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PRODUCT CUSTOMIZATION USING REVERSE ENGINEERING TECHNIQUE

PESCARU, R[oxana]

Abstract: *This paper focuses on the use of innovative technologies in manufacturing high degree customization products. As known, a serial of human activities of high performance leads to customized products. The paper represents the beginning of an entire cycle of works focused on the sport industry (footwear) designed for high performance. The present work targets are: making a short analysis of the achievements made using the Reverse Engineering (RE) technique combined with the most recent concepts from product engineering; presenting the necessary stages in the process of manufacturing customized products by means of the RE together with CNC and Rapid Prototyping techniques; applying the RE technique in the process of manufacturing customized footwear for high performance human activities.*
Key words: *Reverse Engineering, Scanning, CAD/CAM*

1. INTRODUCTION

Nowadays, in order to ensure market success, product engineering must be grounded on top technology. Reverse Engineering technique (RE) is an important engineering tool in integrated engineering. RE integrates CAD and CAM itself from product engineering and develops using computer aided numerical control (CANC), Rapid Prototyping (RP), Rapid Tooling (RT) and even Rapid Manufacturing (RM). In fact, these technologies make RE an efficient technology (figure 1).

This paper focuses on the technique of manufacturing customized products using RE. The customized product is that object whose particularity is given by its unique/specific traits. Customized products are widely connected with human activities. For example some of the products to be personalized are: shoes such as ski boots, football boots, helmets, sportsmen glasses and so on.

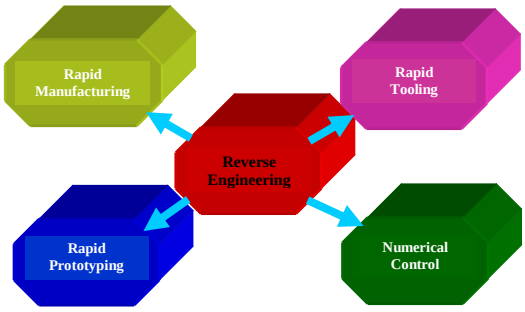

Fig. 1. Technologies integrated with RE

2. THE STAGES OF CUSTOMIZATION

As aim, this paper is conducted towards customization of products directly related to human body components. The most applicable for customization is the sport equipment industry. For example shoe type products such as SKI BOOTS and SHOES are perfect customized products. The ski boot is a product that needs to be personalized on the sportsman foot.

As a result of the research made by the authors, the stages contained by this type of customization are presented in figure 2.

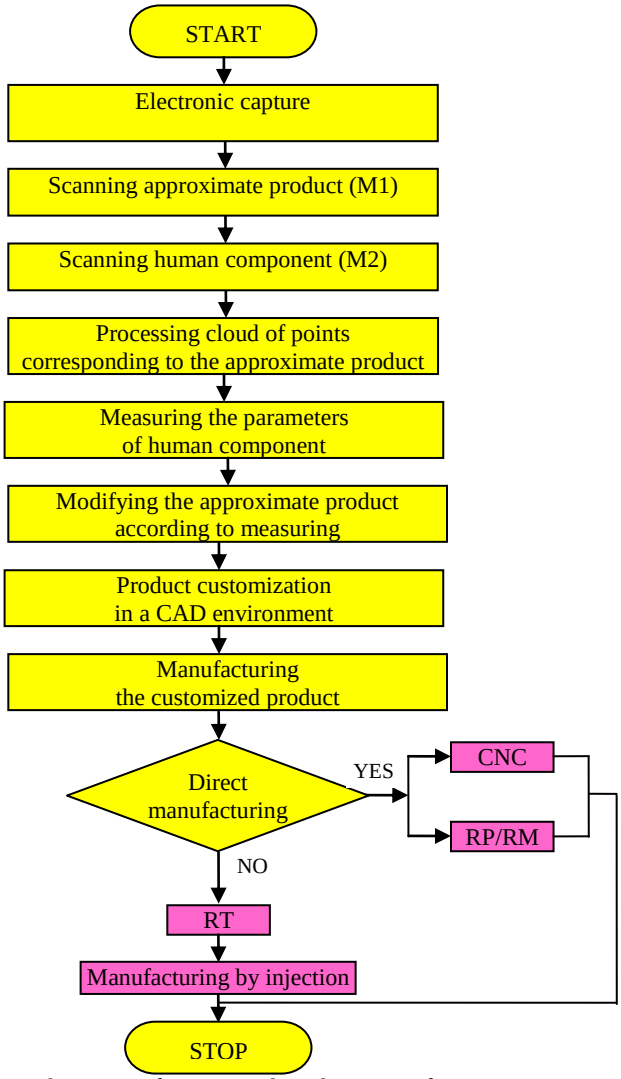

Fig. 2. The stages of customized products manufacturing

The first stage implies obtaining an electronic capture of a similar product M1 (nonpersonalized) to the desired one by means of a 3D scanner. The difference to a standard RE project is the necessity of scanning the involved human component (human foot) by means of a specialized 3D scanner. As a result of the two scannings we have two clouds of points (primary images of the scanned elements). The next stage is manufacturing the cloud of points corresponding to the M1 product. The resulting curves need to be exported in a CAD environment in order to 3D modeling the M1 product (by this, customization is afterwards highly simplified).

3. DATA REQUIRED FOR CUSTOMIZATION

In order to obtain the necessary data for customization dedicated scanners need to be used. Figure 3 presents the 3D „Easy-Foot-Scan" (*** a, 2009) scanner. In order to scan, four laser projectors and eight video cameras are used. An advantage of this scanner is the fact that is not daily light sensitive.

Another type of scanner, used by the ERTL-RENZ company in Germany, in order to capture the human foot, is „Lightbeam", figure 4 (*** b, 2009). By means of it, the 3D shape of the human foot (length, height and width) can be captured.

Fig.3. „Easy-Foot-Scan"

Fig.4. „Lightbeam"

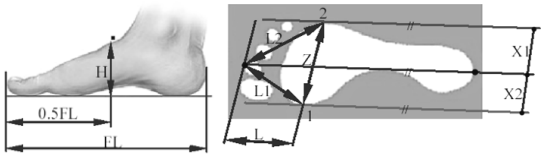

Fig. 5. The foot parameters

The main parameters of a human foot according to figure 5 are (Butdee & Tanqchaidee, 2008): FL-the foot length, H-the foot height, Z-the foot width, L-the distance between the head foot to the most width foot, X_1-the distance between the neutral line and the left corner line, X_2-the distance between the neutral line and the right corner line, L_1-the diagonal line from the head foot to the left foot width, L_2-the diagonal line from the head foot to the right foot width.

4. SHOE TYPE PRODUCT CUSTOMIZATION

In order to customize the ski boot, the stages from all figure 2 must be followed, taking into consideration that first the 3D copy of the foot must be obtained. This stage can be realized by means of a scanning process, as shown. The purpose of the scan is analyzing and measuring the foot in order to obtain an adequate shape of the ski boot. The next stage implies choosing the type of ski boot that corresponds to the shape of the scanned foot figure 6 (*** c, 2009).

In order to customize, traditionally, the process starts from a wooden model (one of the possibilities). This model is compared to the shape of the scanned foot and adjusted by adding or removing material until it best corresponds to the shape of the scanned foot. The next step implies creating the boot according to the shape of the foot, by means of a certain technology (future papers will study the technology of boot manufacturing).

Another example of customized product focuses on SHOES IN EXTREME SIZES (*** d, 2008). Here the first step implies choosing the model of the shoes desired by the client. The next step supposes scanning the human foot (figure 7).

Then, using dedicated software, to customize, the dimensions of the shoe are being modified (figure 8).

It is important to outline that the modification of the shoe, taken as initial model, implies a serial of problems that still need to be solved. Having all the necessary data concerning the human foot, the shoe last can be processed. In order to do this option is CNC processing by means of milling.

Once the shoe last realized, the process of customization is started using an available technology.

Fig. 6. Ski boot type choosing

Fig. 7. Scanning the human foot and its shape

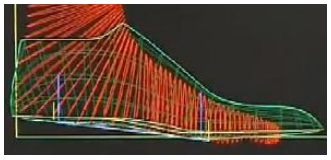

Fig. 8. Modification of the shoe parameters

5. CONCLUSION

The aspects presented above have outlined the utility of the RE technique in product customization. For exemplification the category of sport products has been chosen. The paper has synthesized a scheme that needs to be completed in order to be able to customize products based on human components. The paper has also outlined the difficulties that customization generally encounters. These difficulties are: modification of the reference model according to the geometrical and numerical characteristics of the item to be customized. The issue needs to be solved by using the RE tools, CAD media and CNC/RP technologies without using shoe last models.

6. FUTURE RESEARCH

Future research intends to offer solutions to the following problems: shoe last models cancellation; creating a data base focused on a graphic library of components designed for customized products, shoe type; discovering/elaborating the software tool that allows electronic image integration of the human component and the initial model of the product chosen for customization; customized product manufacturing by using the CNC and RP technologies. This research is going to focus on boot manufacturing for performance sportsmen.

7. ACKNOWLEDGEMENTS

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