Development of Data Base To Evaluate Fit And Balance Of Closely Fitted Men's Shirt

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ABSTRACT: *This research aims to use advanced 3D body scanning machine to study close fitted garment on assessment of factor affecting to achieve the proper fit. The main focus of the research is projected on men's wear while the close fitting formal shirt is selected as the test subject. Fifteen Bangladeshi Male in 23-30 years age range participated in the assessment. Analyzing bodies and their characteristics: two bodies are selected for equal chest sizes for further study. One pattern block is made to make garments and the garment is tested on these bodies by 3D scanning to detect the actions. The scanned images are shown to 20 consumers in the same age range from Bangladesh to find the fit comment. Market demand for garment fit and balance is evaluated and compared to verify the findings of this study through a common survey. Finally, this study summarizes the main research results, and puts forward the theoretical inspiration on this basis, and points out the prospect of future research on close fitting men's shirt.*

Keywords: *3d Body scanning; Sizing; Close fitting shirt; Pattern; Fit*

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I.   INTRODUCTION

Fit is an important criteria in a consumer's evaluation of an apparel product (Bye & LaBat, 2005; Newcomb & Istook, 2004). [1] [2] The garment production and retail industries have facing the challenge of providing good fitting garments for the variety of the population from the very beginning of industrial revolution and mass-produced clothing (Ashdown, 2007) [3]. Retailers and manufacturers expect the human body to match the clothing standard for their target market, based on the ideal or hourglass figure (Bye *et al*, 2006). [4] People varies with dimensions, a multitude of size along with different proportions and postures which need to be accommodated (Ashdown, 2007) [5]. Le Pechoux and Ghosh (2002) [6] has ended with the decision that ethnic groups have different body proportions and shapes; while apparel fit problems are likely to be aggravated by the diversity of figure shapes (Ashdown & Dunne, 2006; Bougourd, 2015) . [7] [8] Therefore, dissatisfaction with fit is still one of the major complaints expressed by apparel consumers (Loker *et al*, 2005) [9]. According to Bye *et al* (2006) [10] developing accurate and reliable methods of measuring the body, is one part of solving the fit puzzle. Modern technologies have opened way to overcome these problems which shows that traditional systems need to change. Human body can be analyzed by 3d scanning (Zwane *et al*, 2010 Ashdown, 2002;). [11][12] In this study, it is tried to develop accurate data base of measurements to design closely fitted men shirt and analyzing fit compared with the real body by 3D scanning machine.

The main objective of this research is to find and establish a way to ensure fit and balance of garment according to the body. The objectives of this research are pointed below:

1) To determine body measurement chart for 15 Male aged 24-30 from Bangladesh by using 3d scanning machine.
2) To Study about body and body shape,
3) To Group Body Size.
4) To determine required size chart for preparing closely fitted men's shirt.
5) To achieve proper fit by Scanning garment on body to detect factors affect.
6) To build up a suggestion about real body and garment relationship.

II.   EXPERIMENTAL WORK

1.   MATERIAL

Table 1. Material used of this study

Device	Software
3D body Scanning Machine (Human Solution 1.0)	Anthroscan for collecting and converting 3D scanning data from 3D body scanner.
Digital Camera for taking picture	Adove Illustrator cc

2.   METHODOLOGY

Table 2. Step wise methodology

Male body	The subjects for this study consisted of 15 Bangladeshi Males, five feet four inches or upper, and between the ages of 20-30. The non-probability sampling method were selected for the study form the male Bangladeshi students living in Wuhan city.
Measurements	Measurements are studied to evaluate size classification,body shape classification, garment making , garment study, fit assessment are all taken from 3D scanning. Some measured the discrepancies between body dimension and the sample garment, while others focused on body dimensions and industry standards. In addition, a majority of the studies focused on mature male over the age of 24-30. The aim of this research is to asses the effect of same garment on different body while fit the fit assessment and consumer reaction.
Pattern block	Pattern block was made follow " metric pattern cutting for men's wear" where measurements are taken from 3D scanning data base
Garment	One garment is developed to scan and find the action on two bodies

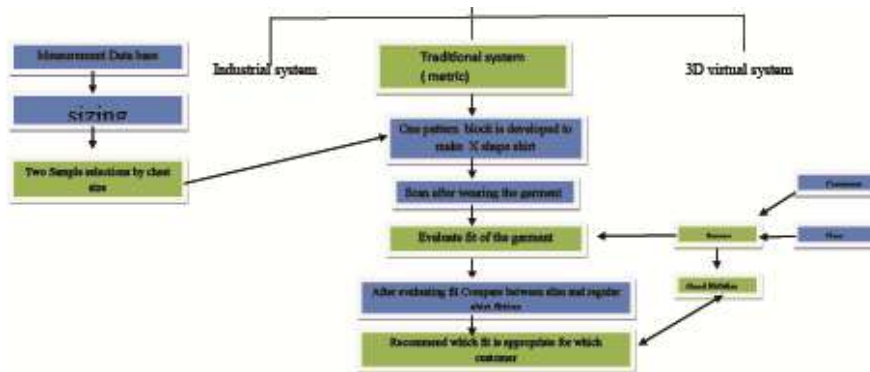The following diagram shows steps for pattern block development:

Fig.1. Pattern making details framework

2.1 Main method of this research
2.1.1 Style of Garments
Close fitted men's shirt is selected for investigation. "X" shape shirt needs to be very closely fit to body. For designating the garment it certain dimension of body needed.

Table 3. Suitable Body selection

Body shape	Average build men (WG-BG<0)	Inverted triangle men (WG-BG<<0)	Tri angle shape men (WG-BG>0)	Rectangle shape men (WG-BG)= 0
Very close fitting shirt	(red)	(blue)	(red)	(red)
Closely fitted Shirt	(blue)	(blue)	(red)	(red)
Table: Suitable body type for X shape Shirt				

Blue color shows the body type who can be selected for the study. As most Males in the study are suitable for close fitted shirt , the data base was well to select to bodies for future study.

2.1.2 Pattern Block
One block was made to create close fitted mens shirt on this study. The pattern development was followed from "Metric pattern cutting for men's wear"

Table 4: Pattern measurements

| Measurement area (cm)	
Neck size	42
Chest	104
Scye Depth	24
Half Back	43
Back waist Dart	2+2=4
Ease Calculation	
Neck size	42-39
Chest	(104-100)= 4
Scye Depth	24-23.6= 0.4
Half Back	43-44.2=0.8
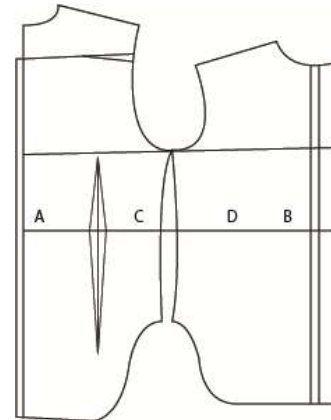
Fig. 2. Pattern block

2.2 Evaluation Fit and Balance:
To calculate the fit and balance configuration an equation was used which is as followed:

$$FB = (FB_{shirt} - FB_{pattern}) = 0$$

Here FB referred to Fit Balance, FB_{shirt} is fit balance belong to shirt, $FB_{pattern}$ is Fit Balance to pattern block.

2.2.1 Fit Balance to pattern:
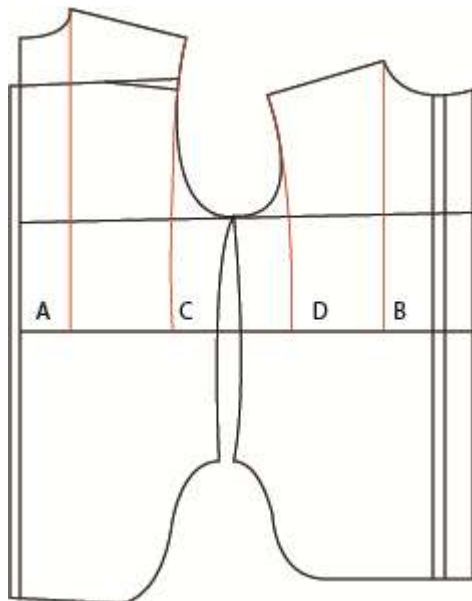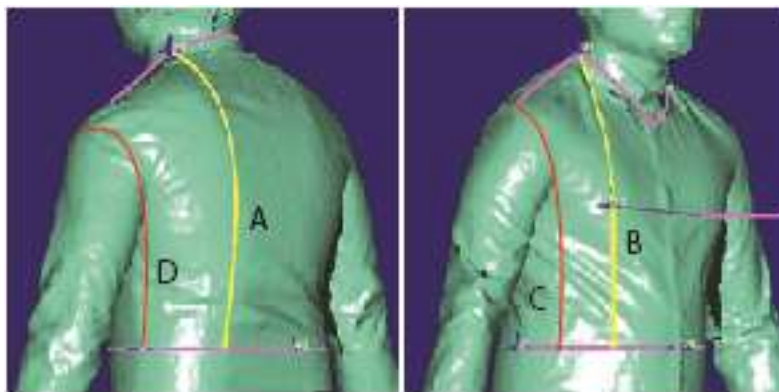

Here
$FB_{Pattern} = LFNB - LFSB$

Here , $LFNB = A+B$
$LFSB = C+D$
So , $FB_{pattern} = (A+B) - (C+D)$

Fig. 3. evaluation of fit from pattern

2.2.2 Fit Balance to Shirt:

Here

$FB_{Shirt} = LFNB - LFSB$

Here, $LFNB = A+B$

$LFSB = C+D$

So, $FB_{shirt} = (A+B)-(C+D)$

Fig. 4. evaluation fit balance from shirt

To check Fit and Balance $FB = FB_{Shirt} - FB_{pattern}$ This value should be zero to be a Balanced shirt.

III.　　RESULTS AND DISCUSSIONS

3D Data primary data base for 15 Males:

Table 5: 3D Measurement Data for 15 males (cm)

SL	Model name	0010 Body height	3030 Shoulder width left	3031 Shoulder width right	3020 Cross shoulder	6510 Waist girth	7525 Hip girth	1520 Neck at base girth	4515 Bust/chest girth
1	MAREUF	176.4	13.0	14.2	46.8	87.7	102.7	41.9	103.3
2	SADIN	175.3	15.5	17.0	54.1	108.6	115.1	45.4	119.1
3	RAJJAK	174.6	13.4	14.2	46.5	89.3	105.5	43.5	98.3
4	NIZAM	179.3	13.9	13.6	48.2	88.8	95.0	43.1	100.7
5	RASEL	172.4	14.1	14.1	48.4	79.3	101.0	42.3	97.6
6	JONY	176.4	13.9	42.1	48.0	86.4	99.3	98.4	94.9
7	RAJA	156.8	12.8	13.7	48.4	94.8	95.6	43.3	105.4
8	ROMJAN	162.6	13.1	12.3	45.6	74.3	94.1	42.1	95.8
9	RATUL	177.1	13.6	13.8	48.6	77.9	93.9	42.8	93.7
10	RAYHAN	172.4	15.4	11.9	47.8	80.8	98.3	43.5	99.5
11	RIAZ	182.5	15.9	15.6	47.2	80.4	99.9	40.0	100.1
12	ROKY	180.3	15.1	14.8	47.7	86.7	106.5	40.8	107.3)
13	ROMIJ	163.3	14.0	12.2	42.2	73.1	86.9	38.7	83.
14	SAIFULR	170.6	13.1	12.8	43.8	81.3	95.3	40.8	95.3
15	SAWON	164.1	14.5	14.0	48.0	83.2	98.2	41.1	102.0
16	SOUROV	171.3	13.6	13.3	45.4)	87.3)	97.2	39.5	98.3

1. Data Analysis:

Table 6: Data Analysis:

sl/ model name	4515 Bust/chest girth	size		6510 Waist girth	Bust/ waist	7525 Hip girth	Bust/hip	Bust - Waist
Romjan	83	**SMALL (88-92)**		73.1	1.13	86.9	1.18	9.9
ratul	93.7			77.9	1.2	93.9	1.2	15.8
jony	94.9			86.4	1.09	99.3	1.14	8.5
saifur	95.3	**MEDUM (96-100)**		81.3	1.17	95.3	1.17	14
rajon	95.8			74.3	1.28	94.1	1.26	21.5
rasel	97.6			79.3	1.23	101.0	1.27	18.3
Rajjak	98.3			89.3	1.1	105.5	1.18	9
SOUROV	98.3			87.3	1.12	97.2	1.11	11
rayhan	99.5			80.8	1.23	98.3	1.22	18.7
Nizam	100.7			88.8	1.13	95.0	1.06	11.9
riaz	100.1			80.4	1.24	99.9	1.24	19.7
saown	102	**LARGE (104-108)**		83.2	1.23	98.2	1.18	18.8
maruf	103.3			87.7	1.17	102.7	1.16	15.6
raja	105.4			94.8	1.11	95.6	1	10.6
rocky	107.3			86.7	1.24	106.5	1.22	20.6
sadin	119.1	**EXTRA LARGE**		108.6	1.09	115.1	1.05	10.5

2. Analysis:

This table shows a comparison of chest measurement with the Standard sizing system. 15 male body shows that

Fig 5: Size segmentation

Fig 5 shows the size segmentation of the participant where "Medium" size poses major share. So it is better to select two figure from this segment for future study.
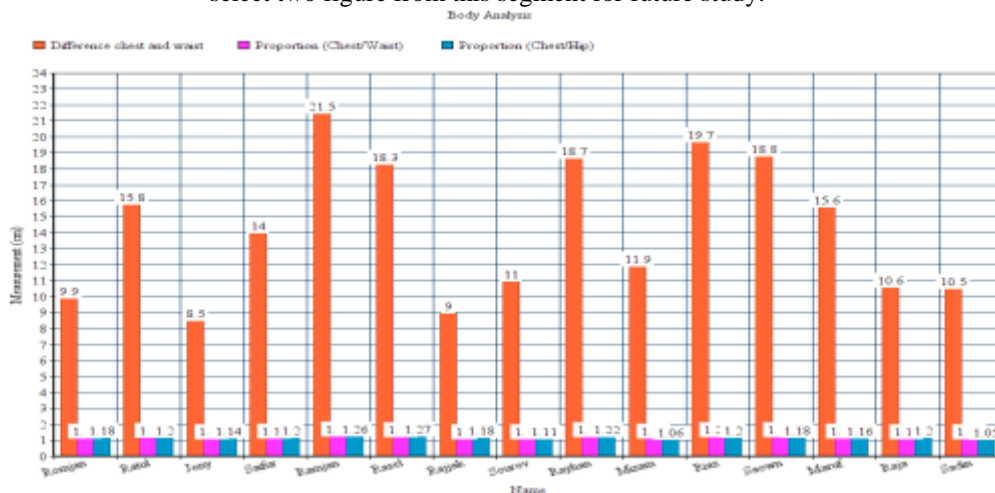

Fig 6: Body analysis

This picture shows that Bust-waist>0 ; which show that close fitting men's shirt can be tested for further study.

3.1 Body selection

From the data analysis it is shown that "Medium" size can be selected for development of garment.

Table 7: Selection of Body for further study

sl/ model name	4515 Bust/chest girth	size	6510 Waist girth	Bust/ waist	7525 Hip girth	Bust/hip	Bust - Waist
saifur	95.3		81.3	1.17	95.3	1.17	14
rajon	95.8		74.3	1.28	94.1	1.26	21.5
rasel	97.6		79.3	1.23	101.0	1.27	18.3
Rajjak	98.3	MEDUM (96-100)	89.3	1.1	105.5	1.18	9
SOUROV	98.3		87.3	1.12	97.2	1.11	11
rayhan	99.5		80.8	1.23	98.3	1.22	18.7
Nizam	100.7		88.8	1.13	95.0	1.06	11.9
riaz	100.1		80.4	1.24	99.9	1.24	19.7

(Closer analysis show that : 1)Bust-Waist>o)

This properties show that they are all can use "X" shirt making. As "Rajjak" and "sourov" has exact same chest measurements they are selected for further study.

Sample Body analysis:

Fig 7:

Name: Rajjack

Size : Medium

Fig 8:

Name: Sourov
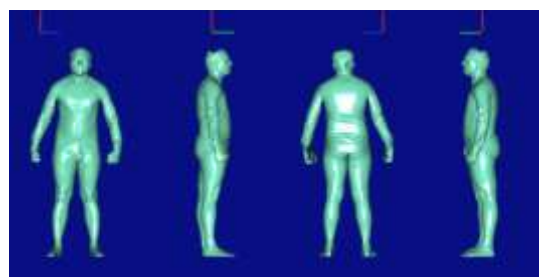
Size : Medium

Shirt analysis :
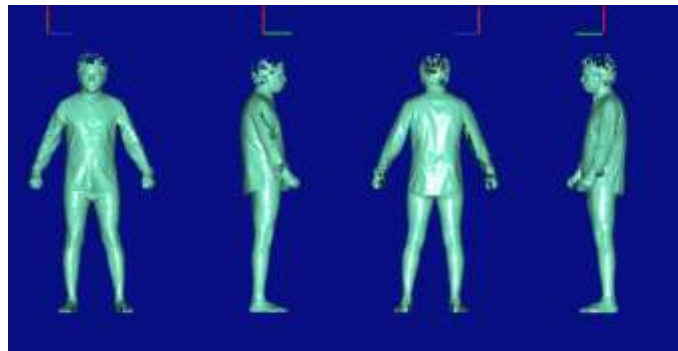

Fig 9: Shirt analysis on Sample 1

Fig 10: Shirt analysis on Sample 2

3. **FINDINGS :**
4.1 Visual Analysis:

Table 8: Visual analysis sample 1 and Sample 2

Check point	Check parameter	Sample 1 Yes No		Sample 2	
Shoulder	1) Uncomfortable and not smooth? 2) Joints are not at the top of shoulder? 3) Pull through the upper arm?			NO	
Bust	1) the seams or closures are located on the front or back of the centre – pull , open? 2) button closure at the back or center front? 3) darts do not point to largest part of the body curve? 4) Dart do not an inch before the largest part of the curve? 5) darts to accelerate the construction the practice is on the bodice front to produce diagonal wrinkles?			NO	
Neck	1) collar is not fit of the neck circumference? 2) incorrect installation? 3) Tight at neck? 4) Uncomfortable?			No	
Armscye	1) Armscye uncomfortable and not attractive for clothes? 2) Arm pulled back and front of the garment? 3) Bites on arm pit?				
Sleeve	1) Sleeves are uncomfortable and not attractive to look? 2) Wrinkles at joining? 3) Uncomfortable on hand movement?				
Back	1) Tigh? 2) stick and roll up? 3) Less Breading breathing space ? 4) loose to body? 5) pulled or tightened at the time of closing?				Loose to create unusual fold
Hip	1) Insufficient space at Hip area? 2) pulling, wrinkling or riding up?				

4.2 Action of same garment on two bodies:
In the table below, S1 (Shirt on sample 1) ; S2 (Shirt on Sample 2); BS1 (Body Measurement of Sample 1); SB2 (Body Measurement of Sample 2)

Table 9: Action of same garment on different body

Measurement name	(S1)	(S2)	Difference (S1 –S2)	(SB1)	Ease to Sample 1 (ES1=S1-SB1)	(SB2)	Ease to Sample 2 (ES2=S2-SB2)
Bust/chest girth	101.8	99.7	2.1	98.3	3.5	98.3	1.4
Waist girth	95	92.8	2.2	89.3	5.7	87.3	5.5
High hip girth	97.7	93.8	3.9	94.4	3.3	97.2	-3.4
Cross shoulder	49.3	45.9	3.4	46.5	2.8	45.4	0.5
Shoulder width left	14.2	12.9	1.3	13.4	0.8	13.6	-0.7
Shoulder width right	15.1	13.3	1.8	14.2	0.9	13.3	0
Shoulder angle left	31.4	25.2	6.2	30.2	1.2	25.7	-0.5
Shoulder angle right	30	28	2	28.7	1.3	27.6	0.4
Neck right to waist over bust	46.9	45.2	1.7	43	3.9	41.3	3.9
Across back width	41.8	37.4	4.4	40.2	1.6	37.4	0
Neck left to waist back	47.8	43.8	4	46.7	1.1	42.4	1.4
Neck right to waist back	48.9	43	5.9	45.5	3.4	41.9	1.1
Neck at base girth	49.8	48.4	1.4	43.5	6.3	39.5	8.9
Side upper torso length left	25.4	22.4	3	19.7	5.7	19.7	2.7
Side upper torso length right	26	21.1	4.9	19.7	6.3	19.7	1.4

4.3 Compared result analysis:
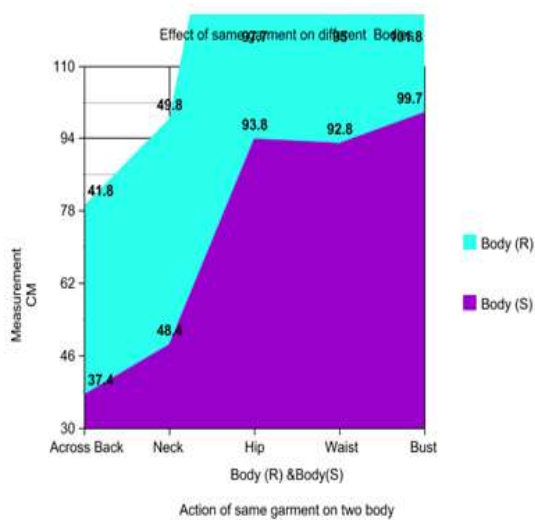
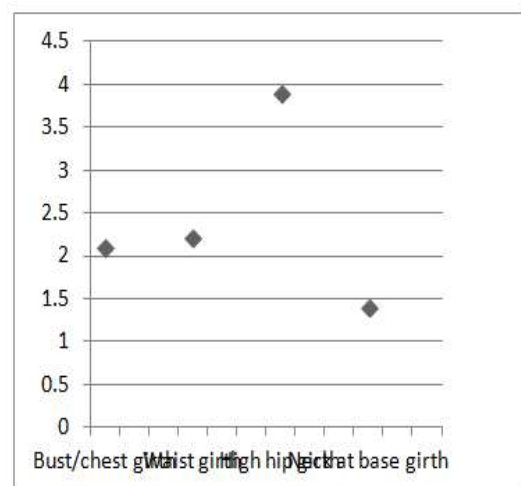Fig 11: Action of Shirt on different bodies
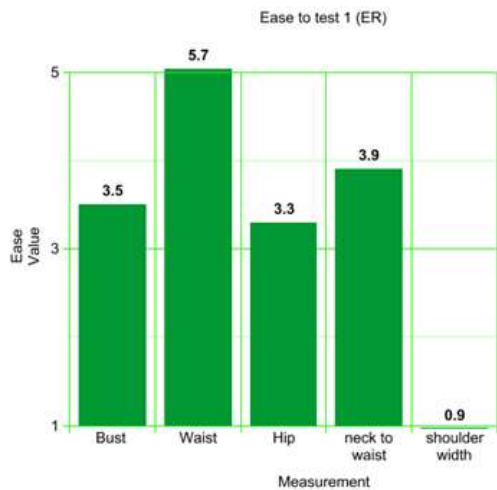

Fig 12: Major differences found
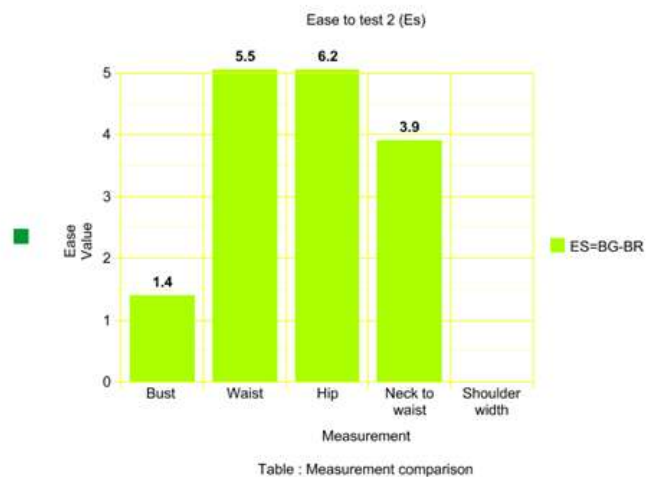
Fig13: Ease to Sample 1   Fig14 : Ease to Sample 2

4.4 Balance calculation:

From the study it is found that waist position of Shirt varied due to action of some factors like 1) Action of Body postures 2) Action pattern to different bodies 3) Action of Fabric property etc. For the Fit and Balance evolution, in first step measurement was taken from 3D scanning , and in second step waist line that belong to the pattern block was marked on Shirt and then put on the body to find the required measurement manually.
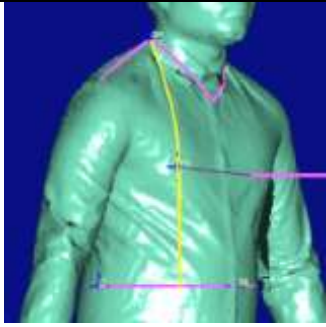
4.4.1 Pattern balance calculation:
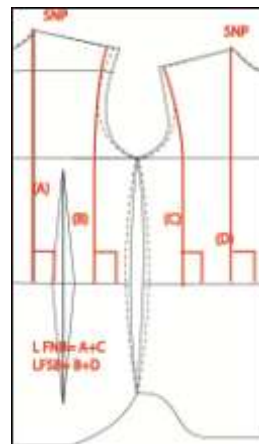
Fig 15: Pattern Balance Calculation:

Table 10: Pattern Balance Calculation

Pattern block			
LFNB	A+ B	(48+40.3)	88.3
LFSB	C+D	(42+35)	77
PB=(LFB-Shoulder forwarding)-(LFSB)=(88.3-4)-77=7.3cm			

Balance Calculation on Sample 1:

Table 11 : Garment Balance calculation

Sample 1				
LFNB			46.9+48.9=95.8	47+48=95
LFSB (Direct from body)			44+42.7=86.7	45.80+42=87.7
GB=LFNB-LFSB			9.1	7.3

FB= FB $_{Shirt}$ - FB $_{pattern}$
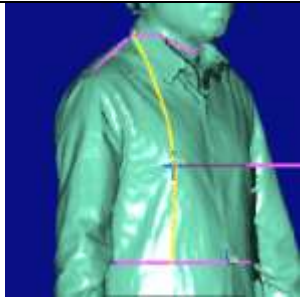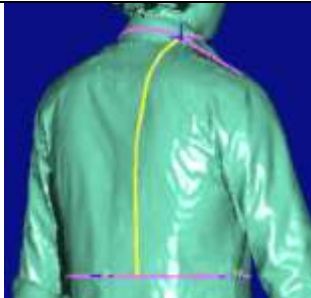
For Body 1 :

From scanning image: FB $_{scanning}$=9.1- 7.3cm= 1.8

From real garment on body, FB $_{manual}$=7.3-7.3=0

Balance Calculation on Sample 1:

Table 12 : Garment Balance calculation on Sample 2

Sample 2			From scanning data	Taken manually
LFNB			45.2+43=88.2	46+42.5=88.5
LFSB (Direct from body)			41.2+35.5=76.7	43+38=81
GB=LFNB-LFSB			11.5 cm	7.5

FB= FB $_{Shirt}$ - FB $_{pattern}$

For Body 1 :

From scanning image: FB $_{scanning}$=11.5- 7.3cm= 1.8

From real garment on body, FB $_{manual}$=7.5-7.3= 0.25

4.   Summary:
Above analysis shows that:
1)   Different body acts differently on same shirt.
2)   Sample one shows well fitted both visually and mathematically.

3) For Sample two the shirt is not proper fitted both visually and mathematically.
5. Survey:
    A survey is done among 20 Male consumers of age 20-30 years from Bangladesh living in Wuhan.
They were asked showing same shirt on different bodies to know which one they would like to buy.
6. Result:
 I. 70% people wants to buy Sample 1.
II. 63% people think sample 1 is well fitted, 22 % people think sample 2 well fitted and 15% none the garment is fitted to body.
III. 84% think sample 2 is comfortable than sample 1.
IV. 57% think sample is suitable for them; 86% think sample 2 is suitable for them. 8% people think both are not suitable for them.

V.   CONCLUSIONS:

This dissertation discuss about Men body structure, suitable shirt for suitable body, fit and balance criteria , fit and balance evaluation, action of same garment on different bodies with in the same size group and finally two surveys to evaluate the findings. Limitations of the study :
1. Air gap, ease distribution can be discussed .
2. Limited number of participants on the study
3. Survey can be choosing female for this recommended fit chart.
4. Study is only aimed to analyze Bangladeshi Male with in certain age limit.
5. Survey can be used upper age of male and female.
This research has very introductory output. This will be just starting of invention.

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