Bio Fashion Design: A Study on Design Strategy for Sustainable Production Line through DIY Bio Experiment

Kazuya Kawasaki, Keio University Graduate School of Media and Governance, Tokyo, Japan, kkzy@sfc.keio.ac.jp

Dr. Daijiro Mizuno PhD RCA, Keio University, Tokyo, Japan, daijirom@sfc.keio.ac.jp

Abstract

There is a growing need for sustainable fashion since the 2010s. As artists and designers explore the potential use of innovative materials developed by synthetic biology and DIY bio-hacking (Myers, 2010), recent practice-led research in fashion design aims at building the better relationship between ecological sustainability and biotechnology to cope with the limited resources available on the earth (Fletcher, 2008). Based on this issue on the material sustainability, this practice-led research analyzes the current production processes of the fashion industry to propose possible solutions by incorporating emerging biotechnology and fashion design in the context of sustainable design. As the methodology, the authors adopt two processes to make bio-garment. First, the experiment of DIY bio has been conducted for culturing ecological bio-material SCOBY (symbiotic colony of bacteria and yeast) that produces bacterial cellulose. The material has similar properties to leather. Second, designing the garment through 3D modeling has been tackled because we aim to make the bio-materials grow onto a 3D printed mold as 'zero waste method' (Rissanen; Mcquillan, 2016) , which can eliminate textile waste at the design stage. By the application of biological materials in the process of dressmaking, this practice-led research has been analyzing the production line of the fashion industry and trying to propose sustainable solutions. Also the research aims to combine emerging biotechnology and sustainable fashion in order to establish the design process as an alternative design process to the polluting industry.

Keywords: Fashion Design, Sustainable Fashion, Bio Design, Wearable Technology, Research Through Design and Design Strategy

Literature Review

Ever since theoretical physicist Freeman Dyson said “The twentieth century was the century of physics and the twenty first century will be the century of biology” in an essay ”Our Biotech Future” in the New York Review, it is believed that biology should give an enormous impact on its environmental consequences, its ethical implications, and its effects on human welfare at the age of the coming century(Dyson, 2007). With the help of exploration and research in the field of wearable technology particularly in the 2010s, the fusion between fashion and biotechnology is about to happen(Ginsberg, 2014). The most developed area of integration of biological processes is Material Science. In the research on sustainable materials, designers and engineers have begun to look at the metabolic processes of microorganisms as a way to synthesize natural composites. For instance, Japanese company “Spiber” is developing the synthetic yarn “QMONOS”, a yarn made by manipulating fibroin. Fibroin has environmentally sustainable characteristics and can be spun into strong and flexible yarn.

Sustainability has become a growing issue in the field of fashion design in the late 2000s and early 2010s. The commercial fashion industry highly relies on mass production and mass consumption, and the resulting accumulation of textile waste has become the root of many serious environmental problems. In the context of sustainability, this study aims to speculate an alternative sustainable form of fashion and invert the system of the current fashion industry(Fletcher, 2007). The paper “Emerging issues in our global environment” published by the United Nations in 2011 states that especially in developed nations, the number of serious environmental problems is increasing, and the world population is estimated to exceed 9.6 billion in 2050.(UN, 2011). Population growth will obviously increase human energy consumption and would also impact the textiles and garment industries. Indeed, the global demand for garments continues to rise—the fabric consumption in 2012 was 78.88 million tons. This is around a 40 percent increase compared to the fabric consumption in 2003, and consumption is expected to continue growing. Synthetic fiber consumption was 50.14 million tons and cotton fiber consumption was 23.46 million tons in 2012. According to the World Apparel Fiber Consumption Survey by FAO(Food and Agriculture Organization of the United Nations), the sum of the world’s fiber consumption has been continuously growing from 38.99 million tons in 1992 to 69.70 million tons in 2010(FAO, 2012).

Based on the background above, this practice-led research aims to speculate more sustainable garment design processes by examining differing stages in the manufacturing of sustainable bio fashion as a single design research project: material developmetn and fashion pattern cutting.
The authors have focused on development of alternative pattern cutting techniques to effectively use the material to shape three-dimensional garments while minimizing fabric waste as remnants. Designers can design garments without any fabric waste using the method of “Zero Waste Fashion” (Rissanen, 2015), however, Rissanen’s proposed techniques is primarily for woven fabrics.
However, a metabolic system of new bio-materials enables us to design a more organic fabric through cooperation with digital fabrication technology such as 3D modeling tool. Hence

undertaken research therefore aims to improve the conventional pattern cutting techniques.

Research Methods

The authors argues that the field of sustainable fashion needs to deal with 1) material, 2) process of production, 3) distribution, 4) use of garments, and 5) disposal (Fletcher, 2008). According to Fletcher, the current fashion industry consists of many stakeholders, and it requires holistic solutions for this wicked problem. If designers of the sustainable bio fashion cope with the complex socio-technical issues, they have to challenge not just a single issue but to speculate and implement the holistic manufacturing processes of the fashion industry from the broad spectrum. To achieve this end, this practice-led research aims to speculate more sustainable garment manufacturing processes by examining differing stages in the manufacturing of sustainable bio fashion AS a single design research project. This paper specially looks at the following design stages:1) material development using bacteria and yeast. 2) pattern cutting based on digital fabrication technology. 3) dyeing using living pigments.

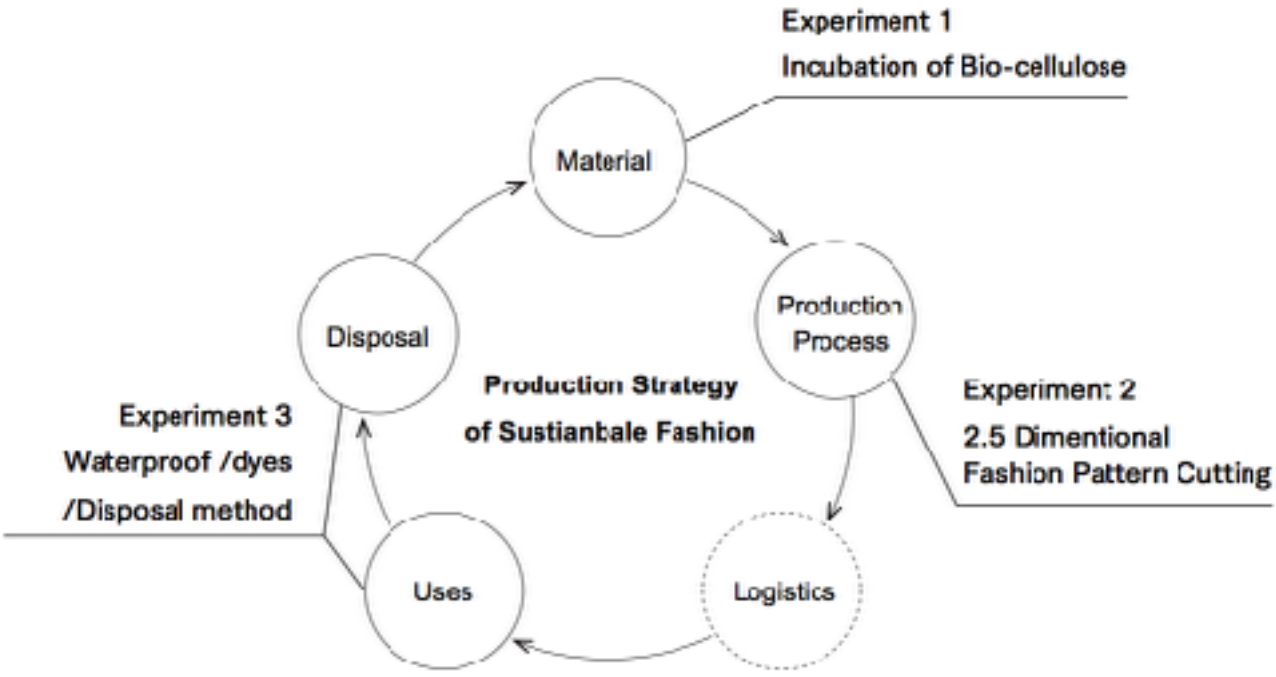

Figure 1: The production Strategy of Sustainable Fashion

Discussion

Experiment 1: Incubation of Bio-cellulose

The authors set SCOBY (Symbiotic Colony of Bacteria and Yeast) as their object of study, practically conducted incubation experiments, recorded their process, and collected their data. The process of research is below:

1. SCOBY is a colony of bacteria that consists of Zygosaccharomyces sp,a yeast, and Acetobacter xylinum, an acetic acid bacteria. SCOBY produces celluloses by the principles of fomentation and a sheet of cellulose is layered to expand its volume and capacity.

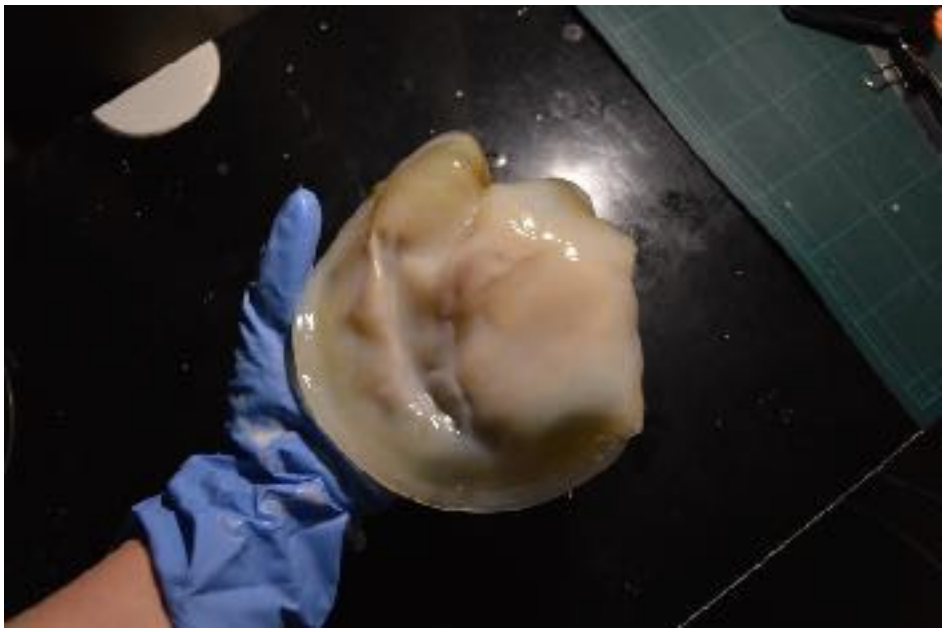

Figure 2: SCOBY (Symbiotic Colony of Bacteria and Yeast)

2. Construction of Incubation Environment: The incubation environment is mainly conducted at home of the author and we made an incubator and a medium. A plastic box was used as the incubator and its size was 800*600*200mm. Medium was made from organic vinegar water, sugar, and green tea.

3. Record of Incubation Experiments: The experiment of incubation was done for 14 days at one room of an apartment in Tokyo. We recorded the temperature, moisture, and water temperature by an infrared thermometer. Also, we noted the process of this experiment.

4. Washing and Drying Materials: As it has been 12 days since the experiment started, the thickness of the material reached 25mm. After that, the material was taken off from the tank and we washed and dried it. After the finish of washing, the material was dried for

2 days.

Figure 3: Washing and Drying Materials

Experiment 2: 2.5D pattern cutting

The process of fashion design is mainly premised on pattern cutting for two dimensions except knit and leather. However, a metabolic system of new bio-materials enable us to design more organic fabric. Based on that techniques, the current garments production process that we all are taking for granted today will radically change.

This practice improves the conventional technique of pattern cutting and invents an alternative design process. This research uses a material called SCOBY as a case-study. It would be one of the interesting features of SCOBY that you could control its shape during the cultivation process by constructing its environment or situation. In other words, if you incubate SCOBY on a curved surface of a tank, SCOBY will produces textile along the curved shape. It would be one of the interesting features of SCOBY that you could control its shape during the cultivation process by constructing its environment or situation.

These processes in which SCOBY produces three dimensional fabric have a high affinity with digital fabrication. Also, following this method, designers can design garments without any fabric waste. Then, the authors used a large-scale tectonic 3D-printer that can generate human-scale objects, and created a mold in order to model bio-materials. On the mold, the authors incubated the material. The detailed process of this practice is below:

1. Production of the sleeve pattern: The authors made the fashion pattern impregnatedwith calcinated plaster.

Figure 4: Physical Scanning with calcinated plaster

Figure 5: Physical Scanning tailored suit fashion pattern

Figure 6: Physical Scanning tailored suit fashion pattern

2. Scanning of the pattern with a 3D scanner: The authors scanned, digitized the pattern, and edited the data for printing it with a 3D printer and CNC milling machine.

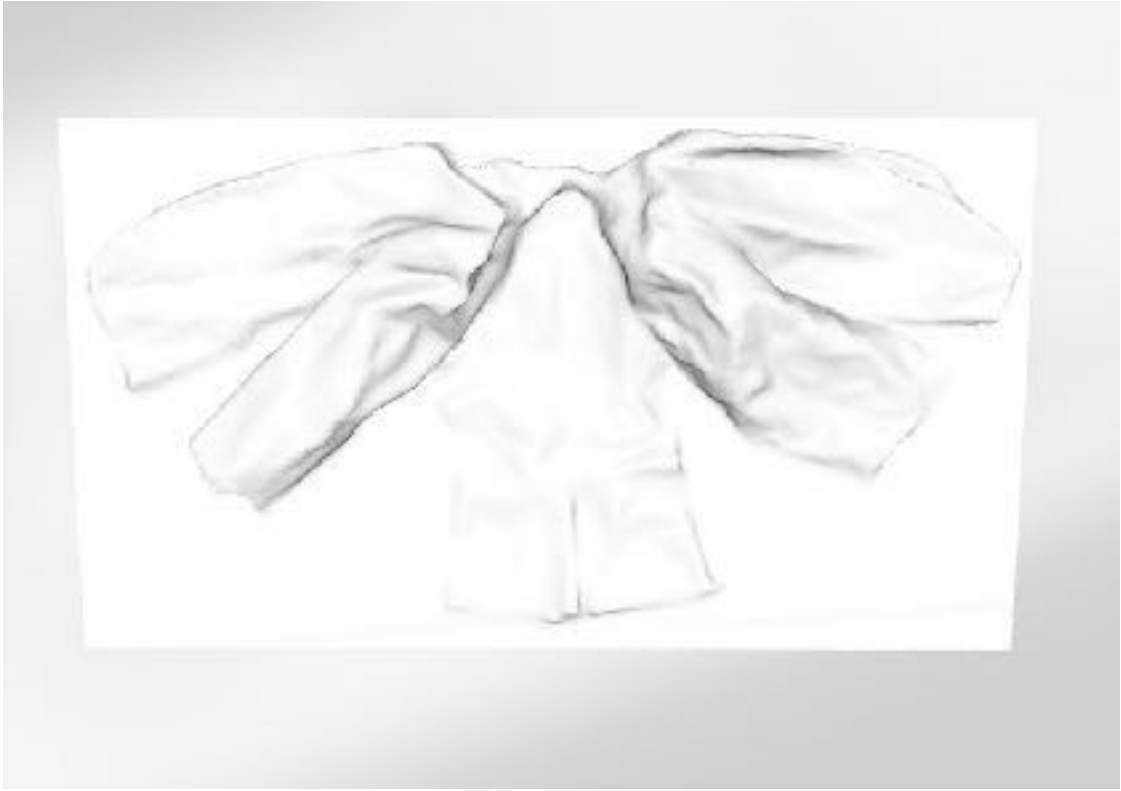

Figure 7: 3D date of tailored suit fashion pattern

3. Printing the edited data: The authors 3D printed the sleeve data with the 3D printer and CNC machine, which is specialized for large scaled data, especially for architects.

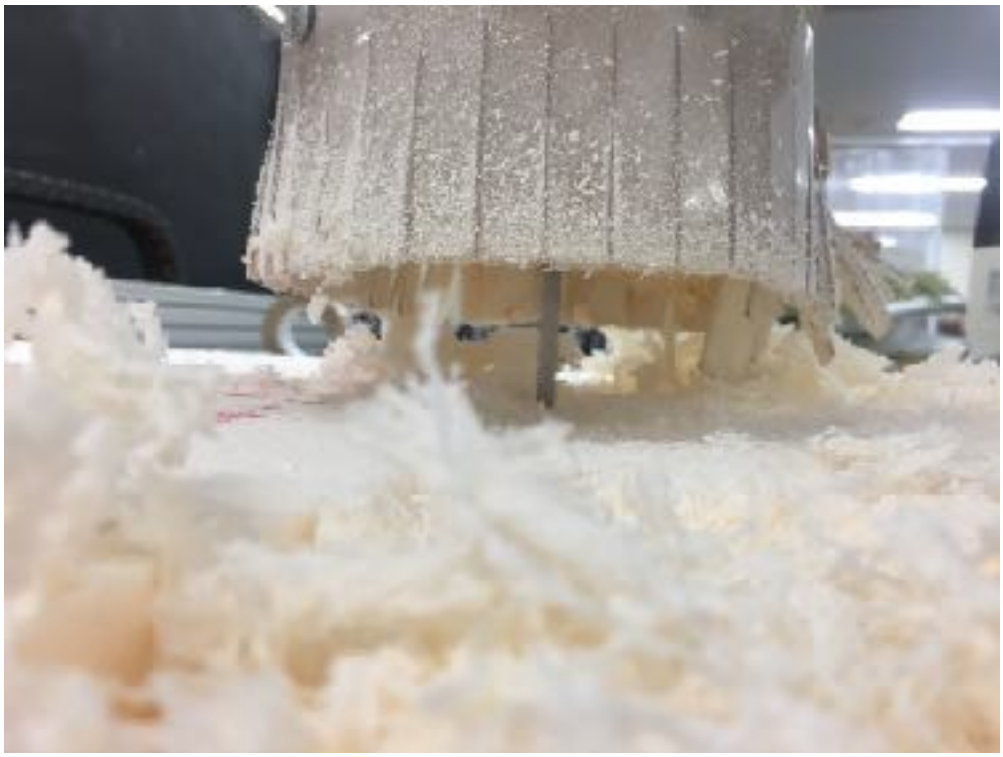

Figure 8: Milling the pattern with CNC Milling machine
(Shopbot)

Figure 9: 2.5 dimensional fashion pattern

4. Molding the biomaterials: The authors dried the biomaterials out on the catted pattern, and molded the curved surface without straightening materials.

Figure 10: Molding test

5. Sewing: After drying, the authors cut and sewed the material.

Figure 10: Molding test output

In order to create carve shapes in the design phase, the conventional 2D pattern cutting is based on darts which cause many textile wastes. On the other hands, the 2.5D method enables us to change darts into molds to omit textile emissions. The scale of mold depends on available dimensions of digital fabrication machines. Then, the authors separate the data into components of garments: like the bust, waist, and hip. It suggests a use of 2D straight pattern and 3D mold in combination. The authors developed parts of pattern of 3D carve shape like shoulder, bust and hip with digital fabrication tools: CNC Milling Machine (Shopbot) and 3D printer. The combination of 3d and 2D fashion pattern prototypes have it both ways of the zero waste method and creation for carve shape.

Experiment 3:

To create a comprehensive sustainable production line, it is necessary to develop a finishing process that includes dyeing in relation to the previous research. This is an experiment to develop dyes that uses bacteria with color-pigments. Although there are various ways in which to use the principles of fermentation such as indigo dye, this research aims to invent a new dyeing method that can be applied to bacterias.

1. Incubation of Janthinobacterium lividum : the authors incubated a bacteria provided by the Waag Society, Janthinobacterium lividum, and confirmed microbial growth.

2. Construction of Incubation Environment : The authors conducted the experiments at a laboratory with a clean bench, an autoclave, and an incubator. The incubation was done in a sterilized environment in the clean bench. Then, utensils were treated with the autoclave.

Figure 11: Incubation Environment

3. Record of Incubation Experiments : The bacteria was incubated in the incubator wherethe temperature was controlled at 30°F.

4. Experiments of Textile Dyes : The authors cut cotton, hemp, and silk fiber into 80mm squares. Also, we transfuse N/A medium into the fabric, and incubated on themedium.

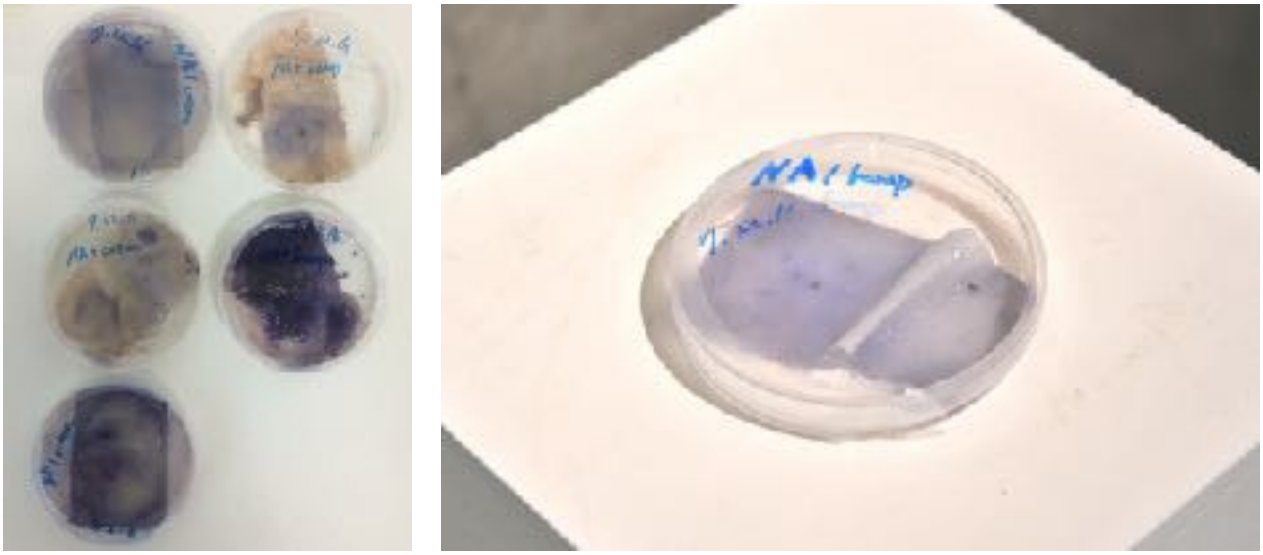

Figure 12: Textile Dyes

Conclusion

So far, the research has revealed the possibilities of the 3D design process for bio-material SCOBY as sustainable material. However, several challenges still remain. For examples, the study of waterproof of the materials and the development of the garment design methodology. The ultimate goal of the research is speculation on an alternative production line and design strategy toward the future of sustainable fashion.

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Author Biography

Kazuya Kawasaki

Born in 1991, is a fashion designer who is trying to create a new era of "speculative fashion". He designs fashion works that speculate about an alternative fashion industry in order to explore the possibility of fusion between fashion design and emerging technology such as biotechnology and wearable technology. Kazuya's works have been presented at Are Electronica (Linz, 2017), National Museum of Scotland (Edinburgh, 2017), Hong Kong Design Institute (2016, Hong Kong), Design lndaba (2016, Cape town), and AXIS gallery (Tokyo, 2015). He is working as a textile researcher at Poiesis Labs founded by Shiho Fukuhara.

Dr. Daijiro Mizuno PhD RCA

Born in Tokyo in 1979, completed an MA and a PhD in Fashion Design at Royal College of Art. Daijiro's research projects speculate about how design can make a positive impact on our society. Daijiro is currently working as an Associate Professor at Keio University Faculty of Environment and Information Studies while working as a freelance design researcher. Daijiro also works as a co- editor in chief of fashion design critique periodical, Vanitas.