3
Subjective assessment of clothing fit

W   Y U

3.1   Definition of fit

Clothing fit has long been regarded as the single most important element to customers in clothing appearance. The principles of fit are, however, not clearly understood, and the definitions of fit vary from time to time, and depend on the fashion culture, industrial norm and individual perception of fit. Some general definitions are introduced here for basic reference purposes:

> 'Fit is directly related to the anatomy of the human body and most of the fitting problems are created by the bulges of the human body' – Cain.[1]

> Clothing that fits well, conforms to the human body and has adequate ease of movement, has no wrinkles and has been cut and manipulated in such a way that it appears to be part of the wearer' – Chamber and Wiley.[2]

> 'Fit is defined as a combination of five factors; ease, line, grain, balance and set' – Erwin and Kinchen.[3]

> 'Clothing fit is a complex property which is affected by fashion, style and many other factors' – Efrat.[4]

> 'Clothing should fit the body smoothly with enough room to move easily and be free from wrinkles' – Hackler.[5]

> 'Clothing which fits, provides a neat and smooth appearance and will allow maximum comfort and mobility for the wearer' – Shen and Huck.[6]

> '[Fit is defined as] the ability to be the right shape and size' – *The Oxford Dictionary*.[7]

These divergent definitions of fit reflect the lack of agreement within the industry on the features which are responsible for a good fit. Therefore, a more detailed understanding of the factors contributing to clothing fit is necessary.
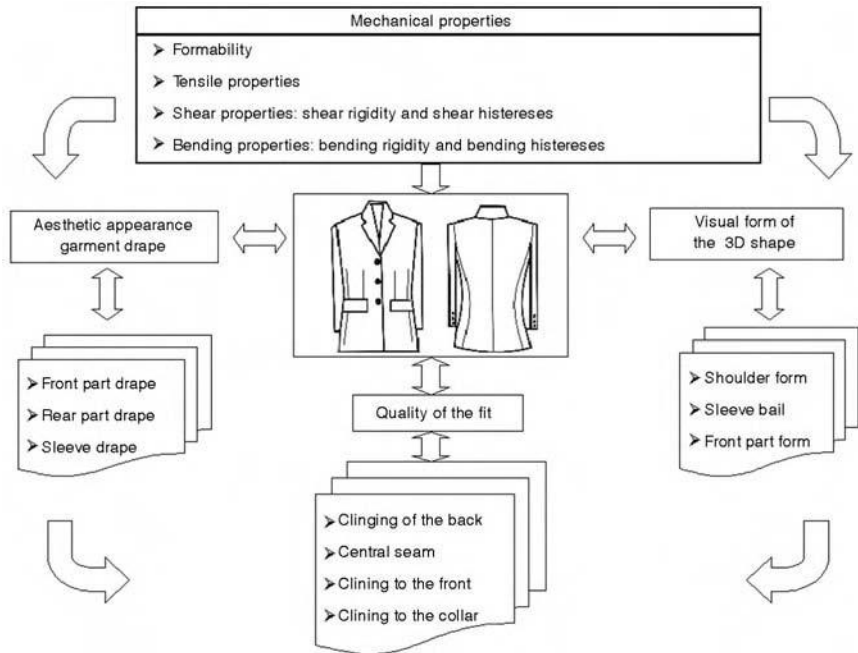
Figure 3.1 Criteria for qualitative evaluation of clothing fit. Source: J Geršak, 2002.[10]

3.2   Influences on clothing fit

Physical comfort, psychological comfort and appearance all play a part in the consumer's perceived satisfaction of fit.[8] Ashdown[9] noted several factors impacting on decisions to understand fit within the research framework. Geršak[10] illustrated the elements determining the quality of clothing fit, which are directly linked to the mechanical properties of fabric which affect the aesthetic drape and 3-D shape, as shown in Fig. 3.1.

Understanding fit from a consumer's perspective is complex. LaBat and DeLong[11] suggested two external influences (social message of the ideal body and fashion figure in the industry) impacting and two personal influences (body cathexis and physical dimensional fit of clothing) impacting on the consumer's satisfaction with clothing fit.

3.2.1   Social message of the ideal body

The satisfaction of fit is affected by a societal message concerning the ideal body. The balance of body proportion and symmetry of body segments are all important. For example, Armstrong defined a lady's ideal figure as one where the shoulder width equals the hip width, with the waist (measurement) girth 10 to 12.5 inches smaller than that of the bust and hip.[12]

3.2.2   Fashion figure in the industry

The fashion industry's portrayal of an idealised figure, for example taller and slimmer in proper proportion and balance, is always presented through fashion illustrations, photography and catwalk models. Wacoal has compiled several indices of beauty based on their research findings: 'Golden Proportions' (1955); 'Beautiful Proportions' (1979); and 'Golden Canon' (1995).[13]

3.2.3   Body cathexis

Body cathexis is defined as positive and negative feelings toward one's body. Various scales evaluating body cathexis have been used to examine attitudes toward the body. Secord and Jourard's original body cathexis scale[14] consisted of 46 physical characteristics used to measure satisfaction and dissatisfaction on a seven-point Likert scale. LaBat and DeLong[11] selected a scale developed by Rosen and Ross[15] to measure body cathexis on a nine-point Likert scale. Hwang[16] studied the relationship between body cathexis, clothing benefits sought and clothing behaviour for 19 body parts.

   Wenger[17] and Frederick[18] have examined the fit preferences from a consumer's viewpoint. They revealed that women who were satisfied with a particular body part preferred a definite fit at that area. The overweight group reported much less satisfaction with their bodies and the fit of their clothing. An understanding of the fit preferences of consumers allows designers better to define fit for individuals and target markets.[19]

3.2.4   Physical dimension fit of clothing

The physical dimension of clothing is a key element of fit evaluation in numeric form. The clothing size can also significantly affect customer satisfaction. The next section will describe, in detail, various methods of testing fit.

3.3   Testing methods for dimensional fit

To verify whether a garment fits the dimensional specifications, it can be tested by using different standards, such as live models and dress forms. Advantages and disadvantages of these different standards are listed in Table 3.1.

3.3.1   Live models

Live models, although expensive, are commonly used for evaluating clothing fit because real human bodies are involved and their comments on the clothing are sensible. However, they tend to make judgements based on subjective and qualitative preferences, which vary from one person to another and from time to

Table 3.1 Advantages and disadvantages of fitting standards

Fitting standard	Advantage	Disadvantage
Live model	Real body shape	Subjective and qualitative
	Real movement	Psychological interruption
Dress form	Static and convenient to use	Subjective and qualitative
	High repeatability	Personal assessment of tension

time. Moreover, the way in which the live models are selected and how the fit is defined and evaluated, could affect the results significantly.

Several studies examined the fit satisfaction of consumers and their perception of fit of various clothing items at specific areas. However, due to the complexities involved, studies based on live models were confined to a limited sample size.

In order to standardise the fit scenario, reference procedures have been developed to perform the subjective evaluation of clothing that fits a live model. Huck *et al*,[20] who evaluated protective overalls, asked each subject to complete an exercise routine, consisting of a series of body movements which represented the physical movements, as defined in Table 3.2, which might be required in a work environment where the garments under investigation are worn and stretched. The researchers recorded their visual observations of the movements of the subjects, and each subject was asked to complete a wearer acceptability scale after completing the exercise protocol.

Table 3.2 Exercise protocol

Exercise order	Procedure
1	Kneel on left knee, kneel on both knees, kneel on right knee, stand. Repeat exercise four times.
2	Duck squat, pivot right, pivot left, stand. Repeat exercise four times.
3	Stand erect. With arms at sides, bend body to left and return, bend body forward and return, bend body to right, and return. Repeat exercise four times.
4	Stand erect. Extend arms overhead in the lateral direction, then bend elbows. Repeat exercise four times. Extend arms overhead in the frontal direction, then bend elbows. Repeat exercise a total of four times.
5	Stand erect. Extend arms perpendicular to sides of torso. Twist torso left and return, twist torso right and return. Repeat exercise four times.
6	Stand erect. Reach arms across chest completely to opposite sides. Repeat exercise a total of three times.
7	Walk a distance of 100 yds (91m) (or walk on the spot for at least 3 min).
8	Crawl on hands and knees for a distance of 20 ft (6 m) (or crawl on the same spot for a minimum duration of 1 min).

Source: ASTM F1154-99a 'Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical-Protective Suit Ensembles'.

The National Association of Hosiery Manufacturers (NAHM) Standard also describes a live model testing procedure for women's pantyhose.[21] It suggests that the models do standing, sitting and walking exercises. The clothing of each model is then evaluated for reasonable tension, tendency to slide down and to wrinkle. Merchandise testing Labs (MTL) suggested live models should wear the clothing for a reasonably long period and rank preferences relative to good/poor fit.[22]

3.3.2   Dress form

Fashion designers and pattern makers must have their customers' specified dress forms which represent the average size and shape of the target market. They may develop the silhouette on the dress form by direct fabric draping, or fit the prototype on the dress form for evaluation. As dress form is very important to ensure the fit of the clothing, its quality is always of concern both to industrialists and academics. However, commercial dress standards are still unsatisfactory due to their limitations in terms of size and shape accuracy. Companies tend to make their own dress forms which represent the body figures of their target customers.

Cascini *et al*.[23] has patented a range of mannequins, FORMAX®, based on all body conformations extracted from anthropometrical statistics obtained from a low-cost body shape silhouetter 'ScanFit system'. CAD Modeling is a company providing a complete set of such mannequins representing realistic models for the target population to which the garments are dedicated.[24]

Based on research on 3-D human morphology and garment engineering, Alvanon[25] sells tailor-made dress forms and a platform for objective and subjective assessment of a garment's fit, so as to reduce sample making costs, raise efficiency in production and increase accuracy of fit.

The Digital Human Laboratory[26] in Japan, in collaboration with the Bunka Fashion College, has since 1996 developed a series of new dress forms (Fig. 3.2a) which looks more real than the conventional dress form (Fig. 3.2b). The conventional dress form is handmade from clay, hence its shape is artificial. The new dress form represents the average dimensions of the target population measured by an optical 3-D body scanner, and the 3-D data were modelled using about 500 data points which are defined and based on anatomical landmarks (Fig. 3.3). The average form was calculated using an FFD technique, and was manufactured by rapid prototyping. A dress form is made by modifying the average form by reducing the unnecessary curves, but is still very close to the actual human body shape. Bunka Fashion College started selling the new dressmaking dummies from September 2000. A Japanese company Taninaka[27] also provides information on the web, but now refuses to sell the dummy overseas (Fig. 3.4).
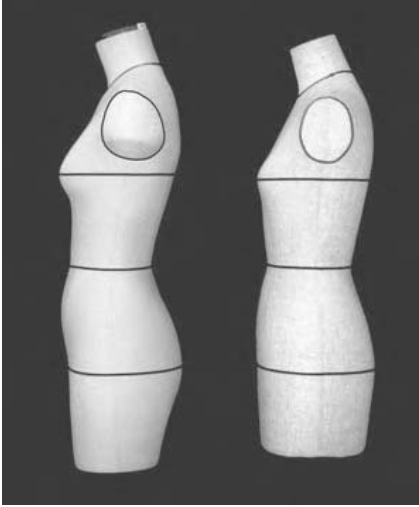
Figure 3.2 Difference between the (a) new and (b) conventional dress form. Source: Makiko Kouchi, Masaaki Mochimaru and Yumiko Ito, 2001: Development of a new dressmaking dummy based on a 3-D human model. Proceedings of Numerisation 3-D Scanning 2001.

Figure 3.3 Digital human body model based on anatomical landmarks. Source: Makiko Kouchi, Masaaki Mochimaru and Yumiko Ito, 2001: Development of a new dressmaking dummy based on a 3-D human model. Proceedings of Numerisation 3-D Scanning 2001.
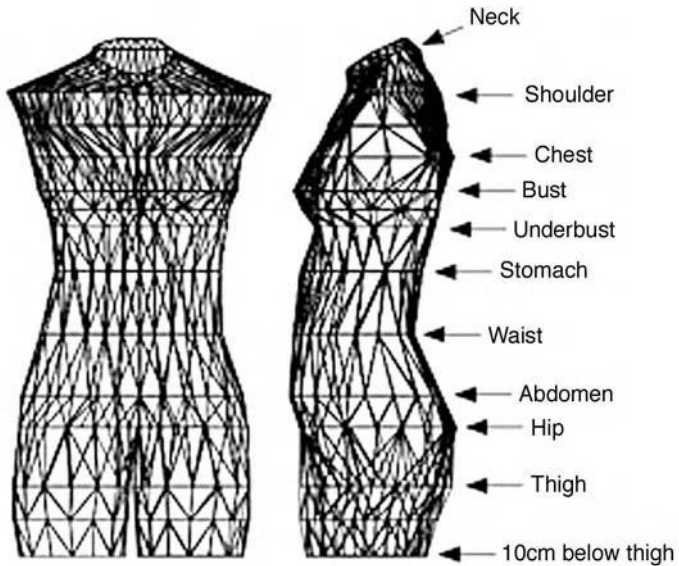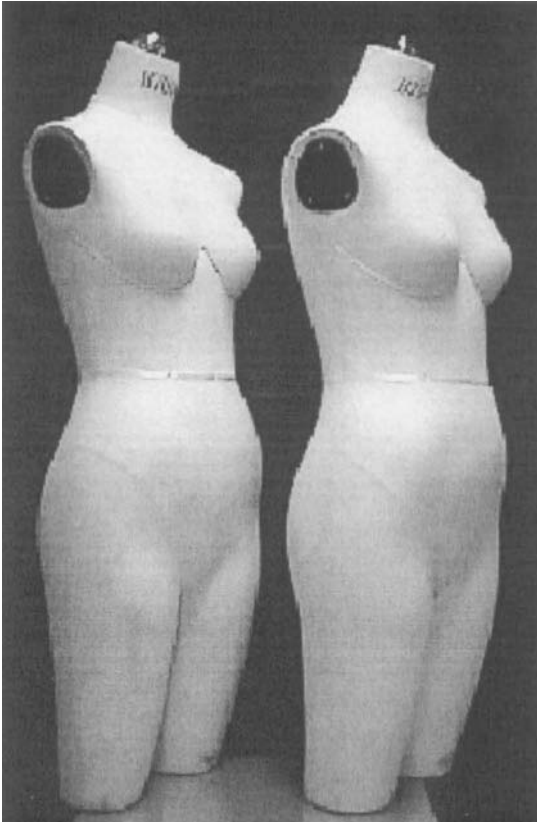
Figure 3.4 Taninaka's Dress stand. Source: http://www2.nsknet.or.jp/~taninaka/main-page.html

3.4   Subject rating scales

3.4.1   Likert type scale

Likert scaling[28] presents a set of attitude statements. Subjects are asked to express agreement or disagreement on a five-point scale. Each point of agreement is given a numerical value from one to five. Thus a total numerical value can be calculated from all the responses.

3.4.2   Wearer acceptability scale

Huck *et al*[20] designed a wearer acceptability scale (Fig. 3.5) after completing a range of body movements. The nine-point scale consisted of a series of descriptive adjective sets to determine how subjects felt and also how they perceived the fit and comfort of their clothing.

Place a check (tick) between each pair of adjectives at the location that best describes *how you feel:*

1.	Comfortable	9	8	7	6	5	4	3	2	1*	Uncomfortable
2.	Acceptable	9	8	7	6	5	4	3	2	1	Unacceptable
3.	Tired	1	2	3	4	5	6	7	8	9	Rested

Place a check (tick) between each pair of adjectives at the location that best describes *the clothing you are wearing:*

4.	Flexible	9	8	7	6	5	4	3	2	1	Stiff
5.	Easy to put on	9	8	7	6	5	4	3	2	1	Hard to put on
6.	Freedom of move-ment of arms	9	8	7	6	5	4	3	2	1	Restricted movement of arms
7.	Easy to move in	9	8	7	6	5	4	3	2	1	Hard to move in
8.	Satisfactory fit	9	8	7	6	5	4	3	2	1	Unsatisfactory fit
9.	Freedom of move-ment of legs	9	8	7	6	5	4	3	2	1	Restricted movement of legs
10.	Freedom of move-ment of torso	9	8	7	6	5	4	3	2	1	Restricted movement of torso
11.	Dislike	9	8	7	6	5	4	3	2	1	Like
12.	Loose	9	8	7	6	5	4	3	2	1	Tight
13.	Crotch of overall right distance from body	9	8	7	6	5	4	3	2	1	Crotch of overall too close or too far from body

*Number added for reader reference only

Figure 3.5 Wearer acceptability scale. Source: Huck *et al.*, 1997.[20]

3.4.3   Fit evaluation scale

In 1993, Shen and Huck[6] developed a subjective scale which contained 25 items in three categories: overall fit, bodice front fit and bodice back fit. For each item, nine responses were possible, ranging from 'much too tight' to 'much too loose'. The middle position for each fit criterion indicated a 'good' fit. Yu *et al.* have applied this scale for the fit evaluation of men's jackets as shown in Fig. 3.6.

3.5   Subjective fitting guide

Clothing fit is influenced by fashion trends, personal preference and the intended end-use of the clothing. The overall fit generally contains five elements: grain, set, line, balance and ease. The lengthwise grain runs parallel to the centre front and centre back of the clothing. The crosswise grain runs horizontally at the bust/chest and hip levels. Good set refers to a smooth fit with no undesirable wrinkles. The lines of the clothing follow the silhouette and circumference lines
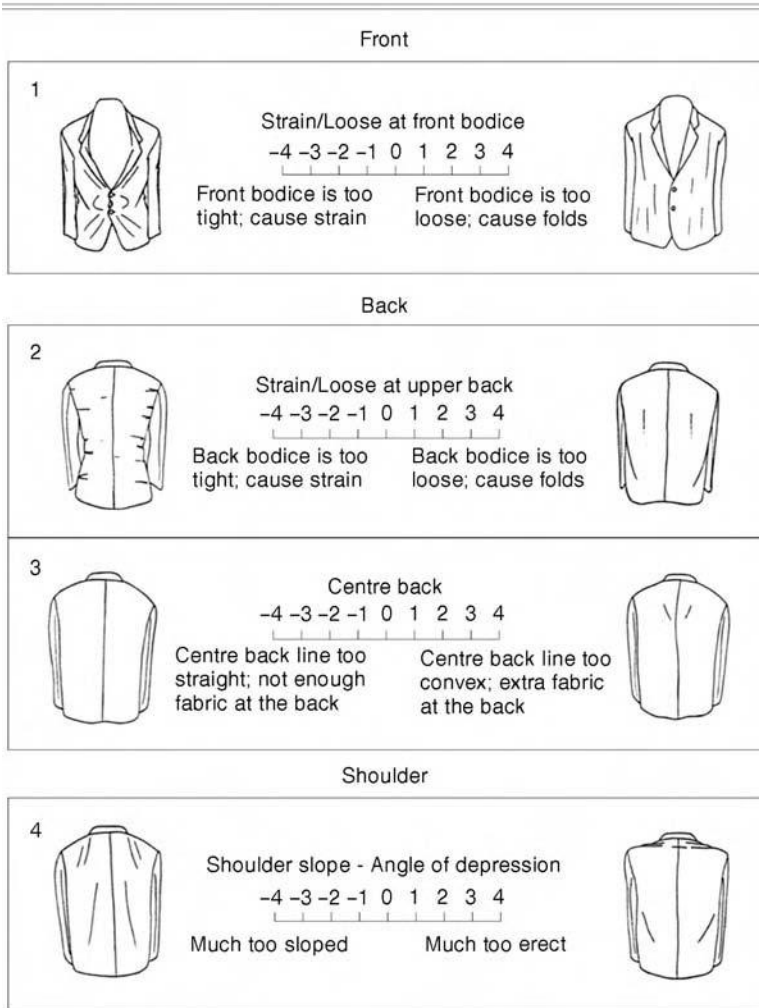
Jacket #: _____

Front

1

Strain/Loose at front bodice
-4 -3 -2 -1 0 1 2 3 4

Front bodice is too   Front bodice is too
tight; cause strain   loose; cause folds

Back

2

Strain/Loose at upper back
-4 -3 -2 -1 0 1 2 3 4

Back bodice is too   Back bodice is too
tight; cause strain   loose; cause folds

3

Centre back
-4 -3 -2 -1 0 1 2 3 4

Centre back line too   Centre back line too
straight; not enough   convex; extra fabric
fabric at the back   at the back

Shoulder

4

Shoulder slope - Angle of depression
-4 -3 -2 -1 0 1 2 3 4

Much too sloped   Much too erect

Figure 3.6 Fit evaluation scale. Source: Yu *et al.*, 'Assessment of Garment Fit', Proceedings of the HKITA & CTES Conference on Hand-in-hand Marching into 21st Century, April 1998, 125–129.

of the body. Clothing that is balanced appears symmetrical from side to side and front to back. It also requires adequate fitting ease to provide comfort and allow room for movement. Additional ease for style reasons is called 'design ease'. A complete checklist of clothing fit observations can be found in the book by Brown and Rice.[29]

For conventional fit of formal wear, Rasband[30] has given a comprehensive guideline of clothing fit. For example, the neckline should sit on the curve
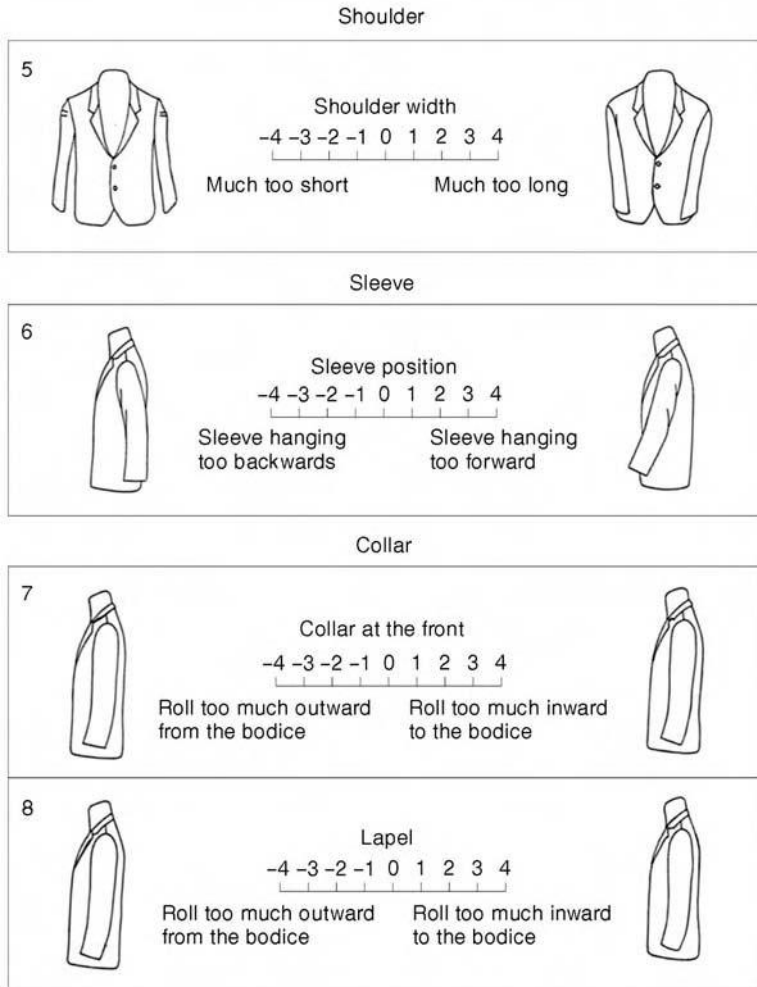
Figure 3.6 Continued.

around the neck base without wrinkling or gaps. A suit collar reveals about half an inch of the shirt collar at the centre back, whereas the outer edge of the suit collar just covers the neckline seam. Lapels should lie symmetrical and flat without gaps. Armholes should be large enough to allow for easy movement without cutting into the arm, binding or gaps. Upper back areas must lie smooth, with no wrinkles or strain at the armhole seam when arms are moved forward; as well as the absence of horizontal wrinkles, bubbles or bulges below the collar.

Centre front and back seams should be centred on the body and fall straight down, perpendicular to the floor. The side seams should intersect the waistline at

a 90º angle. Set-in cap sleeves should lie at the end of the shoulder and curve smoothly around the armhole, without puckers or wrinkles. Fullness is evenly distributed along the front and back. Ease at the elbow should be sufficient to allow the arm to bend without binding or discomfort. Long sleeve cuffs should end at the wrist when the arm is bent upward at the elbow. When arms are down at the sides, the cuffs of the long sleeves should hang no longer than the wrist joint. The shirt sleeve cuff should be about half an inch longer than the jacket sleeve.

3.6   Conclusions

Clothing fit is a complex issue and has been defined in divergent ways. Aspects of fit do not just involve the 3D body shape and the fabric properties which affect clothing drape and appearance but also include a social message, fashion, body cathexis and clothing physical dimensions. Live models and dress forms represent common standards used to test clothing fit through wear trials and judged by experienced assessors. The assessors would subjectively judge the fit in qualitative terms or grade the quality of fit in terms of quantitative scales. Fitting guides and checklists are well provided to assess whether clothing can fit the figure smoothly and accurately, and whether clothing seams follow the natural line of the figure. However, the subjective approach is still not very precise for communication purposes. It has been generally agreed that clothing fit is a critical feature of the effectiveness of clothing appearance. Research work has been carried out to rationalise the problems of fit and explain its complexities using a logical approach and understanding.

3.7   References

1   Cain G, *The American way of designing*, New York, Fairchild Publications, 1950.
2   Chamber H and Wiley E, *Clothing selection*, New York, 1967.
3   Erwin M D and Kinchen L A, *Clothing for modern*s, 4th edn, New York, Macmillan, 1969.
4   Efrat S, *The development of a method of generating patterns for clothing that conform to the shape of the human body*, PhD thesis, School of Textile and Knitwear Technology, 1982, Leicester Polytechnic, 234–235.
5   Hackler N, 'What is good fit?', *Consumer Affairs Committee*, May, 1984, 2 (1).
6   Shen L and Huck J, 'Bodice pattern development using somatographic and physical data', *Int J Cloth Sci Technol*, 1993, **5**(1) 6–16.
7   *The Oxford Dictionary*, Oxford, Oxford University Press, 2002.
8   Frost K, *Consumer's perception of fit and comfort of pants*, Washington State University, Pullman, 1988.
9   Ashdown S, 'Introduction to sizing and fit research', The Fit Symposium, Clemson Apparel Research, South Carolina, Clemson, 2000.
10 Geršak J, 'Development of the system for qualitative prediction of clothing appearance quality', *Int J Cloth Sci Technol*, 2002, **14**(3/4) 169–180.

11   LaBat K L and DeLong M R, 'Body cathexis and satisfaction with fit of apparel', *Cloth Text Res J*, Winter 1990, **8**(2) 43–48.

12   Armstrong H J, *Patternmaking for fashion design,* New York, Harper and Row, 1987.

13. URL: http://www.wacoal.co.jp/company/aboutcom_e/ningen/index_e.html

14   Secord P F and Jourard S M, 'The appraisal of body-cathexis: Body-cathexis and the self', *J Counseling Psycho*, 1953, **17**(5) 343–347.

15   Rosen G and Ross A, *The relationship of body image to self concept*, thesis, University of Pittsburgh, Pittsburgh, Pa., 1973.

16   Hwang J, *Relationships between body-cathexis and clothing*, Virginia Polytechnic Institute and State University, Blacksbury, VA, 1996.

17   Wenger J, C*lothing fit and body attitudes*, Colorado State University, Fort Collins, 1969.

18   Frederick N, *The relationship between body cathexis and clothing market satisfaction of overweight women*, unpublished MSc thesis, Washington State University, Pullman, 1977.

19   Anderson L J, 'Understanding fitting preferences of female consumers: Development of an expert system to enhance accurate sizing selection', *Annual Rep - Nat Text Center*, 2001, Sect. 4, (Nov. 2001).

20   Huck J, Maganga O and Kim Y, 'Protective overalls: Evaluation of clothing design and fit', *Int J Cloth Sci Technol*, 1997, **9**(1) 45–61.

21   AFNOR, *Textiles hosiery articles – determination of the dimensions of stretched stockings, tights and other hosiery articles,* NF G 32-104, 1995.

22   Pechoux B L and Ghosh T K, 'Apparel sizing and fit', *Text Progr*, 2002, 27.

23   Cascini G, Pieroni N and Quattrocolo S, 'Development of a low cost body scanner for garment construction', *12th ADM Int Conf*, Rimini, Italy, Sept., 2001, 5-7, A4-1~8.

24   CAD Modeling', URL: http://www.cadmodelling.it/english/home.htm.

25   Alvanon, *Fit conformance for the apparel industry*, URL: http://www.alvanon.com/home.html.

26   Digital Human Laboratory, *Development of a dress making dummy based on digital human body models for Japanese women*, URL: http://www.dh.aist.go.jp/NIBH/indexcontents/j4reseachperformance/j401contents/press000405-e.html.

27   URL: http://www2.nsknet.or.jp/~taninaka/main-page.html.

28   Likert R, *A Technique for the measurement of attitudes*, New York, New York University, 1932.

29   Brown P and Rice J, *Ready-to-wear apparel analysis,* 3rd edn, Upper Saddle River, NJ, Merrin Prentice Hall, 2001.

30   Rasband J, *Fabulous fit*, New York, Fairchild Publications, 1994.