## **Chapter XX**

# Highly cultured brush man ufactured by traditional bru sh mixing technique "KEM OMI"

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#### ABSTRACT

To hand down the technique of the traditional handicrafts usually takes over a decade. Therefore, the shortage of successors is becoming a serious problem. Thereby there are needs of analyzing the technique scientifically to hand down the technique in less time. FUDE which is Japanese calligraphy brush have been

designated as traditional products of Nara prefecture. It is impossible to manufacture high performance brush from a single raw material, however high performance brush can be obtained by blending many kinds of materials with different characteristics. This process of blending filaments with different characteristics is called "KEGUMI". The next manufacturing process of "KEGUMI" is "KEMOMI". "KEMOMI" is the work to even up the humidity mixing ratio in all the parts of the filaments bunch. Filaments are not to be able to demonstrate the performance only by mixing the filaments with different characteristics, synergy of high performance only begins to appear when filaments are uniformly distributed. In this study "KEMOMI" process was analyzed by the method of Image thresholding and motion analysis.

Keywords: brush, Traditional handicrafts, motion analysis, soliton corporation

#### 1. INTRODUCTION

Traditional handicrafts, more precisely expressed as artisanic handicraft, is a type of work where useful and decorative devices are made completely by hand or by using only simple tools. It is a traditional main sector of craft. Usually the term is applied to traditional means of making goods. The individual artisanship of the items is a paramount criterion, such items often have cultural significance, also aimed to create new tradition of technology. The main idea of the work should be handmade using natural materials, and the fields of handicrafts are widely ranged, such as dyed and woven stuff textiles, metal work, lacquer ware, ceramic arts, calligraphy brush. As of April 2009, there are 211 traditional handicrafts in Japan, specified by the Ministry of Economy, Trade and Industry. Traditional handicraft is specified to satisfy five requirements described below. (1) What is used mainly in daily life. (2) The main portions of a manufacture process are handmade. (3) Manufactured by traditional technology and technique. (4) Traditional raw material is used. (5) The place of production is formed in the fixed region.

However, in recent years traditional handicraft industry is facing serious problems. As for traditional handicrafts main processes are handmade and since it is what is depended on advanced traditional technology, long years are needed for the acquisition to obtain the technique. Furthermore, with change of a lifestyle, the demand of traditional handicrafts articles has showed low transition, causing difficulties of training successors which has become a big subject of the whole industry.

It is not an exception in the traditional "FUDE" (Japanese calligraphy brush) industry of Nara prefecture in Japan. In recent years, an opportunity of taking the brush itself is diminishing, due to the change of a lifestyle such as using a pen instead of a brush, reduction of calligraphy lesson in school, spread of personal computers which can print brush characters easily at home and etc. Moreover, a cheap Chinese brush flows into a market in large quantities, consumer intention to low price products also helped to decrease both the amount of consumption and the quantity of production of a domestic brush.

The surrounding situation of traditional handicrafts industry is very severe as mentioned above. In order to overthrow this situation, such method as mechanizing a section of manufacturing process while leaving a traditional technique, and quantifying master craftsman's work behavior and technique as a data is highly required. Mechanizing the section of manufacturing process enables to lower the cost of manufactured goods, which will be able to oppose against cheap import products from overseas. Quantifying master craftsman's work behavior and technique has potentialities to achieve shortening successor's training period.

As described above, in recent years the demand of traditional handicrafts articles hangs low with change of a lifestyle, increase of the imported product at a low price, and the shortage of raw material, causing doubt of the continued existence. There are some companies which were obliged to discontinuance of business, and there are some cases which relocate a factory to overseas. However, there are companies corresponding to change of such a severe situation, one of them is soliton corporation CO. LTD, which is a brush manufacturing company in Japan. soliton corporation CO. LTD has succeeded in mechanizing a part of manufacturing process, also inheriting the traditional craftsmanship technique of the Nara Fude to manufacture the high quality brush which fulfills contemporary needs. Nevertheless, not all processes are mechanized, even now the important process is manufactured by the manual labor, aimed to apply the warmth of the person's hand and to receive the benefit of the wisdom from traditional craftsmanship as well as being highly efficient with high quality. In this study analysis of "KEMOMI" process, which is supposed as the most important process during brush manufacturing, was taken place using Image thresholding and motion analysis.

### 2. EXPERIMENTS 2-1 Analysis of "KEMOMI" progress degree

The scenery of "KEMOMI" process is shown in Fig.1 and Fig.2.



Fig.1 "KEMOMI" scenery



Fig.2 "KEMOMI" scenery (close up)

#### 2-1-1 Material

In this study three types of PBT (Polybutylene Terephthalate) filaments listed below was used for experiment. The taper is processed to the PBT filaments by the chemical mean (hydrolysis). As the result, row materials of PBT filaments are supplied with the rose in the angle and shape of the taper, even though in the same lot. Therefore, at the stage of "KEGUMI", measurement, selection and classification are taken place to minimize the rose of the filaments. Three kinds of PBT filaments after the selection and the classification process are mixed by 40g each. Two kinds of filaments out of the three were painted red and blue on the opposite of the taper side, which allows checking the mixing degree by eyesight.

(1)520M-0.14-50 (TORAY MONOFILAMENT CO.,LTD.) Large diameter round shaped fiber

(2)SOW-W-0.10-50 (Suminoe Textile Co.,Ltd) Small diameter round shaped fiber (3)521M-0.15-50 (TORAY MONOFILAMENT CO.,LTD.) Star shaped fiber

Three types of PBT filaments set as a bundle and cross section observation of the sample brush using SEM are shown in Fig.3 and Fig.4.



Fig.3 PBT fiber bundle



Fig.4 Cross section observation of three PBT fibers

#### 2-1-3 Image thresholding

To analyze the "KEMOMI" process, Image thresholding analysis was taken place. For the first step, the experiment for deciding the optimal threshold value used for analysis was conducted.

The picture image of the base of the fiber bundle was taken every elapsed time during 7 minutes of "KEMOMI" processing time. In order to determine the optimal threshold value for analysis, 7 minute image, which is thought as the most progressed "KEMOMI" process was used for the first step of analysis. The image was cut to 320×240 pixel size for thresholding. To analyze the "KEMOMI" progress, distribution of the white fiber was focused and threshold value used for next analysis step was computed as the number of lumps of a white pixel becomes the maximum in the 7minutes image. The optimal threshold value presupposed as the same value from which the number of lumps of the white pixel became the maximum. The next step to analyze the share of a white pixel in bundle of fiber was carried out using this threshold.

The image of every elapsed time was partitioned to Upper, Left, Right parts for analysis and each image was analyzed based on a similar threshold computed in the first step, and the occupancy rate of the white pixel at every elapsed time was calculated. In this experiment the master craftsman showed the intention that the "KEMOMI" process was completed after 6 minutes, although extra 1 minute was added for measurement.

### 2-2 Motion analysis of "KEMOMI" process by master craftsman and unskilled operator

Motion analysis of "KEMOMI" process by master craftsman and unskilled operator was taken place due to achieve useful information for shortening successor's training period. Until now improvement in the technique had taken time without the ability of knowing tips of the technique. To see the difference of the motion compared with master craftsman by scientific data, it becomes possible to understand more concretely and more clearly.

Motion analysis was measured by using MAC 3D SYSTEM (made by the Motion Analysis Inc.) which is the optical real time motion capture system with 6 infrared cameras and a video camera(sampling rate:100Hz). Image of MAC 3D SYSTEM is shown in Fig.5. MAC 3D SYSTEM extracts the position of the infrared reflective marker stuck on the subject with three-dimensional coordinates. In this study 16 pieces of infrared markers were set. The "KEMOMI" process of master craftsman and an unskilled operator was recorded 3 times respectively to compare the difference.

Test subject

- 1. Master craftsman: 43 years old male, 17 years of "KEMOMI" experience.
- 2. Unskilled operator: 51 years old female, 8 month of "KEMOMI" experience.

## 2-3 Influence which a "KEMOMI" progress ratio has on finished product

150 brushes of finished product manufactured from 25%, 50%, and 100%"KEMOMI" progress degree were prepared for verification to see the influence of "KEMOMI" progress degree to finished products.

#### 2-3-1 Brush fiber distribution observation

2 brushes were chosen as forbearance from each "KEMOMI" progress degree, in order to evaluate the mixture condition of three kinds of fiber items which forms a brush, the scanning electron microscope was used and the arbitrary section of the brush was observed to count a sum total of fiber and its items.

#### 2-3-2 Rigidity evaluation

In order to evaluate the rose of the brush rigidity of the finished products, micrometer (MHD-50M Mitsutoyo Ltd.,) was set on the top of the scale, displaced down to 2mm and load was measured at each 0.1mm displacement. 20 brushes from each "KEMOMI" progress were chosen as forbearance.

#### 2-3-3 Ink maintenance performance evaluation

20 brushes were chosen as forbearance to measure the amount of ink maintenance of each brush according to "KEMOMI" progress. The brush was first weigh in dry condition, subsequently was immersed in water for 3 minutes. After 3 minutes immersion in water, the brush was hung for 1 minute with a condition of tip turned down. After that weight of wet condition was measured.

#### 2-3-4 Incidence of defective rate evaluation

In order to evaluate the quality stability of a brush manufactured from different "KEMOMI" progress, defective rate of longer than reference value, shorter than reference value, slant, loop, twist, was counted on all 150 final products.

## RESULT AND DISCUSSIONS 3-1 Analysis of "KEMOMI" progress degree

Fig.5 shows the optimal threshold value calculated from the image of 7 minutes "KEMOMI" progress. The number of lumps of the white pixel became the maximum when the threshold value was 49. The occupancy rate of the white pixel at every elapsed time was analyzed using this threshold. The analysis result of occupancy rate of the white pixel at every elapsed time is shown in Fig.6.



Fig.5. The number of lump of white pixel with increasing threshold on the image at 7 min.

The share of a white pixel settled around in the passage of 3 minutes to approximately 20 percent. During 3minutes to 5minutes, change was seen only on left image which declined 10%, moreover during 5minutes to 6minutes, 10% decline was seen in right image. At the time of 6 minute progress, the white pixel share settled down to 9% and settled to 12.7% after 7minutes of progress. The share of a white pixel share showed the lowest at 6 minutes, this result shows that the experience of master craftsman matches with this analysis. From this result, "KEMOMI" progress can be divided to 3 stage as follows.

STEP 1 Start to 3minutes. The rapid mixing stage.STEP 2 3minutes to 5 minutes. The overall adjustment stage.STEP 3 5minutes to 6 minute. The finishing stage.



Fig.6 Change in white pixel count during "KEMOMI"

## 3-2 Motion analysis of "KEMOMI" process by master craftsman and unskilled operator

The results of motion analysis are described below.

- 1. The average number of time which master craftsman applies to a "KEMOMI" process is 6 minutes, and an unskilled operator takes 8 minutes.
- The unskilled operator took an action of arranging the fiber bundles bottom for 35 times an average in the work for 8 minutes, which master craftsman took only 10 times in 6 minutes.
- The unskilled operator's right hand in earlier stage only moves 44% compare to master craftsman
- 4. The unskilled operator's left hand only moves 59.2% during the process compare to master craftsman

The result shows that unskilled operator takes 2 minutes longer to complete "KEMOMI" process. Unskilled operator took time to arrange the fiber spreading apart from the bundle, from there to understand that master craftsman has excellent technique to hold the bundle of fibers securely, which enables to complete the process with less arrangement.

Unskilled operator's right hand in earlier stage only moves 44% compare to master craftsman, this can be explained by the following reasons. Three fibers are solidified densely in the early stage of the process, therefore experience and technique are needed for mixing in this stage.

The reason of unskilled operator's left hand only moving 59.2% compare to master craftsman is that unskilled operator has less skills to hold the fiber bundle securely. She had an anxious of spreading the fibers causing her left hand motion becoming small.

For urging the improvement in "KEMOMI" technique, unskilled operator needs to holds below the central point of the fiber bundle, and reduce the number of times

of the motion to arrange a fiber bundle, moreover, needing to be conscious of moving a left hand greatly and practicing the early stage of the process.

#### 3-3 Brush fiber distribution observation

Table.1 shows the result of fiber distribution observation of each "KEMOMI" progress. In 25% progress brush, rose was seen on both the total of fiber and its items. If there is a rose in the number of total fibers, brush of softer than a standard or a stiffer than standard brush will be manufactured irregularly. Furthermore, in the state where three kinds of fibers are not blended equally, it affects the performance of writing feeling and operability of the brush.

Result of 50% progress brush, the sum total fiber number became close to a standard value, but three kinds of items greatly differed in the number of the large diameter size fiber and a star-shaped fiber. The number of sum total fibers and the items became the range of a standard value only after becoming a progress ratio 100%. As shown in the result, the stability of finished product stabilizes only when filaments are uniformly distributed.

25% KEMOMI Progress				
	Total fibers	Large Diameter Fiber	Small Diameter Fiber	Star shaped fibers
Sample A	649	142	338	169
Sample B	553	123	176	254
50% KEMOMI Progress				
	Total fibers	Large Diameter Fiber	Small Diameter Fiber	Star shaped fibers
Sample A	464	180	40	244
Sample B	479	281	36	162
100% KEMOMI Progress				
	Total fibers	Large Diameter Fiber	Small Diameter Fiber	Star shaped fibers
Sample A	484	237	45	202
Sample B	470	243	42	185

Table.1 result of fiber distribution observation

#### 3-4 Rigidity evaluation

The results for rigidity evaluation are shown in Fig.7. When the "KEMOMI" progress stage is low, the rose can be seen in the load. This result dues because the three kinds of fiber materials has not become uniformed in the low stage of "KEMOMI" progress, the rigidity increases when the percentage of large diameter filaments increase and the rigidity decrease when the percentage of small diameter filaments increase. The rigidity is an important element that controls the performance of the brush. Therefore it is important for the brush fibers to be uniformly distributed to secure a stable performance.



Fig.7 Result of brush rigidy evaluation

#### 3-5 Ink maintenance performance evaluation

The result for coefficient of water absorption is shown in Fig.8. The coefficient of water absorption reduces in proportion to "KEMOMI" progress, this is to consider that distribution of the small diameter fiber has influenced. When the small diameter fiber is not distributed uniformly, large space will be made among the large diameter fibers, causing capillary phenomenon to occur which remains the ink inside a brush.

Fig.8 Result of coefficient of water absorption

#### 3-6 Incidence of defective rate evaluation

Fig.9 displays the rejection rate of each brush manufactured by different "KEMOMI" progress. When the stage of KEMOMI progress proceeds, rejection rate of longer than reference value, shorter than reference value, slant, decreases sharply. This result have been caused because when the "KEMOMI" progress stage is low, fiber material of the brush are not uniformly distributed, and thereby fibers will not be inserted constantly in the picker which grips the amount of one brush. This will also give influence to next process of fiber sheath insertion and vibration, which causes irregular arrange of the fiber materials which leads to increase of rejection rate.

Fig.9 Incidence of defective rate

#### 5. CONCLUSIONS

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(process to even up mixing ratio in all filaments bunch) manufacturing was Image thresholding

and motion analysis. The result made it possible to achieve useful information for shortening successor's training period. Moreover the influence given by "KEMOMI" progress degree concerning the performance of the highly cultured brush manufactured by the machine was examined. As a result, "KEMOMI" progress degree gave extensive influence on brush performance such as fiber distribution, brush rigidity, ink maintenance and defective rate of the finished products. The results confirm that it is very important to distribute the material filaments uniformly, therefore improving one's ability of "KEMOMI" process in less time will be required to manufacture a high performance cultured brush.

#### References

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