Analysis of Microplastic Prevention Methods from Synthetic Textiles

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1 Introduction and purpose

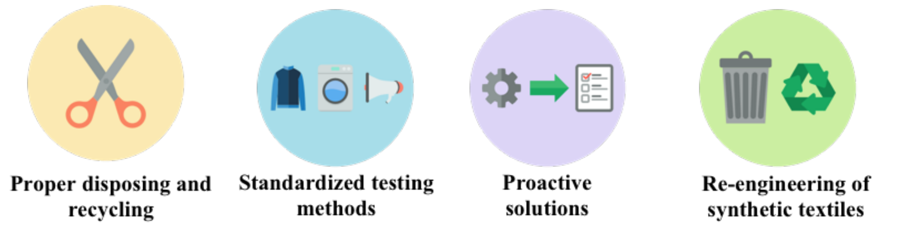
In light of the recent discussions regarding the realization of the UN development goal number 14 concerning the conservation and sustainable use of marine resources, iGEM Lund has set out to aid in the world-wide engagement against microplastic pollution [8]. Microplastic pollution is an ever-growing problem that stems from wasteful lifestyles with propagating adverse effects throughout the entire food chain. Upwards of 10-20 million metric tons of plastic has been estimated to enter the ocean every year. [3] Along with this effort, iGEM Lund also set out to bring more public attention to this problem. Not only through education but also by providing helpful tips as to what society can do to be more proactive in their engagement against the problem. What measures can consumers take to decrease their use of plastics? How can the consumers make more mindful decisions in their shopping habits? How can we make society more aware of the inconspicuous sources of plastics pollution like tire wear, cosmetic products or, in the context of this report, synthetic textiles? This led us to start thinking in broader terms: How can we make a greater impact?

IKEA is a multinational home furnishings company with a vision to have a positive impact on the planet. With a great attention to detail, IKEA puts focus in every step of the product life cycle. From the moment the raw materials are extracted all the way to the end of the product lifespan. IKEA designs products based on Democratic Design principles balancing Form, Function, Cost, Quality Sustainability as well as considering Circular Economy [2].

IKEA does not only deliver furniture but also textiles where some consists of synthetic material. The company has acknowledged the potential environmental effects of these products. It is in their strong interest to find more sustainable solutions while still maintaining quality and equitable prices. After meeting IKEA, we set out to scan the market for different approaches and technologies IKEA and their customers could potentially implement to decrease the release of microplastics from synthetic textiles. We also invited stakeholders working with the same problem to a meeting, enabling a forum for an open discussion.

2 Four Focus Points

In the beginning of the market scan for microplastic preventing solutions, we found a common pattern between the companies and organizations working within this field. Regardless of the way of tackling the problem, all ended up with the same goal, struggles and within the same conflict areas. We have summarized these common focus points based on the textile's life cycle below.



To remedy these struggles and to potentially expand upon the current existing solutions, we decided to interview these stakeholders and later invited them to partake in a meeting. The purpose of the meeting was to initiate an open discussion to give each participant a wider perspective of the problem, allowing them to be inspired by each other's ideas. We do believe that all parties are needed to fight this issue. Textile groups should work cooperatively with filtration researchers and market strategists to optimize the journey from idea to final product. Also, well-established companies would benefit by working with start-ups to produce new innovative solutions. All parties should learn and share ideas from each other to not "re-invent the wheel".

3 Re-engineering Synthetic Textiles

Synthetic textiles begin their shedding from the very first cut in the fabric. That is during the manufacturing phase where the textiles are being prepared into desired sizes and lengths for the tailor to sew together. A study by Swerea IVF for Mistra Future Fashion concluded four following measures to decrease shedding and that should be kept in mind during production [7]:

- The reduction of brushing, a process where the surface of the textile is treated to create a depth and a fuzzy exterior.
- Applying ultrasonic cutting reduced the amount of shed fibers by 50 %
- The removal of pre-existing fibers before shipping the product (how these fibers are recycled remains unstated).
- Recycled PET sources did not shed more than virgin PET sources. This implies that recycled PET could be utilized in this context.

The EU-funded Life+ MERMAIDS project conducted research published by the Plastic Soup Foundation in which they tested different methods of reducing plastic pollution from textiles. The following design parameters affecting shedding from clothing were identified [6]:

- Fiber Length - Shorter fibers increases the probability of the fibers to migrate to the textile surface and increases pilling.
- Yarn twist - Twisting the yarn increases resistance and elasticity. This produces a more compact yarn which equals less shedding.
- Linear density (yarn count) - Referring to the yarn thickness. More thickness implies more fibers and evidently more shedding.
- Fabric density - Greater number of yarns per unit length creates a tighter structure and decreases the probability of shedding.
- Textile auxiliaries - Different pre-treatment chemicals can be used against abrasion and reducing friction between fiber-fiber and fiber-detergent. This protects the textile during the mechanical strain in washing machines.

Yarn companies can use these findings to create textiles that release less fibers. The project also included testing of two bio-based coatings out of pectin and chitosan to protect the textile from physical strain. From an environmental perspective, both are desired coatings and are easily sourceable by-products from the food industry at a low price. They are also non-toxic and biodegradable. The study showed promising results but concluded that more testing is needed before practical application can be realized.

Textile companies adopting the Life+ MERMAIDS project findings could optimize their products to shed less. More emphasis should also be placed on finding alternatives for non-degradable synthetic fibers such as bio-based synthetic fibers. During an interview with Dr Sandra Roos, a researcher at Swerea IVF, it was mentioned that they have started to look more into bio-based synthetic fibers.

Lenzing AG, a textile and nonwoven cellulose fiber company, have for example found that the bio-based alternatives Viscose, Modal, fast-growing corn and Tencel (lyocell) are 100 % degradable [1]. Lenzing's products are patented and costly, but they are confident that the consumer will understand the environmental importance and therefore disregard the increased prize [12].

4 Proactive solutions

What can the consumers do to decrease shedding when the product is finally in their hands? To investigate this question, we looked at solutions and products that could be used in combination with the washing machine where majority of the shedding occurs [12]. One of the products, the Cora Ball by Rozalia Project, was constructed to be easy-to-use and does not require much work for the consumer to integrate in their washing habits. The other solutions were attachable washing machine filters by Wexco Environmental, Environmental Enhancement and Mimbly.

The Cora Ball is a ball which adhere fibers to its surface during the washing process. It is made of soft plastic and is gentle on the clothes. The microplastic fibers get stuck in tangles and aggregates which allows them to be removed by hand. The total amount of fibers which the ball picks up is about 35 % each wash according to the founder Rachael Miller. It is also claimed that a used Cora Ball catches more fibres than a new ball due to exponential adherence of fibers. Customers should therefore not clean their Cora Ball after the first use to increase the efficiency of the ball in future use.

Wexco Environmental have developed a filter that have been used in the septic industry to reduce the amount of waste in the septic system. They have used methods to see how much of microplastics they catch and have reported results upwards of 60 % of the outgoing microplastics. Their current goal is to develop an enhanced filter which would be able to raise the number to 90 %. During the meeting, the company stated their interest in testing their system in combination with other solutions. Environmental Enhancement is delivering a filter to collect lint and follows the same principals as the filter from Wexco Environmental.

Mimbly is installing systems to reuse water in washing machines with the main goal of decreasing the water consumption. While doing this, their system also filters microfibers but unfortunately, they could not go into further detail behind the mechanisms of the filter system for IP reasons.

To sum up, the Cora Ball is an easy-to-use product for the consumers to decrease the release of synthetic fibers. More importantly this product raise awareness of the problem which is fundamentally why it exists. Changing the way people think, regarding the impact from the use of synthetic textiles, on a more fundamental level remains as their main motivation. This implies encouragement of buying less synthetic textiles and washing more responsibly.

Working with the development of similar products, Environmental Enhancement, Wexco Environmental and Mimbly, all had the common goal to improve design and ease of use of their attachable filters without increasing costs to make it available for more consumers. The companies were all open for new collaborations. IKEA already works with Electrolux to produce washing machines and could potentially team up with these companies and adopt these filtering techniques [9].

5 Standardized Testing Methods

A point that all the discussed proactive solutions and research findings have in common is the lack of a standardized testing method to evaluate the amount of shedding. The products must not only be tested, they must also be validated on the same terms for accurate conclusions during the comparison of data. Mistra Future Fashion and Dr Sandra Roos ran into this problem when studying how the manufacturing methodology and different techniques affect shedding [7]. According to Dr Roos, this made it difficult for them to compare their results with similar studies. How were the parameters affecting the test results found in the study by Life+ MERMAIDS, controlled in these studies? Also, how had each textile collected by Mistra Future Fashion been handled? Dr. Roos for example explained that dust accumulated from the machines manufacturing the textiles may be mistaken for the fibers of interest. Therefore, they implemented a step in their measurements to be able to exclude machine-dust in the test results. In this method, they used the presence of metal ions, dissociated from the machines, to improve selectivity by being able to differentiate dust from the fibers shed.

Dr Roos also told us that they have developed a method where they could choose a fiber length of interest and count only that specific type of fiber. To put this in perspective, the Rozalia Project used a method where they calculated all fiber lengths due to less stringent restrictions on their defined parameters. This was due to the internal goal of this measurements was to measure a difference within the same testing procedure. Anyhow, when comparing this data with other available data the struggle remained.

All parties, attending the conference, agreed that this is an important topic that needs further investigation. An external party that are currently doing research in this area and is also looking into developing standardized test methods is the Man-made Fibres Association, CIRFS [5] in one of their focus areas that is called Technical Issues.

Our iGEM project could potentially be applied as a new measurement method. We are right now working with a bacteria-based biosensor to detect microplastics in water samples. Our technique makes use of two molecules that usually accompanying the plastics, namely phthalates and organic pollutants. Phthalates are added to plastics during molding to create flexibility. These usually leak out from the plastic into the surrounding water. The other group, persistent organic pollutants (POP), attaches to the plastic surface during its water-bound lifetime. When these two molecules interact with the bacteria, a green fluorescent protein is expressed which under certain conditions emits measurable light.

6 Proper disposing and recycling

When developing smart proactive solutions one essential question is: “Where should we put the collected fibers”? Sweden and most Nordic countries have a very good and well-developed waste disposal system but in other countries the plastic often ends up in landfill. Rozalia Project is currently working on potential upcycling programs to make use of the collected plastic [4]. The struggle in developing such a program is that it currently doesn’t exist any “fiber-separator” that would be able to sort out the different fibers. Therefore, it is with the current existing techniques hard to recycle the plastics because of the unknown quality, properties and composition of the resulting product.

Another struggle with the recycling of plastics is that it may be downcycled. Due to the harsh conditions during the recycling process, the plastics might be exposed to unwanted polymerization, which results in an undesired composition [10]. Using a chemical recycling method could prevent this, but it is more expensive and the problem with separating the fibers would still remain. [11]

If a method to separate different fibers was developed, each variety of plastic could potentially be refurbished and reused. However, until such a technique has surfaced, this is not possible. Thus, further innovation and advancement in the field of separation of microplastics is very important. Consequently, development of such a technique might also aid in the development of consistent standardized testing method since the differentiation of studied fibers may be controlled.

7 Conclusion

Throughout this entire work our knowledge regarding the microplastic problem improved significantly. In addition, we did not only realize what IKEA could do but also how different companies could work together to deliver even better solutions. We found the connections, seen in Figure 1, between all the participating companies based on what they are working with and what their future goals are. Washing machine filter companies were interested in how their product would work with in conjunction with other proactive solutions as the Cora Ball. They were also concerned in the disposal of the synthetic fibers which is of great importance, otherwise the fibers would counterproductively end up the environment either way.

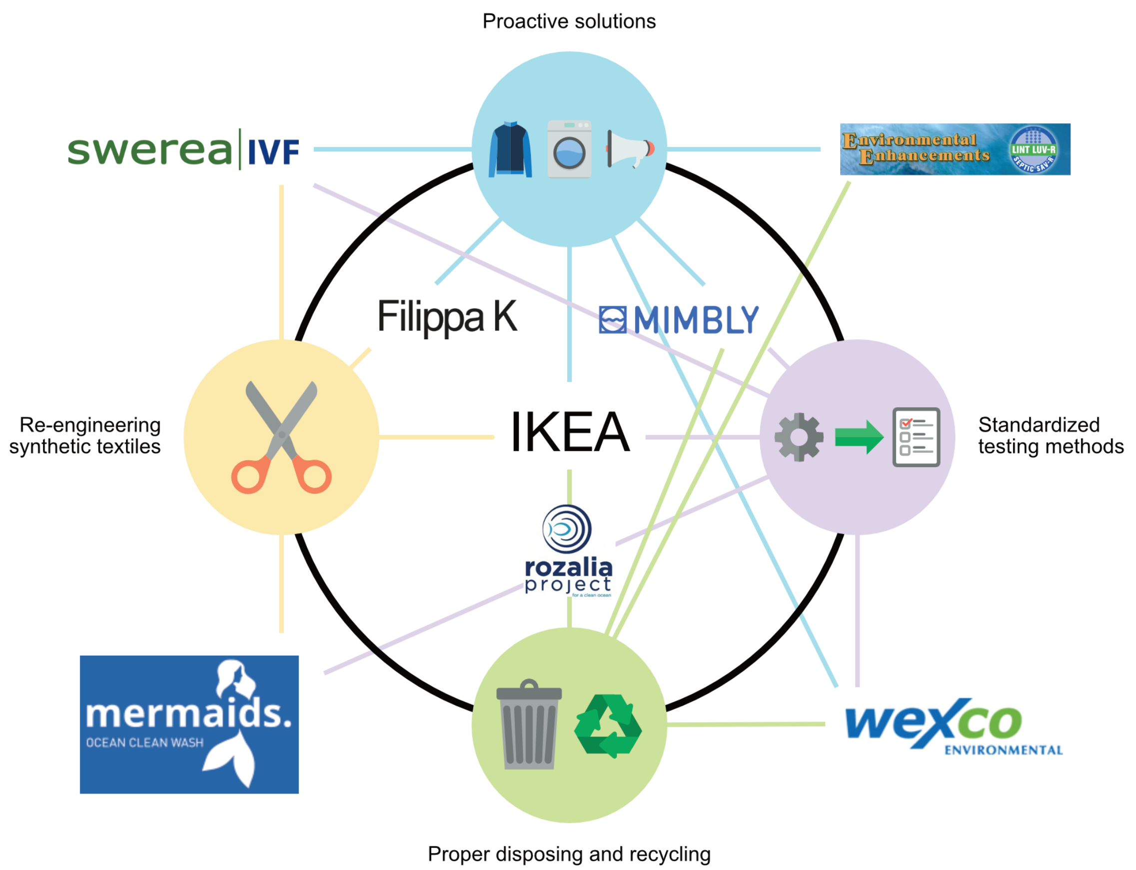


Figure 1: The lines from the company logos to each bubble represents the field they are working within. They also represent the fields each organization and company would be interested to further investigate and potentially work with.

Our vision is that companies become more conscious about the importance of collaborating with others towards the same goal. Such collaborations should not be limited to companies within the same focus area or people with similar expertise. The problem needs to be tacked in its entirety through smart utilization of experts and research across the entire supply chain. From the moment the textile is manufactured until the end of its lifecycle, different methods can be developed and applied to lessen the impact of the synthetic fiber. We hope that our work will serve as an indication that everyone engaged in the prevention of microplastic pollution shares a similar vision and goal. Working together might therefore be the best strategic option to utilize everyone's competence to the fullest.

References

[1] *Green couture.* Chemistry World, 2008. [Online; accessed 1-September-2017].

[2] *Democratic Design - Design for everyone.* IKEA, 2015. [Online; accessed 1-September-2017].

[3] *Global Plastic Production Rises, Recycling Lags.* Worldwatch Institute, 2015. [Online; accessed 1-September-2017].

[4] *Human-scale solution to the biggest pollution problem facing our ocean: Microfibers.* Rozalia Project, 2017. [Online; accessed 1-September-2017].

[5] *Man-made Fibres.* CIRFS, 2017. [Online; accessed 1-September-2017].

[6] *Microfiber release from clothes after washing: Hard facts, figures and promising solutions.* Plastic Soup Foundation, 2017. [Online; accessed 1-September-2017].

[7] *Microplastics shedding from polyester fabrics.* Swedish Foundation for Strategic Environmental Research MISTRA, 2017. [Online; accessed 1-September-2017].

[8] *Progress towards the Sustainable Development Goals Report of the Secretary-General.* UN Economic and Social Council, 2017. [Online; accessed 1-September-2017].

[9] *Washing machines.* IKEA, 2017. [Online; accessed 1-September-2017].

[10] R. Assadi, X. Colin, and J. Verdu. *Irreversible structural changes during PET recycling by extrusion.* Polymer Volume 45, Issue 13.

[11] J. Hopewell, R. Dvorak, and E. Kosior. *Plastics recycling: challenges and opportunities.*

[12] I. Napper and R. Thompson. *Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions.*