



# Development of Art Fashion by Integrating Art and Digital Textile Printing

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**Abstract.** Fashion and art are essential elements of our life because they enrich people's daily lives. As art has a business model of small-scale production and fashion has a business model of mass production, there was little point of contact between the two. However, these two areas are approaching with the spread of digital art in the art world and the emergence of digital textile printing technology in the fashion world. Combining digital art and digital textile printing creates new possibilities for art to enter our everyday life as clothing. This paper describes our attempt to create fashion from digital art under the concept of "wearing art" through joint research between a university and a company.

**Keywords:** Digital art · Digital textile printing · Art fashion · Wearing art

## 1 Introduction

Art and fashion are closely related, but while the status of art has been established since ancient times, fashion existed only in the form of clothing for a portion of the upper-class people until the 19th century. Charles Frederick Worth, a British fashion designer, raised the status of fashion [1, 2]. He created a method still relevant today in which designers create fashion trends for upper-class women. He is also the first to present his work to the public using human models.

After that, various forms of collaboration between artists and fashion designers were born. The first well-known collaboration between surrealist Salvador Dalí and Italian fashion designer Elsa Schiaparelli is famous for fashion designs using lobster. In 1965, fashion designer Yves Saint-Laurent launched the Mondrian Collection, inspired by the composition established by the Dutch abstract painter Piet Mondrian [1, 2]. These influences also spread to the art world, and it is common now that fashion exhibitions are held at world-famous museums such as the Metropolitan Museum of Art in New York.

In this way, the worlds of art and fashion seem to be getting closer, but that is limited to collaborations between a few well-known artists and fashion designers. In the world of fashion worn by the public, the distance between art and fashion is still far, and the general public is not in a state of wearing art fashion. This is because connecting the analog worlds of art and fashion takes time and money.

However, innovation is currently occurring in the world of fashion. It is because digital textile printing [3] is being introduced into the fashion world. For a long time in the world of fashion, clothes have been produced using analog methods such as hand-made designs, textile printing, and sewing. Digital textile printing, on the other hand, attempts to digitize the textile printing process. This could change the whole process of fashion creation.

On the other hand, artists have mainly created artworks by hand in the art world. Recently artworks using digital technology have become widely recognized. Digital art is art created by using a computer instead of manual painting. As a digital video art creation method using a computer, artworks using CG (computer graphics) have become popular. On the other hand, some artists, such as Naoko Tosa, one of the authors, use digital technology but have been obsessed with the production method of using natural phenomena instead of CG.

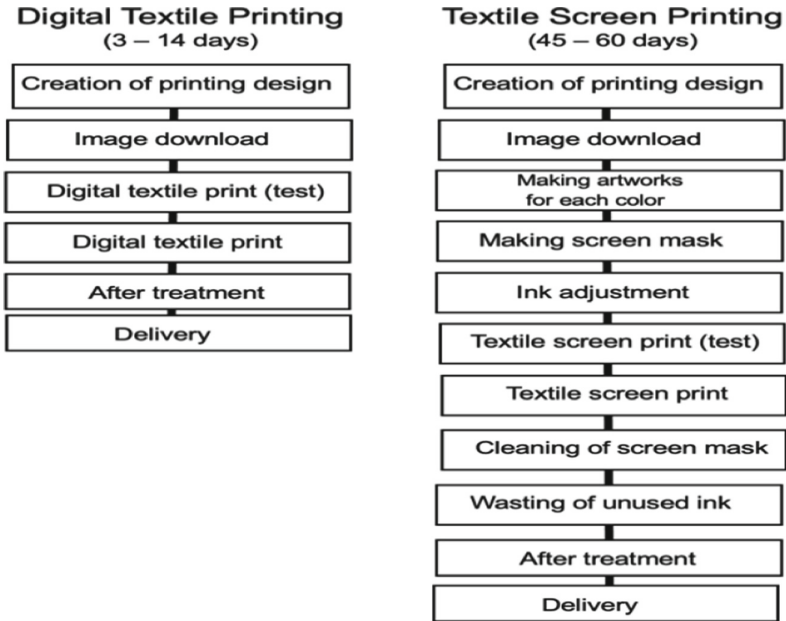
By combining this digital textile printing and digital art, there is a possibility of innovating the world of art and fashion. We are conducting joint research based on industry-academia collaboration to realize this. This paper describes the detailed process of developing art fashion by integrating art and fashion.

## 2 Digital Textile Printing of Clothes

Coloring the raw material fabric requires dyeing when making fashion products. There are two types of dyeing: “dyeing,” in which the fabric is dipped in a dyeing solution, and “printing,” dyes and pigments are printed and fixed on the fabric. Printing is usually used when it is required to draw a detailed design on the fabric and is a traditional method of drawing patterns on fabric by hand. There are two methods. One is to draw on the fabric one by one. In developing high-class Kimonos [3], drawing patterns by artisans is still used. The other is to make a textile screen that corresponds to the design and then pour the dye into the screen, enabling mass production.

In contrast to the conventional analog printing method described above, a printing technology that incorporates digital technology has been born. This method is called “digital textile printing” [4]. Digital textile printing is a technology for printing various designs and images on fabric. Various methods have been conventionally developed for printing high-quality images on paper. Although there are differences in the properties of paper and fashion fibers, the purpose of printing vivid and various colors and fixing them is the same. The ability to print on fabrics by developing inks suitable for textiles made digital textile printing technology development possible.

The printing method for the paper includes an inkjet method and an electrophotographic method. Also, the printing method for fabric includes a direct inkjet method and a thermal transfer method. In the direct inkjet method, pigments and dyes are treated as ink, and ink particles are directly sprayed onto the fabric for dyeing. Printing on silk,



**Fig. 1.** Comparison of digital and analog printing processes [4].

polyester, rayon, cotton, etc., is possible using different inks. On the other hand, the thermal transfer method uses a sublimable dye. It utilizes the fact that the dye vaporized by heating enters the polyester fiber and exhibits a color development reaction.

Figure 1 compares the analog printing and digital textile printing processes. While the analog printing process requires 45 to 60 days, the digital printing process takes only 3 to 14 days, making it possible to reduce the process significantly. In digital printing, the fact that there is no need to create the printing plate required for analog printing has the merit of significantly reducing the process.

Digital textile printing has the characteristic that it is suitable for low-volume, high-variation, and short-delivery production. At the same time, analog printing requires water to clean the textile screen, and there is also a problem with waste ink. As digital textile printing does not have such a problem, digital textile printing is expected as a technology that can contribute to reducing the environmental load.

### 3 Digital Art “Sound of Ikebana”

One of the authors, Naoko Tosa, found that fluids create a flower-like shape by giving sound vibrations to the fluids such as paints and shooting them with a high-speed camera. This method is an art production using a fluid phenomenon. The behavior of fluids is an essential subject of physics research, and research has been conducted under “fluid dynamics [5]”. It has long been known that fluids produce stunning shapes under various

conditions. A typical example is the well-known “milk crown”. Since beauty is a fundamental art component, it is natural to consider fluid dynamics as the basic methodology for art creation.

Figure 2 shows a fluid art production system. When the speaker is placed face up, a thin rubber film is put on it, a fluid such as paint is placed on it, the speaker is vibrated by sound, the paint jumps up, and various shapes are created.

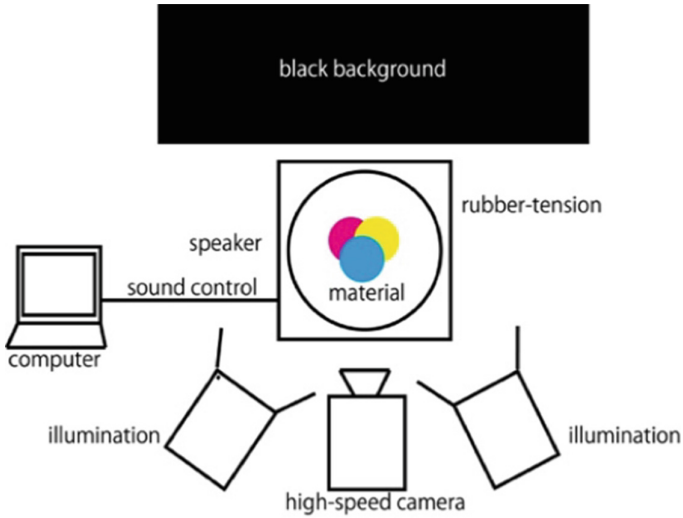


Fig. 2. Fluid art creation system (top view).



Fig. 3. A scene from “Sound of Ikebana”.

Tosa confirmed that various fluid shapes are generated by changing the shape of sound, frequency of sound, type of fluid, a viscosity of the fluid, etc., using this environment [6]. In addition, she edited the obtained video to match the colors of the Japanese seasons and created a digital art called “Sound of Ikebana [7]”. Figure 3 is a scene from the artwork.

In April 2017, as part of her Japan Cultural Envoy’s activities, she exhibited the Sound of Flower at Times Square in New York using more than 60 pieces of digital signage. When Tosa exhibited her “Sound of Ikebana” worldwide as a Japanese Cultural Envoy, she received the following opinion from many art-related people. “Tosa’s digital art, expressed in an abstract form, expresses beauty that Westerners have not noticed until now, and that is the condensation of Japan’s consciousness and sensibilities”. After discussing with many Japanese art critics, curators, researchers, etc., many people agreed with this idea after her return to Japan.

This shows that the Sound of Ikebana is a work that touches the core of art. Ikebana is a minimal expression of natural scenery with a minimal number of flowers and grass [8]. Ikebana can be considered an abstract art that expresses the essence of nature. On the other hand, the Sound of Ikebana is based on the fluid behaviors that rise due to sound vibration. The shape created by it is organic and abstract, and it can be positioned as an Eastern abstract painting in contrast to a Western abstract painting [9].

By using this Sound of Ikebana as a fashion design, it is expected that new designs will be created in the fashion world.

## **4 Integration of Digital Textile Printing and Digital Art**

### **4.1 Basic Concept**

Digital textile printing is suitable for small-quantity production, as mentioned above. In this case, what design is printed on fabric is fundamental for digital textile printing technology and the fashion business. This shows that digital textile printing and digital art go well together.

Digital art can make many copies because it is easy to copy, which reduces its value as art. Therefore, in digital art, a strategy has been taken to maintain or increase the value of art by selling a limited number of copied works. For this reason, digital art is usually exhibited in museums and galleries and is the subject of collection by art collectors, just like traditional art. On the other hand, the apparel industry is based on mass production using the same design. Therefore, art and fashion have been considered in the opposite world.

However, with the advent of digital textile printing technology, the business possibility for small-quantity production and sales has emerged in the fashion world. This small-quantity production/sales concept is the primary driving force for connecting digital art and digital printing. Furthermore, the connection of art with fashion means that ordinary people can wear art as clothing in their daily lives. Since art is an item that exists only in the world, it has been only exhibited in museums and galleries, so it was difficult for art to permeate the general public beyond a small number of art lovers and collectors. The fact that art can be linked to fashion means that art, closed to the little

world of exhibitions at museums, galleries, and collections of art collectors, will be more widely incorporated into the general public.

Also, the connection with art opens up new possibilities for the fashion world. Until now, fashion has been premised on having a copy. Therefore, even expensive clothing has been treated as a consumable item. The fact that art becomes fashion means that clothing, a consumable item, will improve its position as art.

Overturning the conventional concept that clothing is a secondary value, we aim to increase the value of people's life by "wearing art" in their daily lives and leading a prosperous life. This way, the connection between digital art and digital printing is a win-win relationship.

## 4.2 Realization of Art Fashion Using "Sound of Ikebana".

Based on the concept described in Sect 4.1, an attempt led by Naoko Tosa to apply her art represented by the Sound of Ikebana to fashion started as joint research between academia and industry. Applying digital art to fashion is the first experience for us who belong to a university or a company. However, to fully utilize the feature that digital textile printing requires a shorter time than analog printing, we started joint research to complete the joint research between Kyoto University and Seiko Epson. Specifically, the following environment and processes were created and carried out.

### Development of Art Fashion Creation Environment

As mentioned earlier, there are two types of digital printing, the direct textile printing method and the thermal transfer method. We adopted the thermal transfer method suitable for small-quantity production because it does not require post-treatment such as drying. Seiko Epson installed an inkjet printer for sublimation transfer (Epson Sure Color F6350, Fig. 4: left) and a thermal transfer device (ZEUS PZ-13011D, Fig. 4: right) in the Tosa laboratory at Kyoto University. In addition, we installed sewing machines for sewing and built an environment in the laboratory where we can achieve the whole fashion-producing process from design to sewing. Figure 5 shows the entire experimental environment.



Fig. 4. Inkjet printer for sublimation transfer (left) and thermal transfer device (right).



**Fig. 5.** Students are making fashion.

### **Creation of Fashion Design Using Digital Art**

The distinguishable feature of this project is that Naoko Tosa, a professor at Kyoto University and an artist, manages the whole fashion-making process from design production to sewing by using students. This project to make digital art into fashion quickly became possible by having the artist manage the entire process of creating digital art herself into fashion.

As mentioned earlier, digital art, the basis of the design, is mainly the Sound of Ikebana. This art uses physical phenomena and is evaluated by foreigners to express Japanese beauty. Usually, as a Japanese design, really “Japanese” designs have been used, such as flowers loved in the four seasons of Japan as cherry blossoms and autumn leaves. Also, ancient buildings in Kyoto, such as Kinkaku-Ji (Golden Temple) [10], Ginkaku-Ji (Silver Temple), etc., have often been used. On the other hand, the Sound of Ikebana has been accepted by many people in Japan and abroad because it has an abstract and organic shape. At the same time, as mentioned earlier, it makes people feel the beauty of Japan.

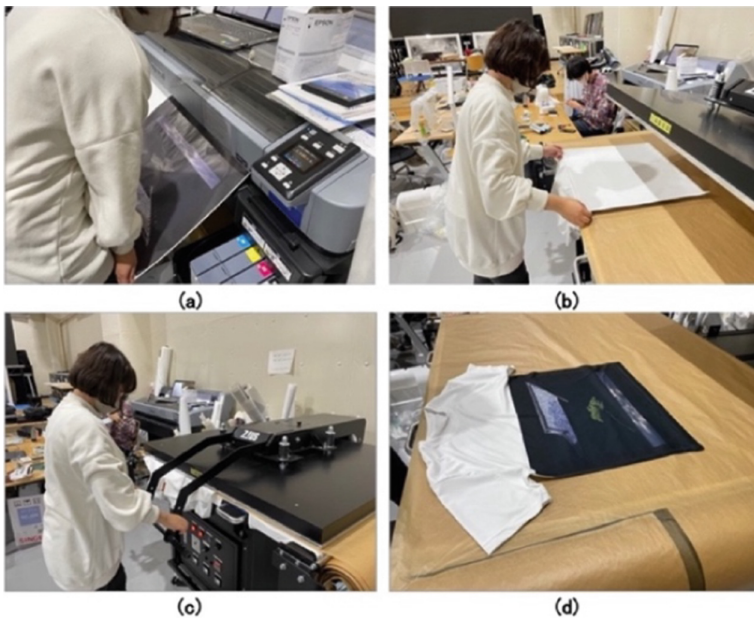
### **Pattern making**

Pattern making is generating a pattern by taking the clothes to make (jacket, dress shirt, etc.) and their size into consideration. As neither Tosa nor the students have experience in this part, we decided to ask an outside person called a pattern designer to do this. Currently, we outsource this part to a freelance patterner. In the case of a custom order, the patterner measures the size of each part of the customer’s body and makes a pattern. Then Tosa places her art image on the paper pattern sent from the patterner as digital data and decides the most attractive arrangement. This work is achieved on the personal computer.

Currently, as mentioned above, the pattern-making part is outsourced. However, the patterner changes the basic pattern according to each customer's size. This means it is possible to automate this part and shift it to in-house production, which is a future issue.

### Printing

Digital data in which the art image is placed on the paper pattern data can be printed. This digital data is printed on special paper with the sublimation transfer printer described earlier and then thermally transferred onto the fabric with a thermal transfer device. The process is shown in Fig. 6. Figure 7 shows an example of a printed result according to the pattern.



**Fig. 6.** Process of printing on fabric (a: output from the printer, b: place the output result inside out on the fabric of the thermal transfer device, c: thermal transfer, d: result printed on T-shirt).

### Cutting and Sewing

The final garment is completed by hand-sewn or sewn fabric with a sewing machine. Figure 8 shows a student sewing with a sewing machine.



**Fig. 7.** Results of printing to match the shape of the pattern.



**Fig. 8.** Sewing work.

### **Final Product**

With the above process, clothes with the design of fashionable digital art are completed. Figure 9 shows an example of the completed dress shirt.

### **4.3 Implementation of a Fashion Show**

The clothes made from Naoko Tosa's digital art mentioned above are new. Anyone can wear art in their daily lives by making the art, which used to be exhibited and appreciated only in art galleries and museums, in fashion. We believe that in the fashion industry, an established and conservative industry, an artist and amateur students have proposed a new fashion production method that makes clothes almost by hand. How will the general public accept such a new attempt?



**Fig. 9.** Example of the completed dress shirt.

As a test case to evaluate our trial, we got the opportunity to utilize Naoko Tosa's solo exhibition held in Harajuku, Tokyo, for two months. In this solo exhibition, she invited celebrities from various fields to have a talk show with her every weekend. She held a mini fashion show before and after the talk show. The talk show is shown in Fig. 10.

The fashion show has been established as an opportunity to announce new fashion works by fashion brands and designers and as a place to advertise them. Fashion shows other than these are limited to those held internally as a place for graduation work by graduates of fashion-related schools. It is an event with a high threshold for people like us who have little connection with the fashion industry. However, we decided to organize it as it was worth trying because making digital art into fashion is a new attempt.

In order to hold a fashion show, it is necessary to hire fashion models. We asked relatively inexperienced free models through a designer we knew. Fortunately, they agreed with the concept of this fashion show and accepted our proposal at a bargain price. Figure 11 shows the fashion show. Tosa devised a way to match the video image behind the fashion model with the clothes the model wears. The models were confused because this was a fashion show directed by an amateur. However, as time passed, the matching between the video image behind and the models' clothes improved, and the visitors highly evaluated it. We also got offers to buy from several visitors and people who knew about the event on SNS.



**Fig. 10.** A scene from the talk show.



**Fig. 11.** Scenes of the fashion show.

## 5 Future Possibilities

### 5.1 Realization of “Wearing Art” Fashion

As mentioned earlier, the fashion industry has been a world of selling clothes with new designs to consumers. It was a world of anticipating changes in consumer tastes and creating and selling clothes based on designs that matched them. The fashion industry is a society based on “design thinking [11]”.

On the other hand, art does not adapt to changes in society and consumers' tastes in a short period but anticipates changes in the sensitivities and aesthetics of society and consumers in the future and presents them to society and consumers. Although traditional fashion was based on "design thinking," incorporating art into fashion means trying to create fashion based on "art thinking [12]".

In order to appeal that our attempt is trying to create a new trend in fashion, based on the concept of "wearing art" fashion, we must clarify and appeal to its difference from conventional fashion.

## 5.2 "Wearing Art" Fashion Branding

To show that the world accepts the concept of "wearing art," selling clothing that makes art into fashion must be successful. Establishing a fashionable clothing brand of Tosa art is necessary for our attempts to succeed. In other words, it is necessary to differentiate art fashion from "wearing art" as a flag from fashion based on conventional design. There are issues such as where to narrow down the customer and set the price for that purpose. For this, it is necessary to take the following processes.

- It is necessary to arrange many opportunities to appeal to the world with a new art fashion that fuses art and fashion, for example, by organizing fashion shows in various opportunities.
- It is necessary to sell art fashion at EC sites, etc., and use it as a clue to know the customer base and the appropriate price range.

Fortunately, some customers who want to buy this art fashion have already appeared. For example, they are the head of the Ikebana school in Kyoto, a young promising Noh player, and prominent calligraphers who carry Japan's traditional culture. They always try to anticipate the future and introduce new things while maintaining tradition. In other words, they aim to bring about "art innovation". This shows that they deeply understand the implications of our attempts. One way is to have such people wear our art fashion at events and other occasions so that Tosa's art fashion will be recognized by society as a brand.

## 5.3 Commercialization of Art Fashion Production Environment

Another business possibility is to target the fashion production environment created by us. As mentioned earlier, we could create a fashion production environment relatively easily with the cooperation of Seiko Epson. The core is the inkjet printer for the sublimation and thermal transfer devices. The others are work desks and simple sewing machines, as shown in Figs. 4 and 5. Through our experience, we confirmed that art fashion could be made in a small space and a relatively short time.

The art design production by the artist and the pattern making by the pattern designer is the most time-consuming parts, and the part after printing is completed within 1 to 2 days. This time, regarding art design production, it is a process of cutting out the appropriate part from the digital art Sound of Ikebana created by Tosa according to her sensibility. So it was completed in about half a day. If the part to be outsourced to the

pattern is not custom-made, the pattern could be sent to us as digital data once we tell the patterner the type and size of the clothes. It was confirmed that the whole process of developing clothes could be completed in 3 days. It was a surprise to us, who had no experience in fashion, to experience that fashion that incorporates art can be done in such a short time and almost by ourselves.

Many young artists and designers want to make fashion using their art and design. Based on our experience, young artists and designers can create the clothes they want in a short period by utilizing the technology of digital textile printing. Of course, it will be difficult for young artists and designers to purchase an inkjet printer or a thermal transfer device for sublimation transfer. If so, the business of preparing a fashion production environment, as shown in Figs. 4 and 5, and lending them to young artists and designers would be meaningful. Furthermore, the business of selling such a fashion production environment to fashion-related vocational schools and even art-related universities will have great potential.

## 6 Conclusion

This paper described an attempt to make digital art into fashion by fusing digital art and digital textile printing. Art and fashion have many things in common, and collaborations between artists and fashion designers have been taking place for a long time. However, it has been done in a minimal world where fashion designers use the artworks of a few famous artists as designs and make them into fashion.

Art appreciation has been limited to exhibitions at museums and art galleries, with a few exceptions. However, to realize a prosperous society, art must permeate society more. At the same time, it is necessary to maintain the high quality of art rather than simply being a design that is consumed. On the other hand, recently, as a method of drawing a design on clothes, a technology called digital textile printing has been developed in which a design image of digital data is printed directly or by transfer onto clothes, in contrast to the conventional manual analog textile printing. Digital textile printing is based on printing technology on paper and can print or transfer extremely high-definition designs onto clothing fabrics. By fusing these two techniques, art can be made into fashion more easily. For this reason, digital art will have more opportunities to be widely accepted by society, and it will be an excellent opportunity to improve its value in digital textile printing.

Based on this idea, we have started joint research to develop art fashion between Kyoto University and Seiko Epson, led by Naoko Tosa. We created fashion using Tosa's digital art by introducing a digital textile printing system in the Tosa laboratory. The results were obtained in less than a year and successfully presented in a fashion show. In the future, by further pursuing the new directions mentioned in Sect. 5, we would like to discover new possibilities for digital art and digital textile printing and realize true art innovation.

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