

Process Analysis of *Kyo Karakami* Manufacturing

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Abstract. This study is to clarify technique of expert in *Kyo Karakami* manufacturing by using process analysis and the eye motion analysis. *Kyo Karakami* manufacturing consists of “*Some*” process and “*Kata-oshi*” process. “*Some*” process and “*Kata-oshi*” process divided by 4 and 5 phases, respectively. From interview to expert, “*Some*” process divided by 3 steps. In “*Some*” process, expert worked almost same time at each steps. In “*Kata-oshi*” process, expert gave time “phase a” which provide total working time shortening.

Keywords: *Kyo karakami* · Traditional hand crafts · Process analysis · Eye motion analysis

1 Introduction

Karakami is a decorative paper made by coating washi paper with various colors and printing it with a pattern using mica [1–3]. *Karakami* originated in China and spread to Japan during the Nara period. At the time, *Kara-kami* was prized by highborn nobles and was used primarily as writing paper. However, Chinese-made *Kara-kami* was in itself a precious commodity and difficult to obtain. Japanese-made imitations of *Karakami* appeared during the Nara period; these were mainly used by sutra copying offices and for similar documents. The type of *Karakami* used in the Kyoto area for *fusuma* panels and related items is referred to as *Kyo Karakami*. In those days, most *Karakami* was made in Kyoto, and the *Kara-kami* produced there was called “*Kyo Karakami*.” Popular during the Heian period, *Kyo Karakami* was used in *shoji* doors. While it fell out of favor temporarily during the Sengoku period, it flourished again between the Muromachi and Edo periods, when it was used for *fusuma* panels and wallpaper. It is thought that there were 13 producers of *Karakami* in Kyoto in 1839. After the Meiji period, demand for *Karakami* fell, as mechanization advanced and



Fig. 1. An example of Kyo Karakami for ceiling

lifestyles changed. In addition, many *Karakami* producers lost their tools in major fires or wartime destruction. For this reason, only one *Karakami* producer, *Karacho*, is still able to create *Kyo Karakami* using traditional techniques. *Karacho* creates the *Karakami* used in such historical structures as the Katsura Imperial Villa and Nijo Castle. The *Karakami* used in these buildings is of a particular design that is required for restorations. Protecting the techniques *Karacho* cultivated over many years and ensuring that they are passed on to the next generation is vital for keeping Japanese culture alive. In the past, *Karakami* artisans began their training after graduating from junior high or high school. In recent years, the school entrance patterns of young Japanese people have changed, with a higher rate of students going on to college. As a result, some artisans now begin training after graduating from college. For this reason, artisans tend to be over 30 years old by the time they complete their training and are ready to practice. We believe that this training period is a bit too long for modern young people and we hope it can be shortened.

Some study about support for traditional handicrafts technique has been reported [4–6]. However, research of *Karakami* has never reported before. Therefore, purpose of this study is to clarify technique of expert in *Kyo Kara-kami* manufacturing. The process analysis and the eye motion analysis were conducted.

2 Kyo Kara-Kami Manufacturing

2.1 Process

Kyo Karakami manufacturing consists of two processes. One is “*Some*” process which Japanese paper is colored by paint. Two is “*Kara-oshi*” process which after “*Some*” process Japanese paper is printed by block. In “*Kata-oshi*” process, craft worker rubs

on Japanese paper with the flat of themselves hand. Normally, we are inclined to believe that using baren provides good print at “*Kata-oshi*” process. Whereas strong rubbing is not good for printing. If strong rubbing done, pattern will be not print to Japanese paper as shown in Fig. 2. But transfer caused by deficiency of water in paint. Strong rubbing deprives water from paint, so paint viscosity becomes high, and then paint keeps sticking at block. For such reasons that *Kyo Karakami* manufacturing needs delicate hand works.

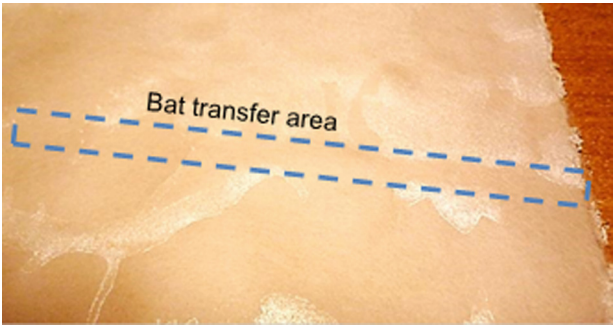


Fig. 2. Bat transfer example of *Kyo Karakami* by too mach pressure

2.2 Material

Kyo Karakami is using Japanese paper; especially *Echizen* Japanese paper is suitable. In “*Some*” process, paint solved by past and water is used. In “*Kata-oshi*” process, paint solved by *Kira* (mica), past and water is used. Mixing *Kira* has the effect of emphasizing printed pattern in angle of watching.

2.3 Tools

In “*Some*” process, the brush is used as shown in Fig. 3. The brush size is changed depending on Japanese paper size.



Fig. 3. Brush for “*Some*” process



Fig. 4. Brush and *Hurui* for “*Kata-oshi*” process

In “*Kata-oshi*” process, the block is used for printing pattern. *Karacho* has more than 600 design blocks [3]. Almost block fixed place of use. Dedicated tool called “*Furui*” is used for putting paint on the block. The *Furui* made by the bamboo loop and the gauze. At first, mixed paint is colored by the brush to the *Furui*, and then paint on the *Furui* is colored to the block. Figure 4 shows the brush and the *Furui* for “*Kata-oshi*” process.

3 Method

3.1 Experimental Outline

In this study, crafts worker performed “*Some*” and “*Kata-oshi*” process. During these processes, we recorded video and measured eye motion.

3.2 Participants

Participants were two *Kyo Karakami* artisans. 26 years career artisan (man) is called expert. 2 years career artisan (woman) is called non-expert. Two participants were artisan of *Karacho*. *Karacho* was established in the 17th century and is the only *Kyo Karakami* factory today. *Karacho* has only two artisans today. So, just two artisans can become participants of this study.

3.3 Experimental Environment

The experiment was conducted on December 18, 2014 at *Karacho* factory. The participants performed “*Some*” and “*Kata-oshi*” processes same of daily work.

3.4 Materials and Tools

For “*Some*” process, *Echzen* Japanese paper and white color paint were used. The white paint mixed by expert with white paint, past and water. The participants use same white paint.

For “*Kata-oshi*” process, Japanese paper after “*Some*” process and other color paint were used. The other paint mixed by expert with other paint, Kira, past and water. The participants use same white paint. The block pattern was selected “*Takara-zukushi*” as shown in Fig. 5. *Takara-zukushi* pattern draws various treasures for example “fish”, “gavel”, “sacred gem” in checker board design [3]. *Takara-zukushi* pattern is difficult printing compared to the other *Kyo Kara-kami* blocks by reason of a lot of convex area.



Fig. 5. Block of “*Takara-zukushi*”

3.5 Measurements

The participants’ motions while working were recorded by a digital camcorder. All work hours were measured from the recorded video.

The participants’ eye motions were measured by eye tracking instruments (Talk Eye II: Takei Scientific Instruments Co., Ltd.). The sampling rate was 60 Hz.

4 Results

4.1 Process Analysis

Total working time in “*Some*” process of expert and non-expert were 40.4 s and 34.6 s, respectively. “*Some*” process was divided by 4 phases as follows. Figure 6 shows schematic images and photos of 4 phases.

Phase A: The Japanese paper is brushed horizontal direction, at the same time the brush is moved from far side to near side.

Phase B: The Japanese paper is brushed horizontal direction, at the same time the brush is moved from near side to far side.

Phase C: The Japanese paper is brushed vertical direction, at the same time the brush is moved from right side to left side.

Phase D: The Japanese paper is brushed vertical direction, at the same time the brush is moved from left side to right side.

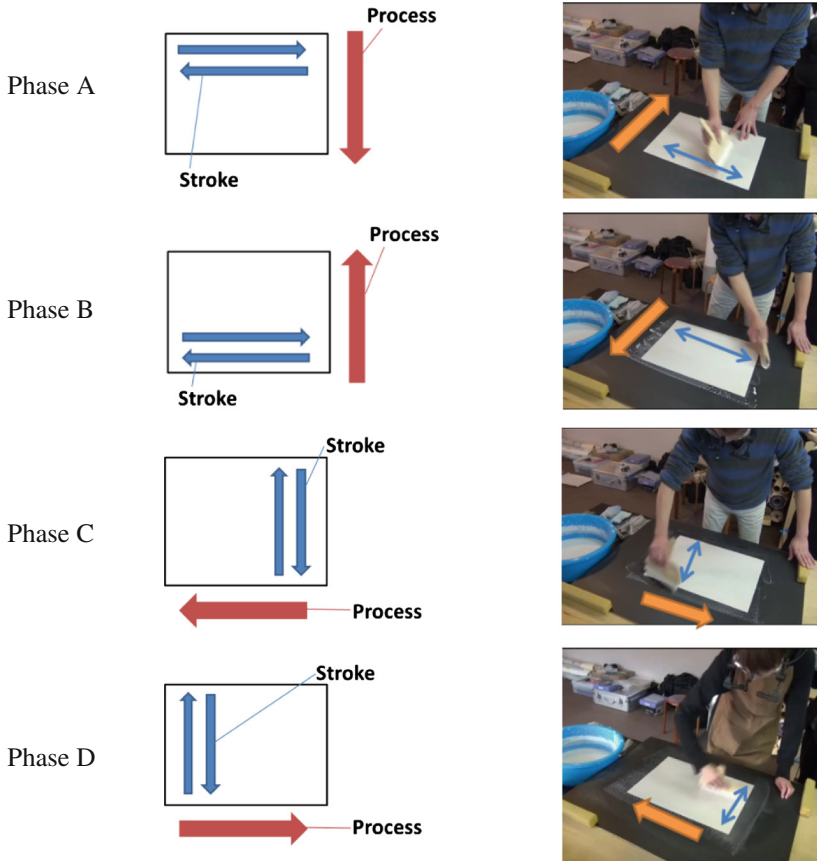


Fig. 6. Schematic images and photos of 4 phases in “*Some*” process.

Table 1 lists working sequence and working time. Expert has done 10 sequences. On the other hand, non-expert finished 7 sequences. Expert have not done phase D. Non-expert have not done phase C.

Total working time in “*Kata-oshi*” process of expert and non-expert were 61.7 s and 73.8 s, respectively. “*Kata-oshi*” process was divided by 5 phases as follows. Figure 7 shows photos of 5 phases.

Phase a: The paint is put into the brush.

Phase b: To paint by the brush to the *Furui*.

Phase c: To color by the *Furui* to the block.

Phase d: The Japanese paper is put on the block.

Phase e: The Japanese paper is rubbed by hands and *Karkami* pattern print to the Japanese paper.

Table 1. Working sequence and working time of “Some” process

Sequence no.	Expert		Non-expert	
	Phase no.	Phase time (sec.)	Phase no.	Phase time (sec.)
1	A	4.90	A	3.69
2	B	4.43	B	3.47
3	C	3.51	D	4.59
4	A	2.74	B	3.71
5	C	4.72	D	4.86
6	A	5.10	A	6.44
7	C	3.91	D	7.79
8	A	3.09	–	–
9	B	4.01	–	–
10	A	3.97	–	–

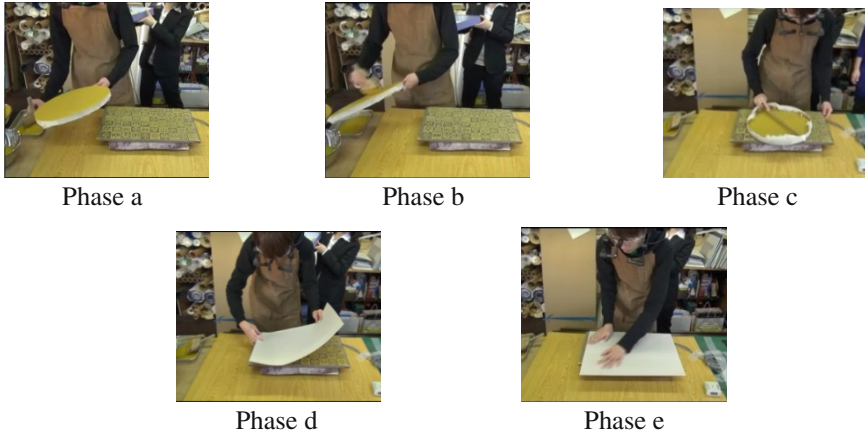


Fig. 7. Photos of 5 phases in “Kata-oshi” process

Table 2 lists working sequence and working time. Expert has done 11 sequences. On the other hand, non-expert finished 9 sequences. Non-expert have done once phase a, b, d. Expert have done repeat phase b, d.

4.2 Eye Motion Analysis

Figure 8 shows line of sight at phase A and C in “Some” process. In phase A and B with to brush horizontal direction, line of sight of expert and non-expert was focused on where the brush would move to next. In phase C and D with to brush vertical direction, line of sight of expert was always in center of Japanese paper. On the other hand, line of sight of non-expert was focused on where the brush would move to next.

Table 2. Working sequence and working time of “*Kata-oshi*” process

Sequence no.	Expert		Non-expert	
	Phase no.	Phase time (sec.)	Phase no.	Phase time (sec.)
1	a	2.54	a	5.41
2	b	1.70	b	6.24
3	c	10.0	c	16.7
4	a	8.20	d	11.7
5	b	1.84	e	14.7
6	d	9.09	c	4.90
7	e	12.5	e	3.72
8	c	5.47	c	5.48
9	e	1.47	e	4.89
10	c	4.81	–	–
11	e	4.05	–	–

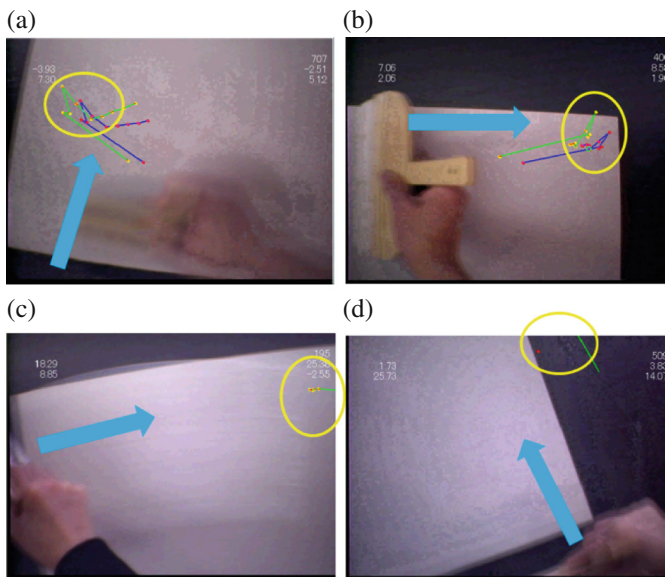
**Fig. 8.** Line of sight in “*Some*” process at (a) expert; phase A, (b) expert; phase C, (c) non-expert; phase A, (d) non-expert; phase C.

Figure 9 shows line of sight at phase e in “*Kata-oshi*” process. Line of sight of expert and non-expert was focused on where the hands would move to next.

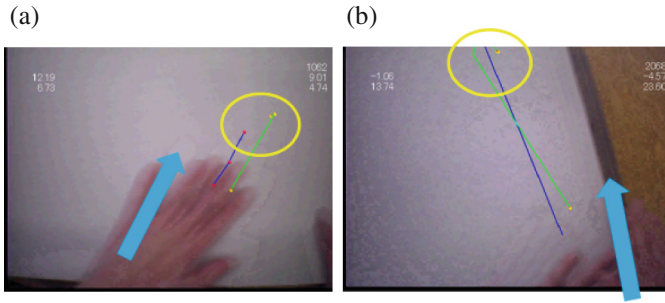


Fig. 9. Line of sight in “Kata-oshi” process at (a) expert; phase e, (b) non-expert; phase e

4.3 Printed *Kyo Karakami*

Kyo Karakami made by each participant was shown in Fig. 10. But transfer was observed in end part of *Kyo Karakami* printed by non-expert. Sometime *Kyo Karakami* is made by big Japanese paper as shown in Fig. 1. In this case, one *Karakami* pattern is printed many times. So that, but transfer on end is due to a deficiency of continuity of pattern.

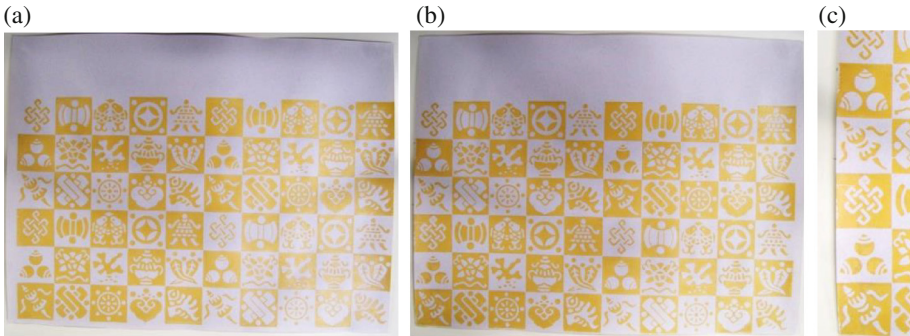


Fig. 10. *Kyo Karakami* made by (a) expert, (b) non-expert, (c) magnified non-expert

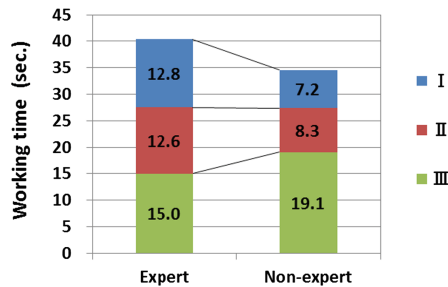


Fig. 11. Working time in step (1)-(3)

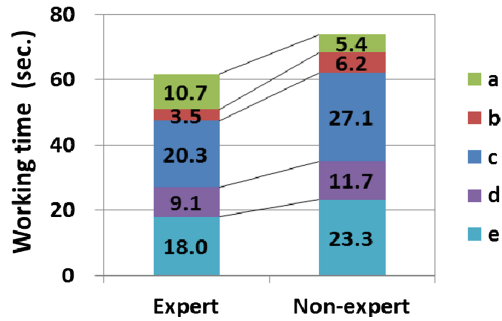


Fig. 12. Working time in phase a-e

5 Discussions

We interviewed expert as “*Some*” process. Expert said the most important point of “*Some*” process is to put paint into the brush with pushing out bristles in paint. In addition, he said “*Some*” process can divide 3 steps; (1) To spread paint, (2) To fit seamlessly into paper, (3) To take out brush lines. If artisan brush not enough paint, step (1) could not be done good condition. Expert divides sequence of two participants. Expert sequences divide into step (1)-(3) as sequence 1-3, 4-6, 7-10, respectively. Non-expert sequences divide into step (1)-(3) as sequence 1-2, 3-4, 5-7, respectively. Figure 11 shows working time in step (1)-(3). Each step working time of expert was almost same. Working time at step (1) and (2) of non-expert was shorter than that of expert. Working time at step (3) of non-expert was longer than that of expert. Non-expert could not put paint into brush; therefore working time of step (1) and (2) was shorter. Moreover, non-expert could not judge finishing job so fast, therefore working time of step (3) was longer.

In phase C and D, line of site of expert was always in center of Japanese paper. Expert said I checked paper condition by peripheral vision in order to lighten his workload. We found out expert’s head didn’t move and non-expert’s head moved every time in phase C and D.

We interviewed expert as “*Kata-oshi*” process. Expert said the most important point of “*Kata-oshi*” process is same as “*Some*” process, to put paint into the brush with pushing out bristles in paint. If artisan brush enough paint, to brush the *Furui* will be enough, and phase c does not need long time. Working time in each phase of “*Kata-oshi*” process is shown in Fig. 12. Working time in phase a of expert was around two times longer than that of non-expert despite total working time of expert was shorter than that of non-expert. We guessed this tendency occurred by expert’ mind. Careful work at phase a will provide total working time shortening.

6 Conclusions

This study is to clarify technique of expert in *Kyo Kara-kami* manufacturing by using process analysis and the eye motion analysis. The most important findings of this research can be summarized as follows:

- (1) “*Some*” process and “*Kata-oshi*” process divided by 4 and 5 phases, respectively.
- (2) From interview to expert, “*Some*” process divided by 3 steps.
- (3) In “*Some*” process, expert worked almost same time at each steps.
- (4) In “*Kata-oshi*” process, expert gave time “phase a” which provide total working time shortening.

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