매스 커스터마이제이션 의류제품의 생산모델 개발
-중년여성복을 중심으로-

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Production Model Development of Mass Customized Clothing
- Focused on Clothes for Middle-aged Women -

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ABSTRACT

이 연구에서는 대량생산의 장점인 낮은 가격대 창출과 주문생산의 장점인 고객지향을 추구하는 매스 커스터마이제이션(Mass Customization) 방식에 따른 의류제품의 생산모델을 개발하였다. 특히 체형이 매우 다양한 시기에 있어 이러한 고객지향적 의복이 더욱 필요한 중년여성들을 대상으로 하여 기성복에서 얻을 수 없는 인체적합도가 높은 의복을 생산할 수 있도록 하였다. 이 모델은 소비자 체형파악과 체형별 패턴제작의 어려움을 해결해주기 때문에 의류제조업체의 패턴제작과정을 용이하게 해주고, 모든 생산이 주문에 따라 이루어지므로 재고부담을 감소시키게 된다.

생산모델은 크게 5 단계로 나뉜다. 1 단계는 소비자가 제품에 대한 정보를 얻어 선택을 하는 단계이고, 2 단계는 소비자의 신체치수 계측 및 입력, 체형판별의 단계이다. 3 단계에서는 이러한 내용을 포함하는 주문서를 작성하여 본사로 전송하고, 4 단계에서는 제품을 생산한다. 그리고 5 단계는 제품의 배송 단계이다. 이 연구에서 실질적으로 검증한 매스 커스터마이제이션 의류제품의 생산과정은 주문단계에서 패턴의 수정단계까지이며, 이후의 마커제작에서 배송단계까지는 생산설비상의 문제 때문에 설명으로 제시하였다. 또한 매스 커스터마이제이션 의류제품에서 특히 중요한 단계는 고객에 대한 접근방법과 가봉 없이도 인체적합도가 높은 의복을 생산하는 것이므로 이 연구에서는 이를 중심으로 다루었다.

Key Words: Mass Customization(매스 커스터마이제이션), Mass Customized Clothing(매스 커스터마이제이션 의류), Production Model(생산모델), Middle-aged Women(중년여성)

Ⅰ. Introduction

As a technological capability, Mass Customization was anticipated in 1970 by Alvin Toffler in *Future Shock* and delineated in 1987 by Stan Davis in *Future Perfect*. Mass Customization is the new frontier in business competition for both manufacturing and service industries. At its core, it is a tremendous increase in variety and customization without a corresponding increase in costs. At its limit, it is the *mass* production of individually *customized* goods and services. At its best, it provides strategic advantage and economic value (Pine Ⅱ, 1999).

Customers have a tendency to seek out customized clothing because they want to wear clothes that fit well and satisfy their individual tastes in fashion. Conversely many buyers dislike the expense, the fitting procedure, and the lengthy production time involved with customized clothing. Consequently, Mass Customization is more necessary in the clothing industry than in other fields. Moreover, mass customized clothing can be invaluable to the middle-aged female clothes buyer, whose somatotype may fall under a diverse range.

The purpose of this study was to develop a production model of mass customized clothing for middle-aged women. In order to develop the model, it was prerequisite to research on the survey about made-to-wear production of ready-to-wear manufacturers (Kim, 2001) and collecting anthropometric data for classifying and discriminating somatotypes (Kim & Jo, 2001). A clothes pattern database and a website for e-commerce were created and tested in order to prove the propriety of the new model.

This new model allowed consumers to avoid lengthy fitting sessions, attain clothes that fit well, and experience a higher degree of satisfaction. Manufactures, in turn, are able to keep lower level of stocks, experiencing greater profit.
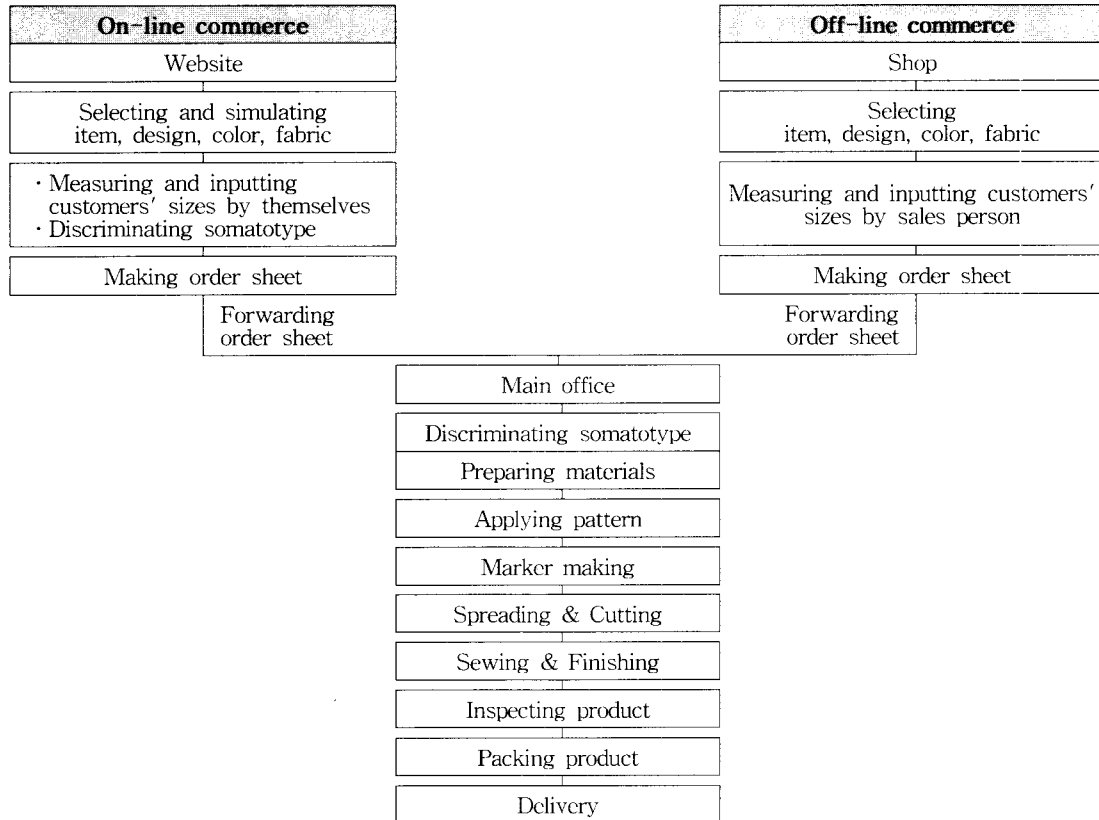
Ⅱ. Methods

Fig. 1 demonstrates the process behind the production model of Mass Customization. Areas of production ranging from marker making to actual delivery were not addressed by this study due to the limitation of available production facilities. The central priorities of the production model are to consider the customers' access to products and to ensure that good quality clothing patterns were created. A pattern database was developed for middle-aged women, with diverse ranges of somatotypes. Furthermore, a website for on-line commerce and an order sheet for off-line commerce were established for this study.

Through previous studies (Kim, 2001; Kim & Jo, 2001), middle-aged women's somatotypes for mass customized clothes were classified and the criteria discriminating them were created. These results were used for the somatotype and pattern database of this study.

Pattern making and grading occurred for each somatotype. These activities contributed to the development of a pattern database. Subjects were chosen for each somatotype. Patterns were applied to them and a fitting trial was carried out in order to substantiate the propriety of the pattern database and

the pattern application.

On-line commerce
Website

Selecting and simulating item, design, color, fabric

· Measuring and inputting customers' sizes by themselves   · Discriminating somatotype

Making order sheet

Forwarding order sheet

Off-line commerce
Shop

Selecting item, design, color, fabric

Measuring and inputting customers' sizes by sales person

Making order sheet

Forwarding order sheet

Main office
Discriminating somatotype
Preparing materials
Applying pattern
Marker making
Spreading & Cutting
Sewing & Finishing
Inspecting product
Packing product
Delivery

<Fig. 1> Process of production model of mass customized clothing

1. Somatotype database

The somatotype classification system from a previous study (Kim & Jo, 2001) was followed and used as the basis of a classification system of this study. The upper body somatotypes of lateral view are shown in Fig. 2 and the lower body somatotypes are shown in Fig. 3.
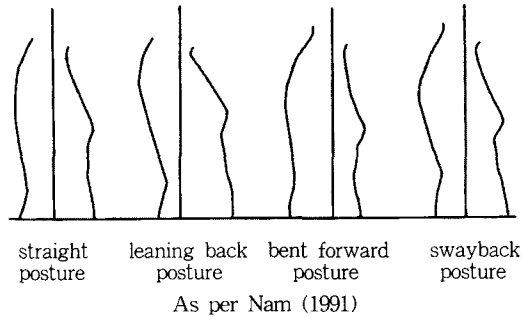
Somatotype classification for upper body	
1. straight posture - medium/small bust	2. straight posture - large bust
3. leaning back posture - medium/small bust	4. bent forward/swayback posture - medium/small bust
5. bent forward/swayback posture - large bust	

※ Criteria: lateral view & bust developemnt
※ Large bust: when the index of *bust circumference / under-bust circumference* $\geq$ 1.15
　Medium/small bust: when the index of *bust circumference / under-bust circumference* $<$ 1.15
※ As per Kim & Jo (2001)

straight　　　leaning back　bent forward　swayback
posture　　　posture　　　posture　　　posture

As per Nam (1991)

<Fig. 2> Upper body somatotypes of lateral view

Somatotype classification for lower body	
1. normal abdomen - normal hip	2. normal abdomen - prominent hip
3. prominent abdomen - normal hip	4. prominent abdomen - prominent hip

※ Criteria: abdomen prominence & buttocks prominence
※ Prominent abdomen: when upper abdomen angle $\geq$ 13.5° or under abdomen angle $\geq$ 21°
　Prominent buttocks: when upper buttock angle $\geq$ 16.5°
※ As per Kim & Jo (2001)

normal abdomen　　　normal abdomen　　　prominent abdomen　prominent abdomen
- normal buttocks　- prominent buttocks - normal buttocks　- prominent buttocks

As per Kim & Jo (2001)
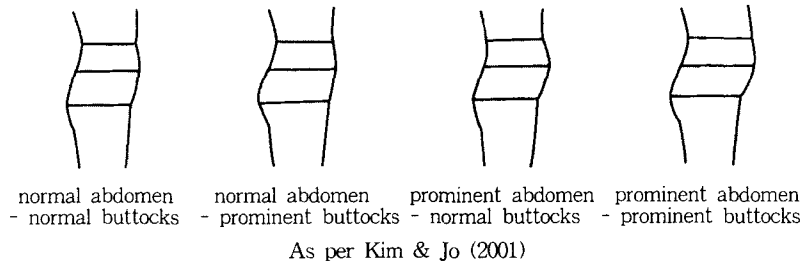
<Fig. 3> Lower body somatotypes

2. Pattern database

1) Item & design

Firstly, four items of fall / winter clothing (jacket, skirt, blouse and slacks) were designed, prior to pattern making. Two basic styles for each item were designed: JK1, JK2, BL1, BL2, SK1, SK2, SL1, and SL2.

2) Pattern making

(1) Basic pattern

Patterns of the basic sizes for standard somatotypes were made first in order to initiate a pattern database. The pattern-making method used in this study is identical to the method used by a manufacturer, who makes one of the most successful brands on the market (Apparel news Inc., 1999). This manufacturer was one of the targets of a previous study and famous for well conformity to middle-aged women (Kim, 2001). The mean of standard somatotype measurement was used as a guide

for creating the basic patterns. From previous studies, the upper garment somatotype was *straight posture - medium/small bust* while the lower garment somatotype was *normal abdomen - normal buttocks*. The basic measurements for pattern making of upper garments and lower garments are shown in Tables 1-2.

<Table 1> Basic measurements for pattern making of upper garments
unit: cm

Item	Measurement	Item	Measurement
waist circumference	76	hip length	19
maximum hip circumference	95	crotch length	26

※ The numbers are rounded off to one decimal places to make pattern making easier.
※ Waist circumference and maximum hip circumference are the means of the measurements of *straight posture - medium/small bust*.
※ A sleeve length of 60 cm, which is used as a basic measurement by most manufactures, was used for pattern-making.

<Table 2> Basic measurements for pattern making of lower garments
unit: cm

Item	Measurement	Item	Measurement
chest circumference	89	back interscye breadth	37
bust circumference	91	front interscye breadth	33
waist circumference	77	back shoulder length	39
maximum hip circumference	96	S.N.P.→B.P.→front waistline length	41
back length	39	–	–

※ The numbers are rounded off to one decimal places to make pattern making easier.
※ Waist circumference and maximum hip circumference are the means of the measurements of *normal abdomen- normal buttocks*.

(2) Patterns for each somatotype

A pattern making method for each somatotype was created on the basis of somatotype differences derived from the anthropometric data (Kim & Jo, 2001). For upper garments, the differences between the front length and back length, and between the front breadth and back breadth were important factors according to a lateral view. The front length and breadth of bust area were also important factors according to bust development. For lower garments, the differences between front breadth and back breadth, front dart distribution, and the position of waistline were variable according to abdomen prominence and buttocks prominence.

Finished patterns (master patterns) for each somatotype were saved into CAD system, Silhouette 2000 made by GERBER for a pattern database.

3) Grading

In order to create various sizes for mass customized clothes, a master pattern was graded into 6 sizes for each somatotype of each design. Usually, ready-to-wear manufactures make a range of 3-5 sizes (Choi, 2000; Kim, 2001), but this range often excludes extremely large or extremely small sizes. As a result, the study sought to create a broader range of 7 sizes in order to address this issue.

The basic pattern size of this study was close to a size 66 in the ready-to-wear system. The seven sizes used in this study were as follows: 44, 55, 66, 77, 88, 99, and 110. K.S. has discarded this system, but in this study the designation of this system was used even though this study followed K.S., because

it is easy to be called, familiar to customers, and also still used for many manufacturers as managing numbers of sizes.

The dimensional increments and decrements of grading used in this study, were based on those used by a manufacturer, who is renowned for having a diverse sizing system and catering for larger sizes (Kim, 2001), due to the anthropometric data for the model of the previous research were not enough to make grading rules for each somatopye. As is evident in Table 3, items between the sizes of 99 and 110 have smaller length increments than that of other sizes. This reflects the fact that the length and shoulder breadth of obese, middle-aged women are not increasing as much as circumferences. Grading was done with the CAD system.

<Table 3> Dimensional increments & decrements of grading   unit: cm (inch)

Item \ Size	44	55	66	77	88	99	110
chest circumference	-10.160(-4)	-5.080(-2)	0	+5.080(+2)	+10.160(+4)	+15.240(+6)	+20.320(+8)
bust circumference	-10.160(-4)	-5.080(-2)	0	+5.080(+2)	+10.160(+4)	+15.240(+6)	+20.320(+8)
waist circumference	-10.160(-4)	-5.080(-2)	0	+5.080(+2)	+10.160(+4)	+15.240(+6)	+20.320(+8)
hip circumference	-10.160(-4)	-5.080(-2)	0	+5.080(+2)	+10.160(+4)	+15.240(+6)	+20.320(+8)
back length	-0.635(-¼)	-0.318(-⅛)	0	+0.318(+⅛)	+0.635(+¼)	+0.635(+¼)	+0.635(+¼)
back interscye breadth	-2.540(-1)	-1.270(-½)	0	+1.270(+½)	+2.540(+1)	+3.810(+1½)	+5.080(+2)
front interscye breadth	-2.540(-1)	-1.270(-½)	0	+1.270(+½)	+2.540(+1)	+3.810(+1½)	+5.080(+2)
back shoulder length	-1.270(-½)	-0.635(-¼)	0	+0.635(+¼)	+1.270(+½)	+1.588(+⅝)	+1.905(+¾)
sleeve length	-0.635(-¼)	-0.318(-⅛)	0	+0.318(+⅛)	+0.635(+¼)	+0.953(+⅜)	+0.953(+⅜)
armhole circumference	-3.175(-1¼)	-1.588(-⅝)	0	+1.588(+⅝)	+3.173(+1¼)	+4.763(+1⅞)	+6.350(+2½)
S.N.P.→B.P. length	-1.270(-½)	-0.635(-¼)	0	+0.635(+¼)	+1.270(+½)	+1.905(+¾)	+1.905(+¾)
S.N.P.→B.P.→ front waistline length	-0.635(-¼)	-0.318(-⅛)	0	+0.318(+⅛)	+0.635(+¼)	+0.635(+¼)	+0.635(+¼)
upper garment length	-1.270(-½)	-0.635(-¼)	0	+0.635(+¼)	+1.270(+½)	+1.905(+¾)	+1.905(+¾)
slacks length	-1.270(-½)	-0.635(-¼)	0	+0.635(+¼)	+1.270(+½)	+1.905(+¾)	+1.905(+¾)

Basic patterns and graded patterns for each somatotype of each design were used to create a pattern database for mass customized clothes.

3. Testing the production model of this study

Nine subjects were selected and identified according to their somatotypes in order to substantiate the propriety of the production model of this study. The closest size pattern for discriminated somatotype was found and applied to each subject. Through a fitting trial of subjects wearing the clothes made with the patterns, fitting was checked.

1) Selecting, measuring subjects & discriminating somatotype

Five subjects were selected to try the upper garments while 4 subjects were selected for the lower garments. The subjects were selected on the expectation that they would represent each somatotype group. In order to establish which group they belonged to, they were measured according to the criteria exhibited in Tables 4-5. These tables also display the subjects' measurements.

<Table 4> Measurements of subjects for upper body somatotypes
unit: cm

Item / Subjects for each somatotype	straight posture - medium/ small bust	straight posture - large bust	leaning back posture - medium/ small bust	bent forward/ swayback posture - medium/ small bust	bent forward/ swayback posture - large bust
age	57	59	51	43	55
stature	161.0	157.0	156.4	153.5	145.0
weight	57.0	63.0	61.0	45.0	57.0
chest circumference	89.0	96.0	91.0	79.0	87.0
bust circumference	92.0	100.2	96.5	83.5	94.0
under-bust circumference	81.0	85.5	85.0	74.0	80.0
waist circumference	75.0	81.0	80.0	69.0	77.0
maximum hip circumference	95.5	102.0	97.0	86.0	103.6
back length	38.0	38.0	37.5	38.3	38.0
sleeve length	53.0	51.7	52.0	55.0	50.0
front interscye breadth	34.7	36.0	37.0	32.0	33.0
back interscye breadth	36.5	38.5	37.8	35.5	39.0
S.N.P.→B.P.→front waistline length	42.0	42.2	43.5	38.5	38.3
S.N.P.→scapular→back waistline length	43.5	42.0	43.2	43.3	42.0
front waistline→shoulder line length	36.5	37.0	37.5	34.5	34.5
shoulder line→back waistline length	37.5	38.0	37.0	36.5	36.5

<Table 5> Measurements of subjects for lower body somatotypes
unit: cm

Item / Subjects for each somatotype	normal abdomen - normal buttocks	normal abdomen - prominent buttocks	prominent abdomen - normal buttocks	prominent abdomen - prominent buttocks
age	44	50	50	57
stature	164.0	157.8	161.4	164.3
weight	64.0	64.0	63.0	78.0
waist circumference	78.7	80.0	79.0	86.5
abdominal circumference	89.0	90.5	92.0	101.0
hip circumference	97.0	97.0	95.3	106.0
waistline→knee length	59.0	60.0	57.0	60.0
waistline→ankle length	94.0	96.5	95.0	98.0
hip length	20.0	19.0	17.5	17.2
crotch length	26.7	27.0	28.5	28.5
maximum hip circumference	98.4	100.0	97.8	110.0
back hip circumference	53.0	54.0	52.7	59.0

Discriminating somatotypes was carried out through the discriminant functions of previous study (Kim & Jo, 2001).

As referred in the previous study, the diagram of 4 somatotypes was suggested instead of angle items (Fig. 3), and each somatotype has a representative value of an angle (Table 6).

<Table 6> Representative values of angles for lower body somatotypes
unit: °

Somatotype / Item	upper abdomen angle	under abdomen angle	upper buttock angle
normal abdomen - normal buttocks	9.2	13.7	12.4
normal abdomen - prominent buttocks	8.5	14.2	19.0
prominent abdomen - normal buttocks	13.7	19.2	11.8
prominent abdomen - prominent buttocks	10.0	24.4	19.6

2) Applying patterns to subjects

When the subject's closest size of upper garments is selected, *bust circumference* is a criterion and for lower garments, *maximum hip circumference* is a criterion, because those items are the bases of pattern making. The selected pattern to the subject was adjusted and each subject's pattern was completed.

All the patterns are derived from the pattern database of the CAD system. When patterns are adjusted, the orders *Alteration* and *Size Code* of System Management were used. As for upper garments, if the proportion of trunk circumferences (*bust circumference*, *waist circumference*, and *maximum hip circumference*) is different from the selected pattern, the *waist circumference* or *maximum hip circumference* can be adjusted. If length is different, it can be also adjusted proportionally. As for lower garments, if the proportion between *waist circumference* and *maximum hip circumference* is different, *waist circumference* can be adjusted. The length of skirts, slacks and crotch can be adjusted.

3) Fitting trial

Two different styles were designed for each item (jacket, skirt, blouse, and slacks) and a pattern database was generated for all of them. Three jackets of JK1 and 2 blouses of BL1 were made for a fitting trial, because the silhouettes of JK1, JK2, BL1, and BL2 fitted similarly, so one upper garment was made for each subject of the upper body somatotype. Since skirts and slacks have different requirements for pattern making, 4 skirts of SK1, and 4 pairs of SL1 were made for each lower body somatotype. The jacket, skirt and slacks were made with 100% wool sharkskin, while the blouse was made with 100% polyester georgette.

A questionnaire about the fitting trial was made in order to check how well the clothing fits each somatotype. The questions about the jacket and the blouse addressed the following issues. *S.N.P.→ scapular→back waistline length, front interscye breadth, back interscye breadth,* and the eases of *bust area, waist circumference, abdominal circumference, maximum hip circumference, garment length,* and *sleeve length.* The questions about the skirt referred to *front breadth, back breadth, the height of front waistline,* the eases of *waist circumference, abdominal circumference,* and *maximum hip circumference,* and *skirt length,* while any about the slacks included specifics such as crotch length.

A 5-point scale was used in the questionnaire, judging panel consisted of 5 people and were comprised of professionals such as professors and graduate students who had majored in clothing and textiles.

4. Production model development of mass customized clothes

1) Construction of website for on-line commerce of mass customized clothes

A website for the sale of mass customized clothes targeted at middle-aged women was created on the basis of research pertaining to the classification and identification of various somatotypes.

The website contained a selection menu, and a simulation segment in which design, color, fabric, measurement and customer input (of their own size data) feature. Somatotype identification and the creation of an order sheet were also included on this website.

2) Construction of order sheet for off-line commerce of mass customized clothes

The aspects of selection, measurement and order sheet creation vary between off-line and on-line commerce. With off-line commerce, retailers (sales people) play a direct role in these dynamics. As a result, they are able to pass on more accurate information to manufacturers. An order sheet for off-line commerce was made for this study in order to reflect those aspects.

III. Results and Discussion

1. Results of making pattern database

1) Pattern making

In order to make patterns for each somatotype, the patterns of standard somatotypes were modified on the basis of the items, which had differences for each somatotype. The results of different construction, combined with the means of the measurement items were used for pattern making (Kim & Jo, 2001).

According to the different structures of somatotype, the mean of each item was used for the measurement of pattern making. At times, adjustment to each pattern was required in order to create distinct somatotype patterns.

The silhouettes of upper garments in this study were all fitted, so the same method was used to modify patterns for each somatotype. As for skirts and slacks, the each method was the same. JK1, JK2, BL1, BL2, SK1, SK2, SL1 and SL2 were worded on. However, due to space constraint, only the somatotype pattern of JK1, SK1 and SL1 will be represented.

(1) Pattern making for upper garments

The important items of the upper body somatotypes as for pattern making were *bust circumference / under-bust circumference, S.N.P.→B.P.→front waistline length / S.N.P.→scapular→back waistline length, front interscye breadth / back interscye breadth,* and *chest shoulder length / back shoulder length.*

These items are indices, so it is necessary to apply the absolute value of each item to the patterns when the indices are applied to them. This is possible because the differences of somatotypes for the upper body are not derived from factors such as build, obesity, stature or weight.

Table 7 represents the measurements of each somatotype for upper garment pattern making. As for the items, *waist front length / back length, S.N.P.→B.P.→front waistline length / S.N.P.→scapular→back waistline length,* the somatotypes were grouped into 3, but the different pattern making for each somatotype was done to make sure differences according to bust development.

<Table 7> Measurements & correcting amounts of each somatotype for upper garment pattern making   unit: cm

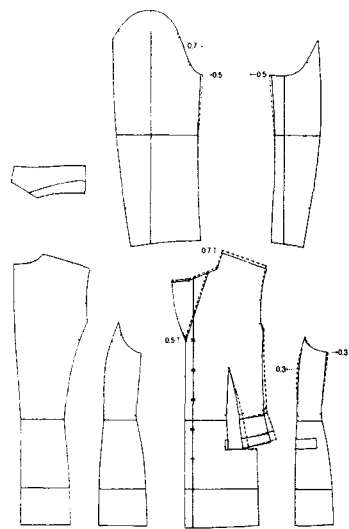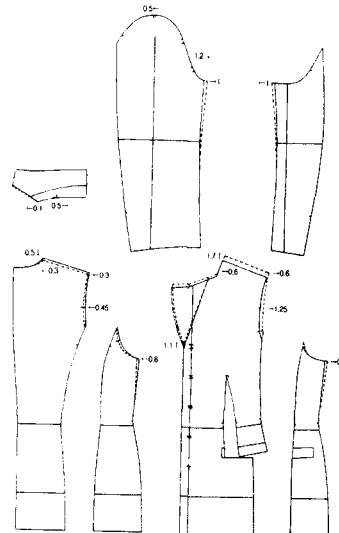| Item \ Somatotype	straight posture - medium /small bust	straight posture - large bust	leaning back posture - medium/small bust	bent forward /swayback posture - medium /small bust	bent forward /swayback posture - large bust
chest shoulder length	37.4	38.1	38.6(+1.2)	37.6	36.9
back shoulder length	39.1	39.9	38.5(-0.6)	39.3	39.9
front interscye breadth	33.1	33.0	35.6(+2.5)	31.9	31.7
	33.1(standard)			31.8(-1.3)	
back interscye breadth	36.8	37.0	35.9(-0.9)	38.1	38.5
	36.8(standard)			38.3(+1.5)	
waist front length	33.3	33.9(+0.6)	34.7(+1.4)	32.4(-0.9)	33.6(+0.3)
back length	38.8	38.9(+0.1)	39.2(+0.3)	39.6(+0.8)	39.7(+0.9)
S.N.P.→B.P.→front waistline length	40.5	41.4(+0.9)	42.6(+2.1)	39.2(-1.3)	40.5(0)
S.N.P.→scapular→back waistline length	42.5	42.7(+0.2)	42.3(-0.2)	43.8(+1.3)	43.8(+1.3)

In order to exclude size difference rather than somatotype difference, the corrections were adjusted, as demonstrated in Table 8.

<Table 8> Correcting amounts of each somatotype for upper garment pattern making   unit: cm

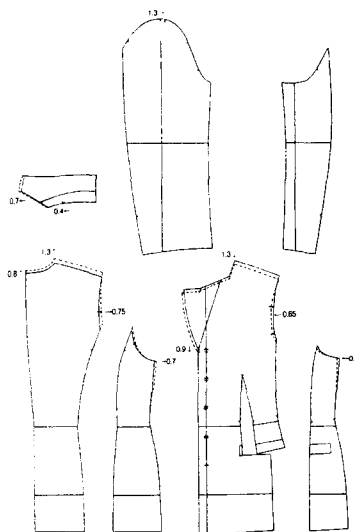| Item \ Somatotype	straight posture - medium /small bust	straight posture - large bust	leaning back posture - medium /small bust	bent forward /swayback posture - medium /small bust	bent forward /swayback posture - large bust
chest shoulder length	0	0	+1.2	0	0
back shoulder length	0	0	-0.6	0	0
front interscye breadth	0	0	+2.5	-1.3	-1.3
back interscye breadth	0	0	-0.9	+1.5	+1.5
waist front length	0	+0.5	+1.1	-0.9	+0.2
back length	0	0	0	+0.8	+0.8
S.N.P.→B.P.→front waistline length	0	+0.7	+1.7	-1.3	0
S.N.P.→scapular→back waistline length	0	0	-0.5	+1.3	+1.3

Fig. 4 shows the somatotype patterns of JK1 according to the measurements and correcting amounts of each somatotype. The pattern of *straight posture - large bust* has longer *front length* and wider *front breadth* than that of *straight posture - medium/small bust*. The pattern of *leaning back posture - medium/small bust* has longer length and wider breadth of front bodice, and shorter length and narrower breadth of back bodice. On the other hand, the pattern of *bent forward/swayback posture - medium/small bust* has shorter length and narrower breadth of front bodice, and longer length and wider breadth of back bodice. The pattern of *bent forward/swayback posture - large bust* has longer length and wider breadth of back bodice and larger front dart, because of the feature of large bust.
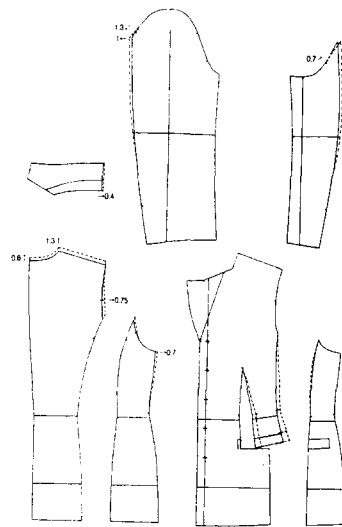
straight posture
- large bust

leaning back posture
- medium/small bust

bent forward/swayback
posture
- medium/small bust

bent forward/swayback
posture - large bust

※ solid line: the pattern of *straight posture - medium/small bust*

<Fig. 4> Patterns of JK1 for each somatotype

(2) Pattern making for lower garments

The important items of the lower body somatotype as for pattern making were *front abdominal circumference, back hip circumference, upper abdomen angle, under abdomen angle*, and *upper buttock angle*.

The lower body somatotype was related to obesity factors such as *weight, Rohrer index, waist circumference, abdominal circumference*, and *maximum hip circumference*. These differences were from the somatotype, *prominent abdomen - prominent buttocks*, so it is not reasonable to apply the absolute values from the differences of this somatotype to patterns. When patterns for this somatotype were developed, the mean of *front abdominal circumference* of *prominent abdomen - normal buttocks* was applied, along with that of *back hip circumference* of *normal abdomen - prominent buttocks* to the patterns of *prominent abdomen - prominent buttocks* somatotype.

Table 9 represents the measurements of each somatotype for lower garment pattern making.

<Table 9> Measurements & correcting amounts of each somatotype for lower garment pattern making   unit: cm, °

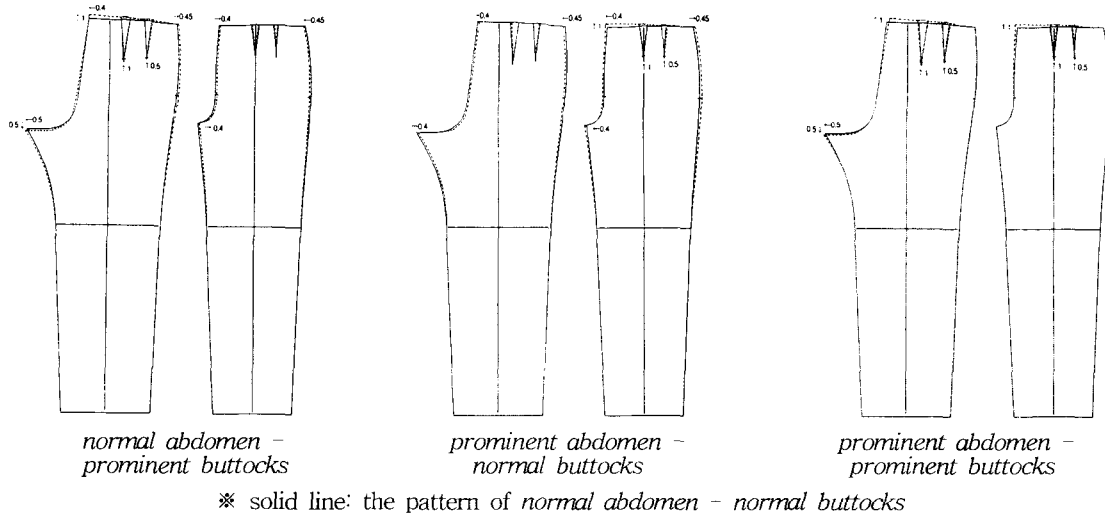| Somatotype Item	normal abdomen -normal buttocks	normal abdomen -prominent buttocks	prominent abdomen -normal buttocks	prominent abdomen -prominent buttocks
front abdominal	43.2	42.8	44.7	45.7
circumference	43.2	43.2	44.7(+1.5)	44.7(+1.5)
back hip circumference	51.0	52.7	51.8	53.1
	51.0	52.7(+1.7)	51.0	52.7(+1.7)
upper abdomen angle	9.2	8.5	13.7	10.0
under abdomen angle	13.7	14.2	19.2	24.4
upper buttock angle	12.4	19.0	11.8	19.6

Fig. 5 shows the somatotype patterns of SK1 according to the measurements and corrections of each somatotype. The pattern of *normal abdomen - prominent buttocks* has a narrower front breadth, wider back breadth, and longer back center length than that of *normal abdomen - normal buttocks*. On the other hand, the pattern of *prominent abdomen - normal buttocks* has wider front breadth, narrower back breadth, and longer front center length. The pattern of *prominent abdomen - prominent buttocks* has longer front and back center lengths but front breadth and back breadth are the same as those of *normal abdomen - normal buttocks*.

The breadths and center lengths of the somatotype patterns of SL1 are similar to those of SK1, but slacks are related to crotch as shown in Fig. 6.

normal abdomen -   *prominent abdomen -*   *prominent abdomen -*
prominent buttocks   *normal buttocks*   *prominent buttocks*

※ solid line: the pattern of *normal abdomen - normal buttocks*

<Fig. 5> Patterns of SK1 for each somatotype

normal abdomen -
prominent buttocks

prominent abdomen -
normal buttocks

prominent abdomen -
prominent buttocks

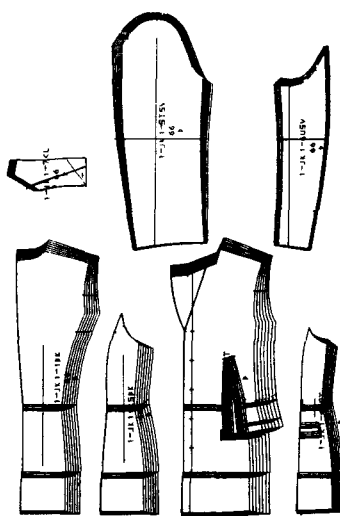※ solid line: the pattern of *normal abdomen - normal buttocks*
<Fig. 6> Patterns of SL1 for each somatotype
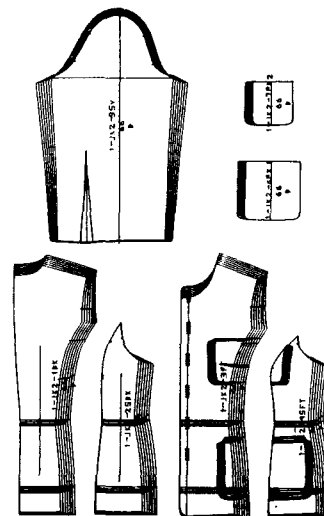
2) Grading

Grading of all patterns for each somatotype was carried out with the dimensional increments and decrements of grading as shown in Table 3. If the anthropometric data of thousands of people had been available to this study, it would have been possible to make increments of grading for each somatotype.

The pattern database of mass customized clothes for middle-aged women was made through grading of all patterns for each somatotype.

Fig. 7 to Fig. 10 are the nested grading patterns of jackets and blouses for *straight posture - medium/small bust*. Fig. 11 to Fig. 14 are the nested grading patterns of skirts and slacks for *normal abdomen - normal buttocks*.

<Fig. 7> Grading of JK1 for
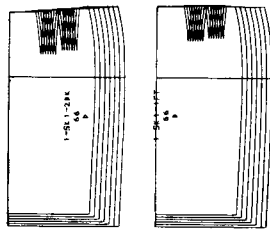*straight posture - medium/small bust*

<Fig. 8> Grading of JK2 for
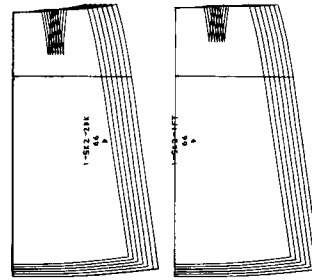*straight posture - medium/small bust*
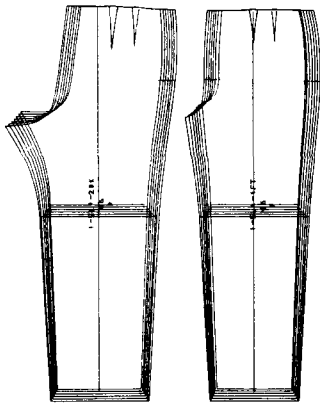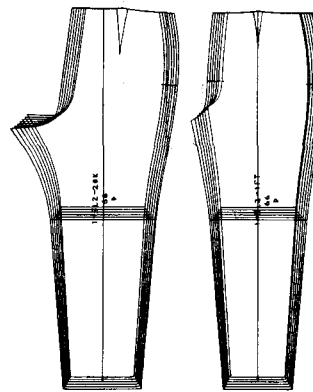
<Fig. 9> Grading of BL1 for
straight posture - medium/small bust

<Fig. 10> Grading of BL2 for
straight posture - medium/small bust

<Fig. 11> Grading of SK1 for
normal abdomen - normal buttocks

<Fig. 12> Grading of SK2 for
normal abdomen - normal buttocks

<Fig. 13> Grading of SL1 for
normal abdomen - normal buttocks

<Fig. 14> Grading of SL2 for
normal abdomen - normal buttocks

2. Results of testing the production model

1) Applying patterns to subjects

The somatotypes of all subjects were distinguished, and they were all representatives of each somatotype, as expected. Their closest sizes for each somatotype patterns were found and the patterns were adjusted to them.

(1) Upper garments

The *bust circumference* of the subject of *straight posture - medium/small bust* was 92 cm, which was close 91 cm, *bust circumference* of size 66, so size 66 was found and just decreased 3 cm of *sleeve length*.

As for the subject of *straight posture - large bust,* size 88 was selected because her *bust circumference* was 100.2 cm. Her *maximum hip circumference* was 4 cm smaller than size 88's, so 4 cm was reduced from that measurement. Also, 4 cm of the *sleeve length* was shortened in order to fit the subject.

The *bust circumference* of the subject of *leaning back posture - medium/small bust* was 96.5 cm, so size 77 was found. Her *maximum hip circumference* was 5.5 cm smaller than it, so the amount of the measurement was reduced and 3 cm of *sleeve length* was also shortened in order to fit the subject.

For the subject of *bent forward/swayback posture - medium/small bust,* size 44 was selected because her measurements were the same as size 44. It didn't need to be adjusted for her.

Size 77 was found for the subject of *bent forward/swayback posture - large bust,* but her *maximum hip circumference* was 2.6 cm larger than the size. So the amount was enlarged. Also, she was so short, so 2 cm of each *S.N.P.→B.P.→front waistline length* and *back length* was reduced and 6 cm of the *sleeve length* was shortened in order to fit the subject.

(2) Lower garments

For the subject of *normal abdomen - normal buttocks,* size 66 was selected. Her measurements were very close to it, so 0.6 cm of *skirt length* and *slacks length* were increased to fit the subject.

The size of the subject of *normal abdomen - prominent buttocks* was close to size 77, and 0.6 cm of *skirt length* and *slacks length* was shortened in order to fit the subject.

For the subject of *prominent abdomen - normal buttocks,* size 66 was found and there was no adjustment.

There was no adjustment for the subject of *prominent abdomen - prominent buttocks* and selected size was 99.

2) Fitting trial

A fitting trial was conducted by assembling a panel of 5 people. They were questioned about the suitability of the patterns used in the research and the appropriateness of size selection.

The upper garments of the five subjects fitted perfectly, reflecting that the somatotype patterns and size selection methods were suitable. Therefore, the somatotype patterns of upper garments and the

method to select size were suitable.

Generally, skirt sizes posed no problems. The exception was the subject with the *normal abdomen - normal buttocks*. The size selection for this somatotype was problematic because her *waist circumference* and *maximum hip circumference* were larger than the measurements for size 66 by 1.6 cm and 2.3 cm respectively. It would therefore be appropriate to select the next largest size, despite the fact that the subject's measurements were closer to size 66.

As for slacks, *normal abdomen - normal buttocks* has a problem like as for a skirt. *Prominent abdomen - normal buttocks* also had a problem, it was a little lack of eases for *abdominal circumference* and *hip circumference*. The subject had a *waist circumference* that was 2 cm larger and a *maximum hip circumference* that was 1.7 cm larger. The fact that slacks usually fit more tightly than skirts and have the additional issue of a crotch meant that there were more difficulties with slacks. Ultimately, the main problem is selecting an appropriate size. This can be solved by choosing larger sizes or by offering a wider range of size.
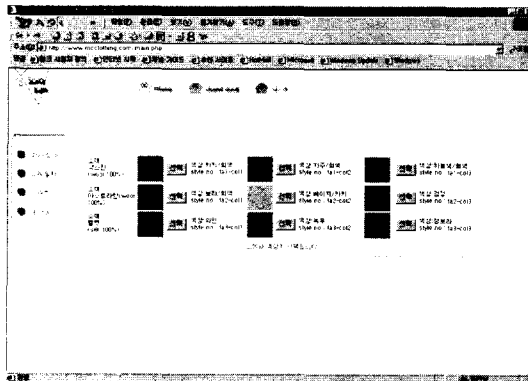
It is therefore advisable to employ a larger skirt and slack size when the subjects' measurements are more than 1.5 cm compared to the smaller size. This is because skirts and slacks are well fitted than jackets and blouses. Additionally, middle-aged women tend to dislike tight clothing.

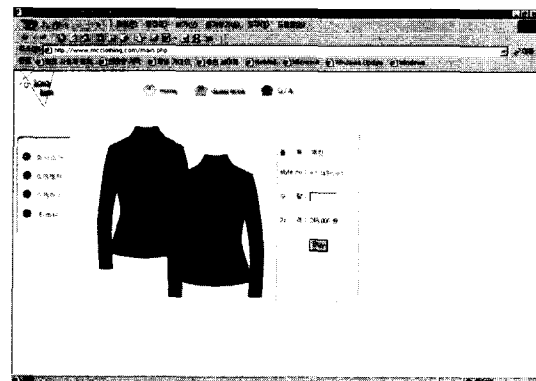## 3. Results of production model development of mass customized clothes

1) Construction of website for on-line commerce of mass customized clothes

This website was made on the basis of studies about somatotypes, pattern making and grading, and a fitting trial. The website begins with an explanation about the website, shopping procedure and about making orders on an order sheet. The address of this site is *www.mcclothing.com*, and its brand name is *Sora Kim*.

People who shop at this site can select the items they wish to buy among jackets, blouses, skirts and slacks. After that, they can choose a design of clothes. Each item has 2 different designs. Depending on their selected item and design, they can also select fabric and color as shown in Fig. 15. Once they select fabric and color, selected design is simulated with the fabric and color (Fig. 16).

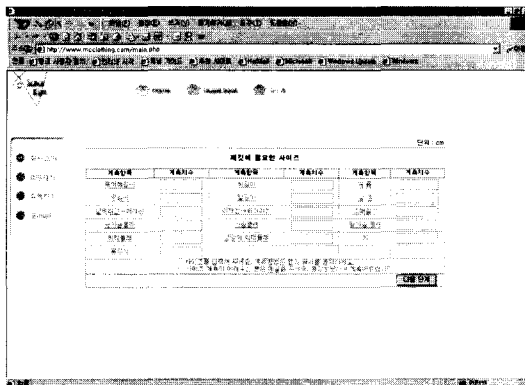<Fig. 15> Fabrics and colors for suits
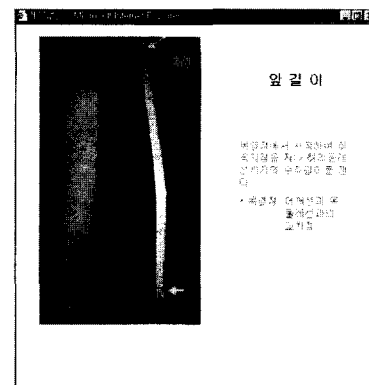
<Fig. 16> Simulation of JK1

When they see the simulation, the customer can decide the quantity of clothes to purchase and click the buy-button. The program will itemize each purchase.

After that, customers should input their measurements on the web page (Fig. 17). This website has 2 different measurement pages for each upper garment and lower garment. When a customer has difficulty in measuring themselves, they can click on the item in question and read the instructions (Fig. 18).

<Fig. 17> Measurement page for upper garments

<Fig. 18> Instruction to measure S.N.P.→B.P.→front waistline length

The customer's somatotype is determined by their inputted measurements. To determine the somatotype for the lower body, a diagram like Fig. 3 was presented.

After this, customers can make an order sheet. They check and put in their information: a place to deliver and a method of payment, and then finish their order.

2) Construction of order sheet for off-line commerce of mass customized clothes

The sales people at off-line trading premises can determine a customers somatotype more precisely than the customers' themselves, resulting in more accurate information about somatotype being transferred to the pattern-makers. Of course, sales people select customers' somatotype on the basis of Fig. 2 and Fig. 3, but final decision for somatotypes was carried out at a main office through customers' measurements. Also, if a shop has sample clothing, a customer can try on samples and the sales person can ascertain which areas need to be corrected.

Fig. 19 exemplifies the order sheet for off-line trading in mass customized clothing. This form demonstrates how a jacket or a skirt is ordered.

Customer's name: Minhee Kim

Telephone No.: 02)2290-1234, 011-9812-1234

Due date: Oct. 8, 2001

Ordered particular

Item	Design	Fabric	Color	Qunt.	Price
jacket	JK1	velvet(FA3)	wine(COL1)	1	₩248,000
skirt	SK1	velvet(FA3)	wine(COL1)	1	₩118,000

Total ₩366,000

unit: cm

Measurements for a jacket

Item	Measurement	Item	Measurement	Item	Measurement
back shoulder length	39.5	S.N.P.→scapular→ back waistline length	40	back interscye breadth	37
back length	39	S.N.P.→B.P.→front waistline length	42	front interscye breadth	37.5
front waistline→ shoulder line length	38	shoulder line→back waistline length	38	sleeve length	56
chest circumference	86	bust circumference	88	under-bust circumference	75
waist circumference	75	maximum hip circumference	98.5	stature	164
weight	55	selected upper body somatotype	leaning back posture		

unit: cm

Measurements for a skirt

Item	Measurement	Item	Measurement	Item	Measurement
waist circumference	75	abdominal circumference	90	back hip circumference	50
hip circumference	96	maximum hip circumference	98.5	skirt length	60
stature	164	weight	55	selected lower body somatotype	prominent abdomen - normal buttocks

Somatotype feature and Matters to be attended

Somatotype feature	• Upper body had the feature of leaning back posture and S.N.P.→ B.P.→ front waistline length was long. • Sleeve length was long. • Lower abdomen was prominent.
When this customer wore ready-to-wear sample *	Sample size: Upper garment: 66, Lower garment: 66 Feature: • The front hemline of a jacket was lifted • Sleeve length was short. • The front hemline of a skirt was lifted and the side seam was tilted to the front. • The front breadth of a skirt was narrow. • The center of front waistline was low.
Matters to be attended	This customer doesn't want very fitted style.

* It is for a customer to try on sample clothes.

<Fig. 19> Order sheet for off-line commerce

IV. Conclusions

Mass Customization has the potential to be a leading production method for clothing and textile industry in the 21st century. A production model for the mass customized clothes for middle-aged women was developed through the course of this study.

The research procedures and results were as follows:

1. The 5 upper body somatotypes were organized in relation to the lateral view and bust development. Somatotype patterns varied according to the differences between the front bodice and the back bodice, and the breadth and length of the back area.

2. The criteria for classifying the lower body somatotype were abdomen and buttock prominence. The somatotypes for this study were broken into 4 categories. Somatotype patterns varied according to the differences of breadth between the skirt/slacks front, the skirt/slacks back, and the dimensions of the prominent areas.

3. A comprehensive database of patterns was assembled by utilizing the analysis of somatotype, pattern making and grading.

4. The propriety of somatotype pattern making and size selection was proved through fitting trial. In order to select the size of lower garments, it was recommended to choose next larger size when the customer's *maximum hip circumference* is above 1.5 cm larger than the closest size.

5. A website for the specific purpose of selling mass customized clothes to middle-aged woman has been designed by using the results from this study.

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