

A Study on the Comparative Evaluation of Wearing Fitness of Women's Ready-made Jackets Using 3D Scanner

3D Scanner를 이용한 여성용 기성복 재킷의 착의적합성에 관한 비교평가연구

Dept. of Clothing and Textiles, Yonsei University

Division of Fashion and Textiles, Dong-A University

**Tongmyong University of Information Technology, School of Art and Design, Dept. of Fashion Design

Haekyung Kim · Chuyeon Suh* · Eunyoung Suk · Soonjee Park · Jiyoung Lim**

연세대학교 생활과학대학 의류환경학과, *동아대학교 생활과학대학 의상섬유학부

**동명정보대학교 정보조형학부 패션디자인학과

김혜경·서추연*·석은영·박순지·임지영**

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Abstract

본 연구 목적은 3차원 인체 스캐너를 이용하여 여자 기성복 재킷의 여유량을 비교, 분석하는 것으로, 2사이즈 7 브랜드의 재킷의 공극량을 계측하여 분석하였다.

첫째, 재킷 단면둘레 분석 결과, B85(몸), B88(허리)를 제외하고 브랜드간에 유의한 차이를 나타내지 않아, 전반적으로, 브랜드간 제품치수에는 차이가 없는 것으로 나타났다.

둘째, 인체와 재킷의 단면둘레 분석 결과, 재킷의 배둘레를 제외한 모든 항목에서 유의한 차이가 나타나 피험자, 재킷 모두 사이즈에 따라 유의적인 차이가 있음을 알 수 있다.

셋째, 기본사이즈 B85에서는 허리를 제외하고는 패턴 F가 가장 여유량이 많은 것으로 나타났으나, B88의 경우, 부위별로 각기 다른 패턴에서 여유량이 가장 많은 것으로 나타나, 각 부분마다 브랜드별로 그레이딩 룰이 다를 수 있다.

넷째, 착의 단면은 인체와 의복간의 여유량 분포를 명백히 보여주며, 어깨, 가슴, 엉덩이처럼 몸에 밀착되는 부위는 다른 부위에 비해 패턴간, 각도별 편이가 적은 것으로 나타났다. 몸, 허리, 배에서는 옆보다는 앞, 뒤로, 가슴에서는 앞뒤좌우의 30° 방향, 엉덩이의 경우, 옆, 뒤보다는 앞쪽에 여유량이 집중되어 있는 것으로 나타났다.

다섯째, 브랜드별 평균공극길이에 대한 분산분석 결과, 전반적으로 패턴 F가 가장 공극량이 많고, 패턴 D가 작은 것으로 나타났다.

여섯째, 사이즈별 평균공극길이에 대한 t-검정 결과, 몸과 배 부분에서, B88이 B85보다 공극량이 적은 것으로 나타나, 기준부위인 가슴, 허리, 엉덩이 부분뿐만 아니라 몸, 배둘레의 치수에 대응할 수 있도록 그레이딩 룰 값을 산정하여야 함을 알 수 있다.

Key words: evaluation of fitness, women's ready-made jacket, 3D scanner, space length between body and garment; 착의평가, 여성복 재킷, 3차원 스캐너, 공극길이

I. Introduction

The rapid development of the computer industry

consequents in development of various computer applied systems in fashion industry. Recently, number of programs that make drafting, designing, grading with personal computers at

ease have developed. Also in the research area of clothing ergonomics, 3D scanner has been used in the studies on the body measurement. Utilization of the 3D scanner and CAD program satisfied the needs of researchers in the field of clothing ergonomics, such as automatic body measurements and analysis on the wearing ease. Moreover, it suggested the possibilities to construct clothes directly from body to garment.

Among ready-made garments, jacket is the most complicated in pattern making and clothing construction and hard to satisfy the fitness. Especially in women's wear, there are wide range of jacket design but the disagreement of size specification among brands and inconsistency of body size with product size give rise to consumers' complaints. But the quantitative method to evaluate the wearing ease or ready-made jacket hasn't been developed yet.

Therefore, the purpose of this study is to compare and evaluate the wearing ease of women's ready-made jackets using 3D scanner. Specifically, space length indicating the wearing ease, were evaluated according to brands and sizes.

II. Method

1. Subjects

Four female subjects who aged in twenties were selected for the experiment, two subjects for the size B85(bust girth 85cm), two subjects for size B88(bust girth 88cm). The measurement results of subjects were shown in Table 1.

2. Selection of jacket patterns for experiment

For experiments, formal jacket patterns were collected from seven women's wear brand (targeting late 20's to early 30's). In total, fourteen patterns were used from two sizes of each brand.

Table 1. Body Size of Each Subject

(unit: cm)

Subjects Items	B85		B88	
	S1	S2	S3	S4
1.Height	163.6	162.5	162.5	163.1
2.Bust Height	118.5	117.0	115.8	116.7
3.Waist Height	101.9	100.5	100.3	99.8
4.Hip Height	80.4	79.5	81.1	79.8
5.Back Length	38.0	38.0	37.5	38.0
6.Front Interscye	32.3	32.0	33.3	33.7
7.Back Interscye	34.5	33.7	34.5	34.5
8.Bust Girth	84.0	83.5	87.8	88.7
9.Waist Girth	66.5	65.5	69.0	71.1
10.Abdomen Girth	77.0	76.5	83.5	84.2
11.Hip Girth	90.5	89.0	91.6	93.0
12.Bust Width	27.0	26.8	28.0	27.5
13.Waist Width	24.0	23.6	24.8	24.5
14.Hip Width	31.5	32.0	33.3	32.8
15.Bust Depth	21.3	21.0	22.6	22.0
16.Waist Depth	16.1	15.8	17.8	17.0
17.Hip Depth	20.5	19.8	21.0	20.7
18.Weight(kg)	52.4	51.8	54.8	56.2

The style used in the study were basic and similar one another. The basic pattern size(i.e. size B85)was selected for the study. Size B88 was also included because these two size have a majority of the whole sales volume. The patterns of jackets were shown on Fig. 1.

3. Body scanning

3D Whole Body Scanner from Cyberware of United States was used for this study. According to the previous research method of Kim, Suk and Suh(2000), each subject was scanned eight times, with basic underwear and with jacket over it. The subjects set their feet apart about 20cm wide and lifted arms about 30°. In order to maintain the same standing posture, a supporter was set on each side and indicated the points where the hand touches the supporter. The interval of scanning

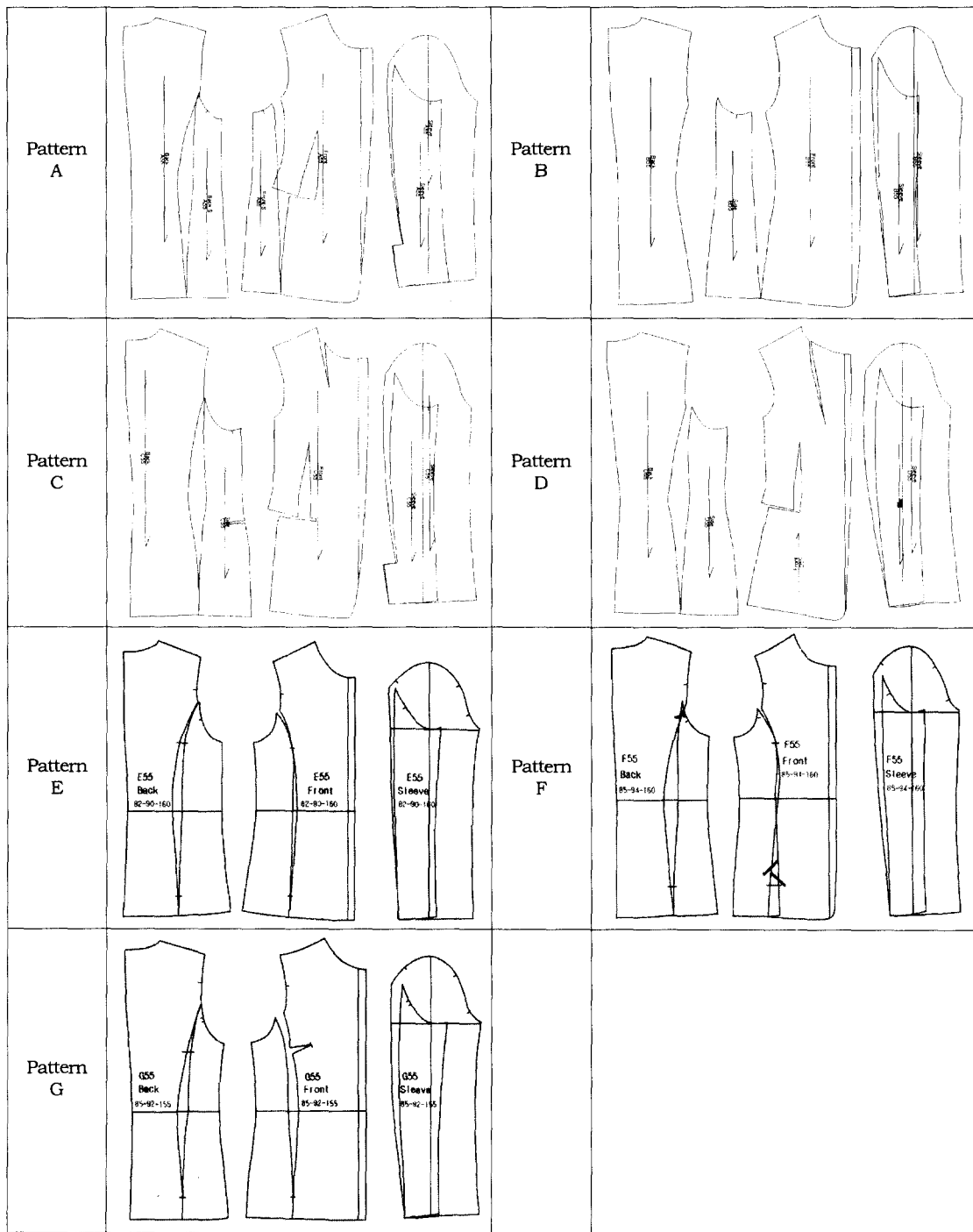


Fig. 1. Patterns of Jackets

was 2mm.

4. Cross sections of body and jacket

The scanned data were turned into 1cm interval of wire frame and saved as *.dxf file and cross sections of body and garments were overlapped using Auto CAD program. Six cross sections of body and garment were made for shoulder, interscye, bust, waist, abdomen and hip. To quantify the wearing ease, the space lengths between body and garment of each part were measured following the method of the previous study by Kim, Suh, Park, Suk, Lim and Kwon (1998).

5. Statistical analysis

For data analysis, ANOVA with post-hoc test, t-test were done using SPSS statistic program(ver 9.0).

III. Result and Discussion

1. The girth of cross sections of body and jacket

The scanned data was turned into wire frame

and saved as Auto CAD file. The cross section of body and jacket were overlapped using Auto CAD program and displayed in Fig. 2. These sections clearly showed the wearing ease of jackets of each body part.

To analyze the difference in cross section among brands quantitatively, we measured the cross section girth of each part of jacket. The results of ANOVA and post-hoc test(SNK method) were shown in Table 2.

All the cross sections of interscye included upper part of arm as one cross section. However, in the case of bust section, the upper part and the trunk were separate. So the measurement was done on the body(trunk) part, excluding upper part of arm.

The size B85 showed no difference in jacket product size except interscye part. Likewise, B88 showed no difference except waist part, where the brand D was significantly smaller than others. On the whole, we could conclude the product size of jacket was similar regardless of brand in most parts.

Table 2. Cross Section Girths of Each Jacket

(unit : cm)

Size	Section	Cross section girths of each jacket							Mean	p-value
		A	B	C	D	E	F	G		
B85	Shoulder	78.83	81.66	81.43	81.89	81.14	83.16	83.97	83.97	0.680
	Interscye	98.49 ^{ab}	98.10 ^a	98.95 ^{abc}	98.85 ^{abc}	99.55 ^{bc}	99.84 ^{abc}	100.01 ^c	98.97	0.013*
	Bust	87.51	86.00	86.86	85.58	86.62	87.62	87.11	86.76	0.055
	Waist	79.06	78.92	78.93	75.59	82.29	80.46	78.48	79.10	0.073
	Abdomen	86.91	86.26	86.80	85.29	88.01	89.04	87.91	87.17	0.767
	Hip	94.97	96.80	95.32	97.46	98.80	99.43	97.95	97.24	0.247
B88	Shoulder	84.41	85.34	82.63	86.10	86.97	85.32	87.83	85.51	0.093
	Interscye	104.22	103.61	103.70	103.44	103.97	103.50	103.71	103.73	1.000
	Bust	92.41	91.45	91.43	90.43	92.29	93.70	91.86	91.94	0.819
	Waist	83.79 ^b	82.08 ^b	82.15 ^b	76.39 ^a	85.99 ^b	80.84 ^b	81.15 ^b	81.77	0.007**
	Abdomen	90.24	87.50	88.84	85.77	90.32	88.51	89.00	88.60	0.164
	Hip	99.57	98.80	97.97	98.18	100.11	99.92	100.23	99.25	0.498

* $p \leq 0.05$ ** $p \leq 0.01$ According to SNK-test results, score were marked with different letters which had significant difference at the level of $p \leq 0.05$ ($a < b < c$).

B85 S1	Shoulder	back 	Waist	
	Interscye		Abodmen	
	Bust		Hip	
B85 S2	Shoulder		Waist	
	Interscye		Abodmen	
	Bust	front 	Hip	
Size & Subject	Line type	Pattern A —★— Pattern D —△— Pattern G —⊕—	Pattern B —◎— Pattern E —◆— Body ———	Pattern C —◇— Pattern F —♥—

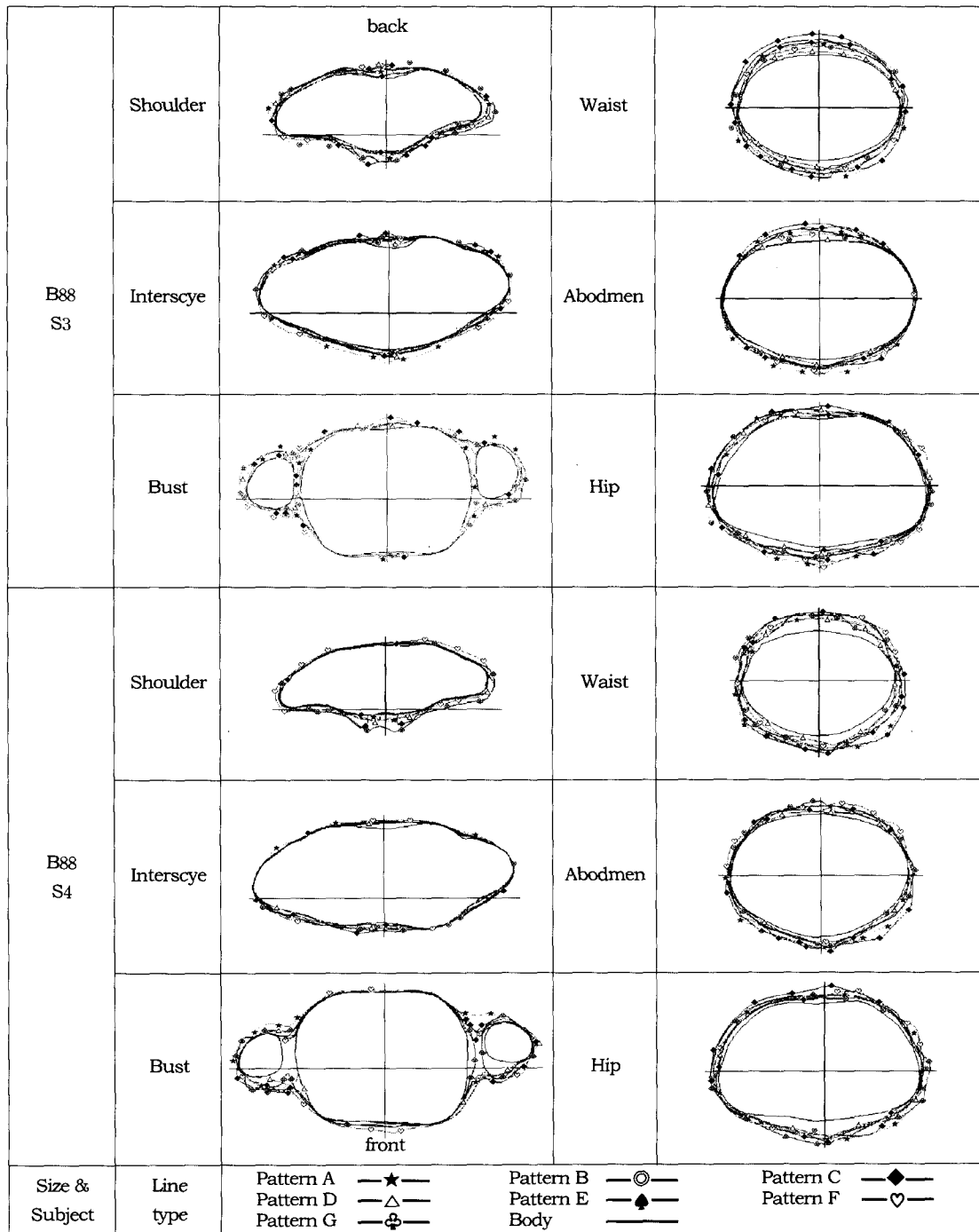


Fig. 2. Overlapped Cross Sections of Body and Jacket

Table 3. T-test Results of Cross Section Girth

(unit : cm)

Measurement Parts	Body			Jacket		
	B85	B88	p-value	B85	B88	p-value
Cross section girth of Shoulder	73.87	81.28	0.000***	81.72	85.51	0.000***
Cross section girth of Interscye	96.68	102.24	0.000***	98.96	103.73	0.000***
Cross section girth of Bust	83.24	88.25	0.000***	86.76	91.94	0.000***
Cross section girth of Waist	65.97	71.74	0.000***	79.10	81.77	0.014*
Cross section girth of Abdomen	76.77	83.30	0.000***	87.17	88.60	0.073
Cross section girth of Hip	88.65	92.66	0.000***	97.96	99.25	0.005**

*p≤0.05 **p≤0.01 ***p≤0.001

In order to test the difference of cross section girth between size, t-test was done and the result was shown in Table 3. In case of body with underwear, the girth of cross section in every part showed a significant difference according to size. It suggested that subjects for B85 and B88 were different in terms of body size. The result in the cross section girths of jacket was in the same manner except abdomen. This showed that there was little pattern size differences in abdomen.

Therefore, when grading, the increasement not only in bust, waist, and hip girth but also in abdomen should be considered with caution. However, this results may not be generalized until it is considered carefully because only two subjects were chosen for each size based on their bust, waist and hip girth.

2. Analysis on the space length of ready-made Jacket

To analyze the wearing ease of ready-made jackets more objectively, space length between body and garment was measured. Space length between body and garment is turned out to be useful in understanding the amount and distribution of wearing ease. The measurement results were shown in Fig. 3.

The values on table were the average ones of 2 subjects of each size. In the shoulder part, the

minimum average space length(M) appeared in size B88 (pattern C, 0.23cm) and the maximum one, in size B85 (pattern F, 1.25cm).

In the interscye as well, the minimum average space length come out in size B88 (pattern D, 0.31cm) and the maximum one, in size B85 (pattern G, 0.83cm). In shoulder and interscye, the average space length of all brands in size B85 was larger than in the size B88.

The maximum average space length in the bust appeared in size B88 (pattern F, 0.87cm) and the minimum one, size B88(pattern D, 0.35cm). In case of the waist, the maximum average space length appeared in size B85 (pattern E, 2.68cm) and the minimum one, in size B88(pattern D, 0.84cm). In the abdomen, the maximum average space length appeared in B85 (pattern F, 1.86cm) and the minimum one, in B88 (pattern D, 0.39cm). In case of the hip, the minimum average space length appeared in B88 (pattern D, 0.79cm) and the maximum one, in B85 (pattern F, 1.70cm).

Comparing the average space length in every part, that of pattern D appeared to be the smallest in most part except the shoulder and the hip, suggesting that pattern D was the fittest design.

In case of size B85, all the space length of pattern F was the biggest in most part except and waist, however, in case of size B88, it was the pattern E in

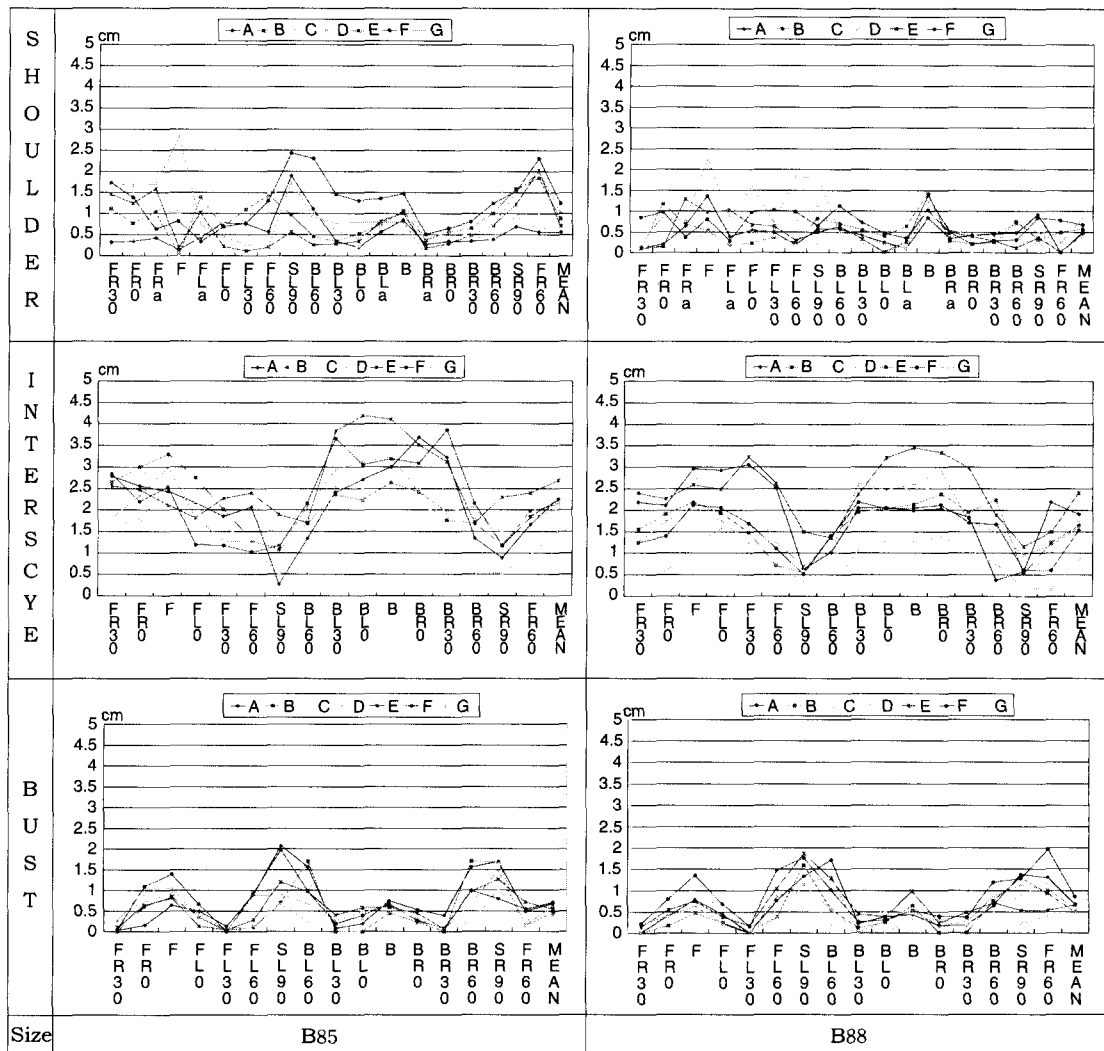
waist and abdomen, pattern F in bust, pattern G in shoulder and hip that marked the largest wearing ease(space length). It suggested that the grading rule value was different according to brands.

The space length marked smaller range and variation among brands in shoulder, bust and hip, where the jacket was close to body, rather than other parts. In interscye, waist and abdomen, more

wearing ease was distributed on back and front rather than side. In bust, FR30, FL30, BL30, BR30 mrked smaller space length than other parts. In case of hip, more wearing ease was distributed on front rather than side and back.

3. Comparison of the average space length by patterns

In order to manifest the difference among



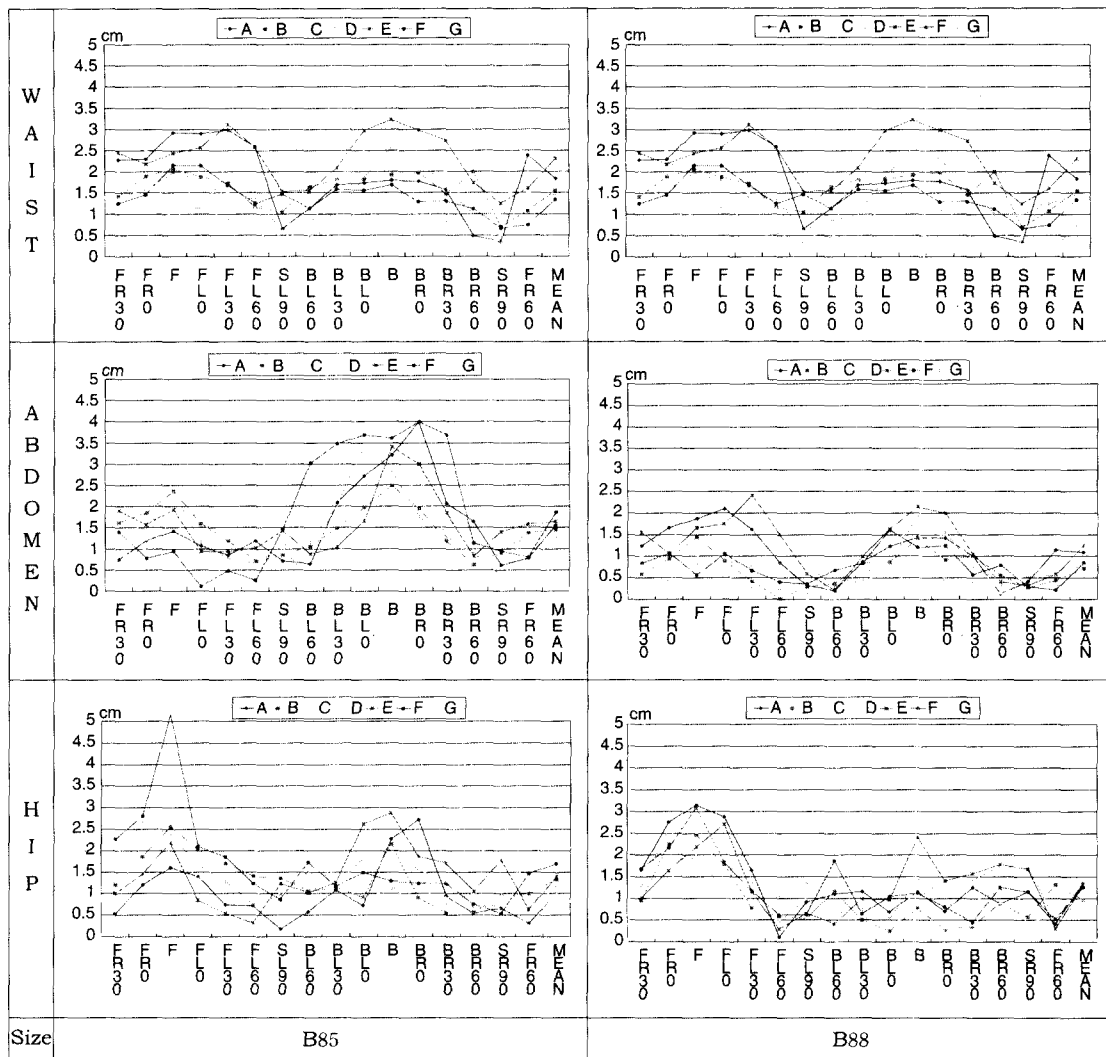


Fig. 3. Space Length between Body and Garment on Each Part

patterns, ANOVA with post-hoc test was carried on. The results were shown in Table 6.

In the shoulder (B85) and abdomen (B85, B88), the space length appeared significantly different among brands. In the shoulder(B85), the space length of pattern A, D were significantly smaller than that of pattern F. In the bust(B88), the space length of pattern D was significantly smaller than

that of pattern F. In the abdomen(B85), the space length of pattern C, D were significantly smaller than that of pattern F. In the abdomen(B88), the space length of pattern D was significantly smaller than that of A, D were larger than that of other patterns. As a whole, pattern F had the largest space length and pattern D marked the smallest one.

Table 6. The Results of ANOVA with Post-hoc Test on the Average Space Length among Patterns

(unit: cm)

Section	Pattern Size	A	B	C	D	E	F	G	Max-Min	p-value
Shoulder	B85	0.567 a	0.887 ab	0.770 a	0.733 a	0.712 a	1.251 b	1.027 ab	0.684	0.01*
	B88	0.467	0.565	0.228	0.406	0.498	0.675	0.842	0.614	0.57
Interscye	B85	0.507	0.789	0.653	0.549	0.791	0.639	0.830	0.323	0.12
	B88	0.466	0.412	0.384	0.313	0.530	0.522	0.517	0.217	0.33
Bust	B85	0.684	0.445	0.582	0.378	0.543	0.702	0.621	0.324	0.08
	B88	0.670 ab	0.514 ab	0.511 ab	0.349 a	0.648 ab	0.874 b	0.580 ab	0.525	0.05*
Waist	B85	2.248	2.130	2.125	1.528	2.679	2.243	2.019	1.151	0.59
	B88	1.908	1.641	1.770	0.839	2.395	1.532	1.607	1.556	0.13
Abdomen	B85	1.558 ab	1.451 ab	1.258 a	1.173 a	1.646 ab	1.859 b	1.521 ab	0.686	0.01**
	B88	1.091 b	0.705 ab	0.908 ab	0.394 a	1.240 b	0.835 ab	0.822 ab	0.846	0.02*
Hip	B85	1.012	1.334	0.996	1.146	1.399	1.704	1.473	0.708	0.79
	B88	1.348	0.965	0.910	0.955	1.322	1.251	1.360	0.349	0.36

*p≤0.05 **p≤0.01

According to SNK-test results, scores were marked with different letters which had significant difference at the level of p≤0.05(a<b)

Table 7. The Results of T-test on the Average Space Length by Size

(unit: cm)

Pattern	Section Size	Shoulder	Interscye	Bust	Waist	Abdomen	Hip
A	B85	0.567	0.507	0.684	2.248	1.558	1.012
	B88	0.467	0.466	0.670	1.908	1.091	1.348
	p-value	0.775	0.772	0.718	0.325	0.012*	0.521
B	B85	0.887	0.789	0.445	2.130	1.451	1.334
	B88	0.565	0.412	0.514	1.641	0.705	0.965
	p-value	0.403	0.202	0.496	0.436	0.033*	0.497
C	B85	0.770	0.653	0.582	2.125	1.258	0.996
	B88	0.228	0.384	0.511	1.770	0.908	0.911
	p-value	0.071	0.014*	0.777	0.590	0.137	0.808
D	B85	0.773	0.549	0.378	1.528	1.173	1.146
	B88	0.406	0.313	0.349	0.839	0.394	0.955
	p-value	0.302	0.043*	0.771	0.314	0.072	0.661
E	B85	0.712	0.791	0.543	2.680	1.646	1.399
	B88	0.498	0.530	0.648	2.395	1.240	1.322
	p-value	0.500	0.109	0.284	0.564	0.090	0.881
F	B85	1.251	0.639	0.702	2.242	1.859	1.704
	B88	0.675	0.522	0.874	1.532	0.835	1.251
	p-value	0.014*	0.055	0.132	0.264	0.026*	0.302
G	B85	1.027	0.830	0.621	2.019	1.521	1.473
	B88	0.842	0.517	0.580	1.607	0.822	1.360
	p-value	0.428	0.044*	0.633	0.544	0.026*	0.830

*p≤0.05

The result of t-test by size on the average space length were shown in table 7. In the bust, waist and hip, there was no significant difference in the average space length between two sizes. On the other side, it was the pattern F in shoulder and pattern C, D and G in interscye, pattern A, B, F and G in abdomen that the space length had significant difference between size B85 and B88. In other words, more patterns appeared to have difference in average space length according to the size in interscye and abdomen than other parts. And in all of these cases, the space length of size B88 was smaller than that of size B85. It suggested that in these parts the space length of size B85 was significantly smaller than size B85. Therefore, the grading rule values should be settled considering the increasement of body size in the abdomen and interscye as well as the bust, waist and hip, which were the basic parts of measurement.

IV. Conclusion and Summary

This study was carried out to analyze and compare the wearing ease of women's ready-made jackets using 3D scanner. Seven brands of women's wear and two subjects for each size (i.e. B85, B88) were selected for experiments. Furthermore, the space length between body and jacket were measured on the overlapped cross section. The results were as follows.

First, In size B85, there were no difference among brands in the girth of cross section of jacket except for the interscye part(B85) and the waist(B88). The product size of jacket was similar regardless of brand in most parts.

Second, In cross sections of body, all the girth were significantly different between size group B85 and B88. In cross section of jacket, only abdomen measurement was not different between size

groups.

Third, In case of size B85, most space lengths of pattern F except interscye and waist were higher scores than other patterns. However, in case of size B88, the highest space length of each part was discovered in several patterns, meaning that the grading rule of body was different according to patterns.

Forth, About the ease distribution, the length marked smaller range and variation among brands in shoulder, bust and hip, where the jacket was close to body, rather than other parts. The portion having more wearing ease in the cross section were; back and front in the interscye, waist and abdomen : FR30, FL30, BL30, BR30 in the bust: front in the hip.

Fifth, The results of ANOVA on the average space length by patterns showed that, as a whole, pattern F had the largest space length and pattern D marked the smallest one.

Sixth According to t-test by size groups, in interscye and abdomen parts, the space length of size B88 was significantly smaller than size B85. Therefore, the grading rule values should be considered in size increasement of the abdomen and interscye as well as the bust, waist and hip.

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