A Study on Use of Anthropometric Data and 3D Body Scan Data at Apparel Industry

Jongsuk Chun

Associate Professor, Department of Clothing and Textiles, Yonsei University, Seoul, Korea

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Abstract

The 3D measurement data expected be useful to give appropriate garment fit and development of MTM(Made-to-Measure) CAD software. The researcher surveyed the need and use of national anthropometric data of the apparel industry. 17 Korean apparel manufacturers participated in the study. The need of anthropometric data at 5 different apparel business sectors was measured: men's suit, women's dress, casual-wear, underwear, and active sportswear. The result of the survey shows that height and bust, waist, hip circumferences are needed by all of the business sectors. The body measurements at the scye and upper arm area were need most by the men's suit manufacturers. The women's foundation garment manufacturers were well prepared for the use of the 3D body scan data and they expected the potential benefits of 3D body scan data would be great. The researcher also conducted a case study and found a pro and con of the using 3D body scan data for apparel product developing process. In the current stage of technical advance, a reasonable method was required to get nude like scan data for the women's foundation garment manufacturer. The researcher concluded that the apparel designer could use the 3D scan data for developing tremendous style garment design and pattern making.

Key words : apparel manufacturers, anthropometric data, 3D scan data.

Ⅰ. Introduction

The potential benefits of a national sizing survey are tremendous. The body measurement data entered a confidential database, accessible by the consumer for use in clothing purchases, by retailers/brands for order fulfillment and by manufacturers. The Korean national anthropometric survey had been performed four times in 1979, 1986, 1992 and 1997. In addition to these anthropometric surveys, the Korea Agency for Technology and Standard, Ministry of Commerce, Industry & Energry (MOCIE) has plan to measure Korean men, women, and children in 2003. The survey will utilize both traditional measuring method and 3D body scanning method. The most anthromometric surveys have been measured the human body with traditional tools, such as calipers and tape measures. But body measurement data alone do not provide enough anthropometric information for equipment or apparel designs that precisely fit human users. The new 3D body scanning technology permits to capture the 3D geometry of objects

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E-mail : jschun@yonsei.ac.kr

and human. Meunier et al.(2000)[1] generated fit map of a protective helmet on a soldier by scanning him twice. This technology might indicate the variety and number of sizes, the adjustments necessary, the feasibility of customization, the affect of design changes and more.

The use of 3D body scan data, however, is not well known to the Korean apparel industry. The purpose of this study is finding what body measurements are useful for apparel pattern making and design process. The researcher investigated the use of national anthoropometic data at Korean apparel industry. She also looked into the potential use of 3D body scanning data for developing apparel design and pattern making.

Ⅱ. The Collection and Use of 3D Body Scanning Data at Abroad

The U.S. and UK apparel industries have been interested in scanning customers to produce affordable, custom tailored clothing. The garment makers tried to use an anthropometric data to improve the fit of ready-to-wear apparel as well. They also have an interesting on using 3D body scan data for mass customization of apparel. With this reason, the 3D body scanners replace the measuring tape, and related softwares transfer body measurements and posture data to the MTM CAD/CAM system. It is expected that mass customization or made-to-measure (MTM) garment design would be easier than before with automatic body measurement and posture analysis data. The U.S. Army apparel research center utilized 3D scanning to enhance description of whole body or body segment surface geometry for CAD and other application[2]. These days various body scanners are available at the market. The 3D foot scanner is used for the shoe industry already[3]. The 3D head scanner allows change the design and evaluation process of protective equipment including helmets and masks[4].

The latest anthropometric surveys involved the use of 3D body scanners. In 2001 an extensive database of human body measurements gathered by the Civilian American and European Surface Anthropometry Resource (CAESAR) project[5]. This project involves the collection of 3D body measurements from 8,000 subjects including men and women between the ages of 18 and 65. Scan data are being collected in the United States and in Europe. VF Corp., Levi Strauss & Co., Sara Lee Corp., Gap Inc. and Dayton Hudson are among the U.S. apparel manufacturers that participated in the project[6]. A similar effort was initiated in the UK(Size UK Project). Approximately 11,000 people were body scanned and measured in 4 months beginning in September 2001. Three TC^2 body scanners were used in 8 different locations around the UK. Over 140 measurements were automatically extracted for each subject, requiring only 10 measurements to be taken manually. The data analysis portion of the Size UK project is now underway and it is expected that a new sizing and size distribution information as well as recommended size tables will be provided to the participating UK apparel retailers[7]. TC^2 a not-for-profit U.S. sewn products industry organization, contributed significant human resources and body scanner equipment to

[1] P. Meunier, A. Tack, H. Ricci, H. Angel and L. Bossi, "Helmet accommodation analysis using 3D scanning", *Applied Ergonomics*, 31(4)(2000): 361-369.

[2] S. Paquette, U.S. Army anthropology 3-D data aquisition and application (Natick Activities. 1999).

[3] J. Chun, "Study on input data for developing virtual fitting model at internet apparel shopping sites and comparison of the results", *Korean J. of the Science of Emotion & Sensibility*, 5(4)(2002): 1-10.

[4] http://www.hec.afrl.af.mil/cardlab

[5] G. Stokes, CAESAR Measures th U.S. and Europe, ASTM Standardization News(1997). 22-25.

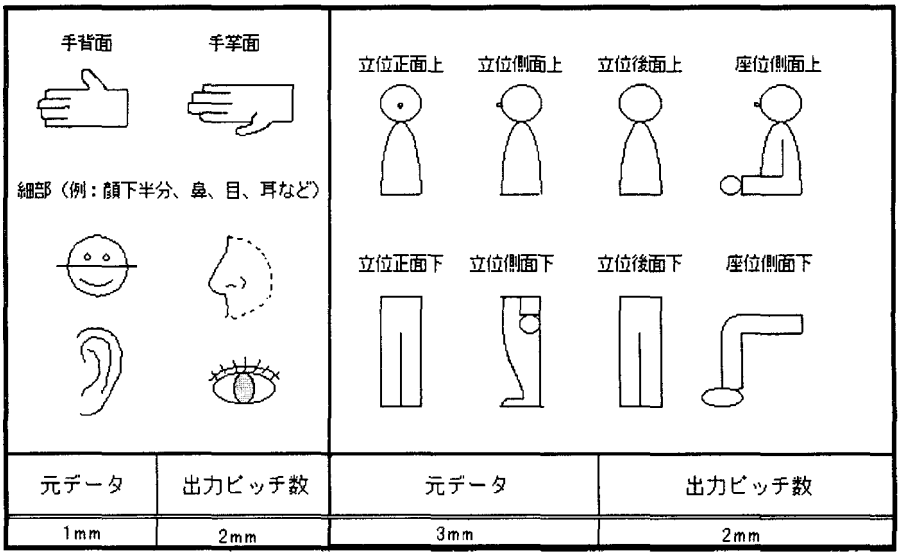
[6] D. Silverman, A better fit through body scanning, Women's Wear Daily(Aug. 1998).

[7] DICTA. DMN, LCF, 2000. *3D Technology Proofing*, Phase 2. specification, (Version, 1.6). (2000).

help make a United States Sizing Survey possible (Size USA Project). A preliminary study has been conducted which suggests that a minimum statistically significant sample size for the U.S. population is 12,000 men and women. In the Size USA project, the body scanning was completed in December. A number of U.S. apparel retailers, universities, and manufacturers, and individual has been participated. The database, accessible by retailers and manufacturers on an anonymous. Brooks Brothers offers a customized new suit with 3D body scanning data. With the new made-tomeasure system using 3D scan data, a custom suit that traditionally takes six to eight weeks to make can be completed within 15 business days[8].

The Somatometric Institute in Greece organized a National Anthropometrc Survey with the use of a whole body 3D scanner, SYMCAD-TELMAT[9]. In Japan, the Research Institute of Human Engineering for Quality Life (HQL) published Japanese body size data that were collected from 1992 to 1994. The data base is composed of 178 body measurements from each of 34,000 Japanese aged from 7 to 90 years. HQL also provides 3D whole body scanning data and 3 dimensional scanning data of body parts such as hand, nose, eyes, and upper- or lower-body of an anonymous subject who has body or age limitation the buyer wants (Fig. 1)[10].

It is widely recognized that the size offerings of apparel in retail establishments serves the consuming public poorly. In a 3D body scanning technology development the apparel industry holds interesting potential for the future. Various techniques are employed to calculate body measurements directly from the 3D body scanning data set. The apparel manufacturers and retailers are exploring body scanning possibilities. The uses of 3D body scan data being utilized in the market are size prediction softwares and advanced pattern making technology.



〈**Fig. 1**〉 The Japanese Body Scanning Data Base in HQL.
(note: partial body scan data is provided at hand-palm, upper side of hand; face: nose, ear, eyes; upperbody and lowerbody at front, side back view at stand, side view at sitting posture)

[8] http://www.sizeusa.com/info.html

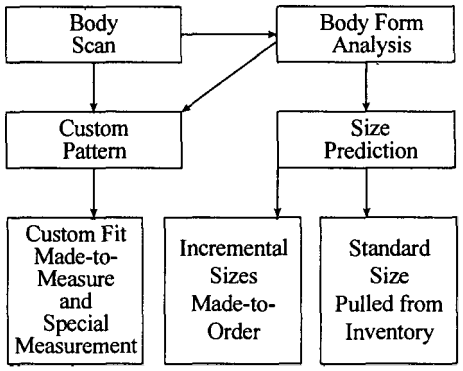
[9] www.bodymetrics.gr

[10] http://www.hql.or.jp

The 3D body scan data are used for eliminating apparel fit problems which are costly and frustrating not only for consumers but also for apparel manufacturers and retailers, whether the expense comes in the form of returned merchandise, lost sales, brand dissatisfaction or time wasted in the fitting room. Apparel companies look closely at the human body - preferably as many different shapes and sizes of bodies as possible, often with little to no clothes on for best results. They identify significant size groups that are not being covered and verify whether specific sizes and grade rules need to be adjusted. The body measurements taken with a tape measure provide only limited information about a person's true shape and curves. As such, 3D body scanners get strong expectation as powerful tool to improve garment fit. Many institutes, like HQL in Japan, make consumers' measurement database, accessible by apparel and other industry manufacturers on an anonymous, data-for-fee basis.

Different manufacturers have different size standards aren't likely to change because they are connected to each firm's perception of its competitive advantage[11]. Techniques of mass customization are expected to enable an increase in apparel product variety, without compromising a company's competitive cost structure. The development of body scanning technology has greatly enhanced the capabilities of mass customization(Fig. 2).

However, before apparel mass customization can become a widespread reality, several issues still need to be solved. One of them is modification of commodity pattern for individuals. It takes a lot of researches to work with both pattern making and application of 3D body scanning data analysis[12]. Made-to-measure(MTM) technology is used for mass customization of the apparel and it is expected to revolutionize



〈Fig. 2〉 The Use of 3D Body Scan for Apparel Industry.

the sewn products industry. MTM technology uses body scanning technology to determine body size and shape. Tecmath 3D body scanner and integrated measurement software are being used to collect and automatically download scan data into programs such as Lectra Systems' FitNet, which is designed to enable retailers to offer customized clothing options to consumers. FitNet stations can transmit measurement data obtained from body scanners over the Internet to manufacturing locations. 3D Custom Fit Corp. has developed 3D relational geometry principles to automatically make 3D basic blocks to fit over individual body scans. The computer generated, custom made 3D slopers are then flattened into 2D garment patterns, which can be imported into standard CAD packages to create perfectly fitted garments[13]. Clarity Fit Technologies also developed a system that can take scan data and convert it into custom made patterns. The firm is focusing on its size prediction solutions and it has developed the Clarity Fitting Room, which is designed to assist consumers in their online apparel shopping.

[11] J. Chun-Yoon, and C. Jasper, "Development of size labelling systems for women's garments", *J. of Consumer Studies and Home Economics*, 18(1994): 71-83.

[12] H. Scheller, and C. Rabon, *Mass Customization Making Progress*, Bobbin. (Sep. 1997).

[13] K. DesMarteau, Special Report: PreProduction and CAD, Bobbin. (Oct. 2000).

Clarity Fit's solution automatically analyzes consumer measurement data, fit preference information and a manufacturer's or retailer's garment specification data in making size recommendations[14]. An algorithm of transform 3D body scanning data to 2D basic men's jacket bodice pattern was developed by [15]Chun et al.(2002). They analyzed a man's 3D scan data collected with Cyberware Whole Body Scanner WB4.

The virtual try on technology is integrate 3D visualization functionality with the capability to use body measurements or 3D body scan data and garment specifications to simulate garment fit. With affordable, increased desk-top computing power, most CAD vendors have increased their capabilities in the area of virtual reality, or presenting digital products in more realistic terms. One of the main advantages of these developments is the improved ability of apparel firms to solicit input about concepts or virtual prototypes before making actual samples. In turn, this should improve the success rate for new styles and expedite the product development process. There also are interesting applications for these technologies in the business-to-consumer (B2C) e-commerce selling arena. Technologies permits the designer to visualize the modifications to pattern pieces in real time, and the 3D virtual style changes automatically as the pattern maker develops a style in two dimensions. New solutions, including 3D body scanning and other technologies, hold the potential to improve the online shopping experience, and improve consumer fit choices. For instance, Lands'End, J.C.Penney Co. and Galeries Lafayette have opted to use virtual try on technology from "My Virtual Model" on their Web sites[16]. My Virtual Model has developed a virtual try on, or virtual fitting room, program that is capable of transmitting large amounts of data over standard Internet. The technology allows consumers to customize a limited set of variables (such as hair color, height and other body measurements) on a virtual fit model, and then select clothing to view on the model[17].

Mass customization options that include customizing the fit have expanded greatly with the continued development of electronically linked body measuring technology[18]. Several different technical systems have been developed body scanning. In addition, processes utilizing 3D relational geometry principles to automatically make 3D basic blocks to fit over individual body scans. The development, however, of method for application of 3D body scanning data for apparel pattern drafting system was not reported much.

Ⅲ. Methods

The study was carried out with two procedures: 1) surveying on the use of anthropometric survey data for apparel pattern making at Korean apparel industry and 2) investigating potential use of 3D body scanning data for

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[14] E. B. Gazzuolo, "Garments of Light, Custom Clothing from Body Scan", *Clarity Fit Technologies*, (New York, 1997).

[15] J. Chun, D. Suh and K. Lee, "A Study on the Use of 3D Human Body Surface Scan Data for Apparel Pattern Making", *The Research J. of the Costume Culture*, 10(6)(2002): 709-717.

[16] G. Lorri, "Shape of things to come: A virtual you on the Net Consumer's 3D image makes online shopping easy", *USA TODAY*, 6(2000), 27.

[17] J. Chun, "Study on input data for developing virtual fitting model at internet apparel shopping sites and comparison of the results", *Korean J. of the Science of Emotion & Sensibility*, 5(4)(2002): 1-10.

[18] L. Burns, and N. Bryant, *The business of fashion*, (Fairchild Publication, New Jersey, 2002).

〈Table 1〉 The Manufacturers Participated in This Study

Business	Company	Year of Foundation	Total Sale in 2000 (billion₩)	Designer/ Pattern Maker(n)	Main Target Age (years)
Men's suit	A	1983	58	9 / 4	30's~50's
	B	1983	120	4 / 2	30's~50's
	D	1979	120	7 / 3	20's~40's
	D	1995	35	5 / 2	21~29
Women's dress	E	1990	43	11 / 3	20~25
	F	1995	53	13 / 3	18~22
	G	1978	53	70 / 22	20's
	H	1955	32	7 / 4	40's~50's
Casual wear	I	1999	65	7 / 1	18~22
	J	1989	77	31 / 7	All age
	K	1988	33	10 / 4	18~23
	L	1999	15	4 / 1	20's~40's
Active Sports wear	M	1988	85	5 / 2	18~23
	N	1990	59	3 / 1	All age
	O	1996	23	16 / 7	20's
Under wear	P	1974	140	NA	20's~30s
	Q	1979	120	NA	All Age

apparel pattern making or design process. The researchers conducted individual interview in 2002. The interviewees were managers of the pattern making division from 17 apparel manufacturers in Korea: men's business suit (n=4), women's dress (n=4), casual-wear (n=4), active sportswear (n=3), and underwear (n=2). Three men's suit manufacturers(A, B, C) produced traditional style suit for middle age men and other manufacturer(D) produced stylized tailored suit for young men. Three of the women's apparel manufacturers(E, F, G) produced garments for young lady in age 20's. The other manufacturer(H) made garments for middle age women. The apparel manufacturers participated in this study were the leading company in Korean apparel industry based on the annual sales volume(Table 1). For the data collection the researcher explained the whole set of body measurements in the national anthropometric survey in 1997. The interviewees evaluated the body measurements that are useful for the apparel pattern drafting. They evaluated each body measurement with 5 point scale: 1 for not useful, 2 for not necessary, 3 for might be necessary, 4 for necessary, and 5 for strongly necessary. The researcher also explained about the 3D body scanning data and asked them what would be the potential use of the 3D body scanning data for the apparel industry.

Ⅳ. Results and discussion

The manufacturers participated in this study were national brands (Table 1). The men's suit manufacturers usually manufactured apparel for middle age men. The manufacturer D was included to know the need of the men's suit brand that targets young men. Many women's dress makers targeted young adults at age 20's in Korea[19]. The manufacturer H was included on purpose to know the need of body measurement data of the women's apparel brand that targets middle age women. The majority of manufacturers had less than 5 pattern maker. Most of the apparel manufacturers in Korea use CAD for pattern drafting and grading. The underwear manufacturers did not want to reveal the company technology advance stage for production, the number of their designers or pattern makers was not known for this study.

1. The Need of Anthropometric Data at Apparel Industry

The result of the interview shows that the national anthropometric data of the men or women is useful for understanding their customer's body size. The interviewees, however, thought that the definition of each measurement is not clear enough. They wanted to know the definition of landmark and measuring method of each dimension with usual words not with professional anatomical words. 76% of them thought the picture or photo of each measurement would be more helpful for them to understand the body measurement definition. The interviewees evaluated the body measurements with 5 point scale and among the 125 body measurements in data, height (μ =4.64), waist circ. (μ =4.53), bust circ. (μ =4.82), and hip circ. (μ =4.32) were considered as the most important body dimensions for the apparel industry (Table 2). The body dimensions selected as useful dimensions were different by the apparel business sectors. The body dimensions considered being useful by men's suit manufacturers are waist height (μ =4.00), front width (μ =4.75), shoulder length (μ =4.25), shoulder width (μ =4.75), back width (μ =5.00), arm length (μ =5.00), under arm length (μ =4.25). back waist length(μ =4.00), and thigh circ. (μ =4.00). The women's apparel manufacturers also considered these dimensions are needed for the pattern making except scye length, scye depth, upper arm circ., and thigh circ. (Table 2). This result shows that the scye and upper arm area are very important area for pattern making and fit of the men's suit. The other dimensions being considered important by the women's apparel manufacturers are trochanterion height (μ =4.00), front waist length (μ =5.00), neck to bust point(μ =4.50), waist length (μ =5.00), and waist to hips length (μ =4.25).

The casual-wear manufacturers wanted relatively small number of body dimensions, compared to the men's or women's apparel manufacturers. They, however, wanted foot dimensions like foot length (μ =4.25), instep length (μ =4.00), foot circ. (μ =4.00), and ankle circ. (μ =4.25). This result shows that casualwear manufacturer have interesting on foot dimensions with business trend that pursued total fashion business. The result of this survey shows that the active sportswear manufacturers have interesting on dimensions related to the head length or trunk circ. The cervicalhead-forehead measurement measures the head length from the back neck point to forehead (glabellare) through the top of the head(vertex) and neck-head-neck measurement measures head length from the left neck and shoulder interface to right neck and shoulder interface through the top of the head. These dimensions were not measured for adults at the anthoropometric survey in 1997, they were dimensions for infants. The interviewee of

[19] S. Oh, and J. Chun, "A study on actual condition of sizing system of women's RTW apparel brands in Korea", *J. of the Korean Society of Clothing and Textiles*, 26(1)(2002): 50-61.

〈Table 2〉 The Need of 1997 National Anthropometric Data at Apparel Industry

ID	Dimensions	Business Sector					ID	Dimensions	Business Sector				
		Men	Wo	Cs	Und	Spo			Men	Wo	Cs	Und	Spo
1	Height	***	***	***	***	***	48	Hip D.		*			
3	Shoulder H.	*				*	52	Shoulder slope(left)	**	*			
4	Cervicale H.	*	*			*	53	Shoulder slope(right)	**	*			
5	Axillary H.	**	**			**	54	Neck C.	**	*	*	**	**
6	Waist H.	***	***	**	**	**	55	Neckbase C.(woman)		***	*	**	**
7	Trochanterion H.		***		**		56	Scye C.	***	***	*	**	**
10	Gluteal furrow H.		**		**	*	57	Upper arm C.	***	**	*	**	**
11	Crotch H.	**	**	**	**	*	58	Elbow C.	*	**	*	**	**
12	Trochanterion H.		**			*	59	Forearm C.	*	**	*	**	**
13	Tibiale H.		*	*	**	*	60	Wrist C.	*	**	*	**	**
14	Calf H.	*	*	*	**	*	61	Upperbust C. (woman)		***		***	
17	Front waist L.	**	***	**	**	**	62	Bust C.	***	***	***	***	***
18	Front W.	***	***	**	**	**	63	Underbust C. (woman)		***		***	
19	Neck-bp (women)		***		***		64	Waist C.	***	***	***	***	***
20	Waist L.(women)		***		***		65	Abdominal C.	**	**		***	**
21	Neck-scapular pt.				*		66	Hip C.	***	***	***	***	***
22	Neck to waist L.		**		*		67	Thigh C.	***	**		**	***
23	Back waist L.	***	***	**	**	**	68	Knee C.	**	**	*	**	**
24	Gluteal arc.	*	**		***	**	69	Calf C.	**	**	**	**	**
25	Waist to hips L.	*	***	**	***	**	88	Head L.		*		**	**
26	Shoulder L.	***	***	***	***	**	89	Head B.		*			**
27	Shoulder W.	***	***	***	***	**	90	Head D.		*			**
28	Back W.	***	***	***	**	**	98	Head C.		*		**	**
29	Arm L.	***	***	***	**	**	101	Hand L.		*		**	**
30	Under arm L.	***	***	**	**	**	102	Hand B.		*			**
31	Cervical-acromiale-stylion ulnare	**	**			**	106	Hand thickness		*			**
32	Crotch front L.		**		**		107	Max. hand C.		*		**	**
33	Crotch L.		**		**	**	109	Foot L.		*	***	**	**
34	Thigh L.	*	*		**		110	Instep L.		*	***	**	**
35	Scye L.	***	*				111	Foot B.		*	***		**
36	Neck B.		**		*		113	Foot C.(I)		*	***	**	**
37	Shoulder B.	***	***		*		114	Foot C.(II)		*	***		**
38	Body B.	**	*		*	***	115	Min. ankle C.		*	***		**
39	Chest B.		*		*		116	Ankle C.		*	***	**	**
40	Waist B.		*				118	Sphyrion fibulare H.		*	***		**
41	Hip B.		*				119	Foot H.		*	***		**
42	Bust pts B. (woman)				***		120	Weight	*	*	*	*	**
43	Breast D. (woman)				***		121	Tibial H.					**
44	Scye D.	***	*				122	Neck-head-forehead		*		*	***
45	Bust D.		*		*		123	Cervical-head-neck		*		*	***
46	Waist D.		*				124	Trunk C.		*		*	***
47	Abdominal D.		*				125	Thigh trunk C.		*		*	**

note) dimensions: B(breath), C(circ.), D(depth), H(height), L(length), W(width)
business sector: Men(men's), Wo(women's), Cs(casual-wear), Und(underwear), Spo(sportswear)
average points with 5 point scale test: ***: (4.0~5.0), **: (3.0~3.9), *: (2.0~2.9)

the active sports-wear manufacturers also claimed that the trunk circ. is useful for making pattern for one piece type garments like show-suits or swimsuit. The cervical-head-forehead and neckhead-neck are useful for making garments with hood. Waist to hips length, bust points breadth, breast depth and abdominal circ. are important for women's foundation or underwear manufacturers. The other dimensions strongly needed also for underwear manufacturers are neck to bust point length, waist length at front, gluteal arc, shoulder length, shoulder width, upper bust circ., bust circ., under bust circ., and waist circ., and hip circ.

2. The Potential Use of 3D Body Scan Data at Apparel Industry

The use of 3D body scan data at apparel industry is not well defined yet. It was believed that the scan data would be useful for their understanding their customer's body shape. The result of the study shows that expected potential use of the 3D human body scan data for apparel industry was different by the apparel business sector. The men's manufacturers expected that the 3D body scan data would be applicable for drafting a pattern with better fitting at back shoulder and upper arm area. A research director at a women's foundation garment manufacturer strongly believed that the 3D scan data would be a powerful tool for design development and pattern making. He said that his company was developing 3D body scanner with Hamamatsu 3D scanner company for 2 years. He added that a software with 3D scanner needed to be developed to fulfill the need of collecting women's body shape data which were not available with the traditional body measurement technique. However, he did not open what would be dimensions collected by their 3D body scan software. It was considered a valuable technical secret of the company. The other pattern making manager at active sportswear manufacturer had positive expectation for the use of 3D body scan data in terms of collecting dynamic anthropometric data which are needed for developing patterns of active sportswear. He claimed that developing a pattern with high human engineering performance was impossible with the body dimensional data provided in anthropometric servery we have so far. He expected that the active dynamic body dimensions would be collected with 3D body scanner.

3. A Case Study of Utilizing 3D Body Scan Data for Women's Foundation Garment

Based on the results of the survey, the researcher performed a case study of utilizing 3D body scan data for women's underwear. The result of the study shows that the posture and experimental suit must be carefully selected according to the final use of the data. The experiment was performed by the following steps. First, the researcher scanned a woman with Cyberware Whole Body Scanner, WB4. The subject wore her own underwear (pants and brasier) and sports-bra style top and thigh length pants made with 4 way stretching fabric. The same type of experimental suits are being used in CAESAR project (Fig. 3). The next step is converting the scanned polygon mesh data into the readable data in AutoCAD program with Cyslice program developed by Cyberware. The third step is selecting the parts of the body scandata which is need for the design process or pattern making or design process. After taking the part of the body scan data needed for the study, the researcher could measure the dimension or flattened with the same method reported at the former study[20].

In this case study, the researcher performed the experiment from the first step though third step. Body scan data were used for developing women's brasier and girdle. The researcher found pro and con of this method. The good point of

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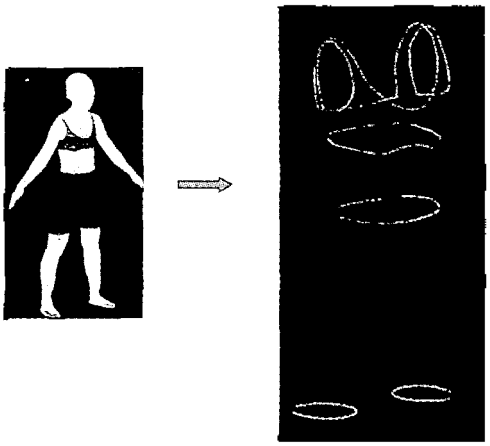
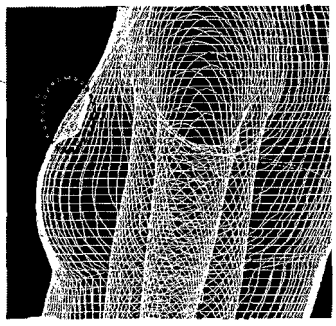
〈Fig. 3〉 Women's Experimental Suits: CAESAR.

this method is that it is relatively easy to take parts of body scan at any parts of the body surface. For example, the researcher tried to select surface body scan data for full cup brasier and thigh length girdle. The style lines of the product were drawn on the subjects's surface scan data and assign the break points on the style line. After connecting the break points the selected area could be cut from the whole body scan data (Fig. 4). This procedure is useful for the products with various styles. The designer can draw style lines as many as she/he can and select the body surface data needed for each design.

As a research manager mentioned in the interview, the shape of the breast in nude is needed for developing the cup shape and proportion. But the national anthropomentric survey has limit to collect women's breast data in nude. The valuable data needed for the brasier design, however, could not be obtained from the scan data of the subject wearing the experiment suit which was used for this study (Fig. 5). The substitutional method would be wearing the bikini style experiment suit. It was reported that the string type bikini style women's experiment suit showing the nude like human body shape was tried at the early stage of research project CEASAR[21]. The reason of not taking the bikini style as women's experiment suit is not reported. It could be assumed that the female subjects would not be happy to be measured with wear-ing bikini style experiment suit in public somehow.



〈Fig. 4〉 The Selected Body Scan Area from The Whole Body Scan Data.



〈Fig. 5〉 The Use Of The Scan Data for Brasier Design.

[21] http://www.hec.afrl.af.mil/cardlab

V. Conclusion and Limitation

The use and need of anthropometric data in Korean apparel industry was reviewed. The researcher found that different body measurements are needed at the various fashion business sector. The men's suit manufacturers wanted anthropometric data at scye and upper arm area to improve the fit of jacket. The sportswear manufacturers wanted the head measurements. The casualwear manufacturers asked foot measurements since they pursued total fashion business. The use of 3D body scan data were expected having tremendous value for developing a pattern. It was claimed that the body dimensions provided in anthropometric servery does not give enough information for developing a pattern. The active sportswear manufacturers want to use 3D body scan data. The manufacturers of women's underwear had strong expectation on the utility of the 3D body scan data because women's nude body shape data were not able to collect with traditional body measurement technique. The case study shows that 3D body scan data could be used for the apparel production. It also shows that the experimental suit must be carefully selected. The use of the 3D scan data was discussed for few idea and not fully tested in this study because of low experience with such a data in apparel industry. For the future study the use of 3D body scan data for the apparel design and pattern developing is needed to be studied.

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