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Development of a 'Body' to Help Japanese Women in their 50s Dress Beautifully

1. Introduction

In Japan today, the apparel market is flooded with highly fashionable goods aimed at young people. When it comes to clothing for middle-aged and older people, however, there are fewer products that satisfy consumer requirements. This became clear in the "Clothing Questionnaire" survey we conducted in 2004-2005, targeting 3,425 male and female respondents in their 50s to 90s. Dissatisfaction was particularly acute among women in their 50s who complained that clothes made for married women are unfashionable and that there are few sizes, no well-designed clothes that fit them, and no stylish clothes that cater for their figure. Although the Japanese diet is lower in calories than the western diet and there is a lower ratio of obesity in Japan, it is nevertheless true that the basic metabolic rate falls and people do less exercise from middle age onwards. Meanwhile, insistence on dietary fads becomes stronger, and as a result the figure gradually changes. In other words, people become fatter. Particularly in Japan, which has rushed headlong into an "ultra-aging society" in recent years, there are calls for healthier lifestyles, and there is even a growing sense of guilt towards becoming fat. There is also a strong tendency to resist change, coupled with a desire to live a long, healthy life; people want to remain youthful forever. One aspect of this is that people don't want their figure to change as they grow older, and since people in this generation had the experience of leading fashion in their youth they want

to remain stylish at any age. They want to look the same as young people. A particular fashion trend in recent years has been for the silhouette to fit the body closely, and there is a growing tendency to be aware of body lines. Meanwhile, in a questionnaire survey on the physique of 688 women in their 50s, many middle-aged women were also found to be concerned about their own figure (especially the waist).

Another fashion trend among Japanese consumers is the obsession with “size 9”. Whatever the actual size of the body, and even if their appearance doesn’t look good to the objective eye, people feel happy if they can wear size 9. They feel reassured that they fit the standard size. In response to this consumer mentality, the fashion industry even uses size 9 as a general label even if the actual waist is larger or the whole garment is on the large side, to enable as many people as possible to wear it. As a result, measurements on finished products vary greatly from manufacturer to manufacturer, and size labeling is rendered meaningless. Another fact is that there is little size variation by brands that produce strongly designed wear; when the body grows a little larger there are suddenly no nicely clothes to wear. In other words, since manufacturers only produce sizes 7, 9 and 11 that are close to the standard, people outside that range are unable to share style trends, and are often left dissatisfied. The cause of this is that in spite of the fact that young women’s figures change greatly with advancing age there are few measured data for this and hardly any shape-related data which make it impossible to grasp figure characteristics.

We therefore carried out “Body research based on measured data with the aim of creating clothes for women in their 50s.” By clarifying the material findings and preparing a mannequin we attempted to provide clothing that would satisfy consumers. We have already developed a nude mannequin based on the average proportions of

young women. This is a revolutionary effort in which we have measured the human body form using three-dimensional scanners and averaged out a standard form from the digital data obtained. This mannequin has been on sale since 2000 and is widely used in sites of education as well as in the clothing industry. In 2004, meanwhile, we used the same method to develop a nude mannequin for a young male, and this also has a track record of commercial sale.

2. Test subjects and methods

2-1 Measurement subjects

The subjects were Japanese women between the ages of 50 and 59. While the subjects measured this time were in their 50s, by measuring this generation we can apply the measurements to clothing design for a broader age range, from late 40s to 60s (before skeletal changes occur). Another reason for choosing women in this generation was that they not only account for a large proportion of Japan's population, have purchasing power and are financially stable, but they also have the experience of enjoying stylish dressing in their youth, and are therefore sensitive to fashion.

2-2 Fitting conditions

As a precondition for outer wear, the subjects wore a soft girdle over brassiere and shorts when being measured. Our survey results prove that many middle-aged women use a brassiere or girdle to pull in sagging breasts or buttocks and thereby maintain their figure. In the results of market surveys and wearing tests on brassieres and girdles, there was a problem resulting from our choice of items with relatively little tightness. This is because, from middle age onwards, our skin loses its elasticity and our muscle strength also weakens, making it easier for underwear fastenings (elastic) to have an effect on changing figure. This point will be expanded later in research and

development on underwear.

2-3 Measurement

As measuring instruments, we used a Martin-type anthropometer, a silhouetter and a three-dimensional scanner. Number of subjects measured – 2004: 129, 2005: 90, 2006-2007: 100, total 319.

We chose about 80 items for Martin measurement, which were necessary in terms of both visualizing figure characteristics and of making clothes. These could then be compared with the measured data for young women that we had already obtained. With the silhouetter and three-dimensional scanner, we made measurements by attaching stickers to the measurement points (landmarks) (Fig. 1). Landmarks in three-dimensional scanning are points of inflection on the body surface and anatomical points in the skeletal frame that are important in terms of designing clothes. These points have the same meaning from individual to individual in anatomical terms, and we processed data on this basis.

2-4 Method of selecting subjects for mannequin development

To ascertain general trends in the figures of women in their 50s as a whole, our first stage was to recruit and measure subjects without any size limitation. From the results, we selected eight items of various measurements in different parts of the body that we deemed particularly important in connection with apparel design (height, weight, bust, waist, hip, anterior axiliary width, waist width and hip width). Of the subjects, we chose two whose measurements were closest to the average in all eight items. We then confirmed the shapes of these two subjects using the silhouetter, and established the subject with most central data in terms of numerical data and shape as the M

(medium) type. In contrast to this, we chose a shorter and thinner subject as the S (small) type and a taller and fatter subject as the L (large) type. Based on the shape data from these three we used polystyrene foam to make 1:2 scale models (Fig. 2). This modeling of human figures produced three-dimensional images of figures that had not been defined in the past making it possible to confirm them visually. With the S type there was little change in Martin measurement data compared to younger women, although when seen from the front the sides and abdomen protruded just below the waist. With the M type the shape from the abdomen to the underbelly changed considerably with the increased measurements, and when seen from the side the thickness of the waist visibly increased at both front and back. Finally, with the L type there was more fat all over the body while both width and thickness increased. The shape of areas that are constricted or made to protrude by underwear also became clear.

From these measurement results we decided the average size, gathered 100 subjects (height 156cm, bust 90cm), and measured them for mannequin development. From these, we selected 39 subjects whose size was suitable, who had little lateral asymmetry, twisting or distortion, and who showed suitable morphological characteristics, and used their three-dimensional data to develop the mannequin digitally.

2-5 Creation of mannequin shape data

First of all, we measured the three-dimensional shape of the body and prepared a homologous model from the data from each individual. A homologous model expresses body surface shape data in such a way that a human figure measured using a three-dimensional scanner is composed from data points with the same number and

the same positional relationship for everyone, whether big or small. By scanning the subjects with the three-dimensional scanner we gathered the shape in the form of point-group data consisting of a maximum of 2,560 points for each 2.5mm of the whole body (Fig. 3). The data volume was too large to make a multiple comparison of these tens of thousands of coordinate points. Therefore, to compare differences in height and physique under the same conditions, we made 26 cross-sections that passed through the anatomical landmarks and points of inflection on the body surface that are important when creating apparel and made division points for each of these cross-sections. The number of division points for each cross-section was the same for everyone (928 points) and we could therefore make the same geometrical structure shape model for all subjects. This homologous model (Fig. 4) enabled us to make comparisons between individuals.

To measure the differences between these homologous models, the FFD (Free Form Deformation) method was used to calculate spatial distortion. FFD is a method whereby a starting grid is laid around human figure model A, its control points are changed in shape to transform it to a shape approaching human body model B, and the volume of movement in control points at this time is taken as the spatial distortion coefficient. We transformed homologous models of all subjects in twos using a combination formula, calculated the amount of movement in the distance between the transformed grid points, and established the model with least divergence in distance as the mean value form. At this time, we also calculated the average form conversion coefficient by averaging out the volume of movement of transformed grid points in all models. We made an average model using the distortion of this grid (transformation grid). We calculated an FFD conversion grid to convert the mean value form model into a laterally symmetrical model, converted the detailed shape data of mean value

forms in the calculated grid, and created the detailed average shape (Fig. 5). From these digital data we used polystyrene foam to make an actual model of the average shape (Fig. 6). At this time both arms were raised by 20 degrees in the posture used for three-dimensional scanning, and the shape of the shoulders had therefore changed compared to when the arms were hanging down. Irregularities in body surface shape were also created by the fastening (elastic) of underwear (Fig. 6). Since there are limits to the capacity to correct these anomalies using digital means, we carried out plaster measurement and corrected the shape. In this way, we completed the basic form of the nude mannequin (Fig. 7).

We used this basic form to take a cast of the mannequin, attached cloth and thus completed the mannequin (Fig. 8).

3. Results

The figure characteristics due to age-related changes were made clear by comparing the results of measurement by various measuring instruments in this study with data on young women (for the latter, we used data measured continuously by ourselves since 1997).

3-1 Body girth balance (Fig. 9)

Figures can be divided into four types by creating a scatter graph with bust measurement divided by waist measurement as the vertical axis, and hip measurement divided by waist measurement as the horizontal axis. Individuals appearing at the bottom left of the graph have little divergence in either parameter and are thick-waisted. At the other extremity at the top right of the graph, is the hourglass type in which the waist is slender compared to the bust and hips. At the bottom right is

the prominent hip figure and at the top left is the prominent bust figure. Individuals marked □ in the graph are 395 young women who tend to be relatively prominent in the hip among the Japanese. These are positioned near the center. In contrast, the 319 women in their 50s (□) gravitate towards the bottom left corner. In other words, since fat accumulates around the waist the waist girth increases and they become thick-waisted. Some are also found towards the top left. This is not because the bust is larger but because fat increases from the sides to the back. This will also become clear from the three-dimensional shape data discussed later. There is no prominence of hips in this group. This is because the hips start to sag with age and the maximum extension of buttocks becomes lower than the position at which the abdomen protrudes. As a result, the body girth does not change very much.

3-2 Balance of inclination, width and thickness using the silhouetter (Fig. 10)

We compared representative whole body profiles of young women with those of women in their 50s. If we draw a vertical line upwards from the middle of the feet and compare the inclination of the body from the waist up we find that the upper body of young women inclines backwards while that of women in their 50s is more or less straight. We obtained the same result when we examined about 100 women. In addition, women in their 50s also accumulate fat at the back of the waist and the hips sag downwards with the result that the curvature of the back (from the shoulder blades to the waist and hips) is weaker compared to that of young women. The thickness of the torso also increases.

3-3 Comparison of average shapes (Fig. 11)

We compared the average shape of women in their 50s, obtained by averaging three-dimensional shape data with the average shape of young women obtained when

developing nude mannequins of young women. A comparison of these shapes from the front and side underlines the difference in figure with age.

From the front, the lateral line of young women from the bust to the waist and hips follows a gentle curve. In women in their 50s, the width is more or less the same from the bust to the waist and the abdomen protrudes just below the waist. From the side, thickness increases all over the body in women in their 50s. In the bust, particularly, the swelling of the breasts is not much different from young women, but the thickness has clearly increased. The part from below the breasts to the lower abdomen protrudes significantly, and the buttocks sag at the back. As a result, there is a clear difference in shape below the buttocks compared to the high position of maximum buttock extension in young women. To show this comparison in numerical terms indicating width balance (Fig. 11), if the shoulders, nipples, waist and maximum buttocks extension of young women are each taken as 1, we see that, in women in their 50s both the nipples and waist width have increased but the maximum buttocks extension width has not changed. In terms of thickness, if the nipples, waist and maximum buttock extension of young women are each taken as 1, the change in the waist is largest at 1.25 but the hips remain more or less unchanged. This is because the buttocks sag and the maximum extension of buttocks is positioned below the swelling of the abdomen.

3-4 Shape data (horizontal cross-section) (Fig. 12)

As for the shape of the torso we created horizontal cross-sections of the neck, shoulders, bust, waist and hips, and a composite diagram using all of these. The thickest part of the torso was the bust (nipples) level, while at the back, the lines of shoulders, bust and hip levels were close to each other. This shows that the curvature

of the back is more or less the same both above and below the waist, while the waist itself is somewhat forward. At the front we find that the waist was near the bust (nipples) and the abdomen protruded outwards.

3-5 Comparison with shape data (horizontal cross-sections) of young women (Fig. 13)

By comparing the horizontal cross-sections with those of young women, changes in the figure of women in their 50s become pronounced. In all cross-sections thickness changes more than width. Although there is little frontal change at the anterior axillary, bust and underbust levels, thickness increases at the back. In contrast, at the waist and maximum abdominal extension there is little dorsal change but considerable protrusion to the front. At hip level, moreover, thickness increases slightly to the front under the influence of the maximum abdominal extension.

4. Discussion

Comparing a jacket made using the completed mannequin with one made using a conventional method (Fig. 14) we see that the silhouettes are clearly different even when worn by the same body. When using a mannequin that reproduces the body shape accurately, with the back following the curve from the shoulder blades to the waist and hips, the silhouette of the back becomes sharp (photo right). Seen from the front, there is no expansion of width and the swelling of the bosom is expressed prominently. When merely increasing the size, as has been the case until now, we do not know which part will change shape in which way. As a result, the whole garment used to be baggy and poorly balanced (photo left). However, by making the shape clearer and more sharply defining the changes in figure compared to young women, it has become possible to express the figure in a tighter-waisted silhouette.

In the average shape model obtained through three-dimensional scanning (Fig. 15), irregularities in the body surface around the brassiere can be seen as a result of the fastening (elastic). Firstly, skin protrudes from above and below the brassiere belt, while compression occurs at the top of the arms and around the outside of the bra pads. This is a common worry for many middle-aged and older women who have lost skin elasticity. It is a reaction caused by compression of skin in which soft fat has accumulated, causing ripples to appear behind the top of the arm when thinly fit outer wear is worn. To eliminate this, we have developed a “ripple eliminating bra” in collaboration with underwear manufacturers. The brassiere completed as a result of this is becoming increasingly popular with many women, who call it “the bra I was looking for”. Many contemporary women spend much of their day wearing a brassiere. Moreover, underwear has a significant role to play when dressing up, and we feel it necessary and essential to consider shapes, materials and wearing comfort that will suit this generation.

5. Conclusion

The nude mannequin developed in this study is an indispensable tool for creating clothes that fit the human body. It faithfully reflects the figures of women in their 50s, the targets of the study. With the tight-fitting silhouettes of clothing today using a nude mannequin that accurately expresses the form of the human body is important in order to produce forms that answer to the desired image. With the completion of this mannequin, it is thought that the level of the apparel industry will improve and it will be possible to make clothes that are highly fashionable and fit the figure. Presently, the apparel manufacturers of mail-order businesses make products using this mannequin, and it has a large public response. The mail-order industry has found it difficult to

reduce the rate of clothing returns of this generation, due to clothing being too baggy. However, through the use of the mannequin, the industry is expected to overcome this difficulty. Additionally, underwear manufacturers use the mannequin while selling its produces on television shopping programs. They can affectively compare the differences of the clothing which would tear or fit well based on the example shown by the mannequin during the program. In this way, the many women who want to dress stylishly, whatever their age, can dress themselves beautifully and thereby be happy.

References:

Mochimaru, M. & Kouchi, M. (2006), Society of Biomechanism Japan (eds.), *Biomechanism Library- Measurement of Man: size, shape and motion* (Tokyo: Tokyo Denki University Press)

Bunka Fashion College, Bunka Gakuen Educational Foundation (2006), *Body research based on measured data with the aim of creating clothes for women in their 50s* (Tokyo: Report by “Educational Important Support Plan Project for Vocational School”)

Images:

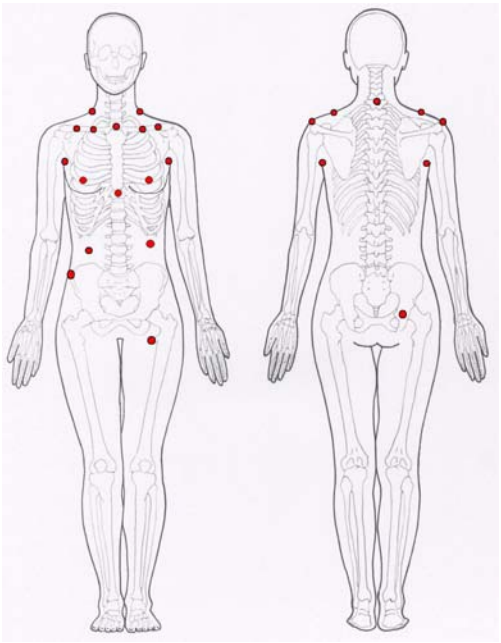

Fig. 1　Landmarks

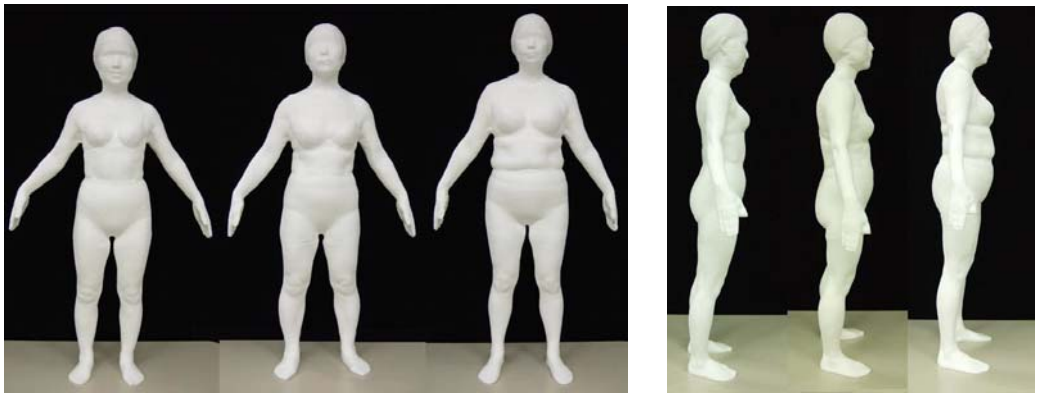

Fig. 2　Models of three types in their 50s (front view, side view)

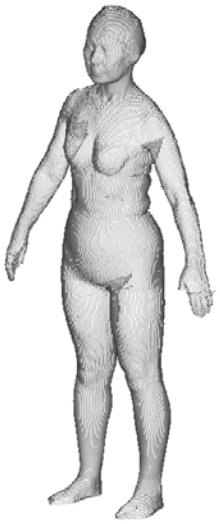

Fig.3 Point-group data

Fig.4 Homologous model

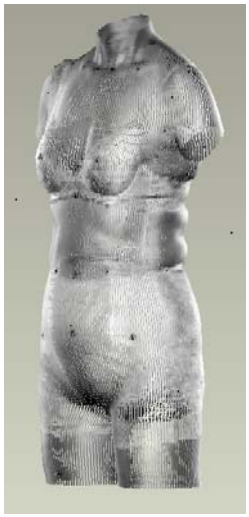

Fig.5 Detailed average shape

Fig. 6 Modeling of average shape: Polystyrene foam

Fig. 7 Basic form of nude mannequin

Fig. 8　Completed mannequin

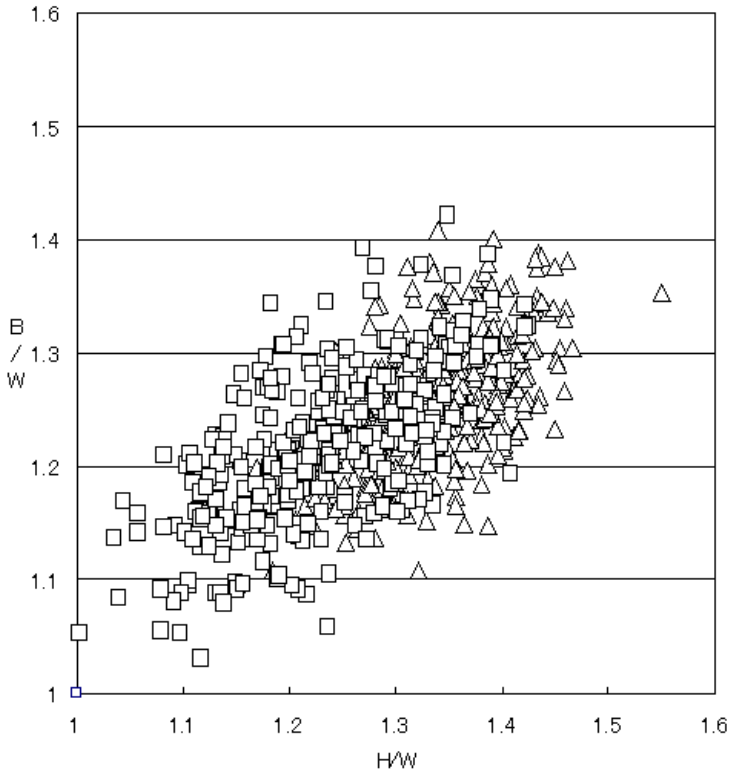

Fig. 9　Body girth balance

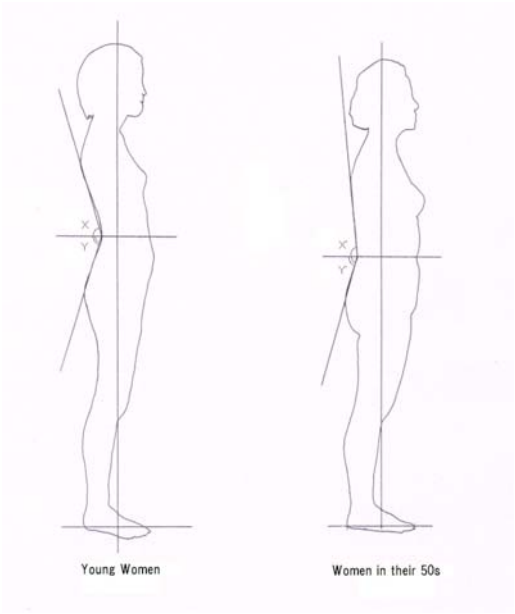

Fig. 10　Silhouetter balance

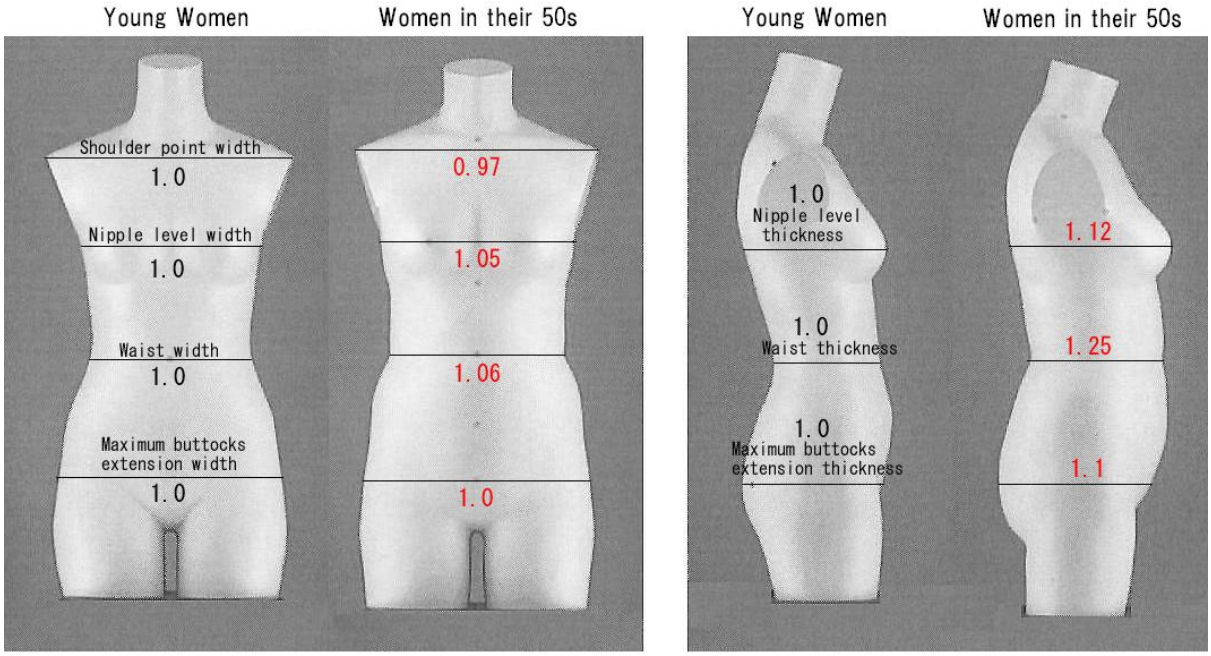

Fig. 11　Comparison of average shape (front, side)

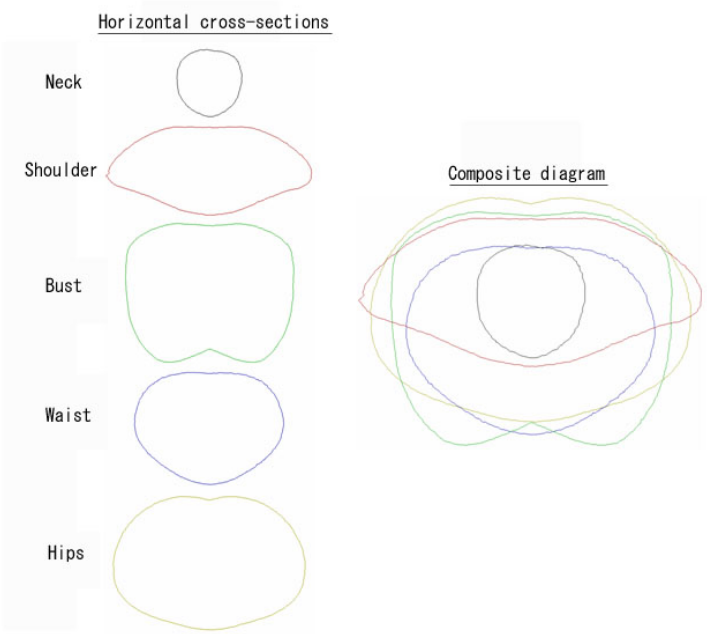

Fig. 12　Horizontal cross-sections and composite diagram

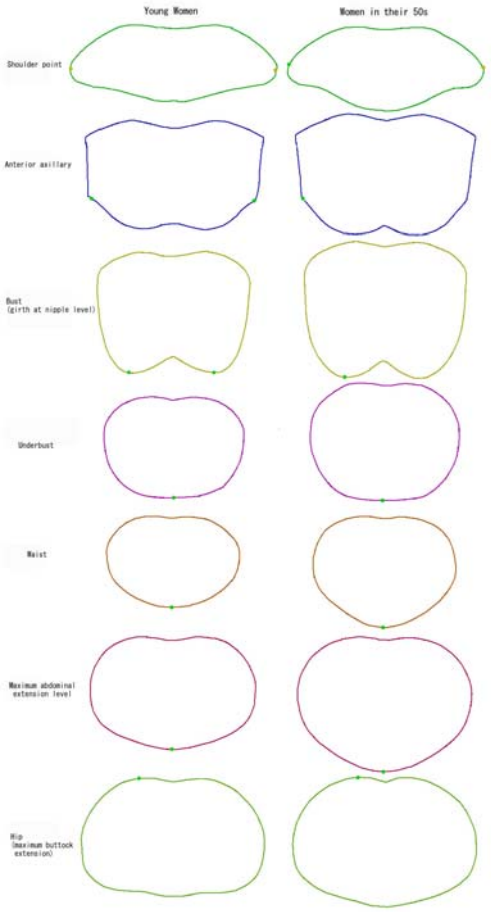

Fig. 13　Comparison of horizontal cross-sections

Fig. 14　Comparison of jackets

Fig. 15　Average shape model