RESEARCH AND DEVELOPMENT OF A NEW GRADING SOFTWARE IN FOOTWEAR INDUSTRY

Pham Ngoc Tuan[(1)], Ho Minh Tuan[(1)], Tran Thi Thu Hien[(2)], Tran Đang Bong[(3)]
(1) University of Technology, VNU-HCM
(2) Ho Chi Minh City Vocational College School
(3) Southern Technology and Agro-Forestry Vocational College

ABSTRACT: *This paper presents research results on improvement of grading process in the footwear industry, a new grading software which is suitable to manufacturing practices, can reduce deviation and increase productivity in the grading process in comparison with the manual method.*

Keywords: *grading process, grading software.*

1. INTRODUCTION

According to statistical data of the Ministry of Industry and Trade, the footwear export turnover of the country amounts to $3.56 billions in 2006, exceeding the plan ($3.35 billions) by 6.1%. Vietnam footwear industry is currently the third export earner after petroleum and garment. The projected export turnover in 2010 is $6.5 billions, with the annual increase of 20%. The goal in 2010 is the production of 720 millions of footwear pairs, 80.7 million of bags and 80 sq. meters of tanned leather, which together constitute the industry export turnover of $6.5 billions. The said objectives make indispensable the application CAD/CAM in new technology and modern equipment.

Shoes grading is the first component of the CAD/CAM material cutting process in footwear industry. In developed countries shoes grading is performed using specialized software of well-known brands like Lectra RomanCad of Lectra, SCS of Palmel. The said software's are however packaged into integrated systems of high cost. Currently, only a few of Vietnamese footwear companies can afford foreign made shoes grading software. For this reason local CAD/CAM systems in general and shoes grading software in particular are urgently required for having technology upgraded and fabrication equipment modernized.

2. CAD/CAM MATERIAL CUTTING SYSTEM IN FOOTWEAR INDUSTRY

CAD/CAM material cutting system in footwear industry consists of the following components (fig.1).

System input are picture files (of .bmp or .jpg format) from scanner (1) or the files containing point sets from digitalizer (2). Digitalizers have disadvantage in high cost, complicated maintenance and the necessity of having the piece contour smoothened. Scanners instead are inexpensive and widespread. The input data after processing by contour digitalizing software (3) will become the set of continuous point representing the piece contour. The piece contour in digitalized form will enter into shoes grading software (4) and cutting layout software (5). At this step the shoe piece will be graded (scaled) into necessary dimensions and arranged into layout scheme so that the material waste is minimized. Data are transferred into central computer (6). The computer (6) provided with controlling software (7) transfers data into CNC controller (8) which will control the press machine (9).

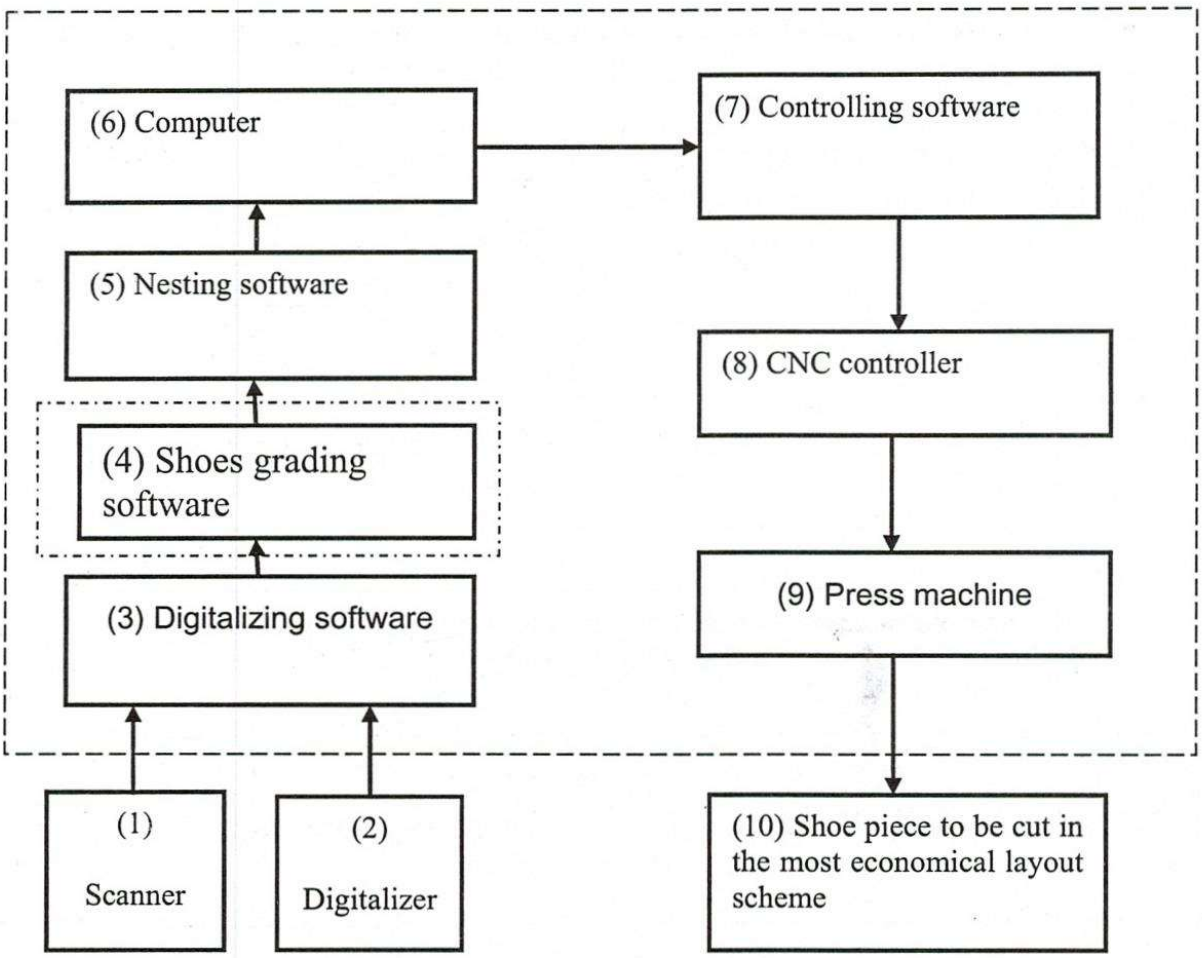


Fig 1. Components of the CAD/CAM material cutting system

3. GRADING ALGORITHM

Shoe grade, is a system of dimension parameters of the shoe that fits to one person. Currently various system of shoe grading are used in the world and depending on regions, different shoe grading system are applicable for each type of shoes (like, men's shoes, women's shoes, children shoes, sport shoes, working shoes).

Grading is the procedure of changing the piece dimensions so as to fit to the foot which is based on the points of augmentation and algorithmic instruments of footwear industry.

Today only several developing and non-developed countries are still keeping manual shoes grading system (fig.2)

Advantage:

- Manually made, without investment in modern equipment
- Low investment cost
- No necessity of computer technology knowledge

Disadvantage:

- Errors of manual operations may be significant and badly controllable
- Absence of synchronization between grading sets
- Low productivity

- Non-utilization of science and technology progresses

Automatic grading procedure is shown in the flow chart of fig.3.

The grading steps are:

Step 1: Select the piece cutting form, draw reference direction

Select the cutting form of the piece to be graded

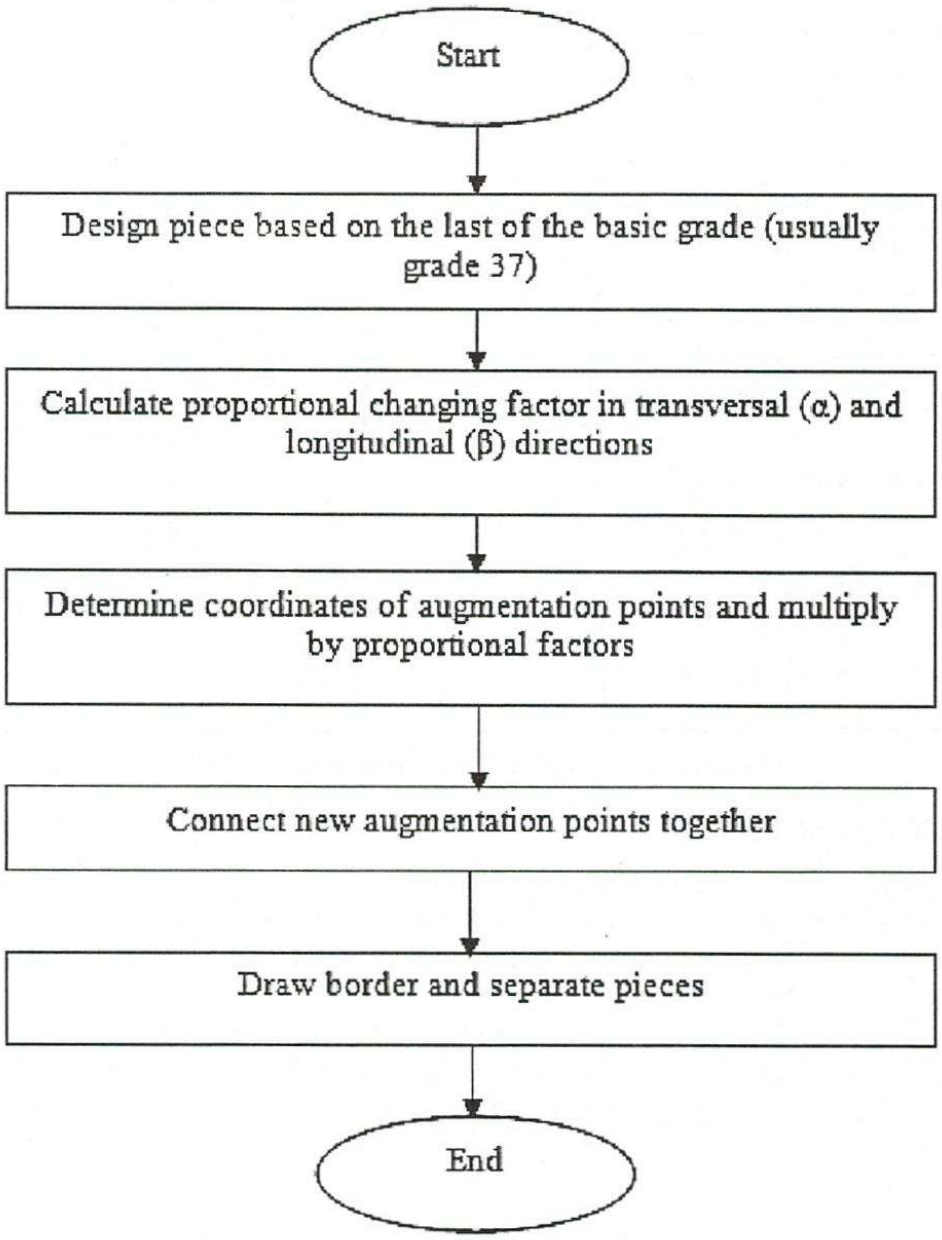


Fig 2. Manual grading procedure

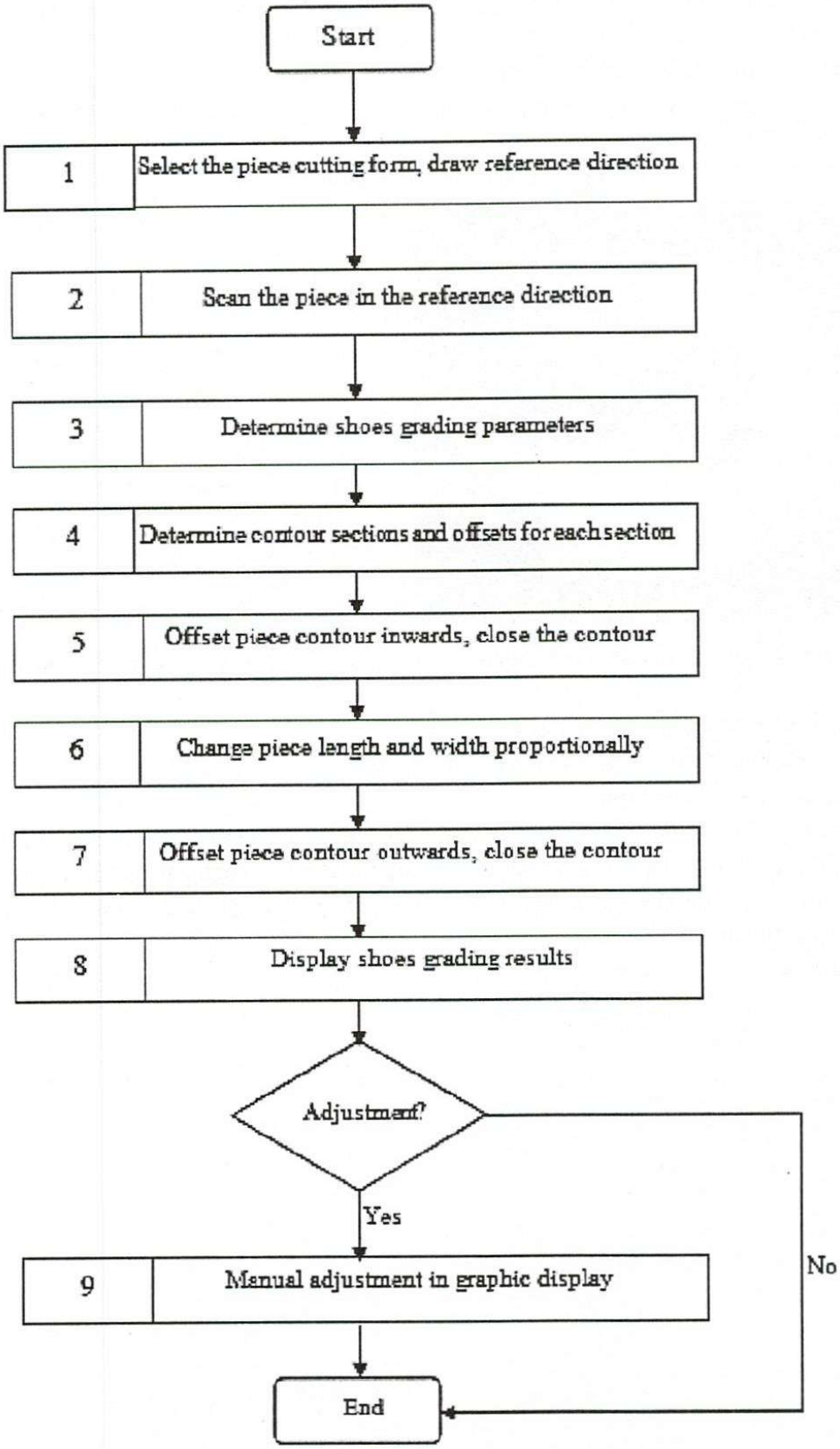


Fig3. Automatic grading procedure

Draw the axis Ox coinciding with the reference direction (The direction connecting shoe toe to heel).

Step 2: Scan the piece in the reference direction.

Place the piece into the scanner so that the axis Ox coincides with machine horizontal direction (approximately)

Perform scanning and digitalizing of the piece contour.

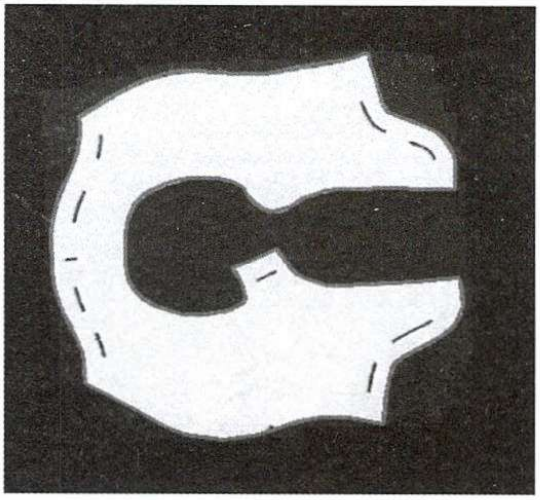


Fig. 4. Scanned image of piece pattern

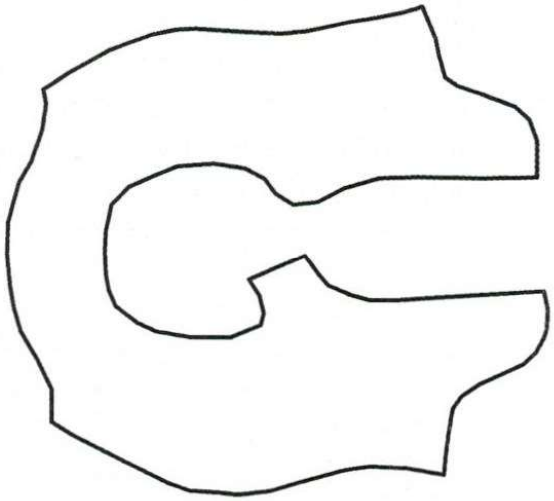


Fig. 5. Contour of scanned piece

Step 3: Determine grading parameters

Enter grading parameters to the dialog box

Length system selection:

French, Italian, EUR, Continental system … each grade step is 2/3 cm = 0.667 cm

UK, US system … each grade step is 1/3 inch = 0.846cm, each half grade step is 0.423 cm

CM, Metric, Mondopoint, Russian, Chinese system … each grade step is 1 cm, each half grade step is 0.5cm

Width system selection:

The width is calculated by the formula:

$$y = Ni.\ A + W.\ B + C$$

where : y is toe fitting width, in mm

Ni is Length grade

W is Width grade

A, B, C are constants

Table 1: Values of A, B, C

System	A	B	C
EUR	4	5	42
UK children	5	5	105
UK adult	5	5	170
CM	6	5	42
CM direct	6	8	58

Selection of shoes group:

- Baby 15- 22 , T = 1,21
- Children 23 – 34, T = 1,19
- Teenager 35 – 40, T = 1,17
- Women 34 – 42, T = 1,15
- Men 38 – 47, T = 1,13

Selection of toe last

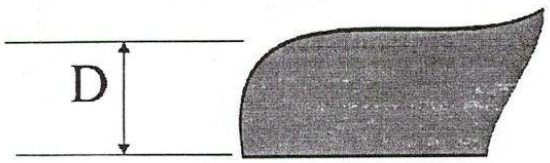
Determined according the toe thickness as 1, 2, 3 cm

Selection of the basic grade (No) and of the grade to be scaled (Ni):

Enter the basic grade No ans select the grades to be scaled Ni.

Calculate Δ_{length} and Δ_{width} between grades:

Δ_{length} : is the difference value beteween two consecutive grades of the upper

	D	Δ_{length}	
Upper	1 cm	7,1 mm	
	2 cm	7,3 mm	
	3 cm	7,5 mm	
Sole		6,667 mm	

and Δ_{width} is taken as the value B in the table of constants

Calculate length grading factor α and width grading factor β:

Call x_o, y_o respectively as length and width of the basic grade (No).

The value α is the scaling factor between the length of the basic grade and of the required grade

$$\alpha = \frac{2/3.x_0.T + n.\Delta length}{2/3.x_0}$$

$$\beta = \frac{y_0 + n.\Delta width}{y_0}$$

Step 4: Determine contour sections and offsets for each section

The user is allowed to devide the piece contour into a number of sections by mouse clicking (fig.6)

The user is allowed to enter the value of width offset for each created section.

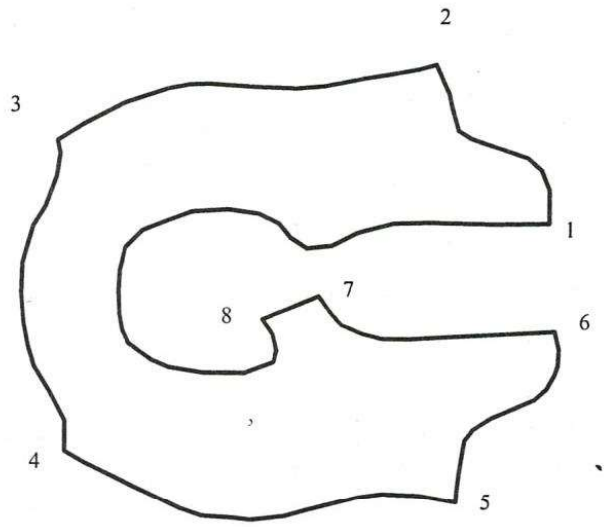


Fig 6. Fragmented piece contour

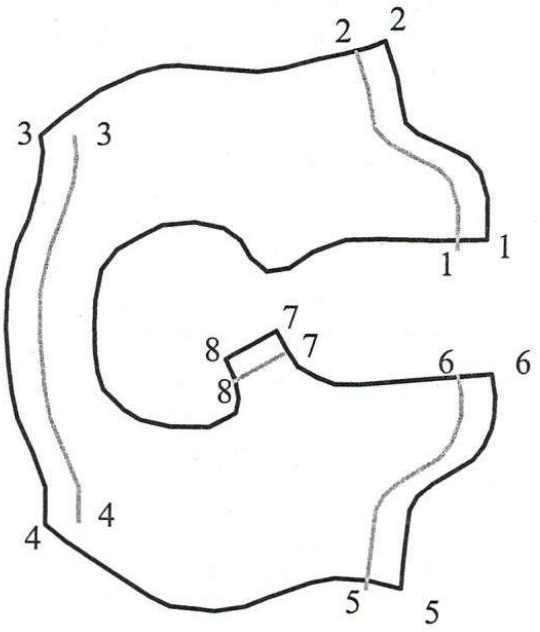


Fig 7. Offsetted fragments of piece contour

Step 5: Offset the piece contour inwards and close the contour

Perform offsetting contour sections inwards according to the selected value of width offset (fig.7).

Apply the operations Trim/Extend for closing the contour (fig 8).

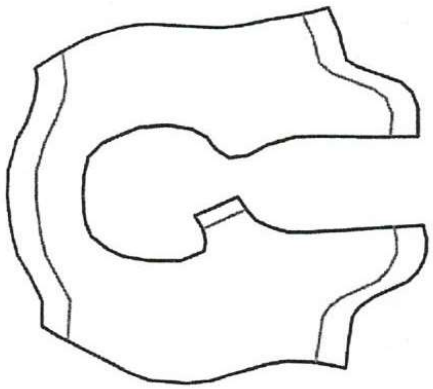


Fig 8. After closing fragments of piece contour

Step 6: Change piece length and width proportionally

Apply the algorithm Affine for changing piece length and width proportionally.

In this case S_x , S_y are two scaling factors in the two directions of X and Y. In the present grading problem $S_x = \alpha$ and $S_y = \beta$. From this the matrix is written like this:

$$[M] = \begin{bmatrix} \alpha & 0 & 0 \\ 0 & \beta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

For convenience of picture display there are two more parameters T_x và T_Y, called negative grading coordinates. In this case the matrix is rewritten as:

$$[M] = \begin{bmatrix} \alpha & 0 & 0 \\ 0 & \beta & 0 \\ T_X(\alpha - 1) & T_Y(\beta - 1) & 1 \end{bmatrix}$$

The initial point set $[N_{cs}]$ is obtained from the algorithm digitalizing piece contour. Multiplying this point set $[N_{cs}]$ by the matrix [M], we obtain the point set describing piece contour of the required grade

$$[N_i] = [N_{cs}][M] = [N_{cs}] \begin{bmatrix} \alpha & 0 & 0 \\ 0 & \beta & 0 \\ T_X(\alpha - 1) & T_Y(\beta - 1) & 1 \end{bmatrix}$$

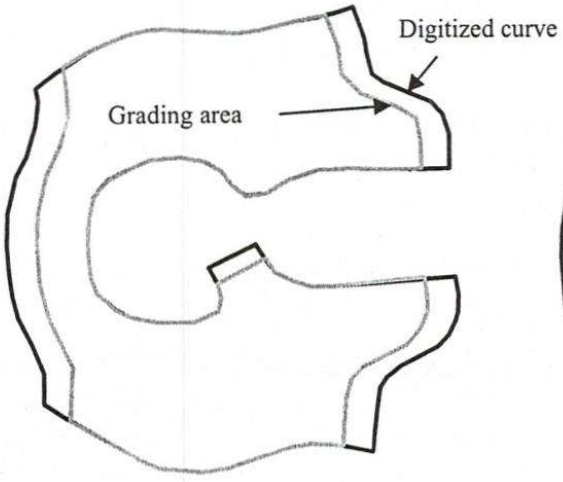


Fig 9. Before grading

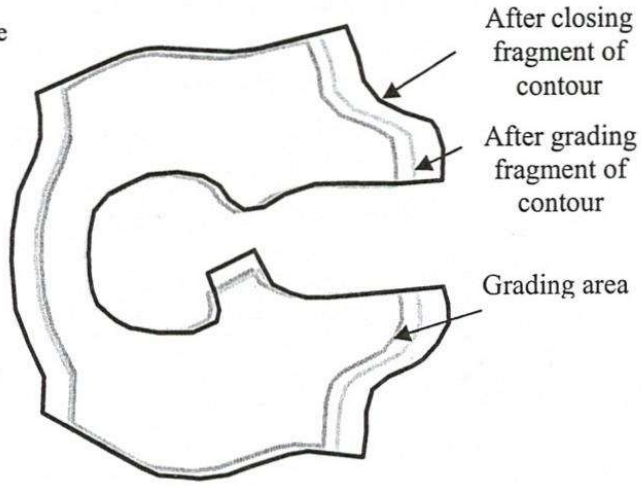


Fig 10. After grading

Step 7: Offset the piece contour outwards and close the contour

Perform offsetting contour sections inwards according to the selected value of width offset

Apply the operations Trim/Extend for closing the contour

Step 8: Display shoes grading results

Displayed are the results of the basic piece and of the graded piece (fig.10).

Step 9: Manual adjustment in graphic display

The user is allowed to to adjust details of the graded piece.

The shoes grading procedure is performed by shoes grading software. This method is being widely used in the world. In Vietnam some big firms are applying this method, but most firms are applying AutoCAD based software instead of application-specific software.

IN compare with traditional shoes grading method (manual method) automated method has the following advantages and disadvantages:

Advantages:

- High productivity.
- High reliability.
- High synchronization between grading sets.

Disadvantages:

- Additional investment cost for software procurement

4. GRADING SOFTWARE

Grading software SGSoft (Shoe Grading Software) developed with the following specifications:

- Be coded in the programming language Delphi.
- Operates on Windows platform which is today a widespread platform.
- Can process and manage data file of the stamping contour which is obtained from digitalizing equipment (digitalizer or scanner) and on which shoes grading is performed
- Supports many grading systems that and common in footwear industry and can be widely applied in footwear fabricating enterprises.
- Allows selection of many footwear systems in the world (Version SGSoft 1.1 has 15 footwear systems).
- Allows selection of suitable shoes types (according to toe last parameters) which will reduce the manual adjustment after automatic grading.
- Can save and supply data for nesting software.

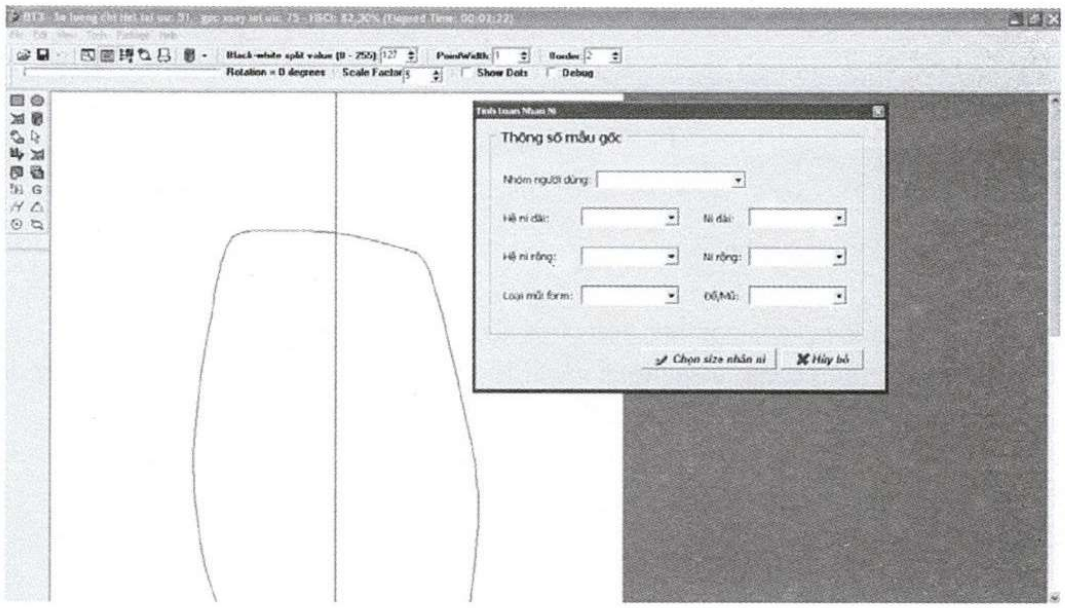


Fig 11. Interface of grading sofware SGSoft

5. APPLICATION

Grading software SGSoft is being step by step applied in footwear companies such as An Thinh Shoes, Vina Shoes, Thai Binh Shoes, Can Tho footwear Company. The practical investigations show that the application of this grading software can reduce the grading time, increase productivity without requirement of qualified staff and improve grading accuracy.

6. CONCLUSION

Automation of grading process and application of grading software in the footwear industry aims to meet the demand of production practices in order to reduce the lead time and increase the effectiveness of footwear production. At the same time data from grading software can be integrated to nesting software, which is also integrated to the controlling software of a CNC press machine for cutting shoe pieces at least material waste. This will improve competitiveness of Vietnamese footwear companies in the world market.

NGHIÊN CỨU PHÁT TRIỂN MỘT PHẦN MỀM NHÂN NI MỚI TRONG NGÀNH GIÀY DÉP

Phạm Ngọc Tuấn[1], Hồ Minh Tuấn[1], Trần Thị Thu Hiền[2], Trần Đăng Bổng[3]
(1) Trường Đại Học Bách Khoa, ĐHQG-HCM
(2) Trường Cao Đẳng nghề Tp.HCM
(3) Trường Cao đẳng nghề công nghệ và nông lâm Nam Bộ

TÓM TẮT: *Bài báo giới thiệu các kết quả nghiên cứu về cải tiến quá trình nhân ni trong ngành giày dép, một phần mềm nhân ni mới phù hợp với thực tế sản xuất, có thể giảm sai lệch và nâng cao năng suất trong quá trình nhân ni so với phương pháp thủ công.*

Từ khóa: *quá trình nhân ni, phần mềm nhân ni.*

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