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Fitting Evaluation of Pattern Making Systems According to Female Body Shapes

Abstract
In order to provide clothing fit, it is necessary to associate garment patterns with body shapes. In this study, basic skirt patterns werecreated using the Computer Aided Design (CAD) system according to Contec, Metric, Müller, and Basic Blocks Pattern Making Systems in order to evaluate fit. These patterns are dressed up on virtual mannequins which have been created in the three-dimensional (3D) virtual sewing and try-on system. The mannequins' sizes (38) and body dimensions are specified according to international size charts. Besides this the body shapes are selected as hourglass, triangle, or rectangle. The fit is evaluated according to pressure and tension maps, which are the tools of the 3D virtual sewing and try-on system. Although the mannequins are in same the size, different results are obtained for each body shape. Also different results are acquired for each pattern making system. Consequently it can be said that the pattern making systems are not suitable for each body shape.

Key words: *body shapes, garment pattern, 3D virtual sewing and try-on system, pattern making systems, fit and satisfaction.*

Introduction

Dressing is one of the fundamental needs of the human being, serving various and diverse purposes [1]. Most people want clothing that fits well [2]. Fit in women's wear is a complex issue with many facts. The earliest conceptual framework on consumers' satisfaction with the fit of ready-to-wear identified personal and external influences, body cathexis and physical dimensions of the garment as important factors influencing fit [3].

Although each person's definition of that may be subjective, satisfaction with clothing fit will be higher if the body shape of the wearer can be considered when the clothing is designed and manufactured. Body shape is the major factor that has an influence on fit and satisfaction with clothing [2]. Ideal body shapes have always been used by the apparel industry, from which technicians take dimensions for pattern making and fitting and designers create their new designs. It is also used by manufacturers for showing their garments, as models for hire , and is needed by consumers for their representation [4].

Making garment patterns accurately is also important. It is necessary to associate garment patterns with body shapes in order to provide fit and satisfaction. Many different pattern making systems are used in the apparel industry, developed according to the nation's anatomy and changes in the pattern preparation steps with respect to different systems. These systems are also widely used in countries which lack their own pattern making systems. Therefore it is necessary to investigate these systems and their fit. In this context the pattern making systems are evaluated using international standard size charts.

In this study, four common pattern making systems are evaluated. The Contec Pattern Making System, developed in Germany, is suitable for computer applications and hand drawing. British researcher Winifred Aldrich developed the Metric Pattern Making System, in which garment patterns can be easily prepared using very few assistant lines. There are some additional measurements and they are added to the body measurements during pattern making. In the Muller Pattern Making System, which was developed by Michael Muller for Germans, the basic measurements are taken from the body directly. Other measurements are calculated during pattern drawing using these measurements. The Basic Blocks Pattern Making System was developed in America by Handford in 1984. In this system, patterns are drawn by the combination of simple blocks [5].

Scientists have been greatly interested in human body shape classification. Based on long-time studies, human body shapes have been classified according to inherent body characteristics and somatoshapes have been determined [6]. Somatotyping is the most recent development in the twenty-five century history of morphological taxonomy and constitutional investigation [7]. Somatotyping reflects the overall outlook of the body and conveys a meaning of the totality of morphological features of the human body [6].

When descriptions of different body or figure shapes are being discussed, the somatoshape terms are not usually the most common. Instead of these terms apparel manufacturers have developed new body shapes [8]. Some apparel manufacturers have used alphabets (H, O, A, X, R, I, S), geometric shapes (Rectangular, Oval, Triangle), names of fruits (Apple,

Table 1. *Female body shape classification [7, 9].*

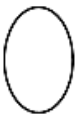
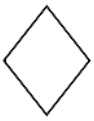
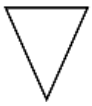
Body Shape	Definitions	Shape
Hourglass	A very small difference between bust and hip circumferences The ratios of bust-to-waist and hips-to-waist are about equal and significant	
Top hourglass	A larger bust circumference than hip circumference The ratios of bust-to-waist and hips-to-waist measurements are significant enough to produce a definite waistline	
Bottom hourglass	A larger hip circumference than the bust circumference The ratios of bust-to-waist and hips-to waist are significant enough to produce a definite waistline	
Spoon	A larger circumferential difference in hips and bust The bust-to-waist ratio is lower than the hourglass shape The hip-to-waist ratio is high	
Triangle	A larger hip circumference than that of the bust The ratio of hip-to-waist was small Larger in the hips than in the bust without having a defined waistline	
Rectangle	Bust and hip measurement fairly equal Bust-to-waist and hip-to-waist ratios are low There is not a clearly discernible waistline	
Oval	The average of the stomach, waist and abdomen measurements is less than the bust measurement	
Diamond	The average of the stomach, waist, and abdomen measurements is more than the bust measurement	
Inverted Triangle	A larger bust circumference than that of the hips A small bust-to-waist ratio	

Table 2. *Bust, waist and hip measurements according to body shapes.*

Bust circumfr.	Waist circumfr.	Hip circumfr.	Final result of formula	Body shape
88	70	96	26.2 > 25.6 cm	Hourglass
86	74		22.2 < 23.0 cm	Triangle
88		97	14.1 < 23.0 cm and 23.2 < 25.6 cm	Rectangle

Pear) and other distinctly shaped things (Hourglass, Bean, Heart) to classify body shapes [4]. They refer to more or less the same figures with different codes of identification and are based on the proportions of the body's silhouette mostly from the front view [9].

Since a desired fit is becoming more important for consumers, research on body shape classification has increased worldwide. Karla Simmons from North Carolina State University studied this subject in 2002 [8]. Simmons created computer software for body shape classification. In her study, Simmons used bust, waist, hip and high hip circumference measurements and the relationship between them in order to identify the body shapes. According to this research Simmons classified female body shapes under nine groups (***Table 1***).

Methods of examining fit, live fit models and dress forms have been commonly used together. Although fit models can vary in their measurements and may not be perfectly symmetrical, they can comment on misfit areas based on judgments of both the feel and look of the garment. Although fit sessions are mainly conducted with live models, patternmakers or designers also use dress forms during product development because they have consistent measurements and are convenient to use. However, apparel professionals consider dress forms as supplementary because they do not accurately represent the shape of a live model [11].

New technology that includes digital virtual human and digital virtual garments has had a significant impact on the current apparel industry. Virtual simulation technology enables the visualisation of a 3D virtual garment on a virtual avatar so that consumers can try on garments with their virtual mannequins before purchasing [12].

Material and methods

The pattern making systems used are developed according to the nation's anatomy where the researches are carried out. In the apparel industry, first the basic patterns must be prepared and after this step model patterns can be acquired by using these basic patterns, which must be prepared accurately in order to obtain a full fit. Therefore the accuracy of basic pattern making systems should be researched. In this study, Contec, Metric, Müller, and Basic Blocks pattern making systems, which are commanly used arround the world, are evaluated. Basic skirt patterns are created in the Gerber AccuMark V8 CAD System according to these four pattern making systems. These skirt patterns are dressed up on virtual mannequins, which have different body shapes in the same size and are created using the 3D virtual sewing and try-on (V-Stitcher) systems. Afterwards the fit is evaluated.

Body measurements of the virtual mannequins are obtained from international standard size charts [13]. The table of normal sizes is used and bust, waist and hip circumference measurements for size 38 are taken from this table. Size 38 is selected due to it is prevalence. These measurements are 88 cm for the bust circumference, 72 cm for the waist circumference and 97 cm for the hip cir-

Table 3. *Colours according to assessment range.*

Assessment range	Colors
Very tight	Red
Tight	Red - Orange
Well	Yellow - Green
Large	Light blue - Yellow
Very large	White

cumference. The skirt patterns are prepared according to these measurements. Measurement ranges are determined for the bust circumference as 86 - 90 cm, for the waist circumference - 70 - 74 cm, and for the hip circumference - 95 - 99 cm according to EN 13402-3: Measurements and Intervals Standard.

The three most common female body shapes are selected as hourglass, rectangle, and triangle in order to evaluate the desired fit. The body measurements of these body shapes are calculated with the help of the study performed by Lee et al [2]. In their study, they developed several formulas, which include bust, waist and hip circumference measurements, to define body shapes. With respect to the measurement ranges discussed above, the mannequins' body measurements are calculated with the help of these formulas. During the calculation process, optimum body measurements are chosen according to the EN 13402-3 standard.

- *The mathematical formula defined for the hourglass category is:*

If (bust-hips) < = 2.56 cm then
If (hips-bust) < 9.22 cm then
If (bust-waist) > = 23.04 cm or (hips-waist)> = 25.6 cm **then shape = "Hourglass"**

- *The mathematical formula defined for the triangle category is:*

If (hips-bust) >= 9.22 cm then
If (hips-waist) < 23.04 cm **then shape = "Triangle"**

- *The mathematical formula defined for the rectangle category is:*

If (hips-bust) < 9.22 cm and (bust-hips) < 9,216 cm then
If (bust-waist) < 23.04 and (hips-waist) < 25.6 cm **then shape = "Rectangle"**

Virtual mannequins are created in a system according to the measurements and body shapes which are shown in ***Table 2***. The skirt patterns are also created virtually according to the four pattern making systems by using 50% Cotton - 50% PES, 252 g/m^2 and twill fabric. The virtual try-on is generated and finally the skirt visuals are procured.

Pressure and tension maps, which are the tools of V-Stitcher, are used to evaluate the fit. The tension map represents the tension level of the stretched fabric based on its physical properties, pattern size and the visual mannequin's size. The

Table 4. *Visuals of skirts according to contec, metric, müller and basic blocks systems for the hourglass body type.*

Pattern making system	General appearance	Visual of skirt's tension	Visual of skirt's pressure
Contec system			
Metric system			
Müller system			
Basic blocks system			

Table 5. *Visuals of skirts according to Contec, Metric, Müller and Basic blocks systems for triangle body type.*

Pattern making system	Visual of skirt	Visual of skirt's tension	Visual of skirt's pressure
Contec system			
Metric system			
Müller system			
Basic blocks system			

Table 6. Visuals of skirts according to Contec, Metric, Müller and Basic blocks systems for rectangle body type.

Pattern making system	Visual of skirt	Visual of skirt's tension	Visual of skirt's pressure
Contec system			
Metric system			
Müller system			
Basic blocks system			

Table 7. General evaluation of hourglass, triangle and rectangle body shapes according to pattern making systems.

Body shape	Evaluation criteria	Contec	Metric	Müller	Basic blocks
Hourglass	Waist line	Large	Well	Very large	Tight
	Hips line	Well		Large	Well
Triangle	Waist line	Large	Large	Very large	
	Hips line		Well	Large	
Rectangle	Waist line	Well		Large	
	Hips line			Tight	

tension map's colours range from white through light blue, green, yellow and orange to red. The tension colour codes represent numeric values in g/cm from 0 (White) to 1000 (Red). The pressure map represents the pressure level exerted by the stretched garment on the body, which depends on the fabric's physical properties, the pattern size and the visual mannequin's size. As on the tension map, the pressure map's colors range from white, through light blue, green, yellow and orange to red. The body pressure colour codes represent numeric values in g/cm^2 from 0 (White) to 100 (Red) [14]. Unfortunately the numeric values of pressure and tension for each color cannot be calculated from the virtual garments due to the disadvantage of V-Stitcher. Alteration in pressure and tension values of the garment is represented only by colours.

In order to evaluate the pressure and tension maps, the five-point likert is used. The assessment range was determined as very tight, tight, well, large and very large. The colours according to the assessment range are shown in ***Table 3***.

Findings

The general appearance, tension and pressure visuals of the skirts are obtained for each pattern making system according to hourglass (***Table 4***), rectangle (***Table 5***) and triangle (***Table 6***) body types.

Conclusions and suggestions

Skirt patterns are generally evaluated for each body shape with respect to the waist and hip lines using V-Stithcer (***Table 7***), the evaluation of which is carried out according to the five-point likert. The assessment ranges are determined as very tight, tight, well, large and very large. The views of the virtual mannequins are analysed for three body shapes using pressure and tension maps. When visuals are evaluated for each pattern making system, different results are obtained for each body shape, although the mannequins in three body shapes are of the same size.

According to the general evaluations of body shapes, it is seen that Contec, Metric, Müller and Basic Blocks Pattern Making Systems can be used for rectangle and hourglass body shapes. Furthermore it is observed that all skirts, which are prepared in four pattern making systems, have fit problems for triangle body shapes. It is possible to say that when the difference between hip and waist circumferences is high, it causes fit problems.

As a result of this study, it can be said that the pattern making systems are not suitable for each body shape. For this reason the pattern making systems should be revised with respect to different body shapes. For instance, the number, location and width of the darts can be calculated according to the difference between hip and waist circumferences in the pattern making systems, which have constant dart widths. Developing alternatives for garment patterns, modeling applications and pattern grading according to different body shapes allows manufacturers to provide fit and satisfaction.

It is very important to find the characteristics of each body shape among races and countries. Body shape comparisons between countries give the opportunity to discover ways of improving the sizing systems of each, as well as impact the development of international sizing standards that could have a significant impact on brands producing products for a variety of international consumers with different sizes and shapes [2]. It can be seen that it is necessary to analyse the target group's body shapes to determine the most appropriate pattern making system.

References

1. Utkun E, Ondogan Z, Tama D. Research on the body sizes of female university students: Turkey Aegean region case study. In: *11th World Textile Conference AUTEX 2011*, France.
2. Lee JY, Istook CL, NamYJ, et al. Comparison of body shape between USA and Korean women. In: *Int. J. of Cloth Science and Tech.* 2007; 19, 5: 374-391.
3. Pisut G, Connell LJ. Fit preferences of female consumers in the USA. *J. of Fashion Markt. and Manage.* 2007; 11, 3: 366-379.
4. Devarajan P. *Validation of 'Female figure identification technique (FFIT) for apparel' methodology*. Department of Textile and Apparel, Technology and Management, North Carolina State University, Raleigh, 2003.
5. Kılıc A. *Development of a new pattern preparation method for skirt and ladies trousers by utilizing anthropometric measurement system.* Department of Textile Engineering, Ege University, İzmir, Turkey, 2011.
6. Singh SP. *Somatoshape and disease. A review, anthropology today: trends, scope and applications. Anthropologist Special Volume* 2007; 3: 251-261.
7. Carter JEL, Heath BH. *Somatotyping – development and applications*. Cambridge University Press, 1990, Transferred to digital printing 2003. http://assets.cambridge.org/97805213/51171/sample/9780521351171ws.pdf.
8. Simmons KP. *Body shape analysis using 3D body scanning technology*. PhD Thesis, Textile Technology and Management, North Carolina State University, Raleigh, 2003.
9. Vuruskan A, Bulgun E. Identification of female body shapes based on numerical evaluations. *Int. J. of Cloth Science and Tech.* 2010; 23, 1: 46-60.
10. Devarajan P, Istook CL. Validation of "Female figure identification technique (FFIT) for apparel" software part 1: describing female shapes. *J. of Text. and Apparel Tech. and Manag.* 2004; 4, 1: 1-23.
11. Song HK, Ashdown SP. An exploratory study of the validity of visual fit assessment from three-dimensional scans. *Clothing & Tex. Res. J.* 2011; 28, 4: 263-278.
12. Lim HS and Istook CL. Comparison of virtual avatars by using automatic and manual method. *J. of the Korean Society of Cloth. and Tex.* 2010; 34: 1968-1979.
13. Istanbul Textile and Apparel Exporter Associations (ITKIB), 2002, Technical Manual Series: Dimensions in Apparel Industry, İstanbul, pp. 24.
14. Browzwear, V-Stitcher product catalog.

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