

A Study on Comparing Evaluation of External Appearance between Real and 3D Simulation of Flared Skirt Focused on Flare Volume and Length

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Abstract

This study compared the flared skirts on 3D simulation and in real to show diverse forms in women's clothing depending on the body's gait and motion. By finding the problems, we suggested the possible methods for utilizing the 3D simulation in the clothing industry. First, the 3D simulation of flared skirts showed similar forms of appearance according to the flare length and volume. However, virtually formed drape shape was even in size and spacing, whereas it was not even in real. Second, according to the results of appearance test on the length and flare volume at 90° and 180°, both real and 3D simulation skirts were evaluated to have outstanding appearances regardless of the skirt length. However, as the flares volume increased, the skirts with longer length were evaluated to have superior appearances compared to the skirts of shorter length. Third, it showed higher resemblance between the real and virtual simulation, when the skirt had less flare and as the skirt length shortened. However, it showed greater difference between the real and virtual simulation when flare volume and length increased. The length and volume of the skirt and the physical properties of the material are predicted to be different between the real and virtual simulation. However, they usually are similar in forms, so it is believed possible to use for predicting the design's silhouette or the feel when it is worn. This method can be applied on internet shopping malls, which can possibly reduce unnecessary time and expenses.

Key words: comparison, external appearance, flared skirt, volume of flare, 3D simulation

I. Introduction

The value of products came to move from

simple, functional value to complex, sentimental values and the evolvement of these values increased quality expectations of the products in

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consumers. Development of the internet, increase in social activities, and with overflowing number of products the expectations on goods were raised as was the standard for selecting products.

Thus the situation left apparel companies in an intense competition to satisfy the diverse needs of consumers. To satisfy the diverse needs of the consumers, the importance of utilizing computers is expanding. Computers are now used for various applications including 3D body scanner, 3D pattern, 3D simulation, and others in the clothing industries.

The use of computers had been mainly for apparel pattern CAD and textile design but recently as more people buy clothing from internet shopping malls, 3D simulations are increasingly becoming important by producing and selling clothing apt to the individuals' body type and sensibility in virtual space.

Application of the 3D simulation can reduce the cost and time it takes to produce actual clothing and can reduce trial and error by checking for difference in silhouette according to pattern and textile, for space, location of pockets, collar shape, location of lines, and others. Some 3D software used in clothing industries include MAYA, i-Designer, Tex 3D, NARCIS, PAD system, Fashion studio, DC-Suite, CLO.

Simulation of virtual pre-built clothing in different sizes with avatars made by inputting personal body data allows you to evaluate the effect and fitting without having to actually wear it, thus I think possibly helping to resolve the difficulties of using internet shopping malls. There are various studies about flared skirts because it has complicated factors in several points. For the studies in relation to body figure from the preceding studies, there are studies

about relationship between change of body shape of lower half of women and 3D shape of flared skirts (Cho & Kim, 1992; S. Lee & Hong, 1999; Ryu, 2006), evaluation of wearing shape with body measurement methods using 3D scanner (H. Kim, Seo, & Seok, 2000), drape property and patternmaking methods of flared skirts (Gu, & Seo, 2009; Han, 1990; H. Kim, 1991; Seo & Lee, 1996), and so on. Also, nowadays, study about 3D simulations of flared skirts (M. Lee, 2006; Park, 2007) are being done, but in personal thought, since 3D simulation is inclined to image evaluation, comparison between simulations and real has high meaning of study.

Therefore this study can, by comparing the 3D simulation clothing with real clothing centered on flared skirts of women's clothing which shows diverse form depending on skirt's flare volume and length, find its problems and by suggesting methods of its use, suggest the possibility of utilizing the 3D simulation in the clothing industry.

II. Method of Study

1. Application Size for Study

The measurements used in this study are based on average size of 'the 6th Korean body measurements survey ("Korean Agency for Technology and Standard", 2014) targeting women in their 20s with the most ideal body types (Table 1).

2. Design for Study

The design selected for this study is the flared skirt, using four types (90°, 180°, 270°, 360°) of

Table 1. Application Size for Study

(unit: cm, kg, kg/m²)

part	size	part	size
Height	160.4	Hip height	79.8
Waist height	97.4	Knee height	41.4
Crotch height	72.9	Waist width	24.5
Hip width	32.3	Waist depth	16.8
Hip depth	21.1	Waist circumference	69.5
Hip circumference	91.4	Abdomen circumference	79.6
Hip length	19.0	Crotch length	69.4
Knee circumference	34.9	Weight	53.1
BMI	20.6		

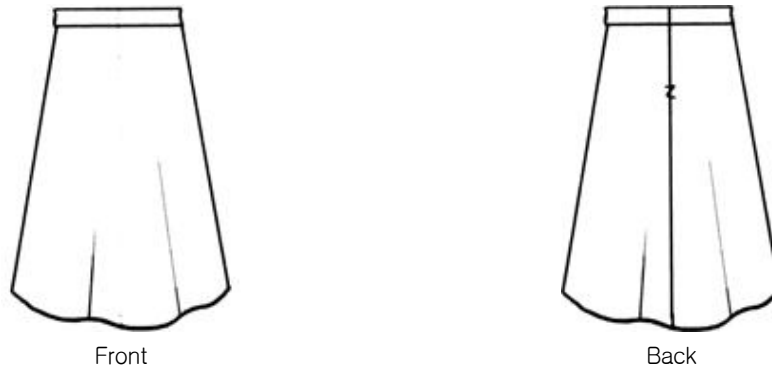


Figure 1. Design of Flare Skirt

flare volume for visual assessment, and the skirt lengths were produced in 3 types 46cm, 56cm, 66cm, which are plus and minus 10cm of 56cm that comes from the waist height (97.4cm) of women in their 20s from ‘the 6th Korean body measurements survey’ minus the knee height (41.4cm) (Figure 1).

3. Method of Patternmaking

Methods of drafting flared skirts include, method of cutting and drafting the width of semi-tight skirts, method of using planar figures

of a truncated cone, or using circular arcs (Miyoshi Machiko, 2002). This study drafted patterns by method of using circular arcs. I chose this method because it is simple and was used for most of the preceding studies. Grain line was placed on a 45° bias that shows the most beautiful appearance of the flared skirt (Figure 2) (Figure 3).

4. Material for Experimental Clothing

The material used in this study is 100% cotton muslin with physical properties of the test port same as Table 2.

Table 2. Physical Properties of Experimental Clothing's Material

	Weight (g/m ²)	Thickness (m/m)	Density(ply/5cm)		Stretch(%)		Strength(kgf)	
			warp	weft	warp	weft	warp	weft
Muslin	148.9	0.34	119.6	110.4	19.4	12.0	30.2	26.8

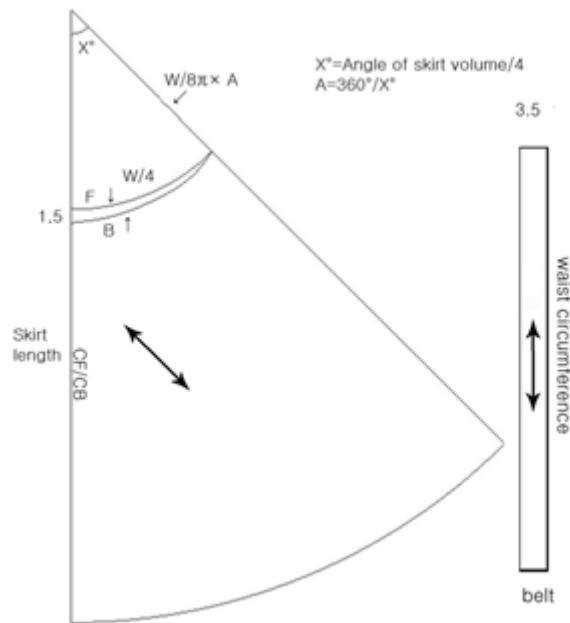


Figure 2. Method of Patternmaking (unit: cm,)
 - Study of modeling clothes-theory I, p.353

5. 3D Simulation Program

For this study, DC Suite 5.0 program developed from the Seoul National University Digital clothing center was used.

6. Method of Measurement

A group of clothing majors with expertise on garments were selected for evaluation of this study. 5 people formed of professors that majored in clothing and experts and 5 students

of clothing major were selected as evaluators. 12 irritants were color printed on A4 size paper to be evaluated in the same conditions.

7. Evaluation Scales

The items for the evaluation to compare real garments with 3D simulation garments on the flared skirt's external appearance, which is dependent on flare volume and skirt length, were chosen based on previous studies (Gu & Seo, 2009; S. Kim, 2013; J. Lee & Han, 2010).

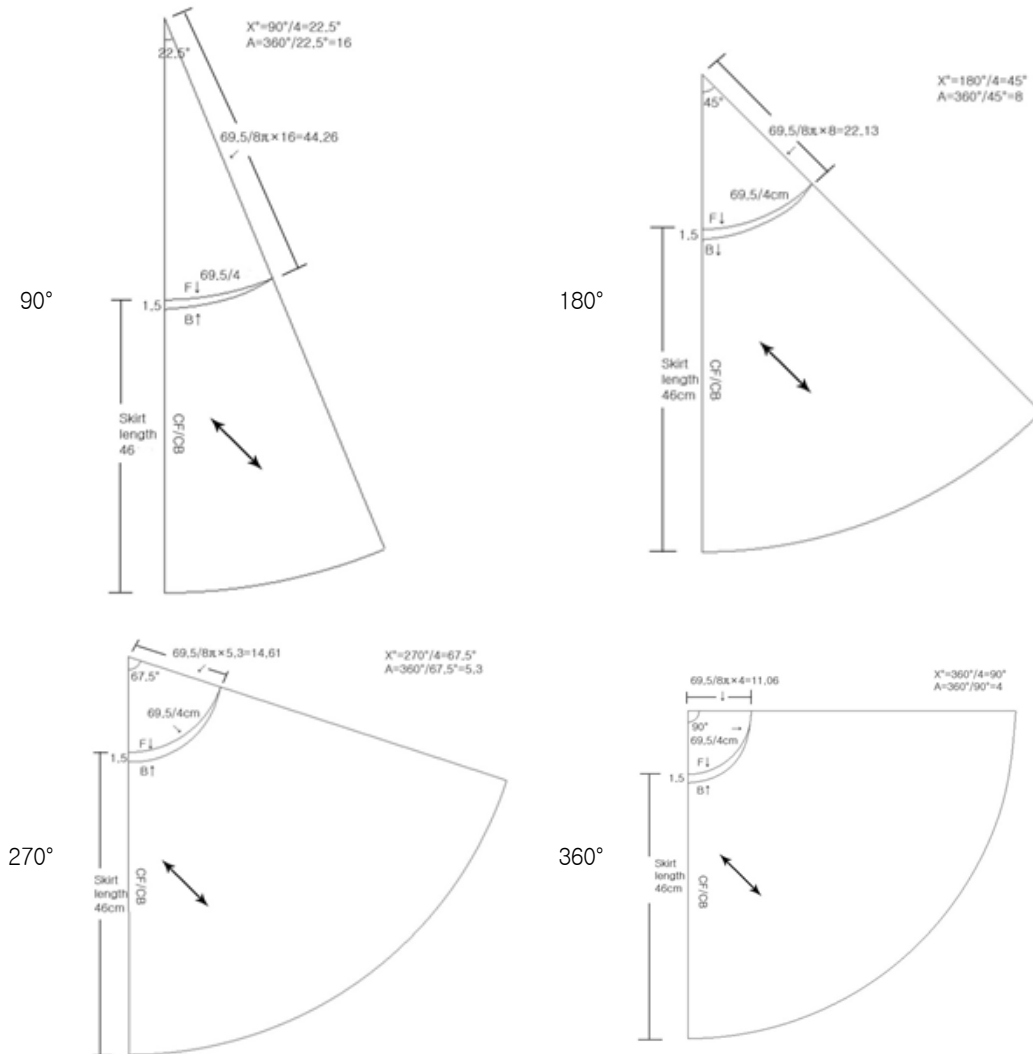


Figure 3. Skirt Pattern as Skirt Angle (unit: cm.)

Two categories, external appearance evaluation and evaluation of comparison of the real and virtual, each with 10 questions to make a total of 20 questions were selected on a scale to 5 for the evaluators to assess. 1 point is given on the left end side, and 5 points for the right end (Table 3).

8. Data Analysis

In this study, data analysis was statistically analyzed through the SPSS 18.0 program. T-test was performed to find out if there are differences in the external appearance evaluation

Table 3. Evaluation Items

	Evaluation of external appearance	Comparing evaluation between real and 3D simulation
1	How about horizontality of waistline?	How about similarity of front silhouette?
2	How about waist space?	How about similarity of side silhouette?
3	How about sideline position?	How about similarity of back silhouette?
4	How about verticality of side line?	How about similarity of front hemline drape's shape?
5	How about horizontality of hemline?	How about similarity of side hemline drape's shape?
6	How about equality of hemline drape?	How about similarity of back hemline drape's shape?
7	How about beauty of front shape?	How about similarity of front pleats' shape?
8	How about beauty of side shape?	How about similarity of side pleats' shape?
9	How about beauty of back shape?	How about similarity of back pleats' shape?
10	How about beauty of total silhouette?	How about similarity of total feeling?

between 3D simulation and real fitting the clothes depending on the skirt volume and length, One-way ANOVA was performed for 3D simulation and real fitting comparisons according to skirt volume and length, and Duncan's multiple range tests were performed for post-verification comparison results. $\alpha = 0.05$ was proven statistically significant.

III. Results

The results of this study to find, by comparing the 3D simulation clothing with real clothing centered on flared skirts of women's clothing which shows diverse form depending on the skirt's flare volume and length, its problems and suggest the possibility of utilizing the 3D simulation in the clothing industry by suggesting methods of its use, is as follows.

First, if you look at the external appearance of 3D simulations according to flare skirt's flare part, it is the same as figure 4. In the case of the 90° flared skirt the front and back of the

skirt is flat, the sides form wrinkles, and wrinkles formed from the midpoint of the skirt length and down without relations to skirt length. In the case of the 180° skirt the middle of the skirt's front and back concave and exhibits wrinkles uniformly. The 46cm 270° skirt showed similar form to the 180° skirt but the longer 56cm, 66cm cases showed slightly smaller wrinkles in more numbers and the wrinkles formed around the waist. In case of the 360° skirt many fine wrinkles uniformly formed and the waist line did not form a horizontal line.

Looking at the appearance of real skirts according to the flare length in flared skirts, it is as shown in figure 5. In case of the 90° skirt, the 46cm and 56cm lengths showed the same wrinkles on each side as had the 3D simulation shown, but in case of the 66cm length the wrinkles were almost all smoothed out. For the 180flared skirt the midsection of the front and back concaved and showed drapes on each side. However the wrinkle sizes or shapes were not uniform as in the 3D simulation. Also, it was more spread outwards than the 90° flared skirt so it appeared to look more plump. In case of

the 270° skirt, the midsection on the front and back is more concaved and the drapes on each side showed to be larger in size. Also, the wrinkles showed to be more stable in skirts with shorter length than the longer lengths. Not only that, but the number of wrinkles tended to increase and the size tended to shrink. The 360° flared skirt had deep wrinkles from the waist belt area, and more wrinkles appeared as the flare widened. Drapes showed stable form as skirt length grew longer and in case of the 46cm and 56cm skirt, they looked plump but in the 66cm skirt wrinkles settled calmly, giving the effect of looking slimmer.

For the 46cm 90° flared skirt, it showed significant difference in appearance between the real and virtual in terms of space, line position on the sides, verticality of lines on the side, horizontality of hemlines, and the drape of hemlines. Location of lines on the sides, perpendicular lines on the side, and horizontality of hemlines showed superior appearance virtually than in reality and the drapes were more evenly set virtually than reality. Horizontality of the waistline, beauty of the front, side, and back, and the beauty of the overall silhouette showed to be similar, having no significant differences between the virtual and the real. For the 56cm skirt, the verticality of side lines and drapes on the hemline showed difference virtually and in reality as the side lines were more perpendicular in reality than virtually and the drapes of the hemline were evenly set virtually but assessed to be not so even in reality. Even in the 66cm skirt, the drapes on the hemlines were set unevenly in reality. So 90flared skirt showed better external appearance virtually than in reality (Table 4).

In case of the 46cm 180° flared skirt, the virtual skirt proved to be superior in than the

real in terms of position of lines on the sides, verticality of lines on the side, the drape in hemlines, the beauty in the front, side, back and overall silhouette, and the horizontality of the hemline showed to be same in the virtual and real. As for 56cm skirts the side line positions, verticality of side lines, drape of hemlines, and beauty of the side, back and overall silhouette showed significant difference with superior appearances in real skirts than the virtual. At the 66cm length the waist space and the beauty in front and sides showed better appearance in actual skirts and virtually the hemline drapes were superior. In case of hemline drapes, they don't form in even size and interval in real skirts but virtually they uniformly have even size and spacing. So 180° flared skirt showed better external appearance virtually than in reality (Table 5).

In the case of 46cm 270° flared skirts, in all aspects such as the horizontality in waist line, waist space, position of side lines, verticality of side lines, horizontality of hemline, and beauty of the front, side, and overall silhouette, the appearance in reality is superior to the virtual except for the hemline drapes. For 56cm skirts its appearance was superior in reality than in the virtual in terms of horizontality of the waist line, waist line space, horizontality of the hemline, the beauty of the front, side, back and overall silhouette, and did not show significant differences in other terms. In 66cm skirts the hemline drapes were shown to be set evenly in the virtual. However, the horizontality in the waist, waist space, and beauty of the front was superior in reality. In other aspects the real and the virtual did not show significant difference. So 270° flared skirt showed better external appearance in reality than virtually (Table 6).













Angle \ Length	90°	180°	270°	360°
46cm				
56cm				
66cm				

Figure 4. Simulation of Skirts









Angle Length	90°	180°	270°	360°
46cm				
56cm				
66cm				

Figure 5. Fitting of Skirts

Table 4. Evaluation of External Appearance between 3D Simulation and Real Fitting for Lengths of 90° Flared Skirt

Skirt length	Contents of evaluation	3D simulation		Real fitting		<i>t</i>
		average	SD	average	SD	
46cm	Horizontality of waistline	4.60	.52	4.60	0.52	.000
	Space of waist	4.70	.48	3.90	0.74	2.869**
	Position of side line	3.80	.63	4.50	0.53	-2.689*
	Verticality of side line	2.80	.42	3.90	0.57	-4.919***
	Horizontality of hemline	3.90	.74	4.80	0.42	-3.349**
	Drape of hemline	4.40	.52	3.70	0.67	2.605*
	Front shape	4.60	.52	4.50	0.53	.429
	Side shape	3.60	.52	4.20	0.79	-2.012
	Back shape	4.30	.82	4.50	0.53	-0.647
	Total silhouette	4.50	.53	4.50	0.53	0.000
56cm	Horizontality of waistline	4.80	.42	5.00	.00	-1.500
	Space of waist	4.40	.52	4.20	.42	.949
	Position of side line	4.20	0.63	4.70	.48	-1.987
	Verticality of side line	3.20	.42	4.60	.70	-5.422***
	Horizontality of hemline	4.00	.00	4.10	.57	-.557
	Drape of hemline	4.50	.53	3.60	.52	3.857**
	Front shape	4.60	.52	4.80	.42	-.949
	Side shape	3.90	.32	4.10	.57	-.973
	Back shape	4.20	.42	4.00	.47	1.000
	Total silhouette	4.30	.48	4.60	.52	-1.342
66cm	Horizontality of waistline	4.60	.52	4.70	.48	-.447
	Space of waist	4.10	.32	4.00	.67	.429
	Position of side line	4.70	.48	4.40	.70	1.116
	Verticality of side line	4.50	.85	4.20	.63	.896
	Horizontality of hemline	3.90	.32	3.80	.42	.600
	Drape of hemline	3.90	.32	3.10	.32	5.657***
	Front shape	3.60	.52	3.80	.42	-.949
	Side shape	4.00	.47	3.90	.32	.557
	Back shape	3.40	.52	3.70	.48	-1.342
	Total silhouette	3.50	.53	3.80	.42	-1.406

*p<.05, **p<.01, ***p<.001

Table 5. Evaluation of External Appearance between 3D Simulation and Real Fitting for Lengths of 180° Flared Skirt

Skirt length	Contents of evaluation	3D simulation		Real fitting		<i>t</i>
		average	SD	average	SD	
46cm	Horizontality of waistline	4.40	.52	4.00	.82	1.309
	Space of waist	4.00	.00	3.60	.52	2.449*
	Position of side line	4.80	.42	3.90	.57	4.025**
	Verticality of side line	4.60	.52	3.70	.48	4.025**
	Horizontality of hemline	4.00	.00	4.00	.00	-
	Drape of hemline	4.50	.53	3.00	.47	6.708***
	Front shape	4.80	.42	3.70	.67	4.371***
	Side shape	4.50	.53	3.50	.53	4.243***
	Back shape	4.70	.48	3.60	.52	4.919***
	Total silhouette	4.80	.42	3.70	.48	5.425***
56cm	Horizontality of waistline	4.30	.48	4.00	.00	1.964
	Space of waist	3.70	.48	3.70	.48	.000
	Position of side line	4.50	.71	3.60	.52	3.250**
	Verticality of side line	3.90	.32	3.30	.67	2.546*
	Horizontality of hemline	4.00	.00	3.70	.48	1.964
	Drape of hemline	4.30	.48	3.00	.94	3.881**
	Front shape	4.30	.48	4.10	.88	.632
	Side shape	4.40	.52	3.80	.42	2.846*
	Back shape	4.30	.48	3.00	.00	8.510***
	Total silhouette	4.30	.48	3.60	.52	3.130**
66cm	Horizontality of waistline	4.20	.63	4.70	.48	-1.987
	Space of waist	3.30	.48	3.90	.32	-3.286**
	Position of side line	4.30	.48	4.60	.52	-1.342
	Verticality of side line	3.90	.74	3.80	.42	.372
	Horizontality of hemline	4.00	.00	4.00	.00	-
	Drape of hemline	3.70	.48	3.00	.47	3.280**
	Front shape	3.60	.52	4.50	.53	-3.857**
	Side shape	3.60	.52	4.00	.00	-2.449*
	Back shape	3.40	.70	2.90	.32	2.060
	Total silhouette	3.60	.70	4.00	.00	-1.809

*p<.05, **p<.01, ***p<.001

Table 6. Evaluation of External Appearance between 3D Simulation and Real Fitting for Lengths of 270° Flared Skirt

Skirt length	Contents of evaluation	3D simulation		Real fitting		<i>t</i>
		average	SD	average	SD	
46cm	Horizontality of waistline	3.50	.53	4.30	.48	-3.539**
	Space of waist	2.90	.57	3.70	.48	-3.394**
	Position of side line	2.80	.42	3.60	.52	-3.795***
	Verticality of side line	1.30	.48	2.90	.57	-6.788***
	Horizontality of hemline	2.50	.53	4.00	.00	-9.000***
	Drape of hemline	3.90	.32	2.20	.42	10.200***
	Front shape	2.80	.42	3.20	.42	-2.121*
	Side shape	1.20	.42	3.20	.42	-10.607***
	Back shape	2.40	.52	2.70	.48	-1.342
	Total silhouette	2.40	.52	3.00	.00	-3.674**
56cm	Horizontality of waistline	3.80	.42	4.70	.48	-4.439***
	Space of waist	2.30	.48	3.80	.42	-7.398***
	Position of side line	3.70	.48	3.90	.32	-1.095
	Verticality of side line	3.80	.79	3.30	.48	1.709
	Horizontality of hemline	3.30	.48	4.00	.00	-4.583***
	Drape of hemline	2.40	.52	2.70	.48	-1.342
	Front shape	2.80	.42	4.40	.52	-7.589***
	Side shape	3.00	.67	3.90	.32	-3.857***
	Back shape	2.50	.85	3.80	.42	-4.333***
	Total silhouette	2.80	.42	4.00	.00	-9.000***
66cm	Horizontality of waistline	3.90	.32	4.70	.48	-4.382***
	Space of waist	2.70	.48	3.60	.52	-4.025**
	Position of side line	4.10	.57	4.00	.67	.361
	Verticality of side line	3.80	.42	3.40	.84	1.342
	Horizontality of hemline	4.20	.63	4.00	.00	1.000
	Drape of hemline	3.90	.32	2.50	.53	7.203***
	Front shape	3.60	.52	4.50	.53	-3.857**
	Side shape	3.60	.52	3.80	.79	-.671
	Back shape	3.40	.84	2.80	.63	1.800
	Total silhouette	3.60	.52	3.70	.82	-.325

*p<.05, **p<.01, ***p<.001

Table 7. Evaluation of External Appearance between 3D Simulation and Real Fitting for Lengths of 360° Flared Skirt

Skirt length	Contents of evaluation	3D simulation		Real fitting		<i>t</i>
		average	SD	average	SD	
46cm	Horizontality of waistline	3.80	.42	4.30	.48	-2.466*
	Space of waist	2.40	.52	3.50	.53	-4.714***
	Position of side line	4.50	.53	3.00	.00	9.000***
	Verticality of side line	4.70	.48	2.10	.57	11.031***
	Horizontality of hemline	3.90	.32	3.60	.52	1.567
	Drape of hemline	3.60	.70	2.20	.63	4.696***
	Front shape	3.10	.57	3.40	.52	-1.236
	Side shape	3.30	.48	2.90	.32	2.191*
	Back shape	3.00	.47	2.70	.48	1.406
Total silhouette	3.00	.47	2.90	.32	.557	
56cm	Horizontality of waistline	2.30	.48	4.60	.52	-10.286***
	Space of waist	2.10	.32	3.50	.53	-7.203***
	Position of side line	3.60	1.17	3.90	.32	-.780
	Verticality of side line	4.10	.32	2.90	.57	5.840***
	Horizontality of hemline	3.70	.48	3.90	.32	-1.095
	Drape of hemline	3.10	.74	2.50	.53	2.092
	Front shape	2.50	.53	4.50	.53	-8.485***
	Side shape	2.60	.84	3.80	.63	-3.600**
	Back shape	2.30	.48	3.00	.00	-4.583***
Total silhouette	2.40	.52	4.00	.00	-9.798***	
66cm	Horizontality of waistline	3.00	.67	4.80	.42	-7.216***
	Space of waist	1.90	.57	4.00	.00	-11.699***
	Position of side line	4.10	.32	4.30	.48	-1.095
	Verticality of side line	4.10	.32	3.70	.82	1.434
	Horizontality of hemline	3.70	.48	4.30	.48	-2.777*
	Drape of hemline	2.60	.70	3.10	.88	-1.411
	Front shape	3.10	.32	4.90	.32	-12.728***
	Side shape	3.50	.53	4.50	.53	-4.243***
	Back shape	3.60	.52	3.20	.63	1.549
Total silhouette	3.40	.52	4.50	.53	-4.714***	

*p<.05, **p<.01, ***p<.001

In the case of 46cm 360° flared skirts the horizontality of waistline and space was found to be superior in reality and for the position of side lines, its verticality, hemline drapes, and the beauty of the side was superior in the virtual. In 56cm skirts all aspects except for the verticality of side lines were better in real skirts. As for the

66cm length the position of side lines, its verticality, hemline drapes, and the beauty of the back showed no significant differences, and in the other aspects real skirts were superior to the virtual. 360° flared skirt showed better external appearance in reality than virtually (Table 7).

Table 8. Evaluation of External Appearance of 3D Simulation for Skirt Length and Flare Volume

Skirt length	Contents of evaluation	90°		180°		270°		360°		F	Duncan Test			
		average	SD	average	SD	average	SD	average	SD					
46cm	Horizontality of waistline	4.60	.52	4.40	.52	3.50	.53	3.80	.42	10.618***	a	a	b	b
	Space of waist	4.70	.48	4.00	.00	2.90	.57	2.40	.52	52.865***	a	b	c	d
	Position of side line	3.80	.63	4.80	.42	2.80	.42	4.50	.53	30.548***	b	a	c	a
	Verticality of side line	2.80	.42	4.60	.52	1.30	.48	4.70	.48	115.463***	b	a	c	a
	Horizontality of hemline	3.90	.74	4.00	.00	2.50	.53	3.90	.32	22.373***	a	a	b	a
	Drape of hemline	4.40	.52	4.50	.53	3.90	.32	3.60	.70	6.353**	a	a	b	b
	Front shape	4.60	.52	4.80	.42	2.80	.42	3.10	.57	44.153***	a	a	b	b
	Side shape	3.60	.52	4.50	.53	1.20	.42	3.30	.48	81.628***	b	a	c	b
	Back shape	4.30	.82	4.70	.48	2.40	.52	3.00	.47	33.333***	a	a	c	b
	Total silhouette	4.50	.53	4.80	.42	2.40	.52	3.00	.47	56.859***	a	a	c	b
56cm	Horizontality of waistline	4.80	.42	4.30	.48	3.80	.42	2.30	.48	56.757***	a	b	c	d
	Space of waist	4.40	.52	3.70	.48	2.30	.48	2.10	.32	59.000***	a	b	c	c
	Position of side line	4.20	.63	4.50	.71	3.70	.48	3.60	1.17	2.867*	ab	a	b	c
	Verticality of side line	3.20	.42	3.90	.32	3.80	.79	4.10	.32	6.000**	b	a	a	a
	Horizontality of hemline	4.00	.00	4.00	.00	3.30	.48	3.70	.48	9.429***	a	a	b	a
	Drape of hemline	4.50	.53	4.30	.48	2.40	.52	3.10	.74	30.126***	a	a	c	b
	Front shape	4.60	.52	4.30	.48	2.80	.42	2.50	.53	46.465***	a	a	b	b
	Side shape	3.90	.32	4.40	.52	3.00	.67	2.60	.84	17.759***	a	a	b	b
	Back shape	4.20	.42	4.30	.48	2.50	.85	2.30	.48	33.634***	a	a	b	b
	Total silhouette	4.30	.48	4.30	.48	2.80	.42	2.40	.52	43.463***	a	a	b	b
66cm	Horizontality of waistline	4.60	.52	4.20	.63	3.90	.32	3.00	.67	15.275***	a	ab	b	c
	Space of waist	4.10	.32	3.30	.48	2.70	.48	1.90	.57	39.000***	a	b	c	d
	Position of side line	4.70	.48	4.30	.48	4.10	.57	4.10	.32	3.600*	a	ab	b	b
	Verticality of side line	4.50	.85	3.90	.74	3.80	.42	4.10	.32	2.482				
	Horizontality of hemline	3.90	.32	4.00	.00	4.20	.63	3.70	.48	2.364				
	Drape of hemline	3.90	.32	3.70	.48	3.90	.32	2.60	.70	16.880***	a	a	a	b
	Front shape	3.60	.52	3.60	.52	3.60	.52	3.10	.32	2.778				
	Side shape	4.00	.47	3.60	.52	3.60	.52	3.50	.53	1.903				
	Back shape	3.40	.52	3.40	.70	3.40	.84	3.60	.52	.231				
	Total silhouette	3.50	.53	3.60	.70	3.60	.52	3.40	.52	.282				

*p<.05, **p<.01, ***p<.001

As a result of comparison with the result of evaluation of appearance of skirts classified by angles, in case of virtual skirts in 90° and 180°, they were evaluated to have an outstanding appearance in almost every term regardless of the skirt's length. In case of the 46cm length skirt, 180° skirts were evaluated to have a far superior appearance. It received the highest assessment in every term except for the margin of waist. But it appeared that 90° skirt was superior in terms except for the position of side lines, verticality, shape of the side. It appeared that the result of evaluation of appearance gets worse at 270° and 360° which has bigger flares on the skirt. But 360° received higher assessment than 270° skirt. In length of 56cm, 90° skirt received the highest assessment, 180° skirt received somewhat lower assessment in the horizontality of waist and space. 270° and 360° skirts received almost similar degree of assessment. In length of 66cm, it appeared to have no significant differences depending on size of the flare of skirt in every term except for horizontality of waist, space of waist, position of side lines and drape hemlines. It received low assessment in degree of 90°, 180°, 270°, 360° in horizontality of waist, space of waist, position of side lines and drape of hemline. So it was evaluated that the bigger the size of the flare of the skirt, the worse it looks (Table 8).

As a result of comparison with the result of evaluation of appearance of real skirts classified by angles, there were no significant differences depending on angles at the horizontality of waist and space, but having smaller flare size on the skirt at position of side lines, verticality of side line, horizontality of hemlines, drape of hem-line, front shape, side shape, back shape and large silhouette, that is with smaller angle, it looks more beautiful. And with larger size of

flare of the skirt, it received low assessment in almost all terms. There were no significant differences depending on the horizontality of hemlines, shape of front and side in 56cm skirt but in other terms, it was evaluated that the less size of the flare of skirt, the more beautiful it looks like in 46cm skirts. It was assessed that 66cm skirt has significant differences in horizontality of hemlines, shape of front, side, back and overall silhouette and has no differences classified by angles in other terms. Unlike 46cm, 56cm skirt, it showed opposite results. In 66cm skirt, it showed difference that the bigger size of flare of the skirt, that is the larger angle it has, the more beautiful it looks. In case of flare size on skirts as more of them there are, and the longer the length of skirt it looks more beautiful than in shorter length skirt (Table 9).

As a result of comparison with real and virtual skirt, in 90° flare skirt, there was no difference in real and 3D simulation skirt when they are 46cm and 56cm, but in 66cm length, it showed average similarity overall, so it was evaluated that it somewhat has differences. In particular, it received low assessment in the wrinkles' similarity of the front and side, and shape similarity of front hem-line drape.

In case of 180° flared skirt, it was revealed that it barely had differences in real and 3D simulation skirts in terms of 'similarity of overall silhouette of front', 'similarity of overall silhouette of back', 'shape similarity of side hem-line drape', and 'shape similarity of back hem-line drape'. But it was evaluated to have less similarity in 56cm and 66cm length. On the other hand, it evaluated that 56cm length has the most similarities in overall look, then 66cm length, and 46cm length has the least similarities.

Table 9. Evaluation of External Appearance of Real Fitting for Skirt Lengths and Flare Volume

Skirt length	Contents of evaluation	90°		180°		270°		360°		F	Duncan Test			
		average	SD	average	SD	average	SD	average	SD					
46cm	Horizontality of waistline	4.60	.52	4.00	.82	4.30	.48	4.30	.48	1.714				
	Space of waist	3.90	.74	3.60	.52	3.70	.48	3.50	.53	.882				
	Position of side line	4.50	.53	3.90	.57	3.60	.52	3.00	.00	18.000***	a	b	b	c
	Verticality of side line	3.90	.57	3.70	.48	2.90	.57	2.10	.57	22.556***	a	a	b	c
	Horizontality of hemline	4.80	.42	4.00	.00	4.00	.00	3.60	.52	22.800***	a	b	b	c
	Drape of hemline	3.70	.67	3.00	.47	2.20	.42	2.20	.63	16.646***	a	b	c	c
	Front shape	4.50	.53	3.70	.67	3.20	.42	3.40	.52	11.094***	a	b	b	b
	Side shape	4.20	.79	3.50	.53	3.20	.42	2.90	.32	10.528***	a	b	bc	c
	Back shape	4.50	.53	3.60	.52	2.70	.48	2.70	.48	29.374***	a	b	c	c
	Total silhouette	4.50	.53	3.70	.48	3.00	.00	2.90	.32	35.945***	a	b	c	c
56cm	Horizontality of waistline	5.00	.00	4.00	.00	4.70	.48	4.60	.52	14.067***	a	c	b	b
	Space of waist	4.20	.42	3.70	.48	3.80	.42	3.50	.53	4.000*	a	b	ab	b
	Position of side line	4.70	.48	3.60	.52	3.90	.32	3.90	.32	12.714***	a	b	b	b
	Verticality of side line	4.60	.70	3.30	.67	3.30	.48	2.90	.57	14.644***	a	b	b	b
	Horizontality of hemline	4.10	.57	3.70	.48	4.00	.00	3.90	.32	1.780				
	Drape of hemline	3.60	.52	3.00	.94	2.70	.48	2.50	.53	5.520**	a	b	b	b
	Front shape	4.80	.42	4.10	.88	4.40	.52	4.50	.53	2.239				
	Side shape	4.10	.57	3.80	.42	3.90	.32	3.80	.63	.800				
	Back shape	4.00	.47	3.00	.00	3.80	.42	3.00	.00	27.667***	a	b	a	b
	Total silhouette	4.60	.52	3.60	.52	4.00	.00	4.00	.00	12.750***	a	c	b	b
66cm	Horizontality of waistline	4.70	.48	4.70	.48	4.70	.48	4.80	.42	.114				
	Space of waist	4.00	.67	3.90	.32	3.60	.52	4.00	.00	1.767				
	Position of side line	4.40	.70	4.60	.52	4.00	.67	4.30	.48	1.744				
	Verticality of side line	4.20	.63	3.80	.42	3.40	.84	3.70	.82	2.220				
	Horizontality of hemline	3.80	.42	4.00	.00	4.00	.00	4.30	.48	4.135*	b	ab	ab	a
	Drape of hemline	3.10	.32	3.00	.47	2.50	.53	3.10	.88	2.415				
	Front shape	3.80	.42	4.50	.53	4.50	.53	4.90	.32	10.040***	b	a	a	a
	Side shape	3.90	.32	4.00	.00	3.80	.79	4.50	.53	3.867*	b	b	b	a
	Back shape	3.70	.48	2.90	.32	2.80	.63	3.20	.63	5.765**	a	b	b	b
	Total silhouette	3.80	.42	4.00	.00	3.70	.82	4.50	.53	4.471**	b	b	b	a

Table 10. Comparison Evaluation between 3D Simulation and Real Fitting

Angle	Contents of evaluation	46cm		56cm		66cm		F	Duncan test		
		average	SD	average	SD	average	SD				
90°	Similarity of front total silhouette	4.70	.48	4.50	.53	3.50	.53	15.718***	a	a	b
	Similarity of side total silhouette	4.10	.74	3.10	.32	2.90	.88	8.787**	a	b	b
	Similarity of back total silhouette	4.60	.52	4.40	.70	3.80	.42	5.571**	a	a	b
	Similarity of front hem drape shape	4.00	.67	4.00	.00	2.70	.48	24.934***	a	a	b
	Similarity of side hem drape shape	3.80	.92	3.70	.48	2.80	.63	6.158**	a	a	b
	Similarity of back hem drape shape	4.20	.42	3.90	.32	3.20	.42	17.341***	a	a	b
	Similarity of front folds' shape	4.40	.52	4.40	.52	2.40	.52	50.000***	a	a	b
	Similarity of side folds' shape	3.90	.74	3.60	.52	2.60	.70	10.692***	a	a	b
	Similarity of back folds' shape	4.40	.52	4.00	.47	3.40	.52	10.059**	a	a	b
	Similarity of total feeling	4.70	.48	4.20	.63	3.30	.48	17.423***	a	a	b
180°	Similarity of front total silhouette	4.30	.48	4.30	.48	3.70	.67	3.904*	a	a	b
	Similarity of side total silhouette	3.50	.53	3.20	.42	3.30	.48	1.016			
	Similarity of back total silhouette	4.30	.48	4.00	.00	3.30	.48	16.929***	a	a	b
	Similarity of front hem drape shape	3.30	.82	2.70	.48	2.80	.92	1.766			
	Similarity of side hem drape shape	3.10	.32	2.50	.53	2.40	.70	4.962*	a	b	b
	Similarity of back hem drape shape	3.30	.48	2.70	.48	2.50	.53	6.985**	a	b	b
	Similarity of front folds' shape	2.80	.42	2.70	.48	2.50	.85	.618			
	Similarity of side folds' shape	3.20	.63	2.80	.63	2.50	.85	2.431			
	Similarity of back folds' shape	2.60	.52	2.70	.48	2.40	.70	.708			
	Similarity of total feeling	3.20	.42	3.80	.42	3.60	.52	4.500*	b	a	ab
270°	Similarity of front total silhouette	4.40	.52	4.10	.32	4.30	.48	1.167			
	Similarity of side total silhouette	3.80	.42	3.60	.52	4.20	.42	4.500*	ab	b	a
	Similarity of back total silhouette	4.20	.63	4.00	.00	3.90	.32	1.400			
	Similarity of front hem drape shape	3.30	.95	2.90	.88	3.70	.67	2.262			
	Similarity of side hem drape shape	3.10	.74	2.80	.79	3.20	.63	.830			
	Similarity of back hem drape shape	2.90	.88	2.50	.53	3.10	.57	2.049			
	Similarity of front folds' shape	3.40	.52	2.50	.85	3.80	.92	7.255**	a	b	a
	Similarity of side folds' shape	3.10	.32	2.30	.48	3.40	1.17	5.669**			
	Similarity of back folds' shape	3.10	.32	2.30	.48	2.90	.74	5.924**	a	b	a
	Similarity of total feeling	4.00	.00	3.80	.42	4.20	.42	3.375*	ab	b	a
360°	Similarity of front total silhouette	3.40	.52	4.40	.52	5.00	.00	36.750***	c	b	a
	Similarity of side total silhouette	3.20	.42	3.80	.42	4.00	.00	14.625***	b	a	a
	Similarity of back total silhouette	3.10	.32	3.60	.52	3.80	.42	7.163**	b	a	a
	Similarity of front hem drape shape	2.40	.52	4.20	.42	4.80	.42	75.214***	c	b	a
	Similarity of side hem drape shape	2.30	.48	3.30	.67	3.50	.53	12.828***	b	a	a
	Similarity of back hem drape shape	2.10	.32	3.10	.57	3.10	.32	19.149***	b	a	a
	Similarity of front folds' shape	1.50	.97	4.10	.74	4.10	.32	42.545***	b	a	a
	Similarity of side folds' shape	1.40	.70	3.10	.74	3.30	.48	25.816***	b	a	a
	Similarity of back folds' shape	1.40	.70	2.80	.42	3.60	.52	39.857***	c	b	a
	Similarity of total feeling	2.50	.53	3.80	.42	4.30	.48	37.597***	c	b	a

*p<.05, **p<.01, ***p<.001

In case of 270° flared skirt, it was evaluated that 66cm length is the most superb in terms of 'similarity of overall silhouette of side', 'pleats' similarity of the front', 'pleats' similarity of the back', and 'similarity of overall looking', then in degree of 46cm and 56cm received a good assessment.

360° flared skirt was evaluated that 66cm length is the most similar in all items. Next were 56cm and 46cm that lined up in order of length. 46cm length had the worst similar.

In case of small flare volume, if skirt length was short, real and 3D simulation skirt had similar external appearances. But in case of big flare volume, if skirt had long length, they were similar. There were significant differences (Table 10).

IV. Conclusion

Cases of buying clothing on internet shopping malls increased recently, and the importance of 3D simulation that can design clothes to fit an individual's body shape and sentiments in the virtual realm has grown larger.

Therefore the results to the study which, by comparing the 3D simulation clothing with real clothing centered on flared skirts of women's clothing which shows diverse form depending on the skirt's flare volume and length, find its problems and by suggesting methods of its use, suggest the possibility of utilizing the 3D simulation in the clothing industry, are as follows.

First, the 3D simulation of flare skirts according to flare length and real fitting showed similar forms of appearance but whereas virtually the drape shape formed in even size and spacing, it was not even in reality.

Second, according to the results of appearance test on the angle of the skirt and length, at 90 and 180 both real and 3D simulation skirts were evaluated to have outstanding appearances without relations to skirt length. However as the angle increased, in other words as the flares in the skirt increased, it was evaluated that skirts with longer length had superior appearances than short length skirts. Especially in case of real skirts, those with a 66cm length in 360° had the most superior appearance. That is, as the angle grew smaller in skirts of 46cm, 56cm length and larger in the 66cm length skirts the better the appearance was, showing difference.

Third, according to the results of comparison between real and virtual skirts, in 90° flared skirts 46cm and 56cm, in 180° skirts 46cm, and 66cm in 270° and 360° skirts showed similar appearances, 66cm in 90°, 56cm and 66cm in 180°, and 46cm, 56cm in 270° and 360° lacked similarity. That is, with less flare on skirts the skirts showed resemblance in reality and the virtual as the skirt length shortened but showed difference in the fact that as the skirt angle increased and skirt length grew longer, reality resembled the virtual.

Length and angle and the physical properties of material is predicted to show change but usually shows similar forms virtually so it is believed not to be impossible to predict the design's silhouette or the feel when it is worn, and with the application of the those such as internet shopping malls we can possibly reduce unnecessary time spent and save cost. As for limitations on this study, is that the experimental materials are limited to 100% woven cotton 1 grade so there is restriction in generalizing the test results, also I reveal the fact that while using the DC suite program there was a problem

where the clothes came off the body in simulation as the skirt width and length increased and showed some difference to automatic simulation where the user randomly fixes the clothes. Therefore, we will be able to increase application of the 3D virtual system by comparing real fitting to virtual fitting in a variety of groups and fibers in follow-up studies.

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