Performance Analysis of Professional Sewing Scissors Using the "So-Hizukuri" Forging Process

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Abstract. Scissors have been around since the ancient times as a useful tool. They come in many varieties and serve just as many purposes. This team of researchers completed an earlier study, investigating the secret to the sharpness of Japanese sewing scissors. Japanese sewing scissors can be traced back 160 years ago to the time Commodore Perry arrived in Uraga, Japan, then perfected over time by the grandfather of Japanese scissors, Yakichi Yoshida, to fit Japanese hands. This forging process came to be known as "so-hizukuri." Today, this traditional technology is known and handed down to just a handful of craftsmen.

Our research team wanted to know why this process created scissors that were so sharp, so we began measuring each ridge in the blades of the scissors. Results showed that scissors forged under the so-hizukuri process had blades that curved between 0–150 micrometers in width. When, in use on a fabric, the two blades intersect along the curve, generating greater friction that translates into sharper blades. We also learned that when the two blades intersect, other parts of the blades do not touch each other.

In this study, we looked at what happens to the user of the scissors and the fabric at the very moment the sharp blades of so-hizukuri forged scissors cut into the fabric. We armed a tailor – someone who is an expert scissor handler – with two different pairs of scissors: one that's so-hizukuri forged, and another that's cheap and sold in discount stores. We then had the tailor cut the same fabric using the same method but with two different scissors and recorded the process using a high-speed camera. We analyzed the footage. Additionally, we observed the surface of the fabric cut by the two scissors under an optical microscope. We found clear differences in the user's movements and the scissors' effects on the fabric, which shall be elaborated upon here.

Keywords: Sewing scissors · Forging process · High-speed camera · Optical microscope

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1 Introduction

There are numerous types of scissors in the world that serve a variety of purposes. And sewing scissors are among those that evolved in a uniquely Japanese way. The mainstream scissors we see today that's shaped like the letter "X" were introduced by Commodore Perry some 160 years ago in the Edo period when his Black Ship docked in at Uraga. Referred to as "Meriken" scissors at the time, they weighed about 1 kg and measured 330–360 mm in length. They were heavy duty scissors used to cut through thick fabric like coarse Rasha and were in no way suited for the hands of the more diminutive Japanese of the time. Yakichi Yoshida was responsible for modifying them to better fit Japanese hands [1]. His proprietary method of forging was called so-hizukuri and has been handed down largely nonverbally from master to apprentice. His forging technique was passed on far and wide, bringing the total number of houses with craftsmen trained in the Yoshida technique to 23. Today, however, very few can say they are able to make scissors using the so-hizukuri method. One of them continues to make sewing scissors that are well respected by high-end apparel tailors.

This team of researchers has studied the secret of scissors forged in the so-hizukuri process. What makes fabric-cutting possible in the first place is the reduction of the two blades' intersection point to the smallest possible width. When we researched why the so-hizukuri scissors are so sharp, we found that they were designed to concentrate the blades' stress point down to the point where the blades intersect. It would not be an exaggeration to say that the size of these points determines the performance of the scissors. We measured the two blades forged in so-hizukuri using a three-dimensional measuring device. The result: with the inner part of the blade as a 0, the deepest part registered a 150 μm curve along the surface. The curve on the inside of the blades catches the fabric as the blades come together. And when the blades meet, the part of the blades that were not touching could be visually confirmed. When light is flashed from behind the scissors, light leaks through the space between the blades and as the blades slide together when the scissor handles are squeezed, one can visually detect a shadow reduced to a black dot rising all the way up from the base of the blades to the tip of the scissors. We realized that the scissor's sharpness was due to this design of concentrating the force of the blades into this one point where it meets the fabric. The inner curve of the blade appears to have been a calculated one made by a precision machine. However, so-hizukuri craftsmen don't rely on machinery, but on their own intuition when they wield their hammer and strike at the metal to pound out a 0–150 μm curve on the blades [2].

In this study, we looked at what effect sharp, so-hizukuri forged scissors had on the user and the fabric the moment the sharp blades cut into the fabric. There are virtually no differences between a pair of craftsman- made sewing scissors and a pair purchased at a 100-yen shop if the issue was simply about dissecting fabric. We had an expert who uses scissors in his profession to use each type of scissors to cut fabric and recorded the action. We then studied the amount of time the cutting action took and analyzed results from the footage obtained on a high speed video camera. The results pointed to a big difference in the cutting process of the two scissors. We also studied the cross section images of the cut fabric under a microscope and detected differences there too. The results will be presented along with an interview with the expert. Through this study, we will discuss the value sharp so-hizukuri scissors add to the cutting process.

2 Methods

2.1 Test Subject

A tailor with more than 45 years of experience in high-end apparel.

2.2 Procedures

We asked the tailor to cut wool fabric using pairs of so-hizukuri forged scissors (Fig. 1), and pairs purchased from a 100-yen shop (Fig. 2). The tailor was asked to cut across the grain, along the grain and on the bias. The tailor used the workstation he usually uses for his work.

Fig. 1. Pairs of so-hizukuri forged scissors (The length of the blade: Thumb finger ring side 99.0 mm, Other four fingers side 100.0 mm).

A high-speed camera, Photron© FASTCAM SA4, was set up in front of the workstation. Markings were made on two points along the blade: Point 1, about a third of the way below the tip of the blade, and Point 2, at the base by the screw. The cutting process was filmed in its entirety and analyzed. Another marking was made on the fabric to indicate the end so that each cutting test would cover the same distance. The motions of the scissors through Points 1 and 2 recorded on the high speed video camera were entered in as data on the x axis, y axis, xy synthesis, then calculated the marker points, speed and acceleration (Fig. 3). Then the dissected fabric was observed under an optical microscope, KEYENCE CORPORATION VHX-900F Series.

Fig. 2. Pairs of purchased from a 100-yen shop scissors (The length of the blade: Thumb finger ring side 85.0 mm, Other four fingers side 99.0 mm).

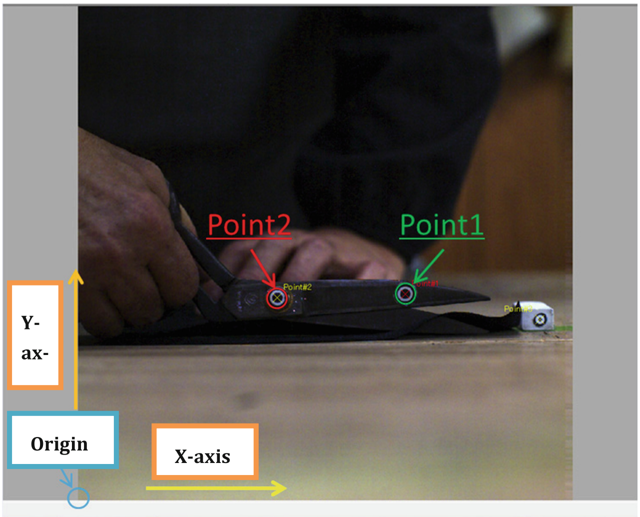

Fig. 3. The position of the markers.

3 Results and Discussion

Figure 4 shows the Point 1 position of so-hizukuri scissors on the X-axis and Fig. 5 shows the Point 1 position of so-hizukuri scissors on the Y-axis. Figure 6 shows the Point 1 speed of so-hizukuri scissors on the X-axis and Fig. 7 shows the Point 1 speed of so-hizukuri scissors on the Y-axis. Figure 8 shows the Point 1 position of 100-yen scissors on the X-axis and Fig. 9 shows the Point 1 position of 100-yen scissors on the Y-axis. Figure 10 shows the Point 1 speed of 100-yen scissors on the X-axis and Fig. 11 shows the Point 1 speed of 100-yen scissors on the Y-axis. The wool fabrics used for the evaluation of the figures from 4 to 11 were cut across the grain.

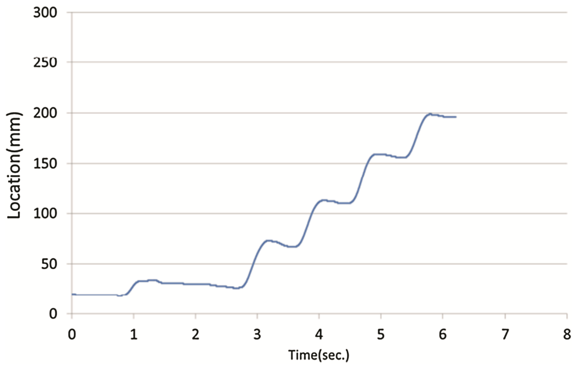

Fig. 4. The Point 1 position of so-hizukuri scissors on the X-axis, when cut across the grain on the wool fabric.

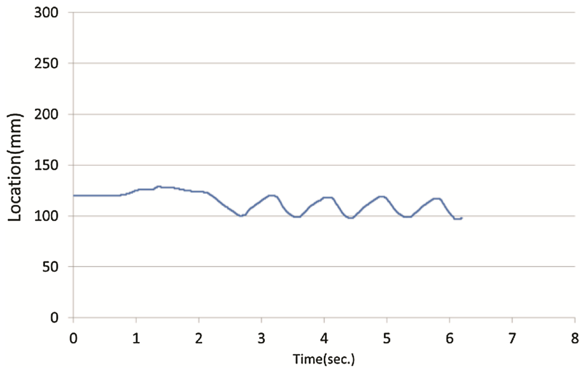

Fig. 5. The Point 1 position of so-hizukuri scissors on the Y-axis, when cut across the grain on the wool fabric.

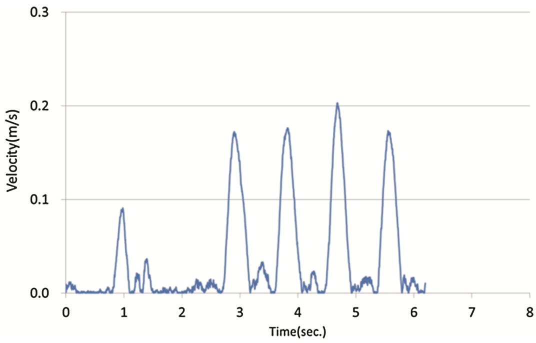

Fig. 6. The Point 1 speed of so-hizukuri scissors on the X-axis, when cut across the grain on the wool fabric.

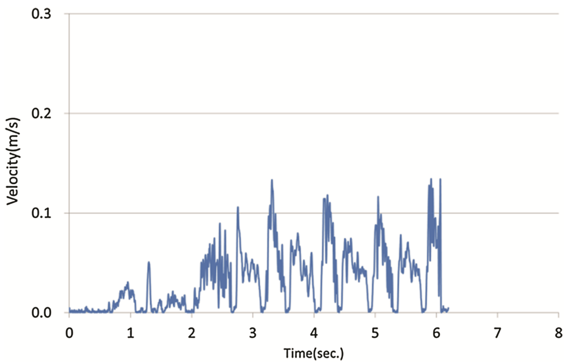

Fig. 7. The Point 1 speed of so-hizukuri scissors on the Y-axis, when cut across the grain on the wool fabric.

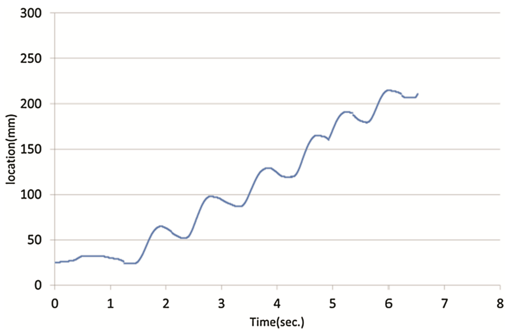

Fig. 8. The Point 1 position of 100-yen scissors on the X-axis, when cut across the grain on the wool fabric.

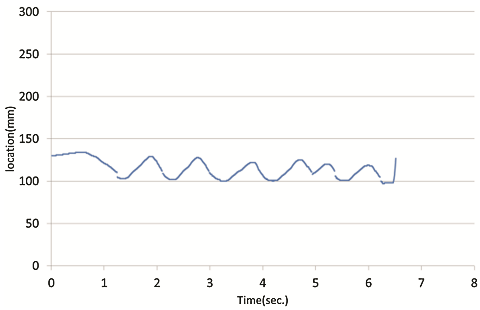

Fig. 9. The Point 1 position of 100-yen scissors on the Y-axis, when cut across the grain on the wool fabric.

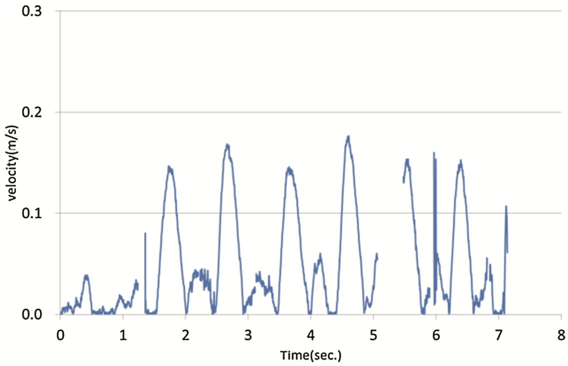

Fig. 10. The Point 1 speed of 100-yen scissors on the X-axis, when cut across the grain on the wool fabric.

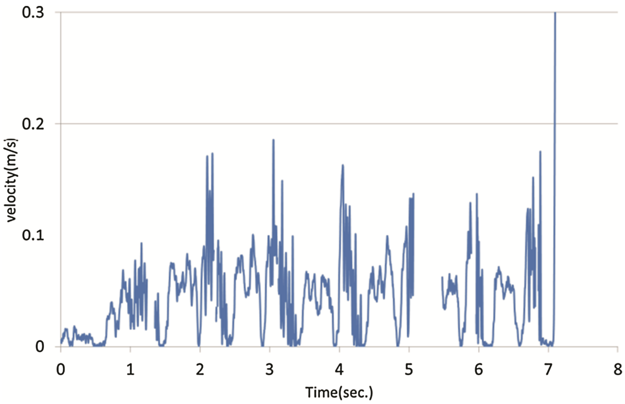

Fig. 11. The Point 1 speed of 100-yen scissors on the Y-axis, when cut across the grain on the wool fabric.

When comparing, Figs. 4 and 8, Figs. 5 and 9, Figs. 6 and 10, Figs. 7 and 11, the amount of the time used for cutting are almost the same in both so-hizukuri scissors and 100-yen scissors, however, there were differences in the movements. It took 3 s for the so-hizukuri-scissors when the blades opened until they closed, while for the 100-yen scissors, it took a little over 1 s when the blades opened until they closed. When observing the number of the blades opened and closed through the entire cutting process, the number of the blades opened and closed of the 100-yen scissors was 1.5 times more than that of the so-hizukuri scissors. Also the blades' open and close width of the 100-yen scissors was irregular.

Results of this research show that in cutting the same fabric, clear differences emerge in the way the tailor moves the scissors and the amount of time he spends cutting the fabric depending on the scissors and in which direction relative to the weave. We will study these results along with an interview with the tailor. When comparing longitudinal and lateral directions of wool fabric, there is a 1-, 1.5-fold difference in speed. This stems from the strength of the yarn in the fabric – whether the yarn is easy to cut through or not determines the amount of time required to dissect the fabric. When we asked the tailor which direction was harder to cut through, he replied that cutting across the fabric was harder. This means that the scissors' performance dropped when cutting across the grain compared with along, and backs data showing a longer time spent on cutting. Even with the same scissors, performance differences emerge when cutting in different directions.

In comparing craftsman- made sewing scissors and a pair purchased at a 100-yen shop (Figs. 4 and 8, Figs. 5 and 9), we see a difference in the number of times the blades open and close when the scissors are in use. The tailor pointed out at the interview that one squeeze did not get the less sharp scissors very far along the fabric. With less sharp scissors, one must tug the scissors back a little on the fabric because pushing them forward only makes the fabric bunch up into the blades. This naturally shortens the distance of each cutting. In this way, dull scissors and sharp scissors end up requiring a different number of strokes to cover the same distance.

When comparing craftsman- made sewing scissors and a pair purchased at a 100-yen shop (Figs. 6 and 10, Figs. 7 and 11), one can see differences in the angle of the blades for sharp vs dull scissors. The tailor said at the interview that he had to open the scissors wide when using the dull pair to cut the fabric. This indicates that the 100-yen scissors are dull, and because the fabric was to be cut crosswise, the scissors under performed.

The cross-section view of the fabric as seen under a microscope is visual evidence of the 100-yen scissors' inadequate severing ability (Figs. 12, 13, 14 and 15). The fabric did not yield properly to the cheap scissors and its surface had flattened. Furthermore, the length of the fabric is also inconsistent (Figs. 13 and 15). With the so-hizukuri forged scissors, on the other hand, there's no fabric flattening and the cut edges are uniform and even (Figs. 12 and 14). Judging from these images, one could conclude that 100-yen scissors, which cause flattening in the fabric, force the users to expend more energy. The pictures show that the fabric was squished and cut. In the interview with the tailor, we were informed that the 100-yen scissors were the hardest to handle. Images from the microscope, the speed with which it took for those scissors to cut, the number of times the blades had to move and how wide they had to open – all back up the tailor's assessment.

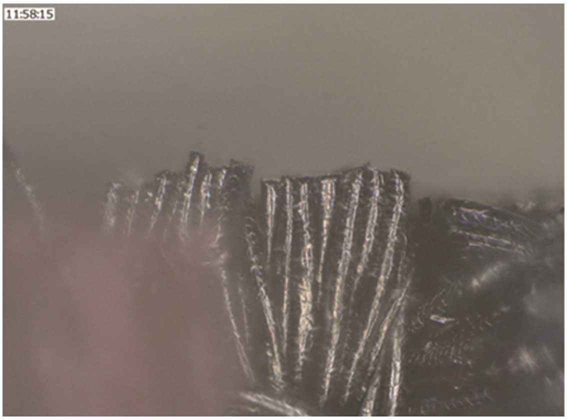

Fig. 12. The cross-section view of the fabric of so-hizukuri scissors (lateral directions of wool fabric, 500 magnifications, 3D).

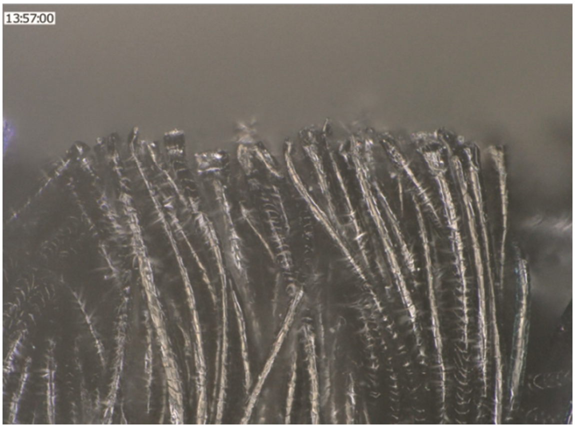

Fig. 13. The cross-section view of the fabric of 100-yen scissors (lateral directions of wool fabric, 500 magnifications, 3D).

On the other hand, regardless of the scissors, and even with fabric that's famous for being difficult to cut like wool, the naked eye was unable to observe a clear difference in the tailor's movements. However, the high speed camera and the optical microscopic observation revealed that there was a large difference. When asked about that the tailor replied that when a craftsman approaches a piece of fabric he subconsciously begins assessing the characteristics of the fabric and how best to move the scissors well before he starts to cut. The consideration that the tailor puts into cutting fabric that's tough or with dull scissors is what makes it difficult for any third person to notice the difference. However, it was not possible to describe in words how the tailor used his scissors. The moment his scissors touch the fabric, the tailor subconsciously selects the best possible

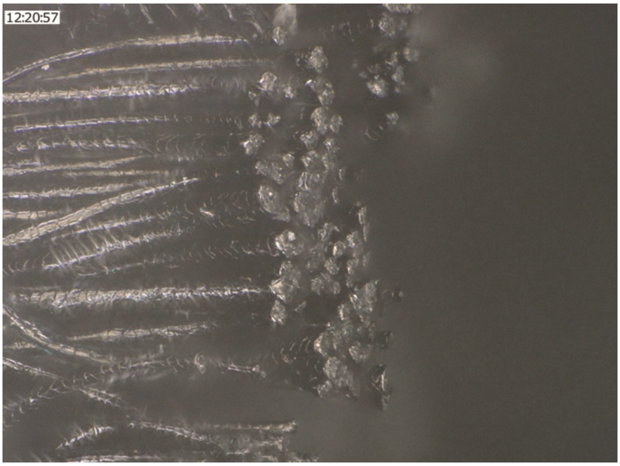

Fig. 14. The cross-section view of the fabric of so-hizukuri scissors (lateral directions of wool fabric, 500 magnifications, 3D, angle of 30 degrees).

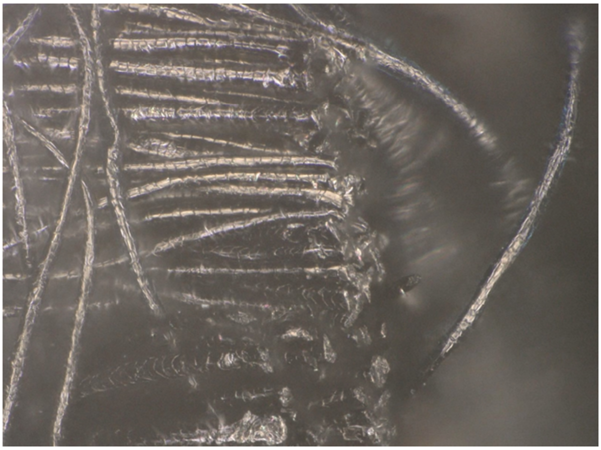

Fig. 15. The cross-section view of the fabric of 100-yen scissors (lateral directions of wool fabric, 500 magnifications, 3D, angle of 30 degrees).

way to handle the scissors to improve its performance. This, we learned, was what is often referred to as the craftsman's technique.

4 Conclusion

Scissors have become such an integral part of our daily lives that we may not even think about their existence. One can say that if their only purpose was to cut paper or fabric in two there are plenty of scissors out there that satisfy those conditions. The act of cutting something in two may appear identical for any pair of scissors, but as the terms "sharp scissors" and "dull scissors" imply, outside of simply dissecting things in two, not all scissors are created equal. For this research, we turned a spotlight on the highly evolved sewing scissors, and investigated the ancient forging process, so-hizukuri, to uncover their secret in producing sharp scissors. We studied what, if any, effect well-performing scissors forged in that process have on the user's movements and the fabric itself. We solicited the help of an expert scissor-handler, a tailor, for this research.

The differences between a dull and sharp pair of scissors are extensive and become apparent in the hands of the users. The characteristics of the scissors affect the speed with which the user can dissect fabric, the way the user moves the scissors, the number of times the blades open and close, among others. The same could be said about fabric alone. The longitudinal yarn in a weave is stronger than the transverse one. It is thereby harder to cut crosswise through the longitudinal thread than the other way around. We found that the direction of the scissors – cutting lengthwise or crosswise – reveals their performance, regardless of the scissors.

Sharp, well-performing scissors rhythmically dissect fabrics without burdening the tailor. We also observed a quantifiable difference in the post-cutting appearance of the fabric. The fabric that was cut by dull scissors was ground down at the edge, creating an uneven and flat appearance to the fabric's weave. This would only serve to lower the quality of tailor made clothes. The purpose of sharp scissors is not limited to simply dissecting fabric in two; they become indispensable tools for scissor-using experts in dramatically raising productivity, bringing out one's abilities and even ensuring a quality finish to tailored outfits.

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