ERRORS THAT OCCUR DURING THE PRODUCTION OF FABRICS FOR REST AND RECREATION - AN EXAMPLE FROM INDUSTRIAL PRACTICE

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Abstract: *Certain negative phenomena that occur when weaving on a shuttle loom are described and analyzed in this paper. The manufactured fabric is used to produce different types of items for rest and relaxation, e.g. garden and home swings, then swings and baby carriers, etc. The fabric is made on a weaving loom with a shuttle, from the company "Textima". The analysis found that, during weaving, errors occur that originate from oil, thicker threads, burls, knots, fuzz, hairs, etc. dominate. These errors can be easily eliminated by careful work and timely interventions on the loom itself. The number of warp and weft breaks is mostly within normal limits and depends on the quality of the yarns used and the quality of their preparation. Inspection of the finished fabric by trained and skilled workers confirms the errors that occur during weaving.*

Key words: Weawing; Yarns, Technical Fabrics, Shuttle Loom, Errors.

GREŠKE KOJE NASTAJU TOKOM PROIZVODNJE TKANINA ZA ODMOR I REKREACIJU - PRIMER IZ INDUSTRIJSKE PRAKSE

Apstrakt: *U radu su opisane i analizirane određene negativne pojave koje nastaju pri tkanju na razboju sa čunkom. Izrađena tkanina se koristi za proizvodnju različitih vrsta predmeta za odmor i opuštanje, npr. baštenske i kućne ljuljaške, zatim ljuljaške i nosiljke za bebe itd. Tkanina je izrađena na tkačkom razboju sa čunkom, firme „Textima". Analizom je utvrđeno da, tokom tkanja, nastaju greške koje potiču od ulja, debljih niti, nabora, čvorova, dlaka, dlačica itd. Ove greške se lako mogu otkloniti pažljivim radom i blagovremenim intervencijama na samom razboju. Broj prekida osnove i potke uglavnom je u granicama normale i zavisi od kvaliteta upotrebljenih pređa i kvaliteta njihove pripreme. Pregled gotove tkanine od strane obučenih i veštih radnika potvrđuje greške koje se javljaju u toku tkanja.*

Ključne reči: tkanje, pređe, tehničke tkanine, razboj sa čunkom, greške.

1. INTRODUCTION

The fabric is formed by interlacing the warp and weft yarns, mostly at right angles. All looms have a periodic system of weft insertion and beating-up for a certain time interval from the total available time provided for the formation of an elementary length of weaving. The improvement of the weaving process followed the appearance of a continuous system of weaving on circular, and especially, on looms with a multi-phase shed, where the weft is fed into the shed during the entire time available to form an elementary length of fabric [1,2].

Fabrics for rest and recreation are mostly made on slower shuttle looms due to the fact that it is necessary to obtain a fabric with a final selvedge that does not fray in practical use, and that is why the production of such fabrics on such looms is favored.

The quality of the finished fabric basically depends on the quality of the warp and weft yarn, the device for weaving preparation and the weaving process itself, as well as the quality of the finishing of the raw fabric. In the fabric manufacturing process, defects in the previous stage will affect the later stage. Therefore, effective detection of fabric defects is one of the key measures for modern fabric manufacturers to control costs and improve product value [3].

Not all possible errors can be predicted, so an ideal fabric cannot be obtained, but a fabric can be obtained within the permissible limits, which is determined by the error norm. The error norm is a basic indicator of work and each work organization has its own norm according to its working conditions, which is determined by a long-term analysis including both the type and number of errors, as well as the causes of errors [4].

In modern textile production, automatic detection of fabric defects is an important way to ensure quality. Usually, detection of fabric damage is achieved by standard manual visual inspection, which has since become inadequate and expensive. Consequently, automatic detection of fabric defects is essential for the textile industry to reduce costs and increase productivity. Compared to manual detection of fabric defects, automatic detection systems are faster and more efficient [4].

It is known that the productivity and product quality of a shuttle loom are relatively lower compared to a shuttleless loom due to high energy consumption, greater losses, and a weft insertion mechanism that is more prone to malfunctions. For weaving on a shuttle loom to be economically viable, a systematic approach to quality control is necessary, specifically the use of error control methods. Regular loom monitoring typically reduces the number of errors, making it a significant method for minimizing defects in shuttle looms. The causes of errors were associated with materials, processes, and human factors, starting from the spinning section to the final fabric production [5, 6].

In addition to the good condition of the loom, the enthusiasm of the workers, and the noise from the loom, the quality of the produced fabric is also affected by the noise from the loom. In general, noise is a major problem in the textile industry, especially if it comes from the working processes of power looms. Excessive noise levels in workers in the textile industry can cause psychological and physiological problems. In power looms, noise is produced due to the movement of mechanical components in the loom. Shuttle looms create noise due to the weft feeding mechanism. According to the study [7], noise measurements were made near a textile loom with a motor power of 1 horsepower and a motor speed of 700 rpm. Otherwise, the noise level usually ranged between 90 dBA and 115 dBA. The research paper suggests reducing the noise of the loom by using a damper. The maximum noise level was reduced from 98.16 dBA to 95.12 dBA by using a damper [7].

Any control of the loom operation during fabric production reduces potential weaving errors. Therefore, the control of weft density during weaving is of great importance in this regard. In the weaving process, there are several causes of weft density variations, such as warp tension variations, electrical power fluctuations, as well as defects in mechanical components, e.g. undesirable gear performance. There is an example of implementing a system for controlling the weft density that uses a PID algorithm and employs digital image processing techniques in a system for measuring weft density. The control action begins by capturing an image of the woven fabric, after which the system calculates the number of wefts per inch. Based on the measured weft density, the speed of individual loom components is adjusted to ensure that the same number of wefts is consistently inserted into the loom shed [8].

The paper follows and analyses the mistakes made in the process of weaving fabrics on a shuttle loom, which is used to make different types of articles for rest and relaxation, e.g. garden and home swings, then swings and carriers for babies, etc.

2. EXPERIMENTAL

The fabric used in the research was made in the textile factory from Leskovac, Serbia. Weaving was carried out on Textima shuttle loom.

One of the important stages in the production of fabrics for rest and recreation is plying, where the previously doubled yarn is given 120 twists/m, which makes the yarn ready for the warping stage. Warping is done in cone sections and the warp is wound on the warp beam (Schlafhorst warping machine, warping width 3 m, warping machine rows capacity 300). The warp yarn thus prepared is ready for the weaving stage.

After weaving, the fabric is cleaned of impurities and small fibers on the cleaning machine, the length is measured and the final inspection of the finished product is performed on the measuring and rewinding machine. The finished fabric is sent to ready-to-wear section, where they are made into garden and home swings for rest and relaxation, then swings and carriers for babies, etc.

On the Textima shuttle loom, weaving is done by inserting the weft alternately from the left and right side using the shuttle. Hollow fabrics can also be worked on this loom, and its advantage is that it gives a finishing selvedge to the fabric that does not allow fraying. This loom can work with seven different colours per weft with 24 harnesses. Currently, the factory is making fabrics on looms with 4 harnesses.

The appearance and technical characteristics of the loom are given in Table 1.

Table 1: Technical characteristics of the shuttle loom

Characteristics	Values
Loom width (cm)	400
Working width (cm)	230
Loom height (cm)	170
Number of revolutions of the main beam (min^{-1})	105
Weft passing speed (m/min)	231
Minimum fabric width (cm)	20
Maximum possible fabric width (cm)	220
Possible weft density range (cm^{-1})	3-60
The opening angle of the shed (rad)	20 - 30
Maximum number of harness	25
The number of harnesses the factory works with	4
Number of shuttles	3 - 7
Maximum number of different wefts	7
Pulling fabric	positive regulator
Warp beam diameter (mm)	600
Shuttle length (cm)	25

The basic properties of warp and weft yarns, as well as fabrics with characteristics, are given in table 2. The yarn, warp and weft, and linen woven fabric were analyzed.

Table 2: Yarn and fabric characteristics

Characteristics	Values
Number of yarn twists (m^{-1})	120
A type of twists	S
Raw material composition	68/32% (PES/ Cotton)
Yarn counts (tex)	25×8
Weft density (cm^{-1})	8
Warp density (cm^{-1})	13
The width of the warp in the reed (cm)	120
The width of the warp on the beam (cm)	130
Mass per square meter (gm^{-2})	140
Shrinkage (%)	5

Figures 1 - 3 show the appearance of the shuttle loom in different stages of work (end of the warp and preparation for tying a new warp and the weaving process).

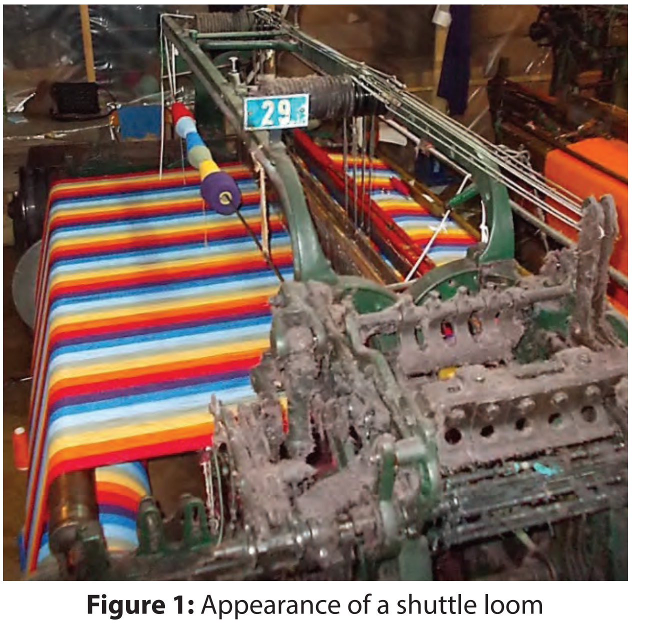

Figure 1: Appearance of a shuttle loom

Figure 2: Picking block - shuttle with weft winding

Figure 3: Finished fabric wound on the fabric beam of the Textima loom

Table 3: Errors that occur during fabric production on 1,000 m

Error types	Number of registered examples
Fat stains	183
Tears	14
Warp streaks	72
Missing warps	66
Stripes from the reed	43
Striped fabric	83
Rare weft streaks	35
Thick threads, burls and knots	201
Fuzz, clumps, hairs	170

3. RESULTS AND DISCUSSIONS

Errors on the fabric, in the case of tracked shuttle looms as a weft feeder, occur due to bad raw materials, but also the loom itself and the operator. Table 3 shows individual fabric errors (mean value) by quality and quantity based on one-shift monitoring and design on 1,000 m of fabric with a 95% confidence level. For the mean values shown in Table 3, according to the confidence level, there is a 95% certainty that these means are within the range of the confidence interval. For example, the confidence interval, for the data shown in Table 3, has the largest numerical value of 2.99 and the smallest numerical value of 1.17. By the way, these statistics were done in the Excel 2021 software in the Data analysis section.

It is noticeable that errors originating from oil predominate, as well as occurrences related to thicker threads, burls, knots, hairs, etc. These errors can be easily eliminated with more attention and timely interventions on the loom itself.

Figures 4 and 5 graphically present the errors on the fabric that occurred during weaving on the loom during the eight-hour working time, i.e. for working in one shift, by recording their number for each hour of machine operation.

It should be noted that all types of errors shown in Figures 4 and 5 are only registered during weaving, i.e. such errors are not removed nor is the loom stopped. Only breaks in the warp or weft threads stop the loom and require the intervention of the loom operator.

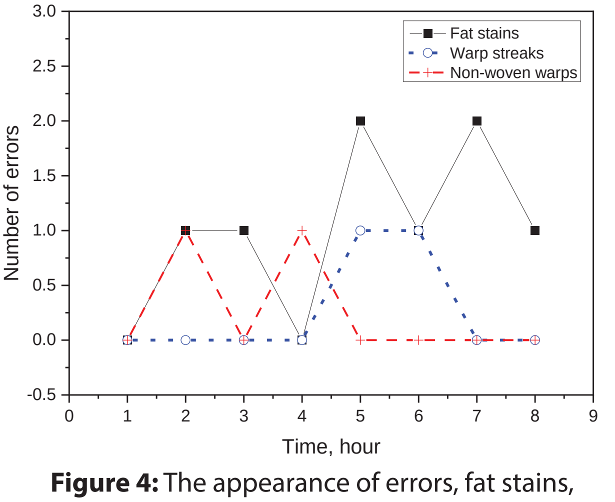

Figure 4: The appearance of errors, fat stains, warp streaks and non-woven warp on the fabric

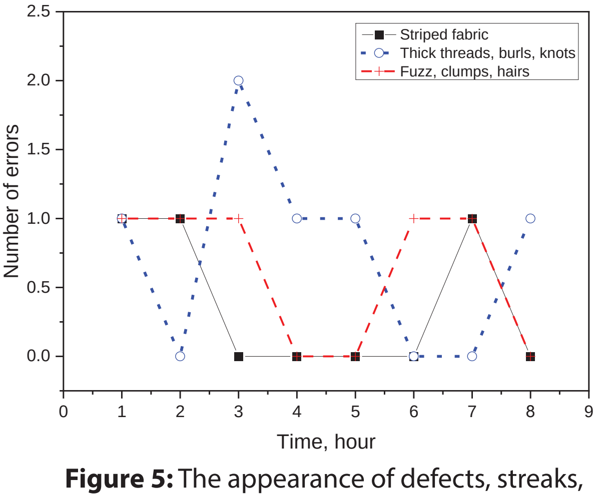

Figure 5: The appearance of defects, streaks, thick threads, burls, knots, fuzz, clumps and hairs on the fabric

Fabrics used for the production of tracked items for rest and recreation fall into the category of technical fabrics, and technical textiles are increasingly used in all branches of industry.

When manufacturing fabrics, it is impossible to create ideal conditions that would enable obtaining a uniform product quality, smaller or larger deviations already occur. This happens due to the fact that the quality of fabrics is affected by many factors, primarily the quality of the starting raw materials, the structure and construction of the fabric, the type of loom, the expertise of the workers, the organization of work, etc.

Table 4 shows the number of warp and weft breaks during one shift, i.e. 8-hour working time. Each number of interruptions in the table is registered during one shift on one loom, i.e. the measurement was during 10 shifts or 10 working days. From this table, it can be observed that the number of breaks in the warp and weft is mostly within the limits of normal values and depends on the quality of the yarns used as well as the quality of their preparation. The warp breaks more, which is to be expected considering the much higher loads it endures during weaving.

The statistical parameters, the standard deviation (SD) and the coefficient of variation (Cv) are relatively high, which means that there are many deviations from the mean value, greater unevenness in the quality of the warp and weft, and eventually, oscillations in the operation of the loom.

Table 4: Number of warp and weft breaks during weaving

Yarns	The number of interruptions	Middle value	SD	Cv, %
Warp	40, 35, 32, 50, 31, 25, 23, 43, 36, 45	36	8.65	24.04
Weft	11, 5, 8, 6, 10, 13, 11, 4, 5, 8	8.1	3.07	37.92

On the device for manual inspection of the fabric, where the errors occurring during the weaving are observed and marked, there is also a device for measuring the length of the fabric, which is used to determine the length of the required piece, and also to measure the weight of the piece.

This fabric or piece in the loom is supplied with a card, on which the following data is entered:

- article, name, code and design,
- number of pieces,
- number of looms and
- errors.

As the present case is manual inspection of defects, inspectors can easily find defects on the fabric by direct observation. Prolonged observation can easily tire the human eyes and lead to an increasing number of unintentionally missed defects. In order to meet the needs of modern industry, it is important to develop methods of fabric defect detection.

4. CONCLUSIONS

Some errors that occur in the weaving process are certainly a problem that should be eliminated, removed or masked. In the first place, the responsibility lies with the operator of the loom, then there is the condition of the loom machine itself, as well as the person in charge of maintenance. Finally, the section manager also bears part of the responsibility, considering that he determines the type of work that should be performed on the loom.

After a practical analysis of weaving and fabrics, it is observed:

- The number of warp and weft breaks is within normal limits and depends on the quality of the yarns used and the quality of their preparation.
- The warp breaks more, as expected, given the many times greater loads it endures during weaving.
- Grease stains, warp stripes and non-woven warp on the fabric as a type of fault can be eliminated by more careful work of the server.
- Stripes on the fabric, thick threads, knots, hairs and lumps are errors that are not tolerated, considering that the fabrics are used to make products intended for export, and are subject to mandatory eco-tex certification.
- Inspection of the finished fabric by trained and skilled workers confirms the errors that occur during weaving, trying to eliminate them, if possible. Of course, some phenomena on the fabric cannot be corrected, so there is hope that this can be done in finishing and dyeing facilities, where part of the problem can be masked and thereby reduce costs.
- Based on these results, a recommendation is made as to how and what to do next, how to reduce the number of errors and improve

the quality of the finished fabric for rest and recreation.

- This work makes a small contribution, both in understanding the causes of errors in the weaving process, and in the appropriate solutions that can be omitted or later eliminated.

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