

A study of the round Variation Design Brassiere Pattern[†]

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Abstract

The purpose of this study is to develop the applied brassiere pattern of women which are fitting for 75A.

The constructing of this experimental brassiere were lower cup, upper cup, front panel and U-wing as well as a full cup embcing the entire breasts.

Basing on the bra model from domestic experiment results, development of an applied design, round side type pattern, has been suggested.

Thus, suggesting the round variation design bra, which is an applied design based on the basic model based on the breast volume.

Based on the sizes that are in reference to Size Korea (2004) and related previous researches, the basic model that has been experimented with 11.4% polyurethane and 88.6% Nylon as the materials, has been selected as the model of research. This takes 75A, the size of which is set according to the underbust circumference and the breasts circumference, as the basic model. It is an application in terms of design, and there is no change to the cup volume or size because it has been moved only from the cutting line.

The applied design changes the right side of the lower cup into an easily-movable form and attaches it to the upper cup, and the lower cup takes the right part of the upper cup to form a cup shape of round variation design. It also changes basic straight form of the wings, and alters them into U-shape.

Key Words : brassiere, breasts circumference, round variation design-shaped

I. Introduction

These days, interest in underwear is surging in line with the well-being trend, making a shift from the previous focus on outwear. Accordingly, the related studies have expanded, ranging from

physical measurement (Lee Hyo-Jin¹⁾) and current situation on wearing (Kim Nam-Soon²⁾) to underwear materials-related needlework (Jeon Hye-Jung³⁾), patterns (Park Eun-Mee⁴⁾, Oh Song-Yoon⁵⁾, Cho Sin-Hyeon⁶⁾), etc. However, It is true that researches in and out of the country have been focused on outer garments.

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No application design development exists yet for brassiere, which requires the most composition even amongst the underwear for which there is no properly-developed teaching material. Also, to develop a variously applicable design, it is necessary to build the ability to create a pattern, based on a basic form of upper and lower cup, not on machine-type such as mold-cup.

Brassiere, one of the underwear items the size accuracy of which is very important, had accuracy rate of around 20% when the cup size was set only with measured values of underbust circumference and bust circumference. This problem emerged in the comparison study on the size per breast volume. This is because if the cup is set using bust circumference, the cup size is affected not only by breasts capacity but also by fat accumulating areas of scapula and chest circumference.

Therefore a detailed body measurement related to chest area must be carried out, yet it has not yet been done even by SizeKorea.

Thus, suggesting a drawing method of round variation design brassiere pattern is intended here

as the first step to suggest production methods of various brassiere patterns, which would be based on brassiere pattern models that are proved through size set-up and put-on experiments with only breasts measurement and not with bust circumference.

II. Research Method

1. Research model size

Modification pattern has been produced, basing on the brassier model⁷⁾ extracted by performing a fabrication experiment on the sizes and properties having the following characteristics

Based on the size <Table 1>, which is in reference to Size Korea (2004) and related previous researches (Park Eun-Mee, 2000, Park You-Shin, 2002, Oh Song-Yoon, 2007), the basic model that has been experimented with 11.4% polyurethane and 88.6% Nylon as the materials, has been selected as the model of research.

<Table1> Model Pattern Size

(unit:cm)

Size Grouping	No.	Items	Size(75A)
Upper Body Foundation -related Size	1	bust circumference	85
	2	Underbust circumference	75
	3	waist circumference	67
	4	waist back length	40
	5	neck base circumference	36.5
	6	waist front length	38.8
	7	bust point-bust point	8.5
	8	shoulder length	12.5
	9	Front interscye	32.5
	10	Back interscye	35.5
Brassiere-related Size	11	Waist front-bust inner length	1
	12	breast point-bust innter length	8.5
	13	breast point-bust outer length	9.3
	14	breast point-bust lower length	6.4
	15	breast point-bust lower vertical length	4.6

According to the existing cup size setting method, A cup is if the difference between bust circumference and underbust circumference is 10cm, so bust circumference has been set as 85cm, and underbust circumference as 75cm. Also, a size satisfying all A cup conditions has been selected by setting the breasts circumference (inner bust length + outer bust length), which is the standard for setting individual cup size, as 17.5cm.

2. Research Tools

A radius template⁹⁾(Radius gage), a triangle, a protractor, an adhesive tape, a piece of tracing paper and, 0.3mm mechanical pencil used to pattern the experimental brassiere.

3. Brassier model

The basic model applied in this research is a 75A size of 2/6 hook & eye with round-type

wire inside, the upper and lower cups of which are connected. Experiment process is as follows.

Primary experiment was performed on 30 female subjects in their twenties who have cup size of 75A, then 11 subjects with satisfactory sizes for this research were selected. Sensory test was performed twice on the test garment produced by the sizes on <Table 1>. When the test garment was first produced with A cup standard breasts circumference as 18cm, the satisfaction was 3.82 being the lowest out of all test categories, but correcting the breasts circumference to 17.5cm then producing second time produced the satisfaction rate of 4.36.

4. Experiment materials

The properties of the materials used for brassier model production is as shown on <Table 2>. Mixture rate has been tested in method KS K 0210:2002, elongation recovery rate in KS K 0815.6.19:2005 A method, weight

<Table 2> Composition of test brassier

sample material	Mixture rate (%)	Tissue	weight (g/m ²)	Tensile strength & elongation(N)		Elongation rate (%)		Elongation recovery rate**(%)	
				wale	course	wale	course	wale	course
outer fabric	nylon:88.6 polyurethan:11.4	tricot	56.6	153	163	46.3	106.7	86.7	93.3
front adhesive interlining	nylon:100	tricot	204.8	283	264	275.2	338.1	92.3	96.7
bottom layer tape	nylon:78.2 polyurethan:21.8								
non-woven fabric of the cup	polyester:100	warp knitting machine	532.9	1512	973	57.9	95.0	-	-
shoulder straps	nylon:77.1 polyurethan:22.9								
others	wire, wire tape10mm, plastic bone, H&E32mm, nylon yarn, cotton yarn								

* 1N = 0.10197 kgf

** Fixed elongation : 50% , no. of 1 round :1 time

Material is decided as polyurethan 11.4%, nylon 88.6%, which are most commonly used in domestic underwear companies.

in KS K 0514:2006, tensile strength & elongation
in KS K 0815:2005 C.R.E TYPE method.

III. Research Result

1. Designing the pattern

1) Bodice model

To help the beginners design easily, the upper body model pattern designed with side dart is set as the basic type.

- ① AB : waist back length<Fig.1>
- ② AA1= BB1 = $B/2+3\text{cm}$
- ③ AC : $B/4$

Previous method of calculating scye depth was $B/4$. This causes many problems when making sleeves, because scye depth becomes deeper in proportion to bust circumference, and thus stretches or shrinks regardless of the body. Therefore, the drafting should follow the formula below:

While the bust circumference standard is 82cm, on each increase of 3 cm in bust circumference increase 0.1 of scye depth from the standard scye depth of 21.3cm against 82cm standard⁹⁾<Table 3>.

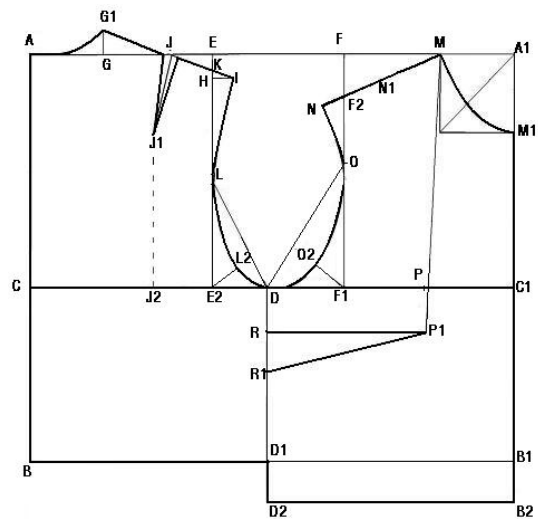
- ④ D : bisecting point of CC1
- ⑤ D1: bisecting point of BB1
- ⑥ AE = CE1: Back interscye /2
- ⑦ A1F = C1F1 : front interscye/2

2) Back petal <Fig.1>

- ① AG : $B/12$

- ② GG1 : $AB/3$
- ③ EH : 2cm
- ④ Draw any perpendicular line from H to EH.
- ⑤ G1I : shoulder length + shoulder dart quantity (1cm)
- ⑥ J : bisecting point of G1I
- ⑦ J1 : end point of the shoulder dart, which is 7 to 8 cm shoulder length from J.
- ⑧ J2 : the intersecting point of where vertical line has been drawn from J1 to CE1. It links J1J2.
- ⑨ K : intersection point of G1I and EH. Find it on the perpendicular extension line of H.
- ⑩ L : bisector of KE1
- ⑪ L2 : when drawing a vertical line of LD from E1, trisector of the line.

Draw a scye circumference line by linking LL2D with a natural curve while maintaining perpendicular at the shoulder end point I.



<Fig. 1> Bodice model

<Table3> Table of Grades of Increase in the Scye Depth Depending on the Bust Circumference Size (unit: cm)

Bust Circumference	82	85	88	91	94	97	100	103	106
Grades of Increase	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Scye Depth	21.3	21.4	21.5	21.6	21.7	21.8	21.9	22	22.1

3) front petal <Fig.1>

- ① $A1M : B/12$
- ② $A2M2 : B/12+0.5$

Drawing a perpendicular line to M and M1, trisecting the diagonal line passing A1, make it 0.5cm smaller than 1/3 point and link MM1 with a natural curve.

- ③ $FF2 : 4\text{cm}$
- ④ MN : back shoulder length(excluding shoulder dart quantity)
- ⑤ O : one-third point of F2F1
- ⑥ O2 : when drawing a vertical line of OD from F1, bisector of the line.

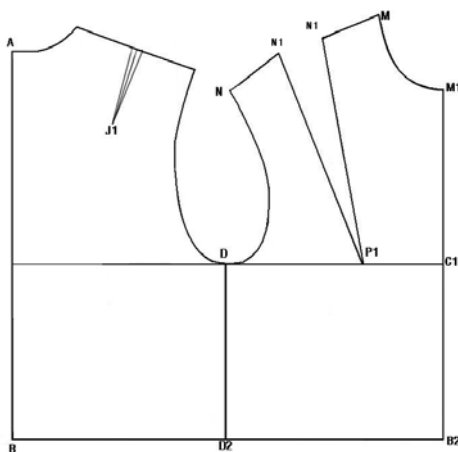
Link OO2D with a natural curve while maintaining perpendicular at the shoulder end point N.

⑦ P : As the bisecting point of C1F1, it draws a perpendicular line to C1F1.

⑧ MP1 : Neck point to breast point. Mark the neck point to breast point length as P1 (BP), which is the perpendicular line from M to P.

- ⑨ P1R : parallel to C1D
- ⑩ $B1B2 = D1D2 : B/24$

$RR1 = D1D2$: finishes the dart by linking P1R1.



<Fig.2> Dart movement of the model

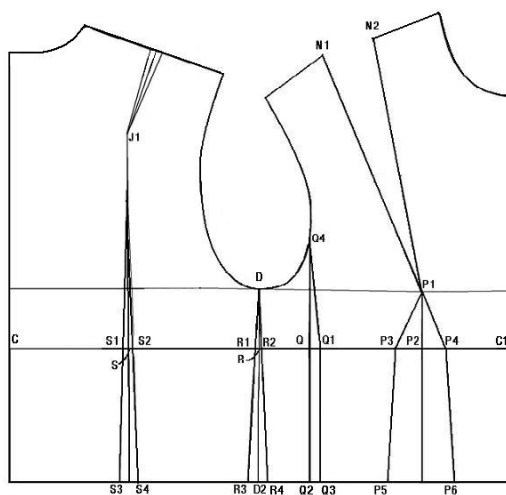
4) Dart movement of the model<Fig.2>

- ① N1 : bisector of MN
- ② After cutting N1P1 and folding RR1, move to shoulder dart. Adjust the sideline with the straight line of DD2.

5) Foundation model <Fig3>

- ① Q: vertical line equivalent to the front interscye.
- ② Draw a circle of 7cm in radius from P1.
- ③ Draw a horizontal line passing P2 that is a lower bust length(5.5cm) away from P1.
- ④ The difference between $B/2 + 3\text{cm}(CC1)$ and underbust circumference/2 is $46.5-37.5 = 9\text{cm}$, which determines the dart quantity.
- ⑤ $P3P2 = P2P4 = 2\text{cm}$ Links to P1 above.

Call the points that are each 3cm away from the intersection of a line passing P2 and the waistline, P5 and P6. Link P3P5 and P4P6 with a straight line.



<Fig.3> Foundation model

- ⑥ Front interscye line $QQ1 = Q2Q3 = 1.6\text{cm}$ Call the intersection point of the waistline and the vertical line of Q, Q2, and call that of the waistline and the scye circumference line, Q4.

Call the intersection point of the vertical line below Q1 and waist circumference line, Q3.

⑦ $RR1=RR2=0.7\text{cm}$ The extension line linking DR1, DR2 becomes R3, R4.

⑧ Draw a vertical line from J1 to the bust circumference line.

⑨ $SS1=SS2=0.5\text{cm}$

Intersection point of the waistline and the extension line linking S3, S4 : J1S2, J1S1.

6) Brassiere model drafting

(1) Lower cup <Fig.4>

① Draw a circle taking lower bust length(7cm) as its radius.

P7 : intersection point of the circle and vertical line below P1.

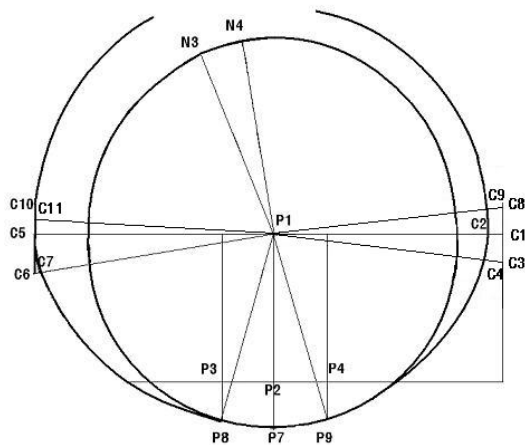
P8 : intersection point of the circle and vertical line below P3.

P9 : intersection point of the circle and vertical line below P4.

② $C1C3=1\text{cm}$

③ $P1C2=P1C4=8.3\text{cm}$: Mark bust inner side length(8.3cm) on P1C3 line.

④ $C5C6=1.5\text{cm}$



<Fig.4> Lower cup

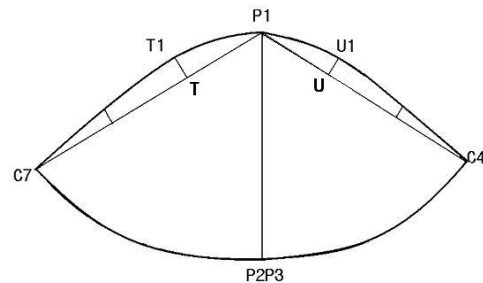
⑤ $P1C5=P1C7=9.2\text{cm}$: Mark bust outer side length on P1C6 line.

⑥ Link P9C4 and P8C7 each with a natural curve.

⑦ Fold P8P1P9 dart line and make a lower cup like <Fig.5>.

⑧ Let us call the one-third point of straight lines P1C7 and P1C4, T and U, and move them 0.7cm vertically, calling them T1 and U1.

⑨ Draw P1T1C7 and P1U1C4 each with a natural curve.



<Fig. 5> Lower cup

(2) Upper cup

① $C1C8=1\text{cm}$ On extension line, $P1C8 P1C9=8.3\text{cm}=P1C2$ <Fig4>

② $P1C5=9.2\text{cm}$

③ $C5C10=0.5\text{cm}$

④ $P1C11=9.2\text{cm}$

⑤ N3, N4 : intersection of the circles with 7cm radius and N1N2 and P1 each as their centers.

⑥ M.P upper cup N3N4 and copy P1C9N4N3C11<Fig.6>.

⑦ $P1T=11\text{cm}$, set the location of shoulder string. N3 location becomes T1.

⑧ $TT1=TT2=0.5\text{cm}$

⑨ C12, C13: Points lowered from the bisecting point of straight line C11P1, P1C9 each by 0.2 cm.

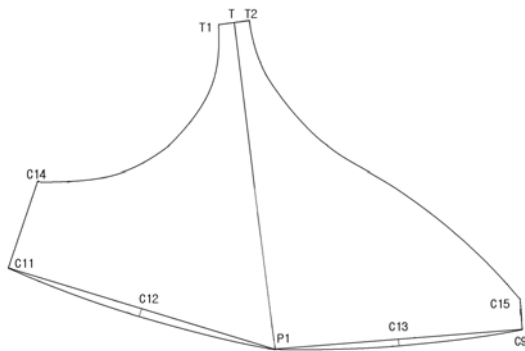
Draw C11C12P1, P1C13C9 each with a gentle curve.

⑩ C14, C15: Points each raised 3cm, 1cm

vertically from C11, C9.

⑪ curve T1C14: draw a concave curve touching the arc whose radius is lower bust length + 0.5cm(7.5cm) from P1. Then complete the upper cup's side upper edge.

⑫ T2C15: draw a curve touching the arc whose radius is lower bust length - 0.5cm(6.5cm) from P1, and the natural curve should be naturally concave toward T2 and convex toward C15.



<Fig. 6> Upper cup

7) Brassiere Application Design

After changing the right side of the lower cup into a shape capable of easy movement, attach it to the upper cup, while the lower cup draws near the right side of the upper cup. Thus the wings change into U shape.

(1) Lower cup variation<Fig.7>

① Draw a vertical line touching the most projected point in curve P1C4.

② $C4C16 = 1.5\text{cm} \sim 2\text{cm}$

With curve ruler No.170, draw a curve that passes C16 and is tangent to line ①.

③ C17 ; intersector of curve C16P1 and P1C4. $C17C18=C17C19$

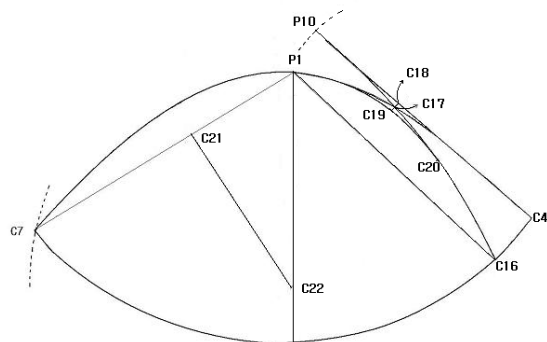
④ Draw a curve passing P1C19C16 with a ruler of No. 60mm, No.170mm.

⑤ C20: intersection point of the curve P1C16 and the curve ②.

⑥ Find as much P10 on C20 as the length of P1C20. Draw a parabola from C20 towards P10 with a compass.

⑦ From the most projected point in curve C7P1, draw a line perpendicular to line C7P1, and find C22 on the location of $C7C21=C21C22$

⑧ Draw a parabola from C22 towards C7.



<Fig. 7> Lower cup variation

(2) Upper cup variation <Fig.8>

① $C13 = 1/2 P1C9$

② $C13C23 = C13P1 = C13C9$

③ Draw a parabola from C23 towards C9.

④ $C14C24 = 1.5\text{cm}$

⑤ Draw a straight line that passes Point C11 and is most tangent to curve C11P1

⑥ With a No70mm curve ruler, draw a curve that passes Point C24 and touches Line⑤.

⑦ C25 : intersector of curve C11P1 and Curve ⑥

⑧ C27 : find as much C27 on C25 as the length of the vertical line from C25 to ⑥

With No.60mm curve ruler, draw a curve passing P1, C27, C24.

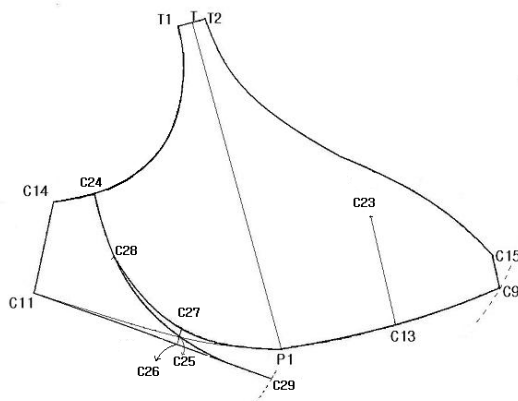
⑨ C28 : intersector point of Curve ⑥ and ⑨

⑩ C29 : Measure the length of C28P1 from C28 and mark it on Curve ⑥. Draw a parabola

from C28 towards C29.

(3) Area movement on upper and lower cup
cup<Left side movement>

C7, make the portion of the overlap between the upper cup C11P1 curve and lower cup In the situation of putting the lower cup<Fig.7> upon the upper cup<Fig.8>, the following conditions should be met:



<Fig.8> Upper cup variation

① Make the overlapping portion (⊖) of upper cup C11P1 curve and lower cup C7P1 curve to be 1/2 of the distance (⊕) between C11 and C7, while lower cup P1 is on the parabola of upper cup C27 and upper cup C11 is on the parabola of lower cup C7 <Fig.9><Fig.10>.

② Move and draw upper cup C22C14C11C27 on lower cup, and extend C22P1 into a natural curve and C14C7 into a straight line <Fig.11>.

<Right side movement>

Meet the following conditions while upper cup <Fig.8>is placed on top of lower cup <Fig. 7>.

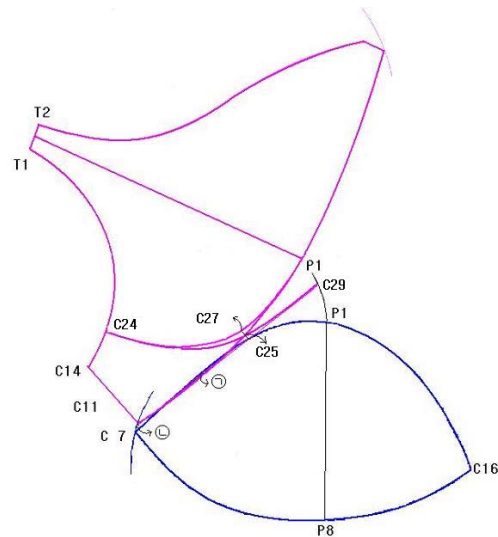
① Make the overlapping portion of upper cup P1C9 curve and lower cup P1C4 curve to be 1/2 of the distance between C4 and C9, while lower cup C4 is on the parabola of upper cup C9 and upper cup P1 is on the parabola of lower cup P10 <Fig.12><Fig.13>.

② Move and draw upper cup P10C4C16 on lower cup, and extend P1C4 into a natural curve and C9C16 into a straight line <Fig.14>.

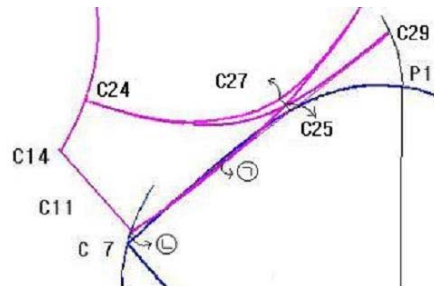
(4) Front petal and wing composition<Fig.15>

Measure the lengths of upper cup C15C16 lower cup C14P8C16, in order to draw the cup circumference line of the front petal.

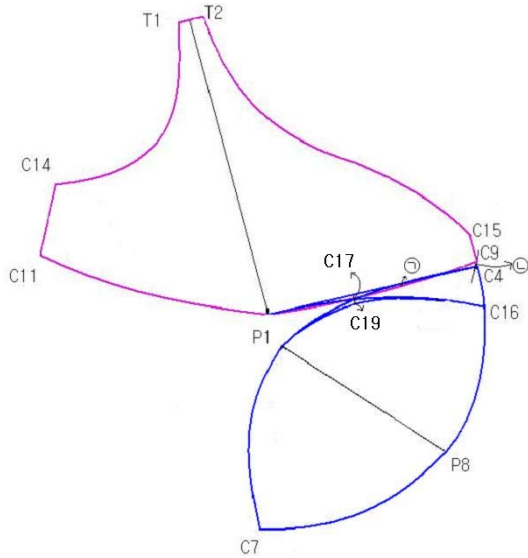
- ① P1P2: draw a circle of 5.5cm radius
- ② V V1:0.5cm
- ③ P1V1V2: 94° Draw Line V1V2.
- ④ V1V3: 0.6cm
- ⑤ Draw P2V3 naturally, and also draw a line parallel to V1V2 and passing V3.



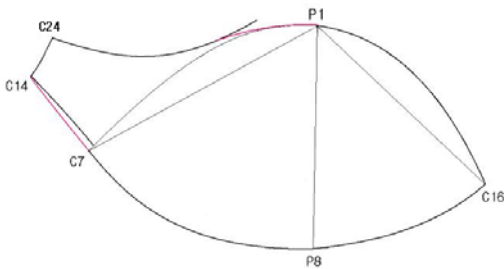
<Fig. 9> Left side movement



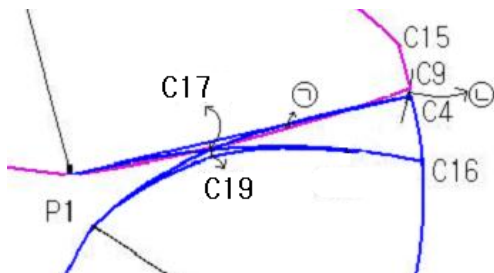
<Fig.10> Partial extension of <Fig. 9>



<Fig. 11> Right side movement

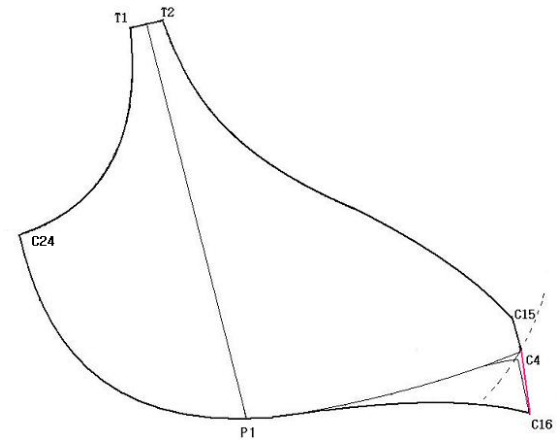


<Fig.12> Finished lower cup



<Fig.13> Partial extension of <Fig. 12>

- ⑥ P2V4= lower cup C14C7P8 <Fig.11>
- ⑦ UU1; 0.9cm Connect P1U1 in a straight line.
- ⑧ U1U2 : 0.4cm
- ⑨ Draw an extension line from P2 to U2



<Fig.14> Finished upper cup

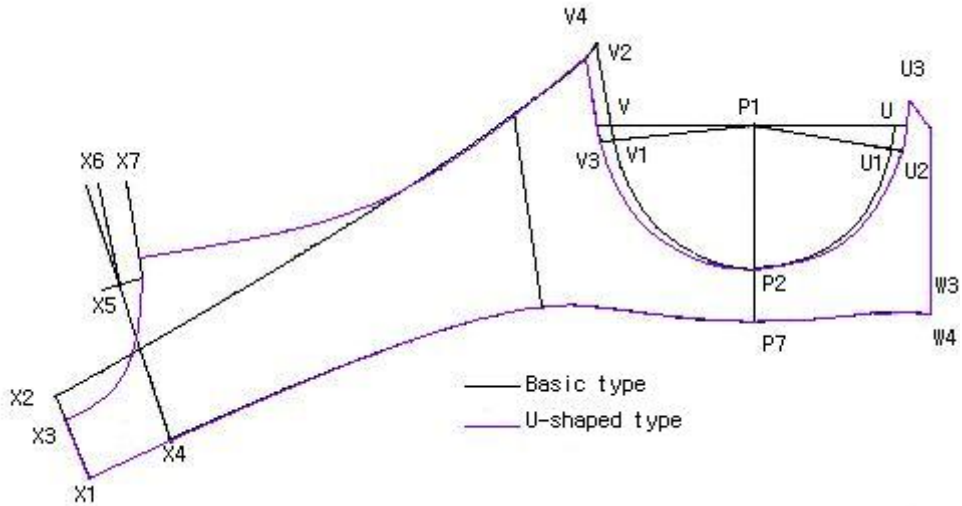
⑩ P2U3= lower cup P8C16+ upper cup C16C15 <Fig.14>

⑪ P2P7 : 0.9cm (wire tape width + lower edge tape width)

⑫ M.P QQ1, R1R2, S1S2 in <Fig.3>. Come in as wide as the hook and eye width (1.5cm) from the back center, and call it X.

Total length is decided as 70cm because according to a previous research, when the total length of a most common 75A brassiere is 65cm, more than 67% of wearers put on a brassiere of at least one size bigger¹⁰⁾. The decision was also based on the medical opinion that foundational undergarments, leggings, skinny Jeans, boots, etc. that are very tight can be bad for blood circulation, and that they can cause skin coloring problem and skin ulcer¹¹⁾.

If 3cm hook and eye is taken out of 70cm, it is 67cm. Only 1/2 is required in patterns, so it becomes 33.5cm. The wing length becomes 18cm if the front petal length 15.5cm is taken out of 35.5cm. The resulting reduction rate becomes 6.91%, and it is reduced by 1cm, 2cm, 2cm and 1cm each from back center line, back dart line, side line and plastic bone. Change from the length-controlled front petal



<Fig. 15 > U-shaped wings and front petal

and wing type basic model to U shape wings.

- ⑬ XX1 : 1.5cm
- ⑭ X1X2 : 3.2 cm The hook and eye width
- ⑮ X2X3 : 1cm The shoulder tape width
- ⑯ X1X4 = 3.5 cm

- ⑰ X5 : The point 6.5 cm distant from X4 and making a perpendicular line to X1X4
- ⑱ X6 : Draw a line that is 12° from the X4X5 extension line.
- ⑲ X7 : Perpendicular line that is 1cm inwards from X6 line
- ⑳ Draw a line naturally from V4 to X7 with No. 1500, No. 4000 templins.

IV. Conclusion

The basic model of bra is being researched in the underwear pattern of increased interest, yet researches on applied design with the basic model as the basis are in short.

Currently, strategic underwear education is extremely weak, and the education method is also carried out with foreign standard. Therefore, bra pattern drafting method that is suitable for Koreans has not yet been established. Especially the applied pattern production method per design has no guide book, so it hopes to suggest a drafting method based on the drafting method produced to fit the body shape of Koreans.

Basing on the bra model from domestic experiment results, development of an applied design, round side type pattern, has been suggested.

Thus, suggesting the round variation design-shaped bra, which is an applied design based on the basic model based on the breast volume.

Based on the sizes that are in reference to Size Korea (2004) and related previous researches, the basic model that has been experimented with 11.4% polyurethane and 88.6% Nylon as the materials, has been selected as the model of research. This takes 75A, the size of which is

set according to the underbust circumference and the breasts circumference, as the basic model. It is an application in terms of design, and there is no change to the cup volume or size because it has been moved only from the cutting line.

The applied design changes the right side of the lower cup into an easily-movable form and attaches it to the upper cup, and the lower cup takes the right part of the upper cup to form a cup shape of round variation design. It also changes basic straight form of the wings, and alters them into U-shape.

The total length of bra is selected as 70cm for a 75A. This is due to the problems such as skin coloring matters, eczema, skin ulcer, etc. occurring from obstacles in the blood flow caused by foundational under garments, and also due to the try-on experiment result that consumers wear bras that are one size bigger than their underbust circumference because they feel "too tight." The reduction rate becomes 6.91%, and four place in total - back center line, back dart line, side line, and Plastic bone - are reduced each by 1cm, 2cm, 2cm and 1cm.

The bra, the basic female underwear, currently has many noticeable problems emerging, such as the previous method of setting the bra size and the size mismatch among the brands, etc. Various media reports make issue of the current situation on women wearing bras of incorrect size. Yet, there is no solution or a connection line for customers to measures their sizes easily and conveniently and to buy bras of according sizes. Neither is there a unity among brands in terms of the cup volume and sizes they produce as well as in terms of the measuring method, which is intensifying the confusion of consumers. Also, there is not much underwear

education system in Korea, and thus development of a napped design -round variation design pattern-based on the bra model developed accordingly with experiment results is suggested.

Under the current domestic situation where technical books and teaching materials are lacking, such bra pattern is considered to be usefully utilized in Orology.

In the future, various bra pattern producing method of various designs should be developed.

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