

## Predicting Garment Appearance Quality from Fundamental Measures of Fabric Tailorability

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**Abstract:** The appearance of a garment is affected by the quality of the fabrics used in its manufacture, as well as a number of factors determined by the technology of the garment manufacturing process. Since fabric quality, as the most important element of garment appearance, is determined by its mechanical properties, it is obvious that these properties directly impact fabric processing properties. It can be seen through various forms of fabric behavior under the loads that occur in sewing. Investigations of the correlations of the stress and fabric behavior are aimed at constructing a method to predict fabric behavior in garment manufacturing processes, as well as to predict the appearance of the garment to be manufactured. The investigation presented here deals with the impact of fabric mechanical properties on the quality of garment appearance, as defined by seam puckering and work-piece flotation. A group of semi-skilled evaluators and experts in the field of garment engineering were evaluating appearance quality. This system of evaluation and comparison of the grades obtained are key factors in the development of the predicting models using the algorithms. It is founded on previous knowledge of correlations among the quality grade of a particular factor of garment appearance quality and the parameters of mechanical properties of the analyzed fabrics, incorporated into the garments. The workings of the method designed result in a prediction of garment appearance quality grade, presented separately for each individual factor of appearance quality defined.

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**Key words:** Textile, garment appearance, quality, subjective estimation, mechanical properties, prediction.

### 1. Introduction:

Garment quality is not determined by the quality of manufacture only, but by a number of other influential factors as well. The most important of them are construction and the quality of the fabrics incorporated in the garments. The garment shaped and manufactured so that it fits the 3D shape of the human body should meet the criteria of appearance quality and comfort in wearing. In the course of

manufacturing, the fabrics from which the garments are made, due to their anisotropic properties, behave in different ways under the loads occurring. Their behavior depends upon their mechanical and physical properties. Formability of the fabrics in particular garments manufacturing processes, and the stability of the newly created form, directly impact garment appearance quality. Additionally, an important role in ensuring the quality of the garment made is played by the additional factors, such as drape, fitting to the anatomical parts of the body, ensuring complete 3D shape and the quality of the appearance of the seams made<sup>1</sup>. These factors cannot be measured, but can easily be evaluated with descriptive grades, visual by nature and subjective. However, descriptive grades present a problem in evaluating garment appearance quality grade, i.e. particular factors and the appearance as a whole, since inconsistencies occur and inability to compare evaluation of

garment appearance quality grade among the manufacturers and among the end-users as well. There are no standards available that could be used as a guide in garment appearance quality evaluation. This is why a subjective method of evaluation is employed, based on experience and set requirements for evaluating appearance quality of particular clothing. Subjective evaluation of quality is widely accepted and its importance respected, since with experience it has become highly sophisticated. However, the problem is that the subjective method, not so easily acceptable from the scientific point of view, does not offer engineering evaluation of garment quality. This is why it is necessary to develop an exact method to obtain an objective evaluation of garment appearance quality. The paper presents a method of predicting garment appearance quality, based on studying the interactions between the parameters of fabric mechanical properties, as measurable values, and garment appearance quality grade, expressed by descriptive subjective grades. The method presented of subjective evaluation of garment appearance quality, aimed at defining elements important for appearance quality. They represent 5 key factors of garment appearance quality, and include proper drape, 3D shape, garment fit, the quality of the seams made and the quality of the garment appearance as a whole. To reach this

goal, the first step included subjective evaluation of garment appearance quality in the course of manufacturing, as well as the additional evaluation based on representation of particular articles of clothing. Parameters of mechanical properties of the fabrics included in the garments were determined for all the garments analyzed using FAST measuring system, and correlations were established among the individual parameters of fabric mechanical properties and garment appearance quality. This correlation is essential, since it constitutes previous knowledge in predicting garment appearance quality.

## 2. Materials and Methods

### 2.1 Models of Ladies' Skirts

Randomly selected models of ladies' skirts (300 different models) were taken for the purpose of investigation. They were launched for the autumn/winter season and partially for the spring/summer. Due to fast-changing fashion trends, and with no sharp boundaries between seasons, the fabrics used in manufacture of the skirts analyzed differ by construction parameters, as well as by their mechanical properties. The parameters of mechanical properties were determined using the FAST measuring system and the FAST – 4testing method<sup>2, 3-7</sup>.

**Table 1. Factors of Garment Appearance Quality**

Criteria Mark	Elements of Garment Appearance Quality	Determination
A	Garment fall and draping	Fall of the front/back part and sleeves, adjustment of different components and materials
B	Assuring 3D shape of a garment	Quality of the form, its spatial characteristics, fullness of the front part, volume adjustment, shoulder and sleeve form
C	Garment fit	Fitting the shoulder to the contour of the body, fitting the front part and collar
D1	Quality of the seams	Seam puckering
D2	Quality of the seams	Seam flotation, shear deformed seam
E	Garment appearance quality as a whole	

### 2.2 The Subjective Evaluation

The factors of garment appearance quality were determined on the basis of the elements for obtaining proper drape, i.e. garment yield, achieving 3D shape, garment fit, the quality of the seams made and the quality of garment appearance as a whole, (Table 1)<sup>8</sup>. Individual factors were subjectively evaluated, so that the appearance quality grade of the factor was evaluated with grades from 1 (low quality) to 5 (excellent), in the course of garment manufacture. The criteria for grading individual factors of garment appearance quality are provided. Each description of the criterion is accompanied with a pictorial representation of the garment manufactured<sup>8</sup>. Each individual factor of garment appearance quality was graded by semi-skilled evaluators. The complexity of the method of subjective evaluation asked for a basis of pictorial representation of the garment evaluated and proper storing of the data for later use. Experts in the field of garment engineering were later on also asked to grade the individual factors of appearance quality. The grades obtained were used to cross check the accuracy of the predicted garment appearance quality.

### 2.3 Attributes and Classes

Parameters of mechanical properties represented the attributes in solving the problem of predicting garment appearance quality, while the individual quality factors were classes. All the attributes were mutually connected. There were six different classes to be predicted (Table 1). As they had five values each, clearly defined but not necessarily equidistant. In practice, we had to choose a discrete manner of work, neglecting the values defined or the common (regression) definition, since we dealt with five different values and the differences among them were not equidistant. Preliminary trials showed that regression was more appropriate for the problem, as it offered more accurate and transparent models<sup>9</sup>. An expert had, on the basis of his previous knowledge, determined attribute characteristics, which were, in his opinion, most important for a particular factor of garment appearance quality. The previous knowledge used included, on one hand, the studies of subjective evaluations of garment appearance quality, and on the other the studies of mechanical properties of the fabrics analysed, augmented by the knowledge of

correlation with the garment appearance quality grade of particular factors, which offered the data on the fabric analyses through the parameters of mechanical properties.

### 3. Results and Discussion

The results of studying the impact of the parameters of fabric mechanical properties on the factors of garment appearance quality are determined using the grades of garment appearance quality factors, as presented by the semi-skilled evaluators and by the experts in the field of garment engineering, regarding the individuals factors of garment appearance quality, as well as using the accuracy grades from the prediction of garment appearance quality.

### 3.1 The Results of Subjective Evaluation of Garment Appearance Quality

The aim of the investigation, i.e. to study the impact of the parameters of fabric mechanical properties on the garment appearance quality grade, and to establish a system for predicting garment appearance quality grade, the first step, after the evaluation of garment appearance quality, included an adequate analysis of the value of the grades, offered by semi-skilled evaluators in the course of manufacture and the grades offered by the experts in garment engineering, based on pictorial representations. The analysis of the correlation between these two evaluations, for particular factors of garment appearance quality, was calculated using the Spearman rank correlation, (Table2).

**Table 2. The Results of the Spearman Coefficient of Rank Correlation Offered by Semi-Skilled Evaluators and Experts**

Elements of Garment Appearance Quality		Spearman's Rank Correlation Coefficient
A	Garment fall and draping	0,930
B	Assuring 3D shape of a garment	0,570
D	Quality of the seams	0,640
E	Garment appearance quality as a whole	0,850

When evaluating on the basis of pictorial representation, the quality of garment fit was not included, since it is almost impossible to grade garment drape and fit on the basis of a pictorial representation only. The analysis of the results of subjective evaluation indicate that when evaluating visually and subjectively, various evaluators expressed different standpoints regarding the pre-determined criteria of quality grad that was evaluated. The analyses performed were then used to compare the accuracy of the prediction of garment appearance quality grade.

### 3.2 The Results of Determining Attribute Characteristics

A data basis, ready to be used, was prepared after the factors of garment appearance quality, of la-

dies' skirts, and determining the parameters of mechanical properties of the fabrics used, employing the FAST measuring system and the FAST - 4 testing method. The fabrics, described by the parameters of their mechanical properties, as well as by grades of garment appearance quality for the garments made from these fabrics. The parameters of fabric mechanical properties were the attributed. The classes to be predicted were applied on the factors of garment appearance quality. An expert in the field of garment engineering had determined the characteristics of the attributed that had, in his opinion, the most outstanding impact on a particular factor of garment appearance quality, (Table3).

**Table 3. Attributes that Impact of Garment Appearance Quality**

Elements of Garment Appearance Quality	Mark of the Element	Mark of the Particular Factor
Garment fall	A	E100-1, E100-2, B-1, B-2, G, W
Shape	B	F-1, F-2, B-1, B-2, W
Fit	C	F-1, F-2, B-2, G
Seam puckering	D1	E100-1, E100-2, G
Seam flotation	D2	B-1, B-2, G
Appearance	E	RS-2, HE-1, F-1, F-2, E100-1,G , W

### 3.3 The Results of Predicting Garment Appearance Quality

The Spearman coefficient of rank correlation (Table 4), was also calculated with the predicted grade values and the grades of particular garment appearance quality factors. All the spearman rank correlations proved to be statistically relevant ( $p=0.01$ ). The analysis of the accuracy of the predicted grades is associated with the comparison of the predicted grades of appearance quality using the grade values obtained in evaluating garment appearance quality grade in the actual manufacturing process. It can be seen that the highest correlation was obtained in predicting garment fit, followed by the

prediction of the appearance quality of the garment as a whole, and the prediction of the drape, i.e. yield of the garment. On the first glance, the results seemed to offer fairly low correlation between the predicted and actual grades, obtained in the course of manufacture. It could be attributed to the fact that the grades predicted by the system were taken as real numbers, rounded to one decimal place, while the grades obtained in manufacture were presented as whole numbers. It means that the values could easily differ at the start by 0.5, eg. that the predicted values of garment appearance quality grade, obtained in the actual manufacturing process.

**Table 4. Spearman Coefficient of Rank Correlation with the Predicted Grade Value of a Garment Appearance Quality Factors**

Elements of Garment Appearance Quality		Spearman's Rang Correlation Coefficient
A	Garment fall and draping	0,560
B	Assuring 3D shape of a garment	0,410
C	Garment fit	0,620
D <sub>1</sub>	Quality of the seams	0,520
D <sub>2</sub>		0,440
E	Garment appearance quality as a whole	0,600

### Conclusion

The method for predicting garment appearance quality came as a result of comprehensive investigations of fabric mechanics, the ability of the fabrics to be transformed from a plane to a 3D form of a garment and stability, e.g. appearance of the newly created form. Analysing the results obtained by investigating appearance quality of the garments tested, employing the properties of the fabrics used in the manufacture of skirts, and the classes are the factors of the quality of the ladies' skirts, we have come to the conclusion that there is a direct correlation between the parameters of fabric mechanical properties and the grade of garment appearance quality reached. A number of parameters of mechanical properties impact each individual factor of garment appearance quality. The

method for predicting garment appearance quality has been determined correlation of the parameters of fabric mechanical properties and the grade of garment appearance quality. The developed method for predicting garment appearance quality grade can be

used in engineering predictions and designing high-quality garments, while at the same time it offers important data on the quality requirements of particular parameters of fabric mechanical properties, necessary to obtain the required garment appearance. It represents a necessary objective technology of measuring and evaluating garment Appearance quality, since the existing conventional methods of subjectively evaluating garment appearance quality should be replaced by a new knowledge-based engineering method.

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