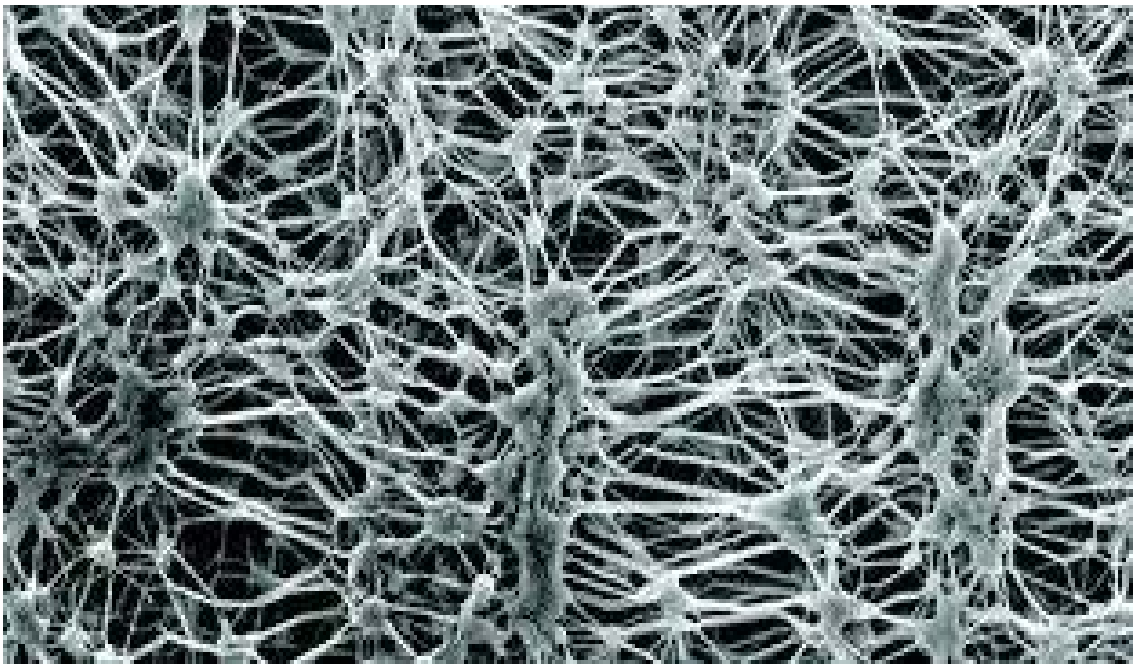
Plastic Microfibers: A Marine Catastrophe and a Simple Solution



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Abstract:

Microfibers are one of the leading pollutants in today's society. During the washing process, tiny fibers that make up our clothing are released into our waterways. Marine organisms end up consuming these fibers. When fisherman catch these organisms so that chefs prepare them for consumers to eat, we are eating our own clothing. In this study, I aim to upcycle microfibers, commonly known as dryer lint, and create clothing. Microfibers were collected from New York City residents ranging from all boroughs. Specifically, hats were made. Three prototypes of hats were made, all from mostly similar techniques, although varying by different materials. Prototype 2 posed as the greatest success, although prototype 3 possessed the greatest potential in making a new hat. Prototypes 1 and 2 were created with Coloration's Glue, while prototype 3 was made using a homemade, organic glue, including a completely organic dye. It seems as if it is highly possible to make a hat by upcycling microfibers and other materials.

Introduction:

Microfibers are one of the leading pollutants in today's society, affecting multiple ecosystems around the world. Microfibers are broken down fine fibers that are found in all clothing. These fibers may be miniscule, but their impact has a tremendously negative affect in our society and in nature. Increasingly, in the past 50 years, plastic litter has had a damaging impact on marine ecosystems (Cole *et al.*, 2014). Marine plastic pollution has been growing at drastic rates, and it has been directly correlated to chemical toxins in the water (Wilcox *et al.*, 2015). It is expected that these rates will not be dropping anytime soon, as plastic demand is high all over the globe.

The majority of anthropogenic debris found in marine organisms in the U.S.A., are fibers from textiles (Rochman *et al.*, 2015). It is predicted that this growing concern will only get

worse, and the origin is simple. Laundry is a direct contributor of the microplastics and microfibers in our oceans (Napper *et al.*, 2016). Microfibers are formed when everyday clothes are washed in the laundry. During the washing process, microscopic fibers that make up clothing break down into smaller particles. Microfiber debris that directly transfers from our laundry to our water systems can have a major effect on not only marine ecosystems and organisms, but also humans. Microfibers have become linked to trigger human biological responses physically and mentally (Rochman *et al.*, 2015). Thus, humans may be affected when digesting seafood because of debris. A study showed that 80% of the fish collected in California had a form of fiber in its GI tract (Rochman *et al.*, 2015).

Additionally, further research suggests that microplastic ingestion has not only been linked to physical harm but may also cause chemical harm to marine habitats (Cauwenberghe *et al.*, 2014). Not only do these data show that pollution is a problem all over the country, but they also show that new, innovative methods to reduce the amount of pollution, specifically plastics and fibers in our oceans, are needed immediately. It is anticipated that the number of microfibers in the ocean, and, in turn, the risk of human and marine organism harm will be reduced. New research from Patagonia has shown that its consumers used an estimated 100,000 jackets each year, releasing fibers into public waterways, the equivalent of 11,900 grocery bags. Stopping the risk of microfibers into our sewage system and, ultimately, in water sources across the country, will precisely target the obstacles humans face.

Thus, targeting areas of both fashion and sustainability are critical. This research aims at capturing microfibers in the environment and transforming them back into fabric. As a proof-of-concept demonstration, the trial of upcycling microfibers in creating a microfiber-reusable product, will be done in order to test lint as layering to produce a hat. Taking these microfibers

out of the waste stream will indirectly decrease the amount of pollutants in the water and will serve as a trial in order to determine if making a product purely out of lint and recycled products will be successful. Then, if correct, microfibers will be targeted immediately through the washing process as the first way of extraction using the Cora Ball, a spherical microfiber catcher.

Project Design:

Problem:

- Can microfibers be repurposed to make a durable piece of clothing?
- Is it possible to make clothing solely out of microfibers/lint or will there need to be another component added?

Hypotheses:

- Microfibers have the ability to be upcycled in order to create a durable accessory.
- There will need to be another binding factor to help make an accessory from the microfibers/lint.

Objectives:

- Determine if the microfibers are robust enough to create a piece of clothing.
- Determine the method of how to make a clothing out of microfibers.

Materials:

Prototype 1:

Item	**Quantity**	**Function**
Microfibers/Lint	1-3 Bags	Used as main building block of paper mache hat
Washer and Dryer	1-3	Used to collect microfibers/lint
Mannequin Head	1	Used as a placeholder for an accurate representation of a human's head
Magazine Paper	20 strips, 10 x 1.5 in.	Used as a layer which separates the microfibers from the human's head
Glue	64 oz. of water 40 oz. of Colorations Glue	Used as a building block for the binding process of the microfibers

Prototype 2:

Item	**Quantity**	**Function**
Microfibers/Lint	1-3 Bags	Used as main building block of paper mache hat
Washer and Dryer	1-3	Used to collect microfibers/lint
Mannequin Head	1 Female Head	Used as a placeholder for an accurate representation of a human's head
Magazine Paper	20 strips, 10 x 1.5 in.	Used as a layer which separates the microfibers from the human's head
Cardboard	TBD	Used as a brim for the hat
Glue	- 64 oz. of water - 40 oz. of Colorations Glue	Used as a building block for the binding process of the microfibers

Prototype 3:

Item	**Quantity**	**Function**
Microfibers/Lint	1-3 Bags	Used as main building block of paper mache hat
Washer and Dryer	1-3	Used to collect microfibers/lint
Mannequin Head	1 Male Head	Used as a placeholder for an accurate representation of a human's head
Magazine Paper	20 strips	Used as a layer which separates the microfibers from the human's head
Cardboard	TBD	Used as a brim for the hat
Natural Dyes	- 4 1/2 cups water - 6 oz. blueberries - 3 oz. blackberries	Using natural dyes allows the color of the hat to be organic, and 100% natural and reusable
Natural Glues	- 48 tbsp water - 4 oz. gelatin - 16 tbsp white vinegar - 8 tsp glycerin	Used as a building block for the binding process of the microfibers

<u>Procedure:</u>

Prototype 1:

A collection of lint was made by soliciting donations from five residents throughout New York City. There were approximately 15 bags of lint collected. A brain-shaped Jello mold was used as a model of a human head. 64 oz. of water and 40 oz. of Colorations Glue were mixed in a bowl. 20 strips of recycled magazine paper with dimensions 10 x 1.5 inches were cut out. One strip at a time, the paper was submerged in the Colorations Glue and water mixture. Piece by piece, the strips of paper were placed around the mold. Once a complete layer of paper was formed, microfiber placement steps were repeated for the next layer of lint. The product was left

to dry for three days until it was completely dry to the touch. Once the drying process was complete, the product was taken off the mold.

Prototype 2:

A collection of lint was made by soliciting donations from five residents throughout New York City. There were approximately 15 bags of lint collected. Mannequin heads were purchased. There were five female heads and two male heads purchased. A female head was used for this prototype. An outline of a hat was made from the lowest points of the hat. The mannequin head was wrapped in a layer of saran wrap. It was then wrapped in a layer of wax paper. The purpose of this step was to make sure the hat would not stick to the mannequin head. 64 oz. of water and 40 oz. of Colorations Glue were mixed in a bowl. 20 strips of recycled magazine paper in the size of 10 x 1.5 inches were cut out. One strip at a time, the paper was submerged in the Colorations Glue and water mixture. The first pieces were used on the outline as a limit of the lowest point of the hat.

The next strips would make a complete layer around the mannequin head. The microfiber placement steps were repeated for the next layer of lint. The product was left to dry for three days until it was completely dry to the touch. Once the drying process was complete, the product was taken off the mannequin head.

Prototype 3:

A collection of lint was made by soliciting donations from five residents throughout New York City. There were approximately 15 bags of lint collected. For variation, a male head was used for this prototype, unlike Prototype 2. An outline of a hat was made from the lowest points of the hat. The mannequin head was wrapped in a layer of saran wrap. It was then wrapped in a layer of wax paper. The purpose of this step was to make sure the hat would not stick to the

mannequin head. A natural dye was created for this hat, and the intended color was red. 4 ½ cups of water were used, as well as 6 oz. of blueberries and 3 oz. of blackberries. The mixture simmered for an hour under boiling water. Once a red color was shown, the solids were filtered out. Three flat sheets of lint were laid out in three different trays. Using a syringe, the dye was gently squeezed onto each layer of lint. The lint was allowed to dry for a day.

Along with a natural dye, a natural glue was used for this hat. 48 tbsp of water, 4 oz. of gelatin, 16 tbsp of white vinegar, and 8 tsp of glycerin was used to make the glue. The mixture was stirred in boiling water until it resembled a sticky residue. 20 strips of recycled magazine paper in the size of 10 x 1.5 inches were cut out. One strip at a time, the paper was submerged in the natural glue. The first pieces were used on the outline as a limit of the lowest point of the hat. The next strips would make a complete layer around the mannequin head. Using a spatula, the layers of lint were carefully taken off their tray and placed onto the hat. A brush was used to cover the lint layer with glue to ensure strength.

Once dried after about fifteen minutes, the hat was removed from the head. Recycled magazine paper was cut out in exact dimensions to form a brim for the hat. The paper resembled cardboard but was physically flimsier. To attach the brim to the hat, five more strips of magazine paper in the same dimensions were used but attached underneath the brim and the inside of the hat. The brim was left to dry. More lint was used to layer the top half of the brim.

Results:

After the three different prototypes were made, they were each ranked on a scale from 1-10 based on three major factors: durability, “wearability,” and attractiveness.

Table 01. ranks durability, “wearability,” and attractiveness on a scale of 1-10. Average of these parameters is also listed.

	Durability	**“Wearability”**	**Attractiveness**	**Average**
Prototype 1	7	2	6	5
Prototype 2	8	8	5	7
Prototype 3	4	5	6	5

Durability tests the prototype’s ability to withstand wear, pressure, and weight. “Wearability” tests how suitable the prototype is to fit a human’s head. Attractiveness measures how appealing the hat might look on a head, and of course this parameter will be the most subjective. On average, Prototype 2 seemed the most successful averaging a 7, whereas Prototype’s 1 and 3 only averaged 5’s. These measurements are subjective, making them not as viable as a standard, rating them in terms of a personal opinion.

Figure 01. Prototype 1 was the first prototype created, using a brain-shaped mold.

Figure 02. Prototype 2 was the second prototype created, using a female mannequin head.

Figure 03. Prototype 3 is the third prototype created, using a male mannequin head.

Table 02. lists pros, cons, and rank, 1 being the best and 3 being the worst, of all Prototypes.

	Pros	**Cons**	**Recycled Material %**	**Rank**
Prototype 1	Model was very durable, lint was able to bind onto paper very well, colorway not too unappealing.	Too small to wear. Only recycled materials were lint and paper. Glue made with plastic, premade. Need binding agent 100% recyclable and organic.	50%	3
Prototype 2	Model was able to fit on woman's head, or small male's head. Lint stuck onto paper well. Outline and vision of brim seemed realistic for next prototype.	Colorway not appealing. Scotch tape was used to attach brim. Glue made with plastic, premade.	50%	1
Prototype 3	Model was 100% recyclable: glue, dye, lint, paper. Brim was able to be attached successfully.	Brim was made using a different type of paper; lighter, flimsier. Because of glue recipe, the hat tended to rip and was less delicate. Thus, couldn't be worn as well.	100%	2

Prototype 2 possessed the highest quality of all models created. However, Prototype 3 contained the most potential in learning from faults through the process and moving forward. For example, a new glue will be used for the next model that will be made. Brim creation also held respectable potential. The process in which attaching the brim to the hat itself was considered a success. The only limitation shown was the type of material used, which was a flimsy recycled packaging box. For future reference, stiffer cardboard should be used in order to obtain a more sturdy brim. Dying technique held attainable quality, making that parameter a successful one.

Another prototype, in the process of being made, will follow procedures stated for Prototype 3, however there will be differences. There will be a different glue recipe used, making the hat more sturdy and stiff, and a different type of paper for the brim. The procedure in

attaching the brim might pose as a different step as well. For this model, the brim and the bottom layer of the paper may be applied before the microfiber layer is applied.

Conclusion:

Of the three prototypes created, Prototype 2 was the most successful, and Prototype 3 possessed the most potential. Both hypotheses were proven to be true, with the fact that microfibers have the ability to create a durable accessory, and that there will be a major binding block in creating an accessory: glue. In terms of objectives, microfibers were found to be durable enough to create a piece of clothing, and the method in which to make a hat, was found.

Future Directions:

Another opportunity in terms of sustainable fashion with the use of microfibers include insulation. Lint used as a replacement for synthetic polyester or feathers for a down jacket might be a considerable option. Not only might it allow for warm clothing, but it also might present an unintended recyclable factor. Clothing and fashion is not the only course of action. Insulation for houses may be an innovative way to reduce the amount of heat able to fuse into houses. In order to test the substitute of microfibers, three boxes must be used. One box containing microfibers, another box containing cellulose or fiberglass, and the last box containing no type of insulation, acting as the constant. Then, measure the warmth of each box throughout time such as a day, a week, a month, etc.

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