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FABRIC HANDLE AND EFFECT OF FABRIC HANDLE ON DIFFERENT TYPES OF WOVEN AND KNITTED FABRICS. I

МЯГКОСТЬ И ЖЕСТКОСТЬ ТКАНИ И ИХ ВЛИЯНИЕ НА РАЗЛИЧНЫЕ ВИДЫ ТКАНЕЙ И ТРИКОТАЖНЫХ МАТЕРИАЛОВ. I

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The overall effect of change in the fabric structure on mechanical and surface properties of the fabric is quite prominent which in turn have influence on fabric handle and other comfort related properties of the fabric. Twill weave makes the fabric flexible for bending and shearing, improves extensibility and compressibility, reduces hysteresis effect and increases smoothness of the surface. The increase in smoothness, fullness and softness of twill weave fabrics in turn enhances the Total Hand Value of the fabric. Hence, fabric construction can be altered to offset the undesirable handle characteristics by selecting a weave that permits greater yarn mobility.

Известно, что изменения в структуре тканей и трикотажных материалов оказывают большое влияние на механические и поверхностные свойства этих материалов. Эти свойства, в свою очередь, оказывают определяющее влияние на свойства ткани на ощупь, а также на их благоприятные свойства. Саржевые переплетения делают ткань гибкой во время сгиба и при резании, улучшают ее растяжимость, сжимаемость, уменьшают эффект гистеризиса и повышают ее гладкость. Увеличение гладкости, объемности и мягкости саржевых тканей в свою очередь повышает продажную способность материала. Поэтому при проектировании ткани должны учитываться факторы, компенсирующие все нежелательные эффекты, которые приводят к большой подвижности нитей в ткани.

Keywords: handle fabric, construction, comfort.

Ключевые слова: свойства ткани на ощупь, структура ткани, удобство ткани.

1. INTRODUCTION

Clothing comfort, being a fundamental and universal need for consumers, is defined as a pleasant state arising out of physiological, psychological and physical harmony between a human being and the environment [1]. The literature [2] generally classifies clothing comfort into three broad categories:

(a) Aesthetic comfort,

(b) Thermo-physiological comfort,

(c)Tactile comfort.

Aesthetic appeal or psychological comfort is mainly based on subjective feelings and fashion trends that influence customer preferences. On the other hand, Thermophysiological comfort relates to the ability of the fabric to maintain thermal equilibrium between the human body and the environment. Thermal, moisture and air resistance properties of the clothing material collectively contribute to the state of thermophysiological comfort of the wearer. The tactile comfort is related to mechanical interaction between the clothing material and the human body and is an intrinsic and essential performance requirement in clothing. Although the fabric tactile properties have long being evaluated by a subjective method called fabric handle [3], it has been demonstrated in recent years that these are quantifiable in terms of physical measures. Most recently, major upsurge on research on friction of fabrics has taken place, as friction plays an important role on the hand of fabrics [4,5]. Hence, the Hand value together with the measured transport properties will determine the true quality of apparel fabrics.

Fabric end uses can be roughly divided into industrial, household and apparel. Fabrics for industrial uses can be chosen on straightforward performance characteristics such as tensile strength, extension and resistance to environmental attack. However, fabrics intended for clothing have less emphasis placed on their technical specification and more on their appearance and handling characteristics such as lustre, smoothness or roughness, stiffness or limpness and draping qualities. Handling the fabric is one of the ways of assessing certain of these properties. 'Handle', the term given to properties assessed by touch or feel, depends upon subjective assessment of the fabrics by a person. Terms such as smooth, rough, stiff or limp depend strongly on the type of fabric being assessed, for instance the smoothness of a worsted suiting is different in nature from that of cotton sateen. Because of the subjective nature of these properties attempts have been made over the years to devise objective tests to measure some or all of the factors that go to make up handle. Fabric stiffness and drape were some of the earliest properties to be measured objectively.

Identification of materials is not only knowledge of the technical specification, but also sensory evaluation. By touching you get such information you cannot get with other senses, e.g. perception of the surface of the product, its temperature, hardness and roughness. Textiles differ from other technical structures in that it must have sufficient strength and at the same time it has to be flexible, elastic and easy to pleat and shape. Very important criterion when you evaluate textiles in traditional use is that the fabric and the garment are comfortable in aesthetic and in physiological sense.

The comfort sensation of a fabric has multidimensional attributes and is impossible to quantify through a single physical property. In order to find a method for the comfort evaluation of textiles, the concept of fabric hand is commonly used to assess fabrics. Term “fabric handle” or simply “handle” or “hand” is also used. Fabric hand refers to the total sensations experienced when a fabric is touched or manipulated in the fingers. It is a complex parameter and is related to the fabric properties such as flexibility, compressibility, elasticity, resilience, density, surface contour (roughness, smoothness), surface friction and

thermal character. Hand is often the fundamental aspect that determines the success or failure of a textile product. [6]

2. DEFINITION OF HANDLE

In order to describe fabric hand satisfactorily, it must be adequately defined. Very often when attempts to define hand are made, the definition is highly dependent upon the individual investigator's scope of interest.

Peirce (1930) describes hand as being the judgment of the buyer which depends on time, place, seasons, fashions and personal preferences. What human finger sense, on the other hand, depends upon the physical properties of the cloth. Thus, data from physical measurements can provide a basis upon which to exercise judgment. For example, in describing the strength of a fabric, no one relie on personal judgment since numerical data of strength tests gives excellent evaluation of the material.

Schwarz (1939) defines fabric hand to be a property judged as a function of the feel of the material and explains that the sensation of stiffness or limpness, hardness or softness, and roughness or smoothness constitutes hand. He reports on the desirability of physical testing which may analyse and reflect the sensations felt and which can assign numerical values to the measurements of these parameters.

Hoffman and Beste (1951), in a study of fiber properties related to fabric hand, report that fabric hand means the impressions which arise when fabrics are touched, squeezed, rubbed or otherwise handled. The handling of a fabric may be conveyed by visual impressions as well as tactile sensations, so it seems proper to include lustre and covering power in the properties considered.

Thorndike and Varley (1961) studied the frictional property of fabric as related to hand and define hand as being a person's estimation when feeling the cloth between fingers and thumb. Their discussion on subjective judgment of fabric hand is based on the assumption that one of the influenced factors is the static and dynamic coefficient of friction between the cloth surface and the thumb or fingers. Other properties of the material may also be involved such as flexibility and thickness when making such an assessment of cloth quality.

Matsuo et al. (1971) define hand, in general terms, as what man sensorily assesses from the mechanical properties of a fabric. These researchers classify hand terminology by using and defining new terms such as "whole hand", "characterized hand" and "evaluated hand". According to their definitions, the "whole hand" of a fabric is what is sensorily transformed from all the mechanical properties of the fabric. When "whole hand" is judged in values, it is transferred to what is called "evaluated hand" which depends on both functional and aesthetic factors. Evaluated hand may also be influenced by fashion, climate, social status and personal taste. When the "whole hand" of a fabric is compared with that of a standard fabric, attention has to be given to the differences in "whole hand" between the two fabrics. Therefore, the hand of the fabric which is compared with the standard must be characterized by descriptive adjectives and is classified as "characterized hand". They list five mechanical properties, i.e., stretching, shearing, bending, compression, and surface friction as principle parameters to define "basic hand". They assume that to each of the mechanical properties there corresponds a sensitivity which man detects sensorily regardless of the extent of the sensitivity. Therefore, "whole hand" corresponds to the assemblage of the basic mechanical properties.

Kobayashi (1973) has applied information theory to an analysis of fabric hand. He regards hand as a tactile evaluation judged from physical stimuli resulting from mechanical properties. He further suggests that visual factors should also taken into consideration to evaluate the hand on a broader scale.

Kawabata (1975) proposed a conception about hand by the hypotheses that hand of a fabric can be completely expressed by the physical property of a fabric ignoring the important and variable human contribution to the assessment of fabric aesthetics.

2.1 Assessment of Hand

Fabric assessment can be analyzed in 2 particular ways:

a. Subjective assessment
b. Objective assessment

2.1.1 Subjective assessment

Subjective assessment treats fabric hand as a psychological reaction obtained from the sense of touch. Apparently it is a valuable method that has traditionally been used by textile technologists and researchers. Although it is probably the most widely discussed aspect of fabric assessment, it is not so well understood due to the reliance on subjective judgments'. The first attempts of hand evaluation of textiles in an organised and quantitative manner were published as early as 1926 and have continued up to the present time. Extensive studies have been made by Binns (1934) of the subjective assessment of hand, with particular reference to rank correlation between judges from varying technical and sociological backgrounds.

Bogaty et al (1956) have studied subjective harshness of fabric with the understanding that harshness is used to describe hand as a "catch-all" word. A series of whipcord suiting made of wool, mohair, viscose and nylon were assessed by panels in both "single fabric" and "paired" methods against soft-harsh paired words. The results show that the judgment of pairs or the inclusion of a standard for reference has no advantage to discriminate fabric harshness. Instead, the "single fabric" method appears to be as efficient and economical as the other methods.

They suggest that fiber diameter and the length of the fibers projecting from the fabric surface are likely to affect the subjective harshness.

Hoffinan (1965) proposes a psychometric approach to analyzing consumer opinion regarding fabric feel, appearance and aesthetics. This approach, which consists of psychology, mathematics, compute and human ingenuity is claimed to be most effective combination for the measurement of people's opinion. Tools used include paired comparisons, disguised replication, scaling, depth interviewing, semantic differential, factor analysis, and similarity testing and proximity maps. He asserts that application of the psychometric approach will be uniquely effective in hand assessment.

Kawabata (1973) stated his detailed investigation of the subjective nature of fabric hand on Japanese men's winter suits. The research was carried out under the auspices of the Hand Evaluation and Standardisation Committee (HESC) of the Textile Machinery Society of Japan. After a long discussion the team of HESC recognized three attributes, which they termed the primary hand values and to which they give the names Koshi, Numeri and Fukurami. They arranged for twenty experts to assess the three primary hands of 500 samples of winter suiting fabrics and adopting appropriate statistical techniques. The subjective hand value was obtained by dividing the fabric into eleven groups, placed them in order of rank from 10 (giving the strongest impression) to 0 (with no feeling). These numbers were calIed the Primary Hand Value (PHV). Furthermore, they also asked the experts to provide an overall evaluation, and place the fabric in order of preference on a scale of 0 to 5 from unacceptable to excellent. They termed this ranking the Total Hand Value (THV). Subsequently, Kawabata and industrial colleagues extended their investigations to men's summer suitings and to women's fabrics.

2.1.2 Objective assessment

Objective assessment attempts to find the relationships between fabric hand and some physical or mechanical properties of a fabric objectively. It quantitatively describes fabric hand by using translation result from some measured values of relevant attributes of a fabric. Techniques used for objective hand evaluation are by special instruments for measuring properties of fabrics corresponding to hand. Peirce (1930) launched a set of mechanical measurements containing flexible (bending) rigidity, compression and frictional property and extensibility, for the purpose of replacing the human sensation or personal evaluation for fabric hand. His remarkable work was undoubtedly of great importance for the development of fabric objective measurement. Since then fabric objective meas-

urement has been focused mainly on mechanical properties, and its application has been confined largely to handle of fabric.

Winn and Schwarz (1939) used the Schiefer Flexometer and Gurley Stiffness Tester to measured fabric flexibility and drape. The physical parameters included bending length, flexural rigidity, bending modulus, chord length, radius of curvature and stiffness. Winn and Schwarz (l940a) suggest that to compare hand parameter data from various objective test methods or apparatus for the purpose of obtaining an indication of the agreement among them, the statistical technique of rank correlation is useful [7].

3. FACTORS AFFECTING ON THE FABRIC HANDLE

In textiles raw material, yarn structure, planar structure and finishing treatments affect the fabric hand. Properties of yarns and fabric made from them are influenced by the degree of twist in the yarn. In woven and knitted fabrics the woven / knitted fabric type and the yarn stitch densities affect to the fabric hand. By knitting it is not possible to produce so tight fabrics than by weaving. The density of knitted fabric depends on the gauge (needle density) of the knitting machine. Nonwoven fabrics differ from knitted or woven fabrics, because they are not based on yarns. They are based on webs of individual fibres, which can be bonded to each other by several means. The texture ranges from soft to harsh. Finishing is an extremely complex subject because of the large number of changes that occur in fabric properties during a finishing sequence. The effects of many finishing operations are interactive. By using various finishing treatments different kind of end products can be produced from the same unfinished woven or knitted fabric.

3.1 Measurement of fabric properties associated with fabric handle

The concept of measuring physical properties of fabrics and associating them with the handle of fabrics was introduced in 1930 (Peirce 1930). Techniques were developed to measure the stiffness and surface friction of fabrics and these measurements were associated with the handle of fabrics. This early work established the principle that fabric handle is associated with measurable physical properties of fabrics, e.g., how fabrics flex and stretch and their thickness and surface friction properties. Increasingly sophisticated testing equipment has since been developed. The most comprehensive system to date is the Kawabata Evaluation System for Fabrics (KESF), which was developed in the 1980s and involves measuring mechanical and physical properties of fabrics that are associated with subjective handle ratings for men's suiting fabrics (Kawabata 1980*a*, 1980*b*). The KESF consists of multiple instruments that measure individual mechanical and surface properties such as fabric tensile, shear, bending, lateral compression and surface friction properties. Another fabric testing system, Fabric Assurance with Simple Testing (FAST) (Ly *et al*. 1988; Lai *et al*. 2002), was also introduced in the late 1980s, which measured fabric properties and related results to fabric handle and tailor ability and to garment appearance. However, the KESF and FAST are configured for woven fabrics and are not well suited to testing lightweight knitted fabrics used for next-to- skin wear. The KESF is also relatively expensive to acquire and complex to operate (Pan *et al*.1993; Bishop 2003; Pan 2006) [8].

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