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Design of Narrow Jacquard Fabrics with Elastomeric Threads

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Abstract: *The paper presents the specific design process of narrow fabrics with elastomeric yarns, which production needs jacquard weaving machine. Some particularities, related with the use of elastomeric threads in the warp are discussed. The design of an elastic band is shown as an example of the application of a narrow jacquard weaving machine and its design software.*
Keywords : *narrow fabrics; elastomeric threads; design; woven textiles*

I. Introduction

Woven or knitted fabrics with elastomeric threads have many applications in lingerie, clothing and sportswear [1]. They are in the background of fashionable and functional garments that are designed to cling to the body, assuring at the same time comfort in several aspects: dynamic, thermophysiological, tactile [2, 3].

A narrow fabric with elastomeric thread (NFET) is often part of the underwear, used in conjunction with knitted fabrics: briefs, bras, leggings [4, 5]. When NFET is used as an inner, invisible part of the garment, they perform a certain function or assure a certain form of the garment. In the case NFET is visible, they are often used as a decoration of the garment and may contain information, e.g. a logo of the manufacturer or the name of the brand. In this sense, NEFT is frequently produced by using modern jacquard technologies that allow weaving of complex figure designs.

The combination of elastomeric threads and common yarns in the structure of NFET require special attention in the design stage of the garment. It is known that the elasticity of the woven macrostructure is much lower than the inherent elasticity of the elastomeric thread, due to the presence of common or “hard” fibres’ yarns [6]. Therefore, the aim of the study is to analyze some particularities of the woven of elastomeric yarns and to show the design of a narrow jacquard fabric with elastomeric yarns.

II. Features Of NFET

The elastomeric threads are involved in the fabric structure as part of the warp yarns. They can be bare or wrapped with synthetic or natural fibres, can be part of complex yarns as well. The covered elastomeric threads are used for fabrics which are required to retain their shape and undergo minor deformations [7]. Different methods are applied to produce covered elastomeric yarns: core-spun yarns, air-covered yarns, double twisted yarns, Siro-spun yarns, etc. [8].

The elongation of a covered elastomeric yarns is determined by the draw ration of the bare elastomeric thread at the time of wrapping it with the other thread or staple fibres’ yarn. The greater the draw of the elastomeric thread is, the higher is the potential for retainment of the elongation of the bare thread.

The cross-section of the elastomeric threads is usually circular or square. Threads with square shape are made by cutting and these with round shape are extruded through nozzles. The circular shape has several advantages over the square [6]. The number of the threads indicates how many filaments are in one inch or 25.4 mm and the numbering is determined by the cross-section.

If in the weaving of NFET elastomeric threads with square cross-section have to be replaced by threads with a circular cross-section or vice versa, it is necessary to consider the difference in the number of the threads and numbering. For example, an elastomeric thread with a square cross-section and number 22 has to be replaced with a thread with a circular cross-section. The simple calculations show that the side of the square shape a is:

$$a = \frac{25.4}{22} = 1.155mm \qquad (1)$$

The diameter of the circle is calculated as:

$$d = \frac{a}{0.886} = \frac{1.155}{0.886} = 1.31mm \qquad (2)$$

The number of the elastomeric thread, calculated with the new diameter of the cross-section, is 20, instead of 22, which was the initial number of the elastomeric thread with the square cross-section.

The elastomeric threads have a specific interaction with the weft yarns. At each first beat of the weft thread, the elastomeric warp threads rise upward, and at the second beat, they descend downward. Thus, the elastomeric threads cause the weft threads to stand in two planes in the woven macrostructure.

After removing the grey fabric from the weaving machine, the relaxation of the elastomeric strands that are under tension in the weaving process results in a tight approximation of the warp threads. Practically, only the second weft is visible on the face side of the NFET, whereas the first weft thread is concealed by the warp yarns. Therefore, when analyzing an NFET sample or testing the finished fabric, it is necessary to stretch the narrow fabric under a microscope or double the number of the visible weft threads.

III. Materials And Methods

3.1 Software and machine

Jakob Muller jacquard weaving machines for narrow fabrics weaving was used for production of the NFET, together with Jakob Muller's brand software MuCAD. MuCAD is a high-tech design software, which controls the design pattern and several machine parameters. The MuCAD software allows some technological calculations to be performed during the design stage, e.g. calculations for machine efficiency or yarn consumption.

3.2 Materials

The warp involves two types of threads: lycra 940 dtex, covered by high-volume polyamide filaments 78x1 dtex with 280% elasticity, and polyamide polyfilaments 78x2 dtex. The weft yarns are polyester texturized polyfilaments 167dtex (32 monofilaments).

The warp includes 291 threads, 35 of which are elastomeric. The width of the gray NFET is 26 cm and that of the finished NFET is 25 cm.

The warp density is 63 threads/cm in the gray fabric and 64 threads/cm in the finished fabric. The weft density is 10x2 threads/cm in the gray fabric and 11x2 threads/cm in the finished fabric.

IV. Design Of A NFET

Figure 1 shows the desired design of the NFET. It involves two colours, letters, and a logo. Figure 2 presents the colour palette window, where the colours and their hues are selected.

Fig. 1. Design of the NFET.

Once the required palette has been made and stored in the program database, the selection of weave patterns has to be done. Figure 3 presents the weave used in the designed NFET. Extremely diverse patterns with practically unlimited repeats are possible. Both patterns with warp and weft view can be selected. The design program allows to automatically construct a weave pattern from just a few starting points, get a negative view that it is also used in the NFET design, change the beginning of the repeat, etc.

Fig. 2. Colour palette selection.

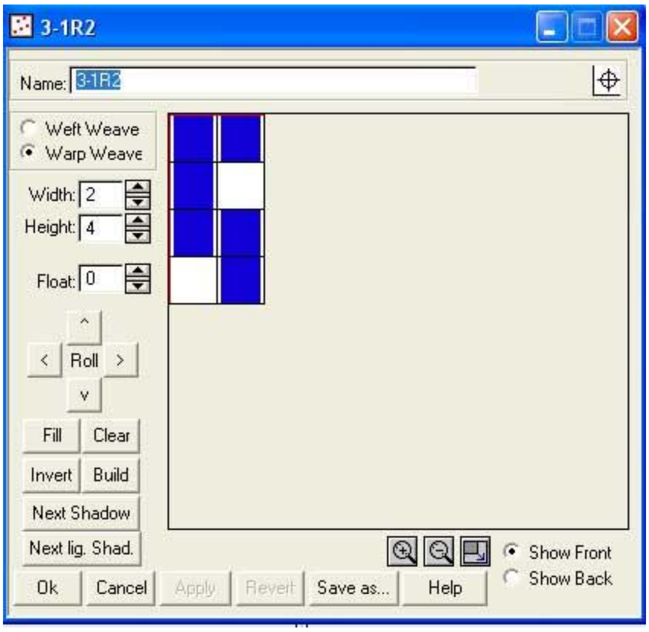

Fig. 3. Weave pattern selection.

One of the important steps in the design stage is the check for presence of single overlaps in the text of the design that will surely not be clear and visible on the final NFET. As it can be seen in Fig. 5 the left-hand side of the letter “T” consists of single overlaps and it must be manually corrected to obtain the appearance of the right-hand side of the letter.

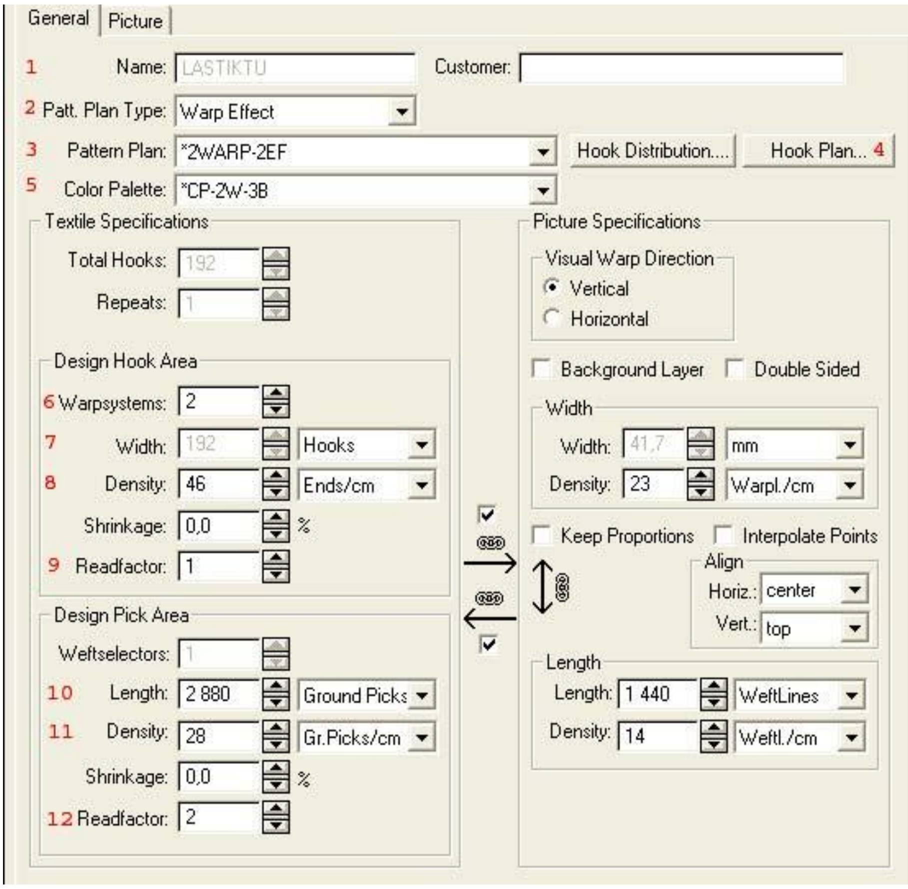

Fig. 4. Design specification.

Fig. 5. Check of the design for single overlaps.

The next design step is the selection of a pattern for each colour, for both face and back side of the NFET – Fig. 6. The program allows fast changes in the already chosen patterns or selection of entirely new ones. The 1-3R2 pattern, for example, is a negative weave of the main 3-1R2, with a shifted beginning of the repeat so as its appearance on the face side of the fabric to be covered by the overlaps of the pattern for the face side. Thus, only the required colour is visible on the face side of the NFET.

The final combination of the weave patterns and the colors is shown in Fig. 7.

After finishing the design process an UPT file is generated to adjust the machine settings. The file is transferable to the weaving machine's memory. It allows the adjustment of different parameters, e.g. the warp and weft density or hooks in operation. A simulated image of the NFET is also available, where the fabric can be viewed from all directions.

The software product only manages the jacquard apparatus, so it doesn’t specify the laws of motion of the elastomeric threads. This is done directly on the narrow weaving machine, where the remainder of the product design is determined by the gear mechanism and the grid chain.

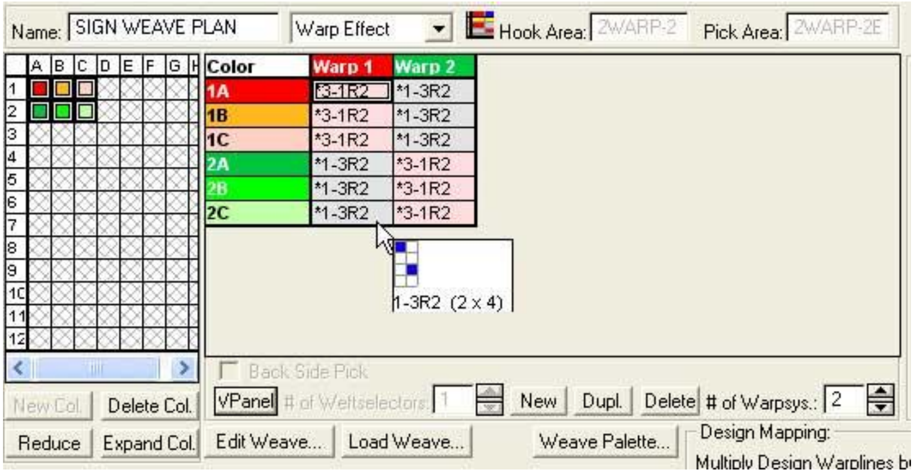

Fig. 6. Settings of the weave patterns.

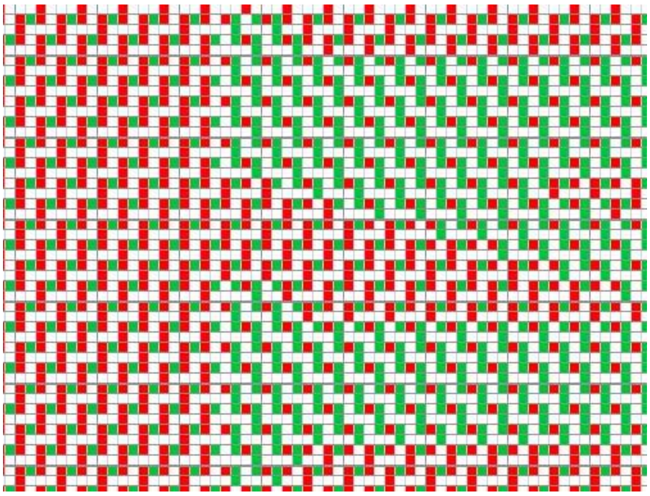

Fig. 7. View of the design colours with weave patterns.

V. Conclusion

The design of jacquard narrow fabrics with elastomeric threads is very specific and requires particular knowledge on all design stages of the product. The modern software products, used with the narrow weaving machines, facilitates to a great extend the design process, allowing fast and easy change of colors, patterns, warp and weft densities, repeats of the elastomeric threads among the other warp threads. This is very beneficial for all the production process, as the nowadays application of narrow fabrics with elastomeric threads is very large and will increase in the future.

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