2

Subjective assessment of clothing appearance

J F A N

2.1 Introduction

Clothing appearance or aesthetics is one of the most important aspects of clothing quality. Aesthetics is a very complicated subject because what is appealing to one person may not necessarily be regarded as appealing by the next person. It is therefore almost impossible to universally define garment aesthetics. Nevertheless, people do have a reasonably common notion or concept of what is good or bad appearance. With the exception of some deliberate use of 'puckered' or 'wrinkled' surfaces, a nicely smooth and curved garment surface is regarded as desirable.[1] Clothing is often discarded because of an unacceptable deterioration or change in appearance, including loss of shape or fit, surface degradation, colour change, change in handle and pilling.

The evaluation of clothing appearance is critical to product development and quality assurance. Subjective visual assessment is still the industrial norm because of the limitations of the many objective measurement systems. Visual assessments can be carried out on the materials and components of clothing as well as on the overall appearance of the clothing. In this chapter, the suitability and limitations of various subjective testing methods and past research on the related issues are reviewed and discussed.

2.2 Assessment of fabric surface smoothness

2.2.1 Assessment of fabric wrinkle recovery

A large number of techniques and methods exist for assessing fabric wrinkle appearance and recovery.[2] One of the factors which influences clothing appearance is the ability of fabrics to recover from induced wrinkles or to retain a smooth surface appearance after wear and repeated laundering. The method often used in industry to evaluate the wrinkle recovery of a fabric is AATCC Test method 128 'Wrinkle Recovery of Fabrics: Appearance Method'.[3] The principle of the method is to induce wrinkles in the fabric under standard atmospheric conditions in a standard wrinkling device under a predetermined

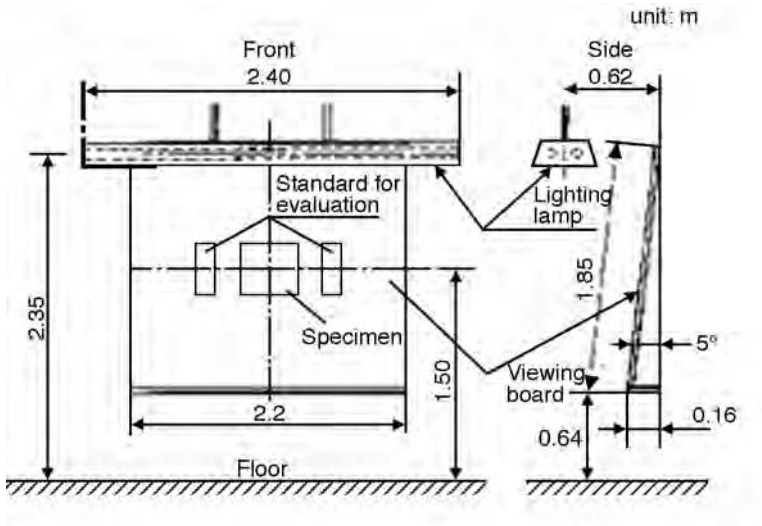


Figure 2.1 Lighting equipment for viewing test specimens. Source: JIS L 1905:2000.[23]

load for a prescribed period of time. The specimen is then reconditioned and rated for appearance by comparing it with three-dimensional reference standards (AATCC Wrinkle Recovery Replica). The viewing condition is shown in Fig. 2.1. At least three trained observers are required to independently rate the degree of wrinkles. The same method has been adopted by the International Organisation for Standardisation[4] and Japanese Industry.

It is generally accepted and experimentally proven that fabric colour and pattern have a significant effect on the perception of wrinkles. Abbott[5] found that a darker fabric will appear less wrinkled than a lighter fabric, as the darker fabric absorbs more light and makes the perception of wrinkles difficult. Salter *et al*.[6] found that the subjective perception of a wrinkle is strongly influenced by the fabric pattern. Check and black-figure fabrics appeared to obscure the extent of wrinkling.

2.2.2 Assessment of pilling propensity

The appearance and aesthetic quality of clothing are also influenced by the fabric propensity to surface fuzzing and pilling. Pills are developed on a fabric surface in four main stages: fuzz formation, entanglement, growth and wear-off.[7] The formation of pills and other related surface changes (e.g. fuzzing) on textile fabrics during garment wear can create an unsightly appearance. This is a particularly serious problem with some synthetic fibres, where the strong synthetic fibres anchor the pills to the fabric surface, not allowing them to fall off as is the case with the weaker natural fibres.

Figure 2.2 View device for pilling assessment.

The pilling resistance of fabrics is normally tested by simulated wear through tumbling, brushing or rubbing on a laboratory testing machine. The specimens are then visually assessed by comparison with visual standards (either actual fabrics or photographs) to determine the degree of pilling on a scale ranging from 5 (no pilling) to 1 (very severe pilling). Figure 2.2 shows a viewing device for pilling assessment. The observers are guided to assess the pilling appearance of a tested specimen on the basis of a combined impression of the density and size of pills and the degree of colour contrast around the pilled areas.

Several test methods (ASTM, ISO, BS and JIS) have been established for the assessment of pilling propensity. They differ in the way the specimens are treated to simulate wear conditions and create a 'pilled' appearance. In ISO 12945-1[8] and BS 5811,[9] specimens are mounted on polyurethane tubes and tumbled randomly, under defined conditions, in a cork-lined box, such as the ICI pilling box (see Fig. 2.3) for an agreed period of time (say 5 hours).

In ASTM D4970[10] and ISO 12945-2,[11] pilling formation during wear is simulated on the Martindale Tester. The face of the test specimen is rubbed, under light pressure for a specific number of movements, against the face of the

Figure 2.3 ICI Pilling Box Tester.

same mounted fabric in the form of a geometric figure, that is, a straight line, which becomes a gradual widening ellipse, until it forms another straight line in the opposite direction and traces the same figure again. Figure 2.4 shows a Martindale Tester.

Figure 2.4 Martindale Tester.

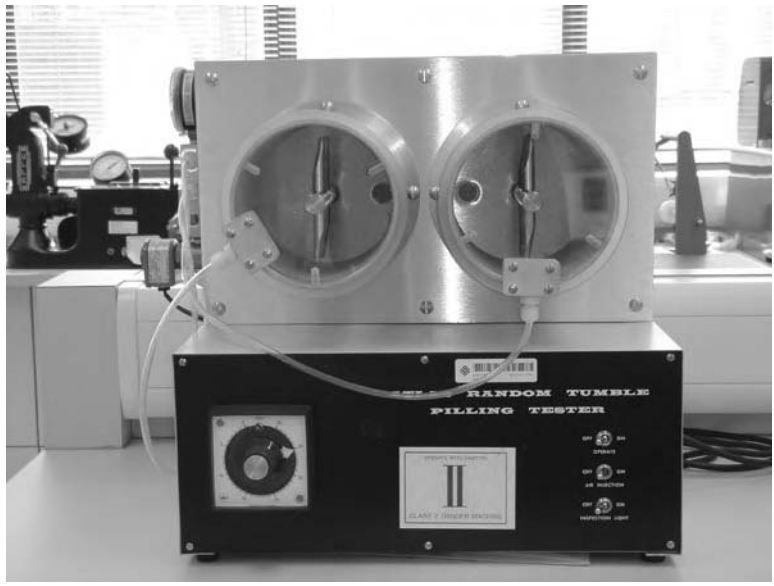


Figure 2.5 Random Tumble Pilling Tester.

In ASTM D3511,[12] D3512[13] and D3514,[14] pilling and other changes in surface appearance which occur in normal wear, are simulated by brushing the specimens to free fibre ends, by random rubbing action produced by tumbling specimens in a cylindrical test chamber lined with mildly abrasive materials, and by controlled rubbing against an elastomeric pad having specifically selected mechanical properties, respectively. Figure 2.5 shows a Random Tumble Pilling Tester. The Japanese standard JIS L1076[15] covers six types of testers, similar to those in the ISO, BS and ASTM standards.

The kind of pilling tester used has a significant effect on the test results. Cooke and Goksoy[16] compared the results of the pilling box, Martindale and Accelerotor testers and found that the Martindale and Accelerotor gave more reliable results, while the results from the pilling box might be misleading. Goktepe[17] investigated the pilling performance of fabrics in the wet state on the Martindale Tester, the ICI pilling box and the pilling drum. He found that use of the Martindale Tester resulted in worse pilling grades than the other two testers, and different pilling testers have different sensitivities for various fibre, yarn and fabric parameters. The chosen tester for the performance evaluation should best simulate the actual wear condition.

The subject of fabric pilling has been reviewed by Ukponmwan.[18]

2.2.3 Surface smoothness after repeated laundering

AATCC Test Method 124[19] is designed for evaluating the appearance, in terms of smoothness, of flat fabric specimens after repeated home laundering. The test

procedure and evaluation method are almost the same as in the two methods mentioned above, except for the difference in specimen preparation and standard replicas.

2.3 Assessment of seam appearance

Visual assessment of seam appearance is conducted by comparing the seams with photographic standards under standard viewing conditions. The American Association of Textile Chemists and Colorists (AATCC), American Society for Testing Materials (ASTM), International Organisation for Standardisation (ISO) and Japan Industrial Standard (JIS) have established respective standards and procedures for visual assessment.

2.3.1 AATCC standard

AATCC Test Method 88B[20] is perhaps the most commonly practised test method in the industry for the assessment of seam appearance. The test method was designed for evaluating the appearance of seams in wash and wear fabrics, but is also applicable to the assessment of seams in both unfinished and finished garments or items.

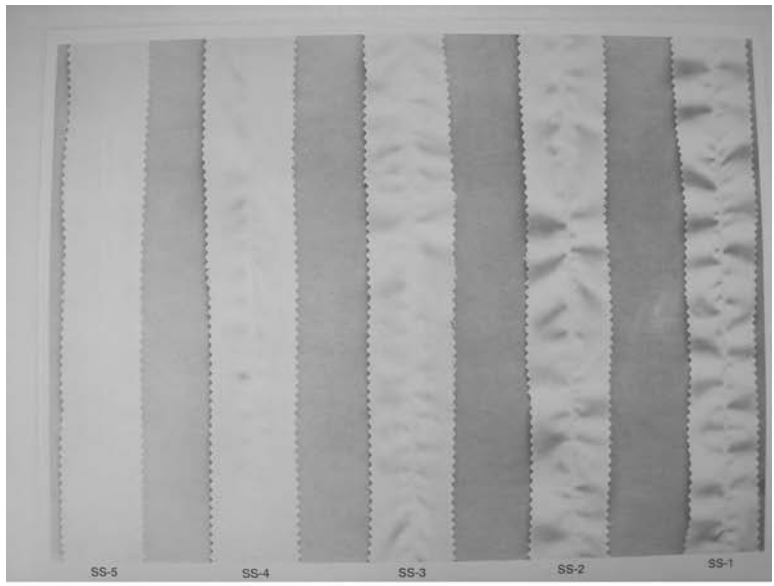
The principle of this test method is to compare the appearance of the specimen seams with the standard photographs, applying the standard overhead lighting procedure. The test specimen is mounted on the viewing board as shown in Fig. 2.1 with the appropriate photographic standard placed alongside. All lights are switched off, except the overhead fluorescent light from two 8 inch F96 CW (Cool-White) preheat rapid start fluorescent lamps. It is also recommended that the side walls of the viewing chamber are painted black, and that black curtains be mounted on either side of the viewing board to eliminate any reflective interference.

Two standard photographic seam smoothness replicas are available, one for single needle seams and one for double needle seams (see Fig. 2.6). The appearance of the seams is graded in five classes.

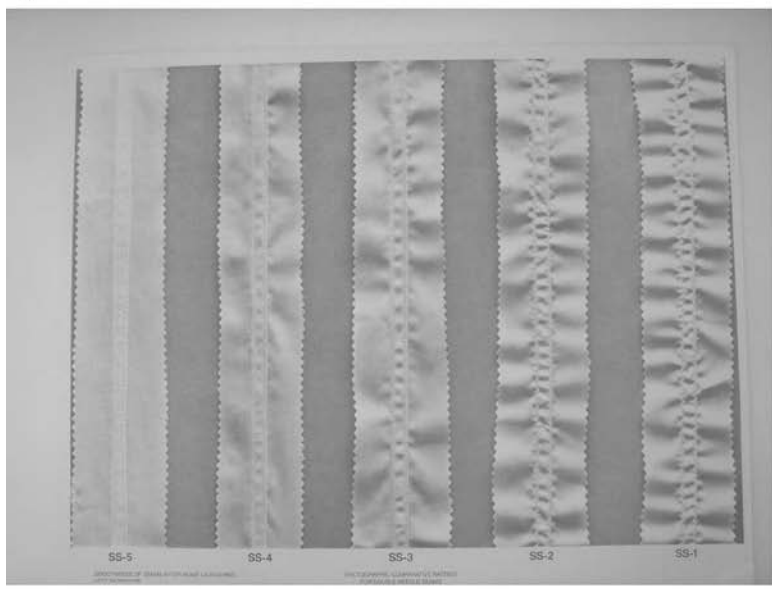
Class 5: Seam appearance equivalent to Standard 5.
Class 4: Seam appearance equivalent to Standard 4.
Class 3: Seam appearance equivalent to Standard 3.
Class 2: Seam appearance equivalent to Standard 2.
Class 1: Seam appearance equivalent to Standard 1.

At least three experienced observers are required, each independently rating at least three test specimens. The average ratings of the observations are reported to the nearest 0.1.

The test specimens could be seamed fabrics, garment parts or finished garments. The samples may be subjected to procedures simulating home



(a)



(b)

Figure 2.6 Photographic Comparative Ratings for Single and Double Needle Seams. Source: AATCC 88B Seam Smoothness Photo Standard. Originally published in the *2001 AATCC Technical Manual*, p.115.[20] Reprinted with permission from AATCC.

laundry practices, e.g. hand or machine washing with appropriate wash cycles, temperatures and drying procedures, so as to evaluate the effect of laundering.[21]

2.3.2 ASTM standard

ASTM D4231-83 (re-approved 1989)[22] provides a standard practice for the evaluation of men's and boys' home launderable woven dress shirts and sports shirts. The standard covers seam failure, shade difference, dimensional change and appearance. With regard to shirt appearance, it extends the method described in AATCC 88B[20] for assessing the appearance of seams, pockets, collars and front plackets, etc. For different parts of garments, it is recommended that users establish appropriate photographic standards. The acceptable level shall be as agreed between the purchaser and supplier.

2.3.3 ISO and JIS standard

JIS L1905[23,24] describes a Japanese Industrial Standard for assessing the appearance of seam pucker in accordance with ISO 7770.[25] The standard is similar to AATCC 88B[20] except that it has a clearer and more detailed description of the testing condition, procedure and rating standard. It defines the viewing board to be at least 1.85 m in length and 1.20 m in width, with the angle of its surface inclined 5^{o} from the vertical and the colour of the surface equal to b_2 of the grey scale. The design of the viewing board is the same as that shown in Fig. 2.1. In assessing garments, however, the viewing board may not be used. Figure 2.7 shows the arrangement for assessing the appearance of garments. The observers should stand 1.2 m away from the garment portion, and the garment portion should be 1.5 m above the floor level (approximately at eye level).

When standard three-dimensional replicas are used for rating, half grades are allowed, but when photographic standards are used, no half grade is allowed. The rating standards are defined in Tables 2.1 and 2.2.

2.3.4 Visual rating standard

The standard three-dimensional replicas or photographic standards may present difficulty in the visual assessment of garment seams, as the seams in the standards may be very different from those in the garments. The garment seams may be curved (e.g. armhole seam) and shaped following the natural drape. The reliability of the visual assessment was found to be a major problem.[26] To circumvent this, visual standards for different garment seams should be established before visual assessment.

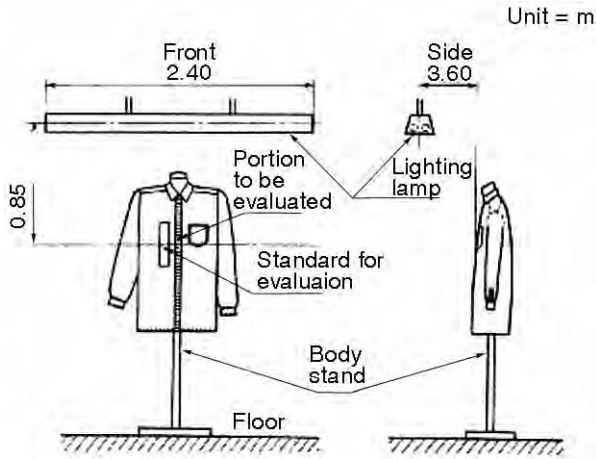


Figure 2.7 Viewing Apparatus for Garments. Source: JIS L 1905:2000.[23]

Table 2.1 Rating standard based on standard three-dimensional replicas

Grade	Rating standard
Grade 5	Appearance showing to be equivalent to, or better than, standard for grade 5
Grade 4.5	Appearance showing to be intermediate between standards for grade 4 and 5
Grade 4	Appearance showing to be equivalent to standard for grade 4
Grade 3.5	Appearance showing to be intermediate between standards for grade 3 and 4
Grade 3	Appearance showing to be equivalent to standard for grade 3
Grade 2.5	Appearance showing to be intermediate between standards for grade 2 and 3
Grade 2	Appearance showing to be equivalent to standard for grade 2
Grade 1.5	Appearance showing to be intermediate between standards for grade 2 and 2
Grade 1	Appearance showing to be equivalent to, or worse than, standard for grade 1

Table 2.2 Rating standard based on photographic standards

Grade	Rating standard
Grade 5	Appearance showing to be equivalent to, or better than, standard for grade 5
Grade 4	Appearance showing to be equivalent to standard for grade 4
Grade 3	Appearance showing to be equivalent to standard for grade 3
Grade 2	Appearance showing to be equivalent to standard for grade 2
Grade 1	Appearance showing to be equivalent to, or worse than, standard for grade 1

Figure 2.8 Grade scale of yoke position. Source: Pang, 2000.[25]

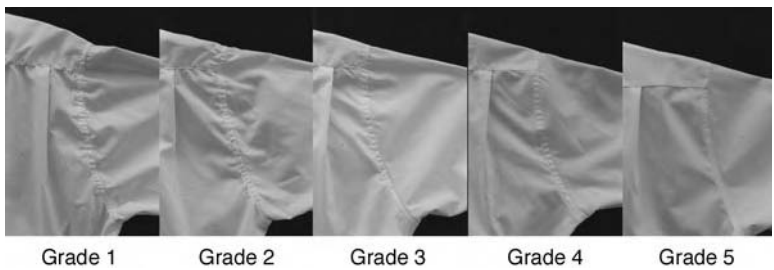


Figure 2.9 Grade scale of armhole position. Source: Pang, 2000.[25]

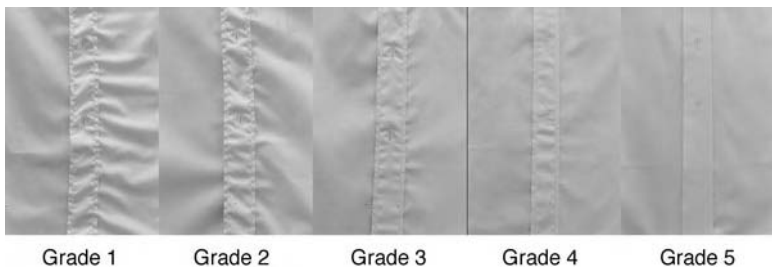


Figure 2.10 Grade scale of buttonhole placket position. Source: Pang, 2000.[25]

Pang[26] established photographic standards of five different garment seams for men's shirts (Yoke seam, armhole seam, buttonhole placket seam, button placket seam and pocket seam) with reference to the photographic standards in AATCC 88B[20] and the ASTM D4231-83.[22] Ten experienced judges were invited to choose a seam from a pool of seams to represent Grades five, four, three, two and one, respectively. The seam that most of the judges ranked as Grade 5 was taken as the Grade five standard. The same procedure was applied to determine Grades 4, 3, 2 and 1. The photographic standards for the seams are shown in Figs 2.8 to 2.12.

2.4 Assessment of crease retention

To maintain good garment appearance, the pressed-in creases in garments (especially in trousers) should be retained after repeated home laundering.

AATCC Test Method 88C[27] is designed for evaluating the quality of crease retention in the fabric. The principle of the method is to subject creased fabric

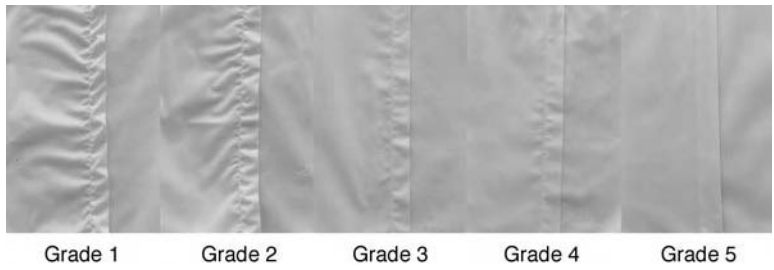


Figure 2.11 Grade scale of button placket position. Source: Pang, 2000.[25]

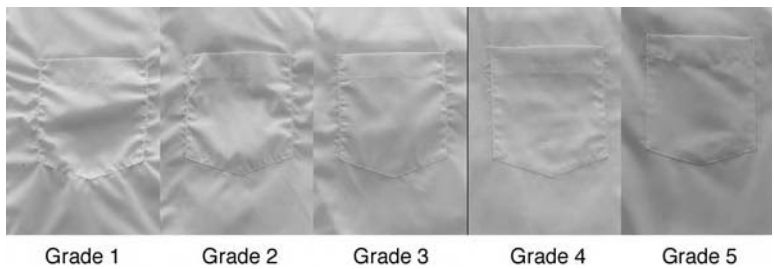


Figure 2.12 Grade scale of pocket position. Source: Pang, 2000.[25]

specimens to standard home laundering practices and then rate the appearance of specimens in comparison with appropriate reference standards under a standard lighting and viewing area.[21] A choice is provided of hand or machine washing, alternative machine wash cycles and temperatures, and alternative drying procedures. Three representative fabric specimens (38 × 38 cm) cut parallel to the fabric length and width, are prepared, pressed and rated, respectively. The AATCC crease retention replicas are in five grades. The viewing condition is the same as that shown in Fig. 2.1.

2.5 Assessment of appearance retention of finished garments

Garment appearance may deteriorate due to poor fabric dimensional stability and pressing performance, poor workmanship during garment manufacture and unfavourable conditions during transport. This problem is especially acute for wool garments. Consequently, the International Wool Secretariat, Japanese branch[28] proposed a test method for assessing the appearance retention of men's suits after final pressing and prior to sale.

The principle of the test is to expose garments to certain temperature and humidity conditions for a period of time and then to check the changes in appearance afterwards. During testing, garments are firstly hung in a testing room at 20ºC and 65% RH (standard temperature and humidity conditions) for 24 hours,

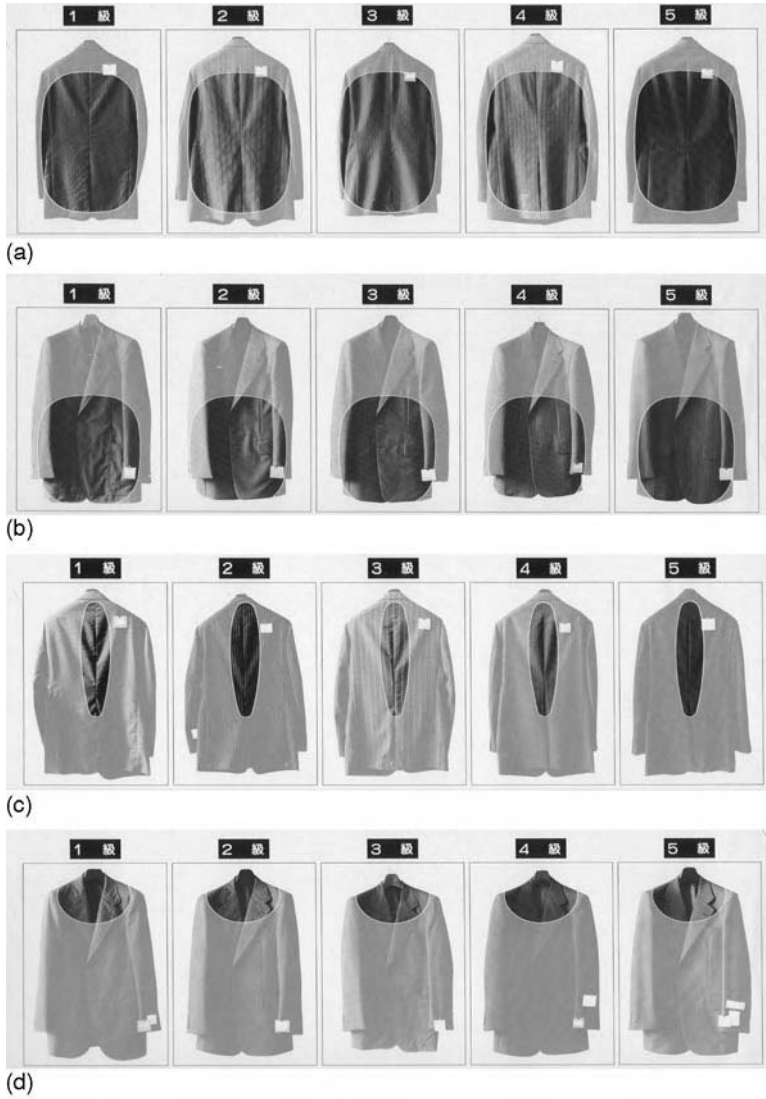


Figure 2.13 Rating Scale for the Appearance of Wool Suits. Source: Mitsuo Hori, IWS Ichinomiya Technical Centre, 1 May 1984.

after which the appearance of each garment part, e.g. collar, shoulder, front, back, side body and sleeve, is inspected and rated according to the photographic standards (Fig. 2.13 shows an example of the standards). The temperature and humidity of the testing room are then changed to 30ºC and 90% RH (high temperature and high humidity) or 20ºC and 40% RH (standard temperature and low humidity) for a period of time (normally 6 hours). Thereafter, the conditions of the testing room are changed back to the standard conditions of 20ºC and 65%

Figure 2.13 Continued.

RH, where the garments are hung for at least 24 hours before being inspected and rated again using the photographic standards. If any part of a garment is rated grade 3 or less (grade 5 = no deterioration, grade 1 = severe deterioration), the garment is considered as unacceptable in terms of appearance retention.

2.6 Reliability of subjective assessment

In carrying out subjective assessments, Slater[29] pointed out that the results may be influenced by many factors outside the control of the person doing the experiment. The subject's personality, state of mind or health, and internal assessment scaling may affect the results in a totally unpredictable manner. It is also crucial to avoid any invalid analysis techniques. To ensure the maximum reliability of the subjective assessment results, the quality of the assessors, the assessment procedure, assessment scaling as well as analysis methods should be considered very carefully.

2.6.1 Training of assessors

The assessors doing the subjective assessment may have different internal assessment scales to rate an observation. Therefore the training of the assessors is very important so as to bring each member of the panel as near to an identical scale as possible.

According to Park and Lee,[30] well-trained expert assessors can give more reliable grading of the seam appearance. Yick *et al.*,[31] in their study of the handle of men's shirting fabrics, compared two groups of assessors, one consisted of members with less experience and the other with more experience. They found that the results from the more experienced group were more consistent. In the AATCC Technical Manual, it is therefore stated that the assessors should be trained well enough to rate the test specimen independently.

2.6.2 Number of assessors in subjective assessment

Increasing the number of assessors can generally improve the validity of the average rating by cancelling out any individual differences in terms of health, state of mind, etc. However, it has been pointed out[32] that, beyond a certain point, it is impossible to increase the reliability of assessment further by increasing the number of assessors. The reliability of the average rating can be evaluated by calculating the 95% confidence interval of the average rating.[33] Three independent assessors are required in terms of the AATCC standards.

2.6.3 Assessment procedure

The assessors may be biased in trying to give what they perceive to be 'appropriate' results or, in the worst case, may deliberately sabotage the experiment. To prevent this problem, blind testing was applied in the evaluation of tactile sensation.[34] Blind testing is obviously not possible for the assessment of garment appearance, although the principle can be applied. It is advisable that the assessors are not aware of the purpose of the assessment and therefore do not appreciate what effect a response will have on the investigation.

2.6.4 Assessment scale and rating technique

The scale for subjective assessment should be devised carefully. Ideally, the intervals between the grades should be equidistant. If possible, objective confirmation of the uniformity of the intervals is useful in ensuring the validity of the scale.

Due to the uncertainty in deriving a valid scale and whether all assessors follow the same scaling during the assessment, several other rating techniques have been developed. The simplest, perhaps, is that of asking for a 'yes' or 'no' answer to a question.[29] The next simplest one is rank ordering. In this technique, each respondent is asked to rate a number of test specimens, in order, from best

to worst, according to the property being assessed. A points system is used (1 for best, 2 for the next, and so on). If an assessor is unable to differentiate between two or more specimens, they can be given the mean rating for those which they declared equal. Once all the specimens have been ranked by all the observers, the specimen with the lowest number of total points is then rated 'best'. This technique was used by Fan and Leeuwner[35] to assess the seam appearance.

Another technique aimed at reducing the bias caused by the problem of scaling is paired comparison assessment. With this technique, a pair of specimens is compared in each assessment. The 'better' specimen of the pair is given a value of 1 and the other a value of 0. Once all possible pairs of specimens have been compared, the sum of all 1 and 0 values for each specimen is calculated, and all the samples are then ranked according to the sum of these totals from all the assessors. This technique was used by Thompson and Whiteley[36] to assess the lightness and yellowness of wool samples and by Ukponmwan[18] to compare the handle of a range of fabrics. Fan *et al*.[37] used the technique to assess the effect of garment size on the perception of body size.

2.7 References

1. Fan J, 'Assessing the quality of garment appearance', *J Asia Text Apparel*, Jun/Jul, 1998 88–90, also *China Text Apparel*, (Aug./Sept.) 1998 84–85.
2. Smuts S, 'A review of the wrinkling of wool and wool/polyester fabrics', *South African Wool & Text Res Inst CSIR TexReport No. 1*, July, 1989.
3. AATCC 128, *Wrinkle Recovery of Fabrics: Appearance Method,* American Association of Textile Chemists & Colorists, 1999.
4. ISO 9867, *Textiles – Evaluation of the Wrinkle Recovery of Fabrics – Appearance Method*, International Organisation for Standardisation, 1991.
5. Abbott N J, 'Wrinkled fabrics, optical illusions and the FRL topometer' *Text Res J*, 1970 **40**(11) 1026–1034.
6. Salter C J, Stephens L G, Higgerson G J and Samuelsdorff M J, 'The perception of wrinkling – the effects of fabric pattern', *J Text Inst*, 1996 **87**(1) 166–171.
7. Cooke W D, 'Pilling attrition and fatigue', *Text Res J*, 1985 **55**(7) 409–414.
8. ISO 12945-1, *Textiles – Determination of Fabric Propensity to Surface Fuzzing and to Pilling – Part 1: Pilling Box Method*, International Organisation for Standardisation, 2000.
9. BS 5811, *Method for Determination of the Resistance to Pilling and Changes of Appearance of Fabrics*, BSI, 1986.
10. ASTM D4970, *Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Martindale Tester*, ASTM International, 2002.
11. ISO 12945-2, *Textiles – Determination of Fabric Propensity to Surface Fuzzing and to Pilling – Part 2: Modified Martindale Method*, International Organisation for Standardisation, 2000.
12. ASTM D3511, *Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester*, ASTM International, 2002.
13. ASTM D3512, *Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Pilling Tester*, ASTM

International, 2002.
14. ASTM D3514, *Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Elastomeric Pad Tester*, ASTM International, 2002.
15. JIS L1076, *Testing Methods for Pilling of Woven Fabrics and Knitted Fabrics*, Japanese Standards Association, 1992.
16. Cooke W D and Goksoy M, 'Problem of predicting pilling performance using laboratory test method', *Mell Textilber, Eng. Ed.* 1988 **69**(4) 250–254 (E134–135).
17. Goktepe O, 'Fabric pilling performance and sensitivity of several testers', *Text Res J*, 2002 **72**(7) 625–630.
18. Ukponmwan J O, 'Appraisal of woven fabric performance', *Text Res J*, 1987 **57**(8) 445–462.
19. AATCC 124, *Appearance of Fabrics after Repeated Home Laundering*, American Association of Textile Chemists & Colorists, 2001.
20. AATCC 88B, *Smoothness of Seams in Fabrics after Repeated Home Laundering*, AATCC Technical Manual, 2001.
21. AATCC 143 *Appearance of Apparel and Other Textile End Products after Repeated Home Laundering*, American Association of Textile Chemists & Colorists, 1996.
22. ASTM D4231, *Standard Practice for Evaluation of Men's and Boys' Home Launderable Woven Dress Shirts and Sport Shirts*, ASTM International, 1989.
23. JIS L1905, *Methods for Assessing the Appearance of Seam Pucker on Textiles*, Japanese Standards Association, 1994.
24. JIS L1905, *Methods for Assessing the Appearance of Seam Pucker on Textiles*, Japanese Standards Association, 2000.
25. ISO 7770 *Textiles – Method for Assessing the Appearance of Seams in Durable Press Products after Domestic Washing and Drying*, International Organisation for Standardisation, 1985.
26. Pang Y T, *A Study on the Evaluation of Seam Pucker in Garments*, MA Dissertation, The Hong Kong Polytechnic University, 2000.
27. AATCC 88C, *Retention of Creases in Fabrics after Repeated Home Laundering*, American Association of Textile Chemists & Colorists, 2001.
28. IWS Japan 'Shape retention test method, clothing service information No. 10', International Wool Secretariat (Aug., 1978).
29. Slater K, 'Subjective textile testing', *J Text Inst*, 1997 **88** Part 1(2) 79–91.
30. Park C K and Lee D H, 'A new evaluation of seam pucker and its application', *Int J Cloth Sci Technol*, 1997 **9**(3) 252–255.
31. Yick K L, Cheng K P S and How Y L, 'Subjective and objective evaluation of men's shirting fabric', *Int J Cloth Sci Technol*, 1995 **7**(4) 17–29.
32. Tezer L, Luning R and Bohland K H, 'Evaluation of carpet surfaces by means of image analysis', *Chemiefasern/Textilindustrie*, 1994 **44/96**(3) 153–156 (E12–13).
33. Fan J and Liu F, 'Objective evaluation of garment seams using 3-D laser scanning technology', *Text Res J*, 2000 **70**(11), 1025–1030.
34. Sweeney M M and Branson D H, 'Sensorial Comfort. I. A psychophysical method for assessing moisture sensation in clothing', *Text Res J*, 1990 **60**(7) 371–377.
35. Fan J and Leeuwner W, 'The performance of sewing threads with respect to seam appearance', *J Text Inst*, 1998 **89** Part 1(1) 124–154.
36. Thompson B and Whiteley K J, 'Visual perception of the colour of scoured wool', *J Text Inst*, 1986 **77**(4) 284–287.
37. Fan J, Newton E, Lau L and Liu F, 'Garment sizes in perception of body size', *Percept Motor Skill*, 2003 **96** 875–882.