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Personal Essay
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Running to Zero-Waste Future

Billions of tons of clothing waste are raging in the mountains, with flames skyrocketing, thick smoke billowing, continuous explosions and pungent gases. People are fleeing in fear like animals, but there is nowhere to escape……This is not a movie scene, it is a real scene of the Kpone landfill site which was built with World Bank funding to resolve the waste disposal problem in Katamanso of Ghana. The fire had been burning for eleven months since August 17, 2019（Besser，2021）, while this is just the tip of the iceberg reflecting the huge waste of clothing.

The world produces 92 million tons of textile waste every year (Ruiz, n.d.) , but materials are what most determine the environmental impact of clothes, which directly contribute to: consumption of water, microplastic pollution, greenhouse gas emissions, soil degradation, rainforest destruction and lastly landfill waste. Brandt (2018) claims that humans only have 12 years left to avoid the irreversible destruction of the planet. Redefining nature fibers, redefining synthetic fibers, and redefining

bioengineered fibers might be effective solutions in such a rush time to help human-beings run to zero-waste future.

Natural fibers, which include cotton, linen, Bamboo textile, wool, camel hair, silk and so on, are no longer address to the needs of the modern fashion industry. For example, cotton is one of the most common fabrics in the world, while it is one of the thirstiest and most chemical-intensive crops to grow. As a result, redefining natural fibers is imperative. Researchers have used 3D printing to creat a tough, sustainable material made of living, breathing algae. Algae fibers would be photosynthetic, absorbing carbon dioxide from the air and breathing out oxygen just like plants（ Patel. 2021）. Algae is easy to make on large scale and is biodegradable. Piñatex is an “innovative, natural and sustainable non-woven textile” derived from pineapple leaves, which is a major by-product from the pineapple harvest (Global Goodness, 2016). As one of great alternatives to animal leather, pineapple leather can reduce 76 million tons of waste pineapple leaves each year, increase farmers' income, and provide a cost-effective synthetic leather (Assoune, n.d.). More than 500 manufacturers, such as H&M, and Hugo Boss, have used Piñatex since 2015.

Besides algae and pineapple, more and more nature fibers with low impact, low emission, and low price will be redefined.

In addition to natural fibers, it is time for synthetic fiber to be redefined as well. Traditional synthetics are man-made fibers coming from fossil-fuel-derived resources through chemical processes. This material has many advantages, such as lightweight, non-wrinkling, and low price. However, its significant impact on the environment. Synthetic spider silk might be an outstanding representative of redefining synthetic fibers. Spider silk is not only the strongest known fiber on the planet but also maintains super elasticity. Since François Xavier Bon de Saint Hilaire wove the first sock by spider silk in 1709（Twilley, 2017）, scientists have never stopped exploring spider silk. Innovation Correspondent Matchar (2017) reported that researchers at the University of Cambridge have invented a new material that mimics spider silk's strength, stretchiness and energy-absorbing capacity. The lab-made fibers containing 98%water and 2% silica and cellulose is completely biodegradable. Moon Parker, developed by Japanese company Spiber in 2018, is the first jacket made of synthetic spider silk (Material District, 2018). Fuzhong Zhang, a professor of energy, environmental, and chemical engineering at Washington University, has created new

spider silk fusion proteins, called bi-terminal Mfp fused silks (btMSilks), and the production has eightfold higher yields than recombinant silk proteins. (Sci Tech Daily, 2023). Mass produce of synthetic spider silk provides possibilities for the development of sustainable clothing.

Although natural and synthetic fibers are still the mainstream of today's textiles, redefining bioengineered fibers might represent the future. Bioengineered fibers made from living bacteria, yeast, animal cells or fungi can break down into nontoxic substances when eventually thrown away. Because many of the organisms involved can be grown to fit molds, which produce the precise amount of textile needed to create an article of clothing without generating excess material to discard (Cirino, 2018). For instance, Cellulose shoes are made by bacteria that naturally produce nanocellulose, and can be further genetically engineered to also self-dye by producing melanin for color (Melton, 2022). This new technology uses a kind of fermentation, in which “gene-edited organisms—like yeast or bacteria—are reprogrammed ” to produce the raw materials for fibers (Oelbaum, 2021). The bacteria going through the fermentation process converts sugar into tiny fibers called nanocellulose, a lightweight material that is eight times stronger than steel, can bind itself to create fine webs

(Yohannes, 2023). Another example are Bioengineered fungi fibers, made from fungi in the lab, are strong, durable, and doesn't need sewing. MycoTEX, a dress was created from mushroom root by the Dutch fashion designer Aniela Hoitink . Interestingly, the designer used petri dishes to feed the mushroom root and directly grew it into a dress on the mannequin (Ross, 2016). It is gratifying that lots of bioengineered fibers have begun trickling onto fashion-show runways and into consumer markets in recent years. In 2021, Adidas released a mushroom leather sneaker, called STAN SMITH MYLO (Adidas, 2021). Definitely, it will be a tendency that bioengineered fibers replace other textiles in the future.

Imaging one morning in 2050, a 3D printer had already printed the clothes you wanted to wear with synthetic spider silk, and the shoes had also grown on the mushroom roots. You go out with them and a handbag made of pineapple leather. When you no longer like them, spider silk can be recycled; mushroom shoes and pineapple leather handbags can become compost for your garden. At that time, the Kpone landfill sites will no longer exist. Redefining nature fibers, redefining synthetic fibers, and redefining bioengineered fibers are leading us to run to zero-waste future.

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