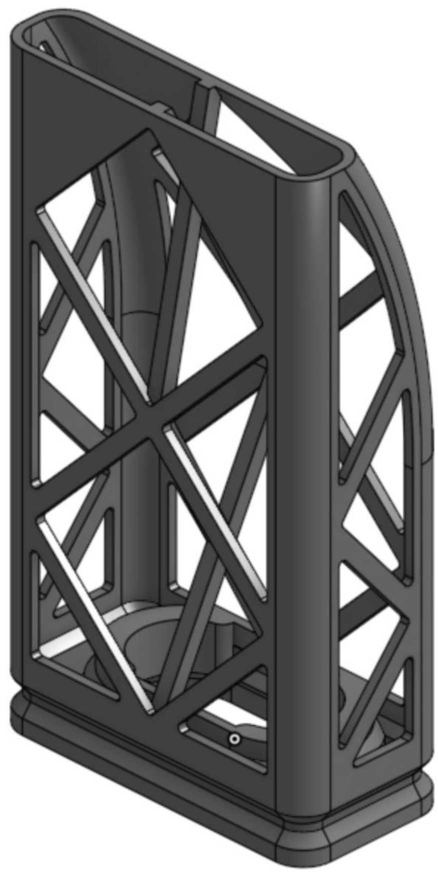

Figure 1: Dust cage in 3d printing orientation. The overhangs are easily printable on a modern consumer 3D printer which enables the part to print with no support. Chamfers are used to avoid 90° overhangs.

Material selection is a critical consideration for 3D printed parts. As shown in Figure 2, the location of the dust bag is near the bottom of the sander under the handle. While the cage shouldn't be exposed to high temperatures it will be exposed to the use and abuse of a hand-held power tool. The team decided to use PETG as it has more ductility and higher layer adhesion strength than materials like PLA which will ensure the long life of the cage under constant vibration and use.

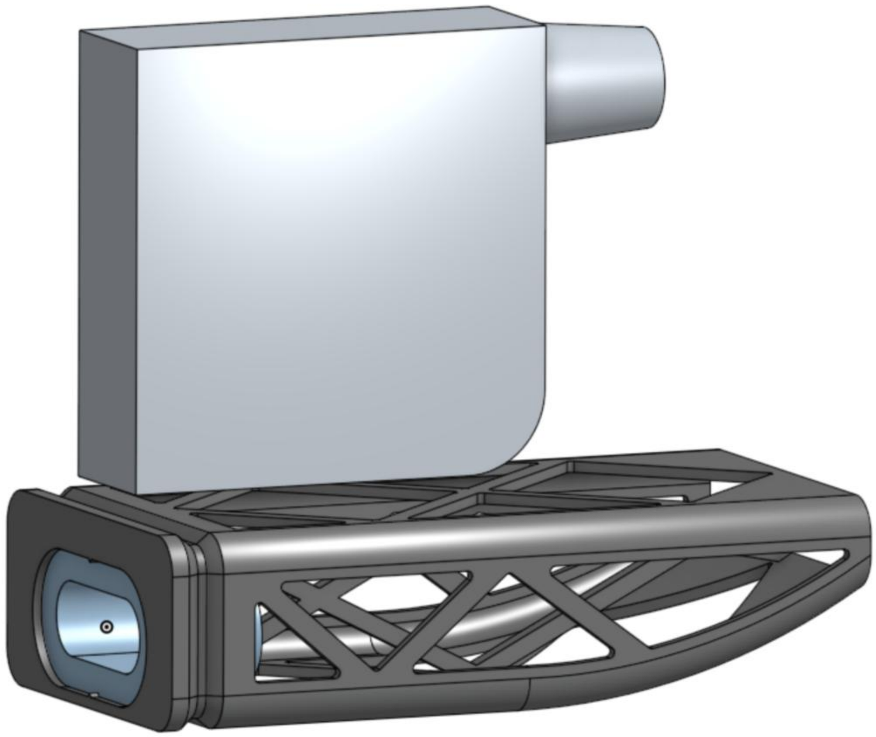

Figure 2: Cage in context to reference geometry of the sander handle.

Construction, Cost, and Performance

The cage was printed on a Bambu Labs P1S in 3 hours and 5 minutes which can be seen in Figure 3. The design uses 68 grams of PETG filament which comes out to just under $1.50. The dust bag is sewn from old t-shirt and flannel fabric that was otherwise headed for the dump. The fabric is laid over the cage and traced. From here a pattern is created and transferred to each layer of the filter. These layers are compiled and sewn into a “sock” shape with an open end. This shape slides over the dust cage and is secured into the grove of the cage.

Figure 3: PETG cage after printing. The design uses no support and requires no cleanup.

Figure 4: 1st and 2nd layer of dust bag. The 1st cotton layer has been fitted to the cage and is now being traced onto the next layer.

Figure 5: Cage self-secured onto dust port. The dust bag is currently removed.

c

Figure 6: The dust bag is securely attatched at the groove. This is the completed assembly.

After assembly the orbital sander was used to great success and the dust bag accessory showed promise. The dual layer fabrics did a solid job of trapping particles and fulfilled design constraint 3. After sanding the bag was easy to remove and empty into the bin. Because it is made of traditional clothing materials it is safe to clean and wash under running water which fulfills design constraint 1. The interface between the cage was sufficiently tight to keep it on the sander during use while still being removable which meets design constraint 2. Because of the tolerance of the dust bag it inflated slightly during use, however, the project adequately sealed the dust and **significantly** reduced the airborne particles as a result of the sander.

Conclusion

Ultimately this project demonstrates how technology and initiative can be combined to extend the life of the seemingly disposable products we interact with. In the future our team looks forward to experimenting further with the filter materials from “trash” fabrics. In our application they are perfect and are just one example of how these materials can be reused and recycled into the engineering workflow. This initiative to repurpose “fast fashion” materials could be a way to reduce the environmental impact of nasty environmental trends.

References

[1] D. Lundberg and J. Devoy, “The Aftermath of Fast Fashion: How Discarded Clothes Impact Public Health and the Environment | SPH,” *www.bu.edu*, Sep. 22, 2022. https://www.bu.edu/sph/news/articles/2022/the-aftermath-of-fast-fashion-how-discarded-clothes-impact-public-health-and-the-environment/

[2] UNITAR, “Global e-Waste Monitor 2024: Electronic Waste Rising Five Times Faster than Documented E-waste Recycling,” *United Nations Institute for Training and Research*, 2024. https://unitar.org/about/news-stories/press/global-e-waste-monitor-2024-electronic-waste-rising-five-times-faster-documented-e-waste-recycling