DYNAMIC CLOTH FELL MOVEMENT
Part II: New measuring device

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Abstract

A new flexible cloth fell movement measuring device, hereafter referred to as the 'needle-mechanical device', has been developed to facilitate the use, for the first time, of a measuring position just 2 millimetres from the cloth fell. In addition, the experimental set-up was built in a combination between the needle-mechanical device and the Weave Master to record the dynamic cloth fell's movement cycles on-loom. The results of these measurements were analysed and discussed in the light of the theory developed in part I.

Key words:

weaving technology, cloth fell movement, warp tension

Introduction

The importance of the cloth fell position is, of course, fully appreciated by weavers and has been commented on by many researchers, mainly from the point of view of its relation to the warp tension. During weaving, the warp tension undergoes a cyclic change that is due to shedding and beating. The shedding in turn causes a cyclic variation in the position of the cloth fell (cloth fell movement), while the beat-up cases a sudden displacement of the cloth fell. Accordingly, a parameter like cloth fell movement should be borne in mind while weaving, in order to obtain better fabric quality and higher loom productivity. One of the major aims of this work is to experimentally study the cloth fell's movement and its behaviour.

Cloth fell movement measuring technique

The measuring technique is the outcome of the interaction between the measuring instruments and the measuring conditions. It presents the adoption of the measuring instruments, precautions, and experimental procedures.

Instrument for measuring cloth fell movement

As the literature indicates, until now no satisfactory method has been devised to measure the cloth fell movement onto the loom, so, a new idea has had to be developed.

The idea we developed depends on a simple and flexible needle mechanical device, fixed onto the loom frame and connected with the Weave Master to measure the cloth fell movement dynamically. The needle-mechanical device as shown in Figure 1 consists of many parts, listed in Figure 1also.

The first idea was to lift the needle away above the cloth fell surface after beat-up and force it down through the cloth fell immediately before beat-up, in order to measure the force affecting the cloth fell (the needle) due to the beat-up process on the same position every loom cycle. Another aim was to translate this force into displacement by using a special force-displacement calibration system to finally establish the cloth fell movement.

This action was assumed to work in harmony through a cord connecting the oscillating bar with the reed via a pulley to lift the needle above the cloth fell surface when the reed is at the back position, and force it to penetrate the cloth fell when the reed is at the foremost position.

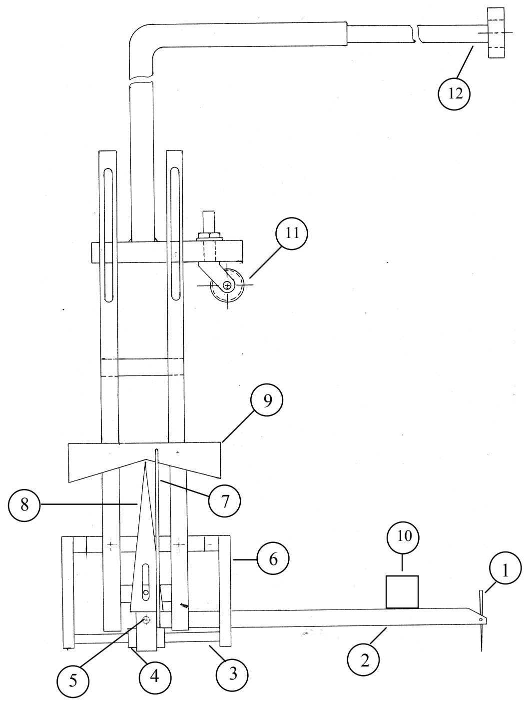


Figure 1. Needle-mechanical device

1 Needle	5 Main axe	9 Scale
2 Oscillating bar	6 Sliding fixation frame	10 Weight
3 Sliding bar	7 Thread carrier	11 Pulley
4 Sliding bearing	8 Pointer	12 Main frame

However, during the preliminary tests carried out for checking this idea, cord breakage was always observed when the weaving machine started operation. Even changing the cord material, specification, length, and manner of connecting it to the reed proved useless.

Nevertheless, because of the flexibility of the design, the needle-mechanical device was still able to achieve the purpose, as shown in Figure 4, by means of using a horizontal oscillating bar instead of the vertical one. This was easily achieved by omitting the cord-reed connection.

Thus, the principal concept became simpler; merely to put the needle through the cloth fell at the measuring position, and start weaving. The forces affecting the cloth fell will push the needle in the direction of force equilibrium; that means, as shown in Figure (2), that if warp tension force is greater than the fabric tension force, then the needle will be pushed towards the warp direction until beat-up takes place. In addition, if the fabric tension force is greater than the warp tension, then the needle will be pushed by the fell to move towards the fabric direction until shedding takes place.

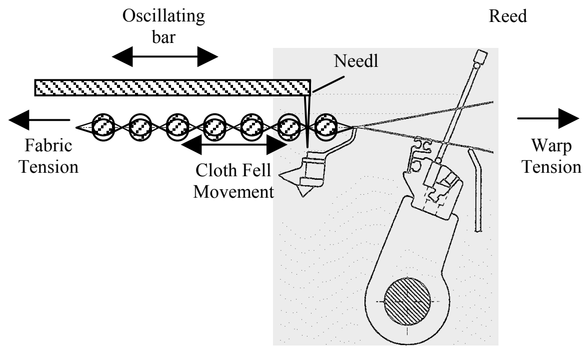


Figure 2. The needle-mechanical device, principal concept

During measurement, the device thread tensions were recorded with the same technique used for warp tension measurements by the Weave Master. The displayed graph presents all the forces affecting the needle at the cloth fell which are exerted by shedding and beating actions.

By using a special force-displacement calibration system, as we will discuss next, the cloth fell positions during shedding and beating could be calculated. In turn, the cloth fell movement could also be calculated.

Calibrating the measuring device

A calibration system was used to translate the force recorded by the Weave Master, which affected the cloth fell, into real displacement. The calibration procedures were carried out as follows:

1. Start the loom at slow motion.
2. Open the shed to maximum height, selecting the main shaft angle to 120°.
3. Introduce the collective measuring head of the Weave Master to the needle-device threads (8 threads), with the same preparation steps for the warp tension measurements.
4. Place the needle at the measuring position.
5. Adjust the thread tension displayed on the Weave Master monitor to 150 cN as thread pre-tension. This action takes place by moving the thread frame to increase or decrease the needle-device threads' extension.
6. Fix a scaled ruler on the cloth fell in such a way that its zero point corresponds to the needle measuring position, when the Weave Master reads 150 cN as the needle-device thread pre-tension.
7. Move the needle towards the fabric direction in 1-millimetre steps, and register the needle-device thread pretension as read by the Weave Master.
8. Draw a trend line for the values of the needle-device thread tension against the needle displacement, indicating its equation as shown in Figure 3.

The position for measuring the cloth fell movement

During the experiments, the measuring device was fixed with the loom frame in such a way as to correspond with the middle position of the fabric sheet.

The measuring position for the needle was kept fixed at a 2-millimeter distance from the fabric support plate, as indicated in Figure 4. The measuring position could be considered as the nearest one for the cloth fell, compared with the literature.

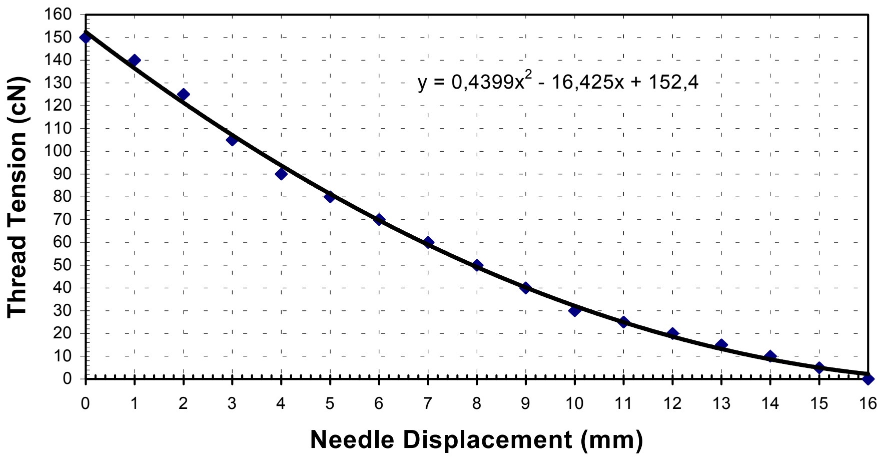
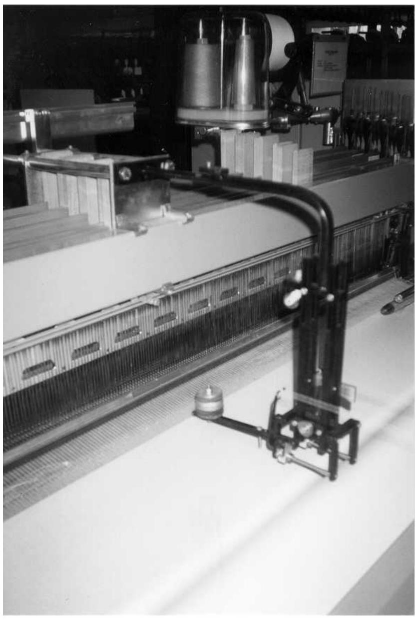
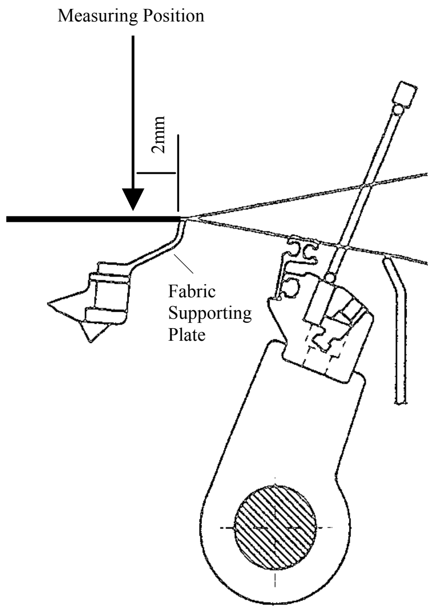


Figure 3. Force-displacement depending calibration curve





a) measuring position across the fabric sheet

b) measuring position relative to the fabric support plate

Figure 4. Cloth fell movement measuring position

Precautions taken during cloth fell measuring

The experimental precautions are those followed during the design, installation, and experiments in order to ensure accurate results. The precautions followed during these experiments can be summarised as follows:

1. Check the loom crank angles at 120° (maximum open shed) when the measuring starts.
2. Check the needle at the measuring position when the measuring starts.
3. Use the same precautions for installing the Weave Master.
4. Check the needle-device thread pre-tension at 150 cN before starting measurements.

Procedures for cloth fell measuring

The experimental procedures are those which are followed before and during the experiment to ensure accurate results. The following procedures have been followed:

1. Start the loom with slow motion.
2. Open the shed to maximum height at 120° of the crank angle.
3. Move the Weave Master to the loom.
4. Connect the device to the mains (90-220V) by means of the main plug.
5. Plug the adapter cable between the loom output (stroboscope) and the trigger input on the side panel of the PC.
6. Plug the measuring head transducer cable between the measuring device and the collective hole on the side panel of the PC.
7. Introduce the measuring head into the course of the needle-device thread between the thread carriers and the thread frame, without loading the thread.
8. Switch on the Master switch on the rear of the PC. The PC is booted up, and a window appears on the screen after several seconds.
9. Leave the measuring head for a warming period of approximately 10 minutes.
10. Adjust the zero point from the zero point submenus.
11. Choose the external trigger type from the trigger submenu.

12. Load the measuring head correctly with the needle-device threads in such a way that the number of threads to be measured (8 warp threads) passes over the middle measuring bar with the same number of threads on either side (4 threads each side).
13. Place the needle at the measuring position.
14. Adjust the thread tension displayed on the Weave Master monitor to 150 cN as thread pre-tension. This action is done by moving the thread frame to increase or decrease the needle device threads' extension.
15. Start the loom and select the warp-averaging program from the Weave Master main menu.
16. Stop the loom.
17. Place the needle at the measuring position again.
18. In the averaging program, enter the number of the required measurements (1 sample).
19. Start weaving and measuring by pressing the loom start button and the 'Enter' key on the Weave Master keyboard in the same time.
20. After a few seconds, the thread tension curve against the loom angle degrees will be displayed on the monitor.
21. Save the curve on the hard disk.
22. Analysis the curve traces.

Analysis of the cloth fell movement cycle

During weaving, the cloth fell movement is influenced by various loom motions, the main ones being the shedding motion and the beat-up motion. The cloth fell cycle undergoes a cyclic change, which is shown in Figure 5.

The salient feature of the cloth fell movement cycle is one peak of a long duration. This peak occurs as a result of the weaving resistance force affecting the cloth fell.

The height of the shedding peak is dependent primarily on the size of the shed. The smaller the shed size, the higher is the peak.

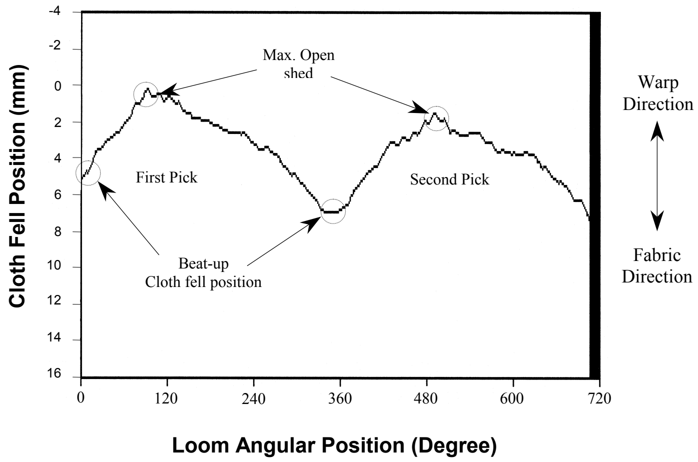
Figure 5-a represents the cloth fell position relative to the loom angular position in its final state, after calibration has been made between the needle device thread tension and the cloth fell position as indicated above. The zero point was selected to have a 2-mm distance from the cloth fell movement as indicated before, at open shed. The selection of the zero point at maximum open shed is different than seen in literature that used beat-up as a reference line. This is because of the difficulty of fixing the needle device into the measuring position, due to the fabric faults that take place at beating.

During beat-up, the reed moves forward, towards the fabric direction, to the foremost position to push the filling yarn into the fabric fell. As the filling yarn is being pushed into the fabric fell, the warp tension increases and the fabric tension decreases. Therefore, the minimum position of the cloth fell will be at beating.

After the reed recedes and the shed continues open, the warp tension increases to the highest value (because the warp tension at open shed is higher than the warp tension at beat-up, as explained in the analysis of the warp tension cycle). Superimposed on the weaving resistance force, the cloth fell moves back toward warp to reach its final position, which corresponds to the maximum open shed. This could be explained as the warp tension exerts force on the last few picks, and so it tends to push those picks back in the warp; this force, transferred to frictional force between the filling yarn and warp ends, causes weaving resistance. The difference between the cloth fell position due to beat-up and the cloth fell position due to open shed represents the cloth fell movement.

During the experimental investigation, the cloth fell movement diagrams were recorded for many picks. Figure 5-a illustrates the cloth fell movement for the first tow picks into the cloth fell, while Figure 5-b illustrates the cloth fell movement diagram for the first ten picks into the cloth fell. This gives an indication about the flexibility of the set-up used through this study.

a) First two picks



b) First ten picks

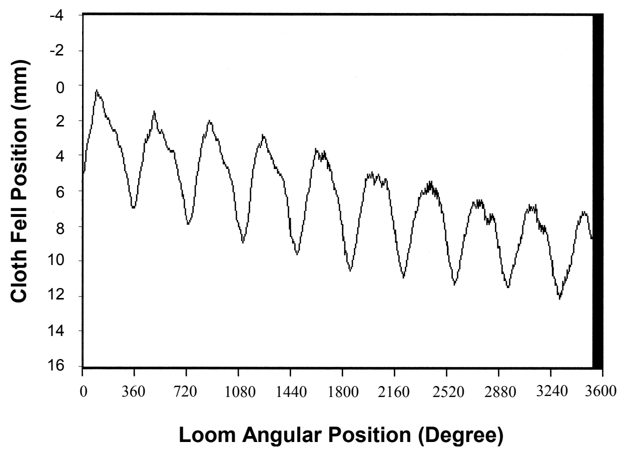


Figure 5. Cloth fell movement dynamic cycle

Conclusion

A survey of the literature relative to the subject (as we did in part I of this series) indicates that there was no satisfactory method available to measure the cloth fell movement on-loom. Therefore, developing a measuring device for the cloth fell movement (the needle mechanical device) is the first fruit of this work.

In addition, constructing a measuring set-up working in harmony, from a combination between the needle-mechanical device and the Weave Master, allowed us for the first time to measure the cloth fell movement just 2 mm from the cloth fell itself. This could be considered as another achievement compared with the design solutions presented in the literature review.

During the primary trials, the dynamic cloth fell movement diagrams were able to record for many picks, which gives an indication about the nature of the new set-up capabilities.

The next research work will be in the area of developing aid diagrams that can help the weaver to adjust the loom without trials by using the new measuring technique.

Acknowledgement

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