INTERACTIVE APPLICATION FOR COMPUTER AIDED DESIGN OF 3D KNITTED FABRICS

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Abstract: Knitting is an exciting textile technology of creating products with outstanding characteristics, such as: knitting to shape, great flexibility in production, controlled properties, and excellent formability. The modern developed electronic flat knitting machines are capable of manufacturing complex engineering structures using its flexible technical characteristics at low manufacturing costs. Among them, the 3D fabrics or fabrics with 3D effects exhibit a higher thickness, compared to the single yarn diameter and provide a great potential for technical applications. The paper presents an interactive lecture concerning the computer aided design of knitted fabrics with surface cells, obtained by wedge technique (partial knitting of rows). The pattern programming has been performed on the pattern station M1, Stoll GmbH, and the fabric with 3D effects has been produced on CMS 530 E6.2 knitting machine. The programming steps were recorded with the explanations so the learners can repeat it several times, according to their own training rhythm.

Keywords: Computer-aided-design, knitting, pattern station, interactive lecture.

1. CAD DESIGN FOR KNITTING TECHNOLOGY

1.1 Introduction to textile field

In textile education there is a lot of fundamental factual information that the learner needs to acquire, particularly with regard to the principles used in textile processing [1].

Knitting is one of the most exciting textile technologies of creating products with outstanding characteristics, such as: knitting to shape, great flexibility in production, controlled properties, and excellent formability. The modern developed electronic flat knitting machines are capable of manufacturing complex engineering structures using its flexible technical characteristics at low manufacturing costs [2]. By exploring the unique technical capabilities of this technology, one can develop a wide area of knitted shapes, made from various raw materials and with applicability in medical field, interior designs, in composite and industrial products.

In the context of the knitting industry development and the demand of the labour market, the need of necessary knowledge, skills and competences offered to the textile engineers becomes a challenge for the higher education system. To achieve this on a sustainable basis, the design of new methods and forms of learning with an enhanced efficiency can be considered an actual trend. The high quality education in the knitting field is ensured by studying the latest technology and by using new teaching methods. The course tutor needs to be able and creative in reconsidering the teaching and assessment materials in order to identify the best strategies of training.

1.2 Pattern designing and machine programming

Knitting process has few important phases and one of them is the pattern design stage. In case of computer controlled flat knitting machines, the patterns are developed on special pattern stations, with a specific programming language. The Computer Aided Design (CAD) course is targeted on
learning the specific programming languages of various pattern station and the design stages of knitted structures. No matter of the pattern station provider, the main stages of designing a knitting program are presented in Figure 1.

Figure 1. Stages in knitted fabrics programming

II. 3D KNITTED FABRICS

3D knitted fabrics or fabrics with 3D applications differ from plane fabric by their higher thickness. Knitting to shape is an important feature of knitting technology because enables the production of shaped fabrics in 2D and 3D. The modern developed electronic flat knitting machines are capable of manufacturing complex shaped engineering structures using its specific technical features [3]. Various techniques are available for developing such a group of fabrics, like: knit and tuck stitches with racking technique; flexible stitch technique; knit and wear technique; double/multilayer (sandwich fabrics); wedge technique (partial knitting) [4].
The fabrics presented in Figure 2 with 3D forms, or 3D effects can be used either for outerwear or for technical destinations, by combining these techniques with yarns having properties in accordance with the product end use [5].

### III. INTERACTIVE LESSON FOR CAD OF 3D KNITTED FABRICS

The paper will focus on an interactive lesson concerning the programming activity of one type of 3D knitted fabric, represented in Figure 3.1. The principle applied for modules development is the partial knitting and these fabrics can be a potential textile surface for end uses, like false floors or phonic isolations. The fabric has been manufactured on Stoll machines, CMS 530 E6.2 and the program for knitting machine is designed on M1 pattern station. This kind of pattern is developed as applications within the course of Technologies for Technical Knitted Fabrics.

The stages indicated in the Figure 3.1 must be performed by the students and all technical requirements must be fulfilled, otherwise the errors given by the knitting program are detected by the Sintral check program, which will not allow the fabric knitting or, will damage the knitting machine parts. The pattern station has a high automation level but the users must have some basic knowledge regarding: computer work, knitting principles and fabric structures, knitting machines components. Usually, the stages must be repeated several times in order to obtain a viable knitting program and a good quality fabric.

From the tutor point of view in this field, one can draw the conclusion that the programming activity is a time consuming one and requires a sustained training. The differences between the students individual learning rhythm lead to the idea of the student independence and flexibility in learning, according to their own learning style, previous knowledge and personal motivation.
Consequently, the static lesson of designing knitted fabric programs has been transformed into an interactive one, delivered in form of a movie, recorded with Camtasia software. The video file includes all steps and detailed explanations, concerning the technical way of developing a pattern on a high specialised pattern station, provided by the German knitting technology builder, Stoll, Company from Reutlingen. Snap shots were taken from the movie and there are presented in Figures 3.2 – 3.8, according to the logical sequence of designing a knitting program.

Figure 3.2. Initial data of the knitting program

Figure 3.3. Pattern cell drawing
Figure 3.4. Adjustments of the pattern cell – knitting carriage direction

Figure 3.5. Pattern cells multiplication
Figure 3.6. Knitting program automatic technical editing

Figure 3.7. Sintral check of the knitting program
CONCLUSIONS

Knitting is a specific area from textile technologies, providing fabrics with engineered properties. The modern developed electronic flat knitting machines have been developed for being capable of manufacturing shaped engineering structures using its flexible technical features at low manufacturing costs.

The education in this field is based on a wide technical content concerning machines, pattern development, computer assistance, which sometime is difficult to be achieved. The qualified staff for the textile industry is the main concern of the education system, considering the high demands and the level of this industry wide world, confirmed by EU documents, as being one of Europe’s major industrial sectors with an annual turnover of 215 billion Euro and a total workforce of 2.6 million [6]. So the delivery of some alternative methods for training and assessment of the specific technical skills can enhance the quality and standards of teaching.

CAD activity is a particular stage of the knitting process on computer controlled flat knitting machines and concerns the pattern preparation together with the necessary set-up of the machines for delivering a good quality fabric. This stage requires a set of knowledge which involves: knitting technology, fabric structure and IT skills.

The implementation of the interactive lessons on the CAD teaching activity simplifies considerably the tutor activity, as the video resources can be managed by the students. The main request concerns the content that must be presented in a pedagogically logical sequence to lead the learner along the knowledge path. The easier classroom management is directly connected to the better results of the students.

From the students’ point of view, the integration of the video instructional materials has many advantages, as they become independent from the tutor. The users of this tool are able to replay the film as many times as they need and like. They can study at home, without being connected necessarily with the CAD laboratory and the pattern station. The learners can manage their time of study and they can stop as long as necessary to understand the details of each stage of programming.

The video lesson provided in the paper is one example of the possibilities that exist for improving the training methods in technical education system, even without being a novelty in
principle. The learning experience by using an interactive lesson in a specific and complex technical area becomes more pleasant and more flexible.

The training and learning activity has an added value and provide a different experience in this particular field. The traditional approach of the lesson design must be reconsidered according to the learner needs and potential. A blended class can also be an alternative solution for CAD in knitting, combining the tutor explanations followed by practicing with the video file, depending on the group skills and level.

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References


