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USING REVERSE ENGINEERING TECHNIQUES IN WEAR IDENTIFICATION OF THE NEEDLE PLATE OF SEWING MACHINE

ŞUTEU Marius Darius[1], BABAN Marius[2], BABAN Calin Florin[2]

[1] University of Oradea, Faculty of Energy Engineering and Industrial Management, Department Textiles, Leather and Industrial Management, 410058, Oradea, România, E-mail: suteu_marius@yahoo.com

[2] University of Oradea, Faculty of Managerial and Technological Engineering, Department Industrial Engineering, 410087, Oradea, România, E-mail: mbaban@uoradea.ro

Corresponding author: Şuteu Marius Darius, E-mail: suteu_marius@yahoo.com

Abstract: *Reverse engineering techniques were employed in this study to determine the wear of needle plates of sewing machines. The wear of such components used in the sewing process of textile products has the effect of bending them. Due to this phenomenon, the sewing needles hit the edges of the hole of the needle plates that leads to their break. As a result of this process the needle plate wears out. The wear of needle plates is manifested by the formation of micro-irregularities on the contour of the hole on the needle plate. Reverse engineering techniques allow to determine the size of the micro-irregularities that comes out on the contour of the hole on the needle plate. In order to apply reverse engineering techniques to establish the degree of wear of a needle plate, the plate was scanned using the Shining 3D scanner and the points cloud of the needle plate were obtained. The points cloud was then transferred to the ShiningForm XOR redesign software, which allows making sections throughout the needle plate. The section where the micro-irregularities have the maximum size was determined, and through the facilities offered by the ShiningForm XOR software the value of the micro-irregularities related to the state of wear of the needle plates was established.*

Key words: *reverse engineering, sewing machines, needle plate, scanning, wear.*

1. INTRODUCTION

Deterioration of various machine components is mainly caused by their wear, which is considered as a response of machines that can conduct to the maintenance activities for these parts [1]. Therefore, wear can negatively influence the textile machine effectiveness and its detection may have a great impact of their productivity. The extant literature presents different methods that can be used for wear identification [2, 3]. In this paper, we propose an approach that is based on reverse engineering, a process involving techniques such as digitization and redesign of the machine parts [4]. Reverse engineering have been used in various applications in the textile industry. For example, reverse engineering techniques were used to design a textile machine yarns pass, which was manufactured after its redesign using selective laser sintering [5]. Employing reverse engineering techniques, the complex 3D geometry of a jacket product was developed in reference [6]. The complex geometric shape of a presser foot base part of a sewing machine was also developed using the reverse engineering method, which was then manufactured with the Inspire 200 3D printer [7].

In the case of sewing machine, as the sewing needles wear they bend and hit the needle plate. As a result of hitting the needle plate, micro-irregularities are created on the contour of the channel of the needle plate. The occurrence of these micro-irregularities has the effect of breaking the sewing thread and the appearance of a defect on the sewing surface of the products. Using reverse engineering techniques allows to determine the size of the micro-irregularities that appear on this contour and, thus, its wear state. This information can be next used for planning maintenance activities, employing either a statistical approach [8] or a predictive strategy [9].

2. MATERIALS AND METHODS

Figure 1 depicts the wear identification approach of a worn needle plate for sewing machines. This approach was based on the Shining 3D Scanner and the ShiningForm XOR software for product redesign. The needle plate is scanned using the Shining 3D scanner, and the ShiningForm XOR software allows the determination of the wear state of the needle plate by measuring the micro-irregularities that appear on edge of its hole.

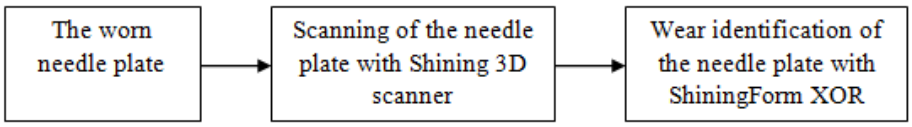


***Fig. 1**: Wear identification of a needle plate [7]*

3. RESULTS

After positioning the needle plate on the scanning table, 15 scans were acquired for different positions of the needle plate using the Shining 3D scanner. Next, these scans were superposed to obtain the points cloud of the needle plate (Fig.2), which was saved into a "*.rge" format as E1015_Mesh_15.rge.

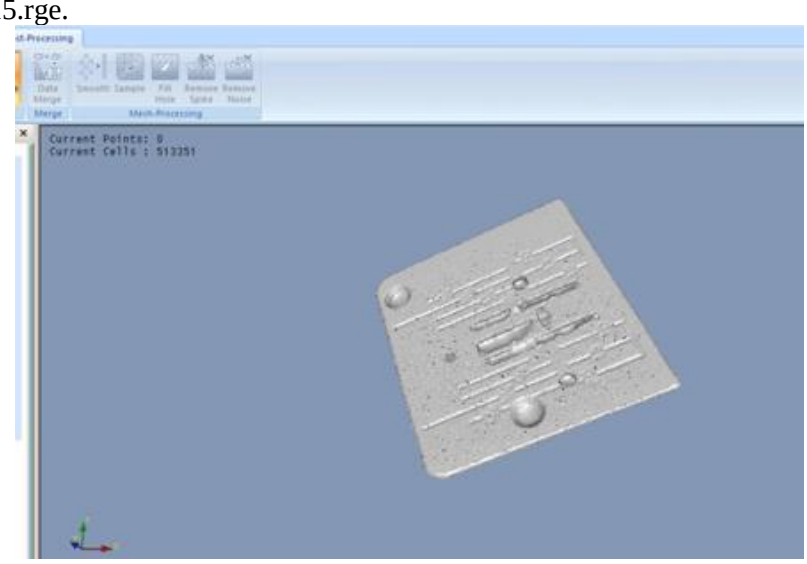
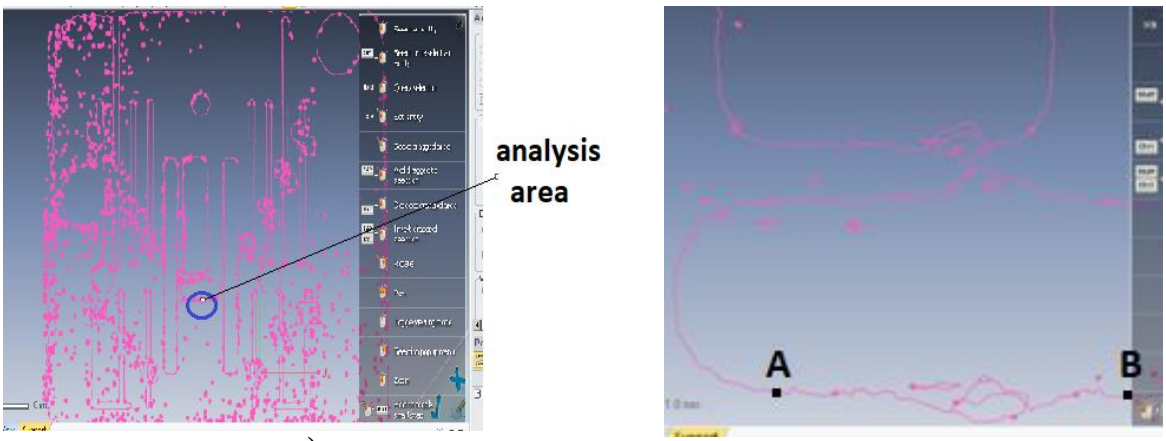


***Fig. 2**: The points cloud of the needle plate*

Then, the file E1015_Mesh_15.rge was imported into the ShiningForm XOR software. Using the Mesh Sketch Setup command of the ShiningForm XOR software, sketches were made to

identify the size of the micro-irregularities of the hole of the needle plate. Figure 3.a shows the sketch of needle plate that corresponds to the largest micro-irregularity, while figure 3.b illustrates the enlarged area of wear of the needle plate. The micro-irregularities that appear on the AB contour will cause the breaking of the sewing thread, so this contour will be next analyzed to determine the wear of the needle plate.



a) b)

Fig. 3*: The sketch containing the analysis area of needle plate wear using ShiningForm XOR software*

A horizontal line was drawn for the AB contour in the resulted sketch, corresponding to the line of the hole of the needle plate for the state when the plate is new (continuous blue line in figure 4). A horizontal line was also drawn corresponding to the size of the micro-irregularity of the needle plate for the state when it is used (dotted blue line in figure 4).

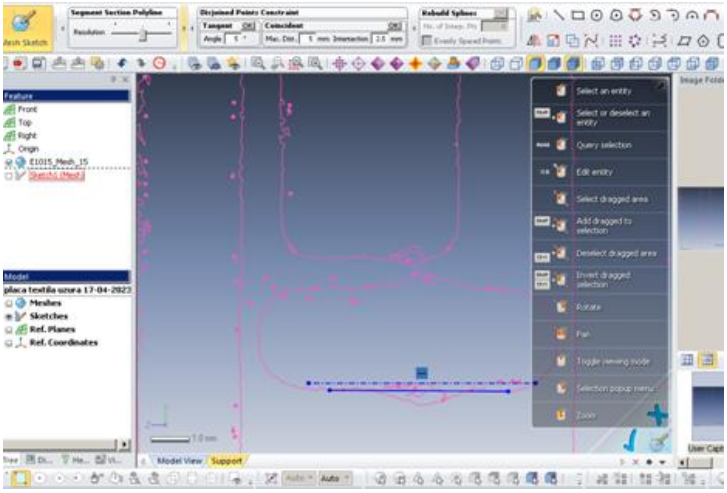


Fig. 4*: Drawing the horizontal lines that define the new and the used state, respectively of the analyzed contour of the needle plates*

The ShiningForm XOR software allows the determination of micro-irregularity dimensions for the wear condition of needle plate. According to figure 5, the value of micro-irregularity for the state of the wear of analyzed needle plate is 0.2658 mm.

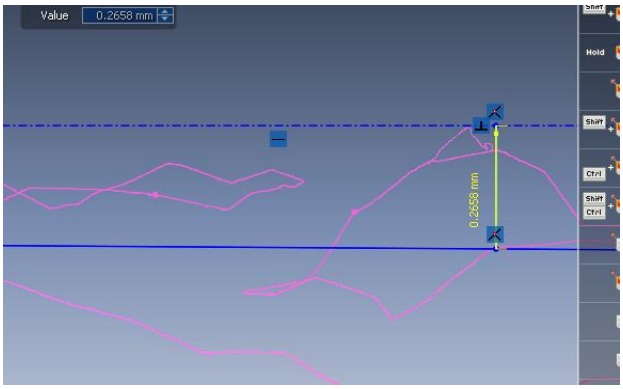


Fig. 5*: Determining the value of the micro-irregularity of the wear condition of needle plate*

4. CONCLUSIONS

This paper presents the application of reverse engineering techniques to determine the wear of sewing machine components. The case study illustrates the employment of such techniques to establish the wear condition of needle plates. Once the values of the micro-irregularities for the state of wear of needle plates are known, it is possible to determine the moment of their replacement, so that the sewing thread does not break because of the needle plates wear.

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