(REFEREED RESEARCH)

STUDY OF CZECH MALE BODY PROPORTIONS AND EVALUATION OF MEN´S SHIRT PATTERN MAKING METHODS

ÇEK ERKEK VÜCUT ORANLARI VE ERKEK GÖMLEK KALIBI HAZIRLAMA METOTLARI ÜZERİNE BİR ARAŞTIRMA

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Received: 22.07.2014 Accepted: 15.11.2014

ABSTRACT

This study deals with the effect of different male somatotypes on men´s shirt pattern design. First, the research is focused on study the proportions among body dimensions of 200 Czech male (subjects) aged from 18 to 60 years, height; chest and waist that mainly define men clothing sizes. Four men´s shirt pattern making methods; Czech, German, Italian and Chinese were analysed. The results indicate that the shirt patterns are mostly drawn out using a constant value for generating the design dimensions instead of using a regression equation for value calculation. These patternmaking methods are totally inadequate for drafting patterns to fit a wide range of men's bodies (male morphology). To solve this problem, this paper examines a proposal for a pattern making method for a men´s slim fit shirt that uses the results of regression analysis of anthropometric data of the Czech men to match the pattern design parameters.

Keywords: Czech male, Anthropometric data, Pattern making method, Shirt.

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1. INTRODUCTION

One of the most important factors which should be satisfied when designing men's shirt is a fit or adaptation to male body shape of as many consumers as possible. Good fit of manufactured shirt ensures a successful product launch, and the consideration of shirt fit includes research based on anthropometric findings. So, the results of anthropometric measurements of the male human body, conducted on a representative sample form the basis for determining shirt sizes of a certain population.

Especially a shirt fit depends to a relatively high degree on our knowledge of the relationships that exist between body dimensions which give a definition of the standardised shirt size. These relationships are frequently presented in the form of what are known as 'body proportions', when the drop value is set e.g. as a difference between chest girth and waist girth for men in centimetre (1).

For this reason, it is meaningful to deal with an effect of anatomical changes in the body on pattern designs and study the body proportions and to analyse their properties by means of statistical methods (2).

The problem of improper fitting may be due not only to body sizes not matching the range of human bodies in the population appropriately, but also to inappropriate pattern drafting methods (3).

A number of pattern making methods for men´s shirts have been published, each involving formulas in the form of either a set of equations, a set of empirical numerical values or indeterminate curves based on the practical experience of experts. It is not clear whether patterns drafted using these methods would fit a wide range of population.

The specific objectives of the study are as follows:

- to provide a thorough understanding of male body proportions among body dimensions based on statistic analyse of the Czech male anthropometric data,
- to investigate procedure of traditional methods and formulae for men´s shirt patterns drafting,
- to propose an improved shirt pattern making method.

2. MATERIALS AND METHODS

The set of 200 Czech male (subjects) aged from 18 to 60 years formed the basis for study the proportions and to analyse their body dimension properties by means of statistical methods. The research is focused on study the proportions among body dimensions: Height (T_1); Chest girth (T_3) and Waist girth (T_4) were taken in an anthropometrical survey carried out in 2006. Measured population was divided into three age categories and percentage of the measured subjects was determined according to the Czech population structure: 51 subjects aged 18-29; 77 subjects aged 30-44; 72 subjects aged 45-60.

In order to evaluate the appropriateness of the existing shirt patternmaking methods, four methods have been chosen, three European and one Asian.

These methods deal with a classic men´s shirt consisting of a collar, two front pieces, a yoke, a back piece, two long sleeves and cuffs. The evaluation steps of this study focus on analyses of the pattern making methods of the shirt block pattern-body section, as the pattern of the other parts may be derived from this essential part. Figure 1 shows the shape of back, yoke and front part of this shirt block pattern in continuous bold line.

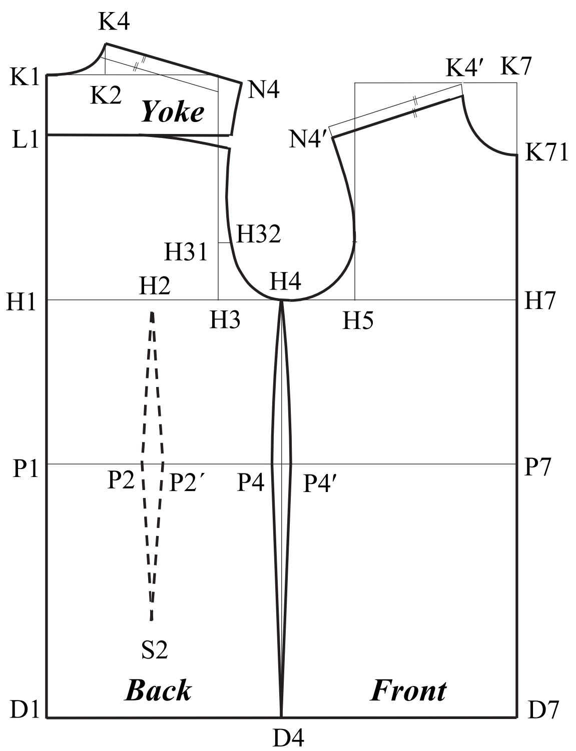

Figure 1. Shirt block pattern-body section: Yoke, Back and Front

3. RESULTS AND DISCUSSION

Statistical analysis of the body measurement data

Considerable research of the body measurement data statistical analysis was carried out with the goal to study relationship between primary body dimensions T_1, T_3, T_4.

The variance among the body dimensions T_1, T_3, T_4 can be analysed from the range of box plots (n=200) is presented in Figure 2.

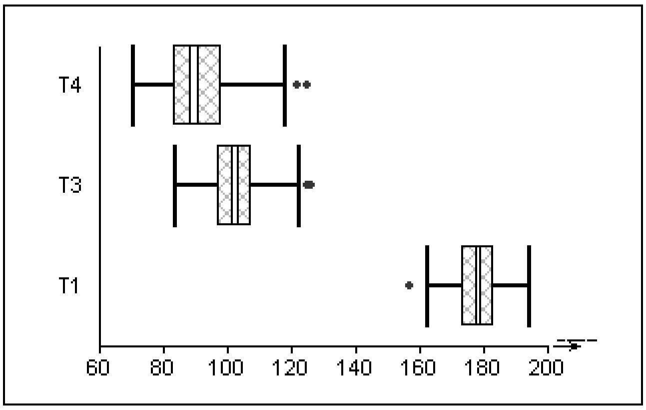

Figure 2. Box plots of body dimensions comparing

Box plots are formed by vertical axis: body dimensions T_1, T_3, T_4 and horizontal axis: value of body dimensions in cm.

Thus the each box plot identifies the middle 50% of the data, median: T_1*=178cm*; T_3*=102cm*; T_4*=89cm*, and the extreme points: T_1*=156cm*; T_3*=125cm*; T_3*=126,1cm*; T_4*=122cm*; T_4*=125cm*. The left and right lines of the box represent the lower quartile is the 25th percentile and the upper quartile is the 75th percentile, while each box shows the minimum values: T_1*=156cm*; T_3*= 84cm* and cm; T_4*=71cm*, and maximum values: T_1*=197cm;* T_3*= 126cm* and cm; T_4*=125cm*, respectively.

Figure 3 represents the mean value of the body dimensions: T_1; T_3 and T_4 in each age category: 18-29; 30-44; 45-60 and 18-60 (entire range), respectively. We can see increasing trend of the amount of girth dimension T_3; T_4, in connection of increasing age, unlike of decreasing trend in case of height.

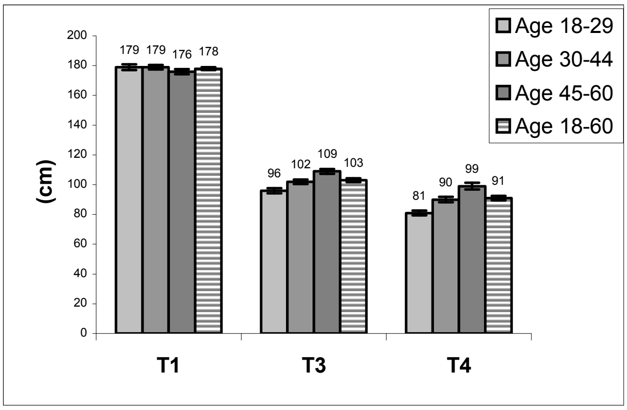

Figure 3. Comparison of body dimension. Results are expressed as mean value ± SE for each dimension, P<0,05

Considering the drop value (difference between chest and waist) we can define Czech male somatotypes. Also the drop value we can use for modification of a pattern construction abscissa of the block pattern design in case of different styles of shirt fit (e.g. Slim Fit, Regular Fit, Relaxed Fit).

Men´s shirt pattern drafting methods evaluation

Four pattern drafting methods for classic men's shirts were investigated in this study including a Czech method (NVS) (4); a German method (Muller & Sohn) (5); an Italian method (Burgo) (6) and a Chinese method (Cham) published in (7).

Although the pattern drafting procedures of these four methods are similar, the pattern parameters are defined using different formulas or table conversions from different body measurements and with different ease allowances.

The aim of this part of the research was to undertake the first step in reviewing the seventeen parameters of the design line segments (see Table 1) that are considered as necessary and sufficient for specifying the pattern geometry of the back piece, yoke and front piece (see Figure 1). Especially, the way they are defined and proposed in these four methods. This nomenclature of the body dimensions required as input design parameters has been used: Height *(T_1);* Neck girth *(T_2);* Chest girth *(T_3);* Waist girth *(T_4);* Nape to waist (back length) *(T_5);* Back width *(T_6);* Shoulder width *(T_7).*

Table 1. Pattern drafting formulas for design line segments determining the back piece, front piece and yoke

Design line segment	Formulas in pattern drafting method			
	Müller & Sohn	NVS	Burgo	Cham
K1H1	$\frac{T_3}{10}$ + 12	$0.1T_1 + 0.15\frac{T_3}{2}$	$\frac{T_1}{8}$ + 2.5	$(\frac{T_2}{8} - 4.5) + (\frac{T_3}{4} - 6)$
K1P1	$\frac{T_1}{4}$	T_5	T_5	From drawing
K1D1	$\frac{T_1}{2}$	Numerical value	Numerical value	Numerical value
H1H3	$\frac{T_3}{5}$ +1	$\frac{T_6}{2}$ + 4.25	$\frac{T_6}{2}$	From drawing
H3H5	$\frac{T_3}{10}$ + 2	$0.25\frac{T_3}{2} + 3.75$	From drawing	From drawing
H1H4	$\overline{H1H3} + \frac{\overline{H3H5}}{2}$	$\overline{H1H3} + \frac{\overline{H3H5}}{2}$	$\frac{T_3}{4}$ +5	$\frac{T_3}{4}$ +4
H5H7	$\frac{T_3}{5}$ - 1	$0.4\frac{T_3}{2} + 2,5$	$\frac{T_6}{2}$ - 1	From drawing
H4H7	$\frac{\overline{H3H5}}{2} + \frac{T_3}{5} - 1$	$\frac{\overline{H3H5}}{2} + 0.4\frac{T_3}{2} + 2.5$	$\frac{T_3}{4}$ +5	$\frac{T_3}{4}$ +4
K1K2	$\frac{T_2}{6}$	$0.2T_2$	$\frac{T_2}{6}$	$\frac{T_2}{8}$ + 2.3
K2K4	Numerical value	$\frac{T_2}{8}$ - 0.5	Numerical value	$\frac{T_2}{8}$ -1
K4N4	From drawing	T_7 + 2.5 + 0,2	From drawing	From drawing
K7K4´	$\frac{T_2}{6}$	$0.2T_2$ - 2	$\frac{T_2}{6}$	$\frac{T_2}{8}$ + 2.3
K7K71	$\frac{T_2}{6}$	$\frac{T_2}{8}$ + 1.5	From drawing	$\frac{T_2}{4}$ - 4.5
H3H31	$\frac{\overline{K1H1}}{4}$	From drawing	$0,5\ (\frac{T_1}{8} + 2.5)$	From drawing
H31H32	Numerical value	From drawing	Numerical value	From drawing
K1L1	Numerical value	Numerical value	Numerical value	$\frac{T_2}{16}$ +2.3
P4P4´	Numerical value	From drawing	Numerical value	Numerical value

Table 1 summarises the different pattern drafting formulas used in the four methods for back, front and yoke panel respectively. In the Műller & Sohn method, there are 12 parameters in the form of regression equations, 4 as numerical values and 1 parameter (from drawing) is determined indirectly from other geometrical pattern parameters. In the NVS method, there are 12 regression equations, 2 numerical values and 3 determined from drawings. In the Burgo method, there are 9 regression equations, 5 numerical values and 3 determined from drawings. In the Cham method, there are 8 regression equations, 2 numerical values and 7 determined from drawings.

The second step in this part of the review was to calculate and evaluate the pattern drafting dimensions of the design line segments in each of these four methods. This enables the calculation and evaluation of the proportions of the design line segment dimensions (see Table 2) in order to predict the fit to the male subjects who have individual body shapes and dimensions (*T_1 =183cm; T_2 = 44cm; T_3 =101cm; T_4 =89cm; T_5 =45cm; T_6 = 41cm; T_7 = 15cm*) which represent the most frequent Czech male somatotypes (drop between chest and waist varying from 10cm to 12cm). These body dimensions were taken in an anthropometrical survey of 200 Czech men carried out in 2006 (8).

In general, therefore, the pattern parameters of the design line segments (see Table 2) that are calculated using these formulas (see Table 1) deviate dramatically in relationship to all other evaluated parameters. Before concluding that the evaluated parameters calculated by these methods do not provide a proper fit to the individual's body shape, one may argue that some of parameters are generated using different formulas with different values for ease allowance and a constant numerical value might cause high deviation.

Table 2. Design line segments as proportions of the back piece, front piece and yoke

Design line segments	Dimensions in cm within pattern drafting methods			
	Müller & Sohn	**NVS**	**Burgo**	**Cham**
K1H1	22.1	25.9	25.4	20.25
K1P1	45.8	45	45	-
K1D1	91.5	85	87	80
H1H3	21.2	24.8	20.5	-
H3H5	12.1	16.4	-	-
H1H4	27.3	33	30.25	29.25
H5H7	19.2	22.7	19.5	-
H4H7	25.3	30.9	30.25	29.25
K1K2	7.3	8.8	7.3	7.8
K2K4	2	5	5	4.5
K4N4	-	17.7	-	-
K7K4´	7.3	6.8	7.3	7.8
K7K71	7.3	7	-	6.5
H3H31	5.25	-	12.6	-
H31H32	1.5	-	1.5	-
K1L1	6	9	8	5
P4P4´	3	-	3	3

The development of an improved patternmaking method for a slim fit shirt

Considerable research has been carried out on developing a novel pattern drafting method for a slim fit shirt to fit a range of body shapes for Czech men. To solve this problem, this paper deals with formulating slim fit shirt pattern formulas using the results of the statistical analyses based on anthropometrical data taken from 200 Czech men that Musilová mentions in (8).

This novel pattern drafting method is defined as necessary and sufficient for specifying the slim fit shirt pattern geometry and drawn out based on pattern parameters calculated using a regression equation of type (1).

$$\overline{ABi} = K_{T1(ABi)} * T_1 + K_{T3(ABi)} * T_3 + K_{T4(ABi)} * T_4 + A_{ABi} + e_i \quad (1)\ (8)$$

Where:

- $\overline{ABi}$ …computed *i*-design dimension [cm]
- T_1 …Height [cm]
- T_3 …Chest girth [cm]
- T_4 …Waist girth [cm]
- $K_{T1(ABi)}$, $K_{T3(ABi)}$, $K_{T4(ABi)}$….reg. coefficients
- A_{ABi}…absolute value [cm]
- e_i…ease allowances [cm]

The distances between the individual design points (see Figure 1) that correspond with the anatomical surface points delimit the design line segments, where A and B correspond to specific design points. Table 3 contains the pattern design algorithms and dimensions of the improved pattern drafting method for men´s slim fit shirt for individual male subjects that have the similar body dimensions as the most frequent Czech male somatotype.

Consequently the templates of the fitted shirts were drawn using the formulas from the experimental improved slim fit shirt pattern method, which include linear distances and curves (see Table 3) using individual male body dimensions. Consequently, five shirts were tailored and test-fitted to five individual male subjects whose body shape and body dimensions correspond to the most frequent somatotypes (drop between chest and waist varying from 10cm to 12cm). All shirts were made of white, 100 % cotton, woven fabric without any elastic textile material. The fitting test results confirmed that the patterns drafted using the improved men´s slim fit shirt patternmaking method provide adequate fit. Figures 4, 5 and 6 shows a fit testing procedure.

Table 3. Pattern design algorithm of the improved men´s slim fit shirt pattern drafting method for design line segments

Design line segment	Formulas	Dimension in cm	Design line segment	Formulas	Dimension in cm
K1H1	$0.125\, T_1 + 0.025 T_3 + 0.05 T_4 - 9.865 + 5$	25	K2K4	$0.125T_2 - 0.5$	5.0
K1P1	$0.25T_1 + 1.275$	47	K4N4	$0.05T_1 + 0.025T_3 + 3.135 + 2.5$	17.3
K1D1	K1P1+ K1H1	72	K7K4´	$0.2T_2\ \ 2$	6.8
H1H3	$\frac{0.25T_3 + 17.7}{2}$	21.4	K7K71	$0.125T_2 + 1.5$	7
H3H5	$0.05T_3 + 0.05T_4 + 2.525 + 2$	14	H3H31	$0.25\, \overline{K1H1}$	6.3
H1H4	$\overline{H1H3} + \frac{\overline{H3H5}}{2}$	28.4	H31H32	$0.05\, \overline{K1H1}$	1.3
H5H7	$0.2T_3 + 1.5$	21.7	K1L1	$0.3\, \overline{K1H1}$	7.5
H4H7	$\frac{\overline{H3H5}}{2} + 0.2T_3 + 1.5$	28.7	P1P4=P4´P7	$0.3T_4$	26.7
K1K2	$0.2\, T_2$	8.8	P2P2´	$0.03T_4$	2.7

Figure 4. The side view

Figure 5. The back view

Figure 6. The front view

4. CONCLUSION

The mean values of the observed body dimensions of test subjects of the Czech male

indicate the changes determined with increasing age. The results of the anthropometric data analyse indicate an increase in chest girth and waist chest girth, unlike of decreasing trend in case of height.

Furthermore, mean value of drop (difference between chest and waist) of test subjects aged 18-29 is 15cm, aged 30-44 is 12cm and aged 45-60 is10cm. The most frequent Czech somatotype has the drop varying from 10cm to 12cm. Therefore this one was chosen as for investigation of four traditional men´s shirt pattern making methods as for testing those improved method for slim fit shirt which is proposed in this paper.

Four men´s shirt pattern making methods; Czech, German, Italian and Chinese were analysed. The pattern templates that were made using the evaluated pattern drafting methods show that these methods would not provide adequate fit to the somatotype subject (customer) and improved pattern drafting formulas are required.

Hence, pattern drafting formulas based on linear regression have been established to determine the design line segments using the results of the statistical analyses based on Czech male anthropometrical data that Musilová mentions in (8). An improved pattern making method was developed and evaluated.

The fitting test results confirmed that the patterns-body section drafted using the improved men´s slim fit shirt pattern method provide adequate fit to randomly selected male subjects (customers) of similar body shape as the observed men´s somatotypes.

Because of the mathematical nature of the formulas in the pattern design algorithm we can use this method in the implementation of the mass customization of shirts.

The presented results provide one of the most important information because they deal with the suitable shirt size.

Problems related to non-fitting shirt for a number of customers could be significantly reduced by effecting of adequate knowledge of proportions among body dimensions of male population in nation and using appropriate paternmaking method.

ACKNOWLEDGMENTS

The authors would like to thank the Faculty of Textile Engineering, Technical University of Liberec for their support and also students: Dominika Glacová and Lucie Mádlová for their Assistance in the Experiment.

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