Standardization of knitting scheme 3D knitwear and integral knitwear design and production

Arkin Ng[a], Jimmy K.C. Lam[b,*], White Pak[b]

[a] *Natalia Fashion Ltd, Hong Kong*
[b] *The Hong Kong Polytechnic University, Hong Kong*
** Presenting Author*

Abstract

Commercial knitting scheme on single knit fully fashion jersey fabric is studied by knitting with different fibres (wool, acrylic, cashmere, pima cotton and combed cotton) under three different knitting tensions (tight, normal and loose tension). Results show that different materials and knitting tension would affect the final fabric length, width, thickness and extensibility. Construction of knitting scheme must under the knowledge of fibers and knitting conditions.

Keywords: Knitting scheme, acrylic, wool, cashmere, knitting tension

1. Introduction and Background

Flat knitting is one of the most important technological inventions for knitwear design and production that has gone through a lot of changes over time (1,2,3). When comparing the primary flat knitting using jacquard steel for needle selection with the state-of-the –art machine for integral shape knitwear, one can readily realize the amount of breakthroughs in this progression. The huge improvement in the efficiency of loop transfer has replaced the flat bed purl knitting machine with double hooked latch needles. The knitting production process evolved from cut-and-sewn piece goods knitting to fully fashion shaped knitting, and finally to integral shape knitting. The latest machine has completely eliminated the cutting and linking processes and put things together in one single operation.

Despite all these technological developments in flat knitting, the compilation of knitting scheme which has been the key instructional method in knitting process is still relied heavily on the skill and experience of individual knitting technicians. With increasing demand for fine gauge knitting and 3-D products, ability to produce fine and accurate knitting schemes is critical for quality assurance of knitwear design and production (4,5). Conventional knitting schemes are work of art of talented individuals often lacking in consistency amongst their compliers. This trial-and-error approach which is sufficient for coarse gauge loose body knitting but crude on body-fitted knitting, 3-D integral shape knitting on fine gauge knitting machine where the requirements are sophisticated and much more demanding.

An effective knitting scheme would embrace good knowledge of 1) knitting structures, 2) knitting machine and its function; 3) shaped panel design; 4) assembling and finishing operations; 5) knitting scheme calculation and 6) costing. A standardization of knitting scheme should be based on sound and proven working principles to assure relevant skills and best industrial practice are incorporated in dealing with the 3-D knitting, integral shape knitting and more complex knitting structures in a uniform manner.

In this paper, a typical knitting scheme from industry will be used and investigated for their application on flat-bed hand kitting machine with different materials, loop length and fabric densities.

2) Experimental Details

A hand knit flat bed machine with 36 inches width, 12 gauge and 432 needles will be used to produce a jersey plain knitted fully fashion panel. A typical knitting scheme obtained from the industry is shown in Figure 1.

Knitting scheme is the statement used to knit the garment parts which is expressed in terms of courses, needles widths and fashioning frequencies in compliance with the dimensions of the specification. In order to validate the knitting scheme obtained from the industry, five different fibres were used, namely 1) 100% acrylic; 2) 100% combed cotton; 3) 100% prima cotton; 4) 100% cashmere and 5) 100% wool. The fabric samples were knitted into three different tightness as suggested from the industry and shown in Table 1.

By using five different materials and three different fabric densities, total of 15 samples were produced. Fabric dimensions (fabric length, width and thickness) were measured both before and after washing under the standard conditions. It is expected that different materials, fabric tightness will affect the final fabric dimensions and fabric appearance. Results will be discussed in the next section.

3. Results and Discussions

3.1 Fabric dimensions and fabric tightness

Figure 2 shows the fabric density (wales per cm and courses per cm) before washing and after washing using 100% acrylic and measured in 3.49cm (10 wales in 1-3/8")

The average courses/cm and wales/cm for dense fabric (tightly knitted) are 9.12 and 6.12 respectively (as shown in Figure 2). For the normal knitted fabric, the average courses/cm and wales/cm are 8.67 and 5.95 (as shown in Figure 3). The result means that using the same knitting scheme, different fabric tightness will affect the final fabric dimensions.

3.2 Fabric thickness with different materials

Using the same knitting scheme, it was found that fabric with different materials will have different thickness as shown in Figure 4. Both cashmere and wool fibres show thicker fabric than cotton (combed and pima cotton) and acrylic fibres. The effect of washing would increase fabric thickness and therefore, all fabrics with different fibres content before washing (as shown in Figure 4) show thicker fabric than unwashed fabrics. These results mean the construction of knitting scheme in terms of fabric thickness must consider the effect of washing and fibers composition.

3.3 Fabric dimensions with different materials

Figure 5 shows fabric dimensions (fabric length and width) for different materials before and after washing using the same knitting scheme. It can be seen wale width (before washing) of cashmere and acrylic is higher than pima and combed cotton. The effect of washing will reduce the wale width for all fibers. This can be explained by shrinkage of fabric which will increase the fabric thickness but reduce the wale width of knitted fabric.

Similar results are obtained from course height. The course height for all fibres before washing is slightly longer than unwashed fibers.

3.4 Fabric extensibility for different materials

Using the same knitting scheme, different fabric extension is measured under different loading, namely 20N, 10N and 5N forces respectively. The result is shown in Figure 6.

Under the loading of 5N force, the extensibility of wool, cashmere and cotton (pima and combed cotton) are similar except for acrylic fiber, which is the lowest one. When the loading is increased from 5N to 10N and 20N respectively, the extensibility of wool and cashmere fibers are highest. This can be explained by the crimp and helix nature of wool and cashmere fibers. They allow a higher fiber extensibility under higher tension.

4. Conclusions

This paper shows the results of commercial knitting scheme on different fibres (wool, acrylic, pima cotton, combed cotton and cashmere) under three different knitting tensions (tight, normal and loose). Results show that different materials will affect the fabric final dimensions in terms of fabric thickness, fabric width and length. The construction of knitting scheme therefore, must take into account the effect of fibers, knitting tension and washing on the final fabric dimensions.

References:

1. Hunter, B (2004), Complete Garments- Evolution or Revolution (Part 1) Knitting International, 111 (1319) p.18-21
2. Hunter, B (2004), Complete Garments- Evolution or Revolution (Part 2) Knitting International, 111 (1320), p.22-23
3. Hunter, B (2004), Complete Garments- Evolution or Revolution (Part 3) Knitting International, 111 (1321), p.20-22
4. Legner, M (2003), 3-D products for Fashion and Technical Textile Applications from Flat Knitting Machines. Melliand International, 9(3). P.238-241
5. Merle, M.L. (2003), Developments in Three Dimensional Knitting for Preforms and Clothing, Proceedings: International Textile Design and Engineering Conference, Edinburgh, Scotland, Heriot-Watt Univeristy, Netherdale, Galashiels, TD1 3HF, U.K.

Fabric Density	Tightness (measured in 10 wales)	Tightness (measured in 10 wales)
Tight	1-3/8"	3.49 cm
Normal	1-4/8"	3.81 cm
Loose	1-5/8"	4.12 cm

Table 1 Fabric density and tightness.

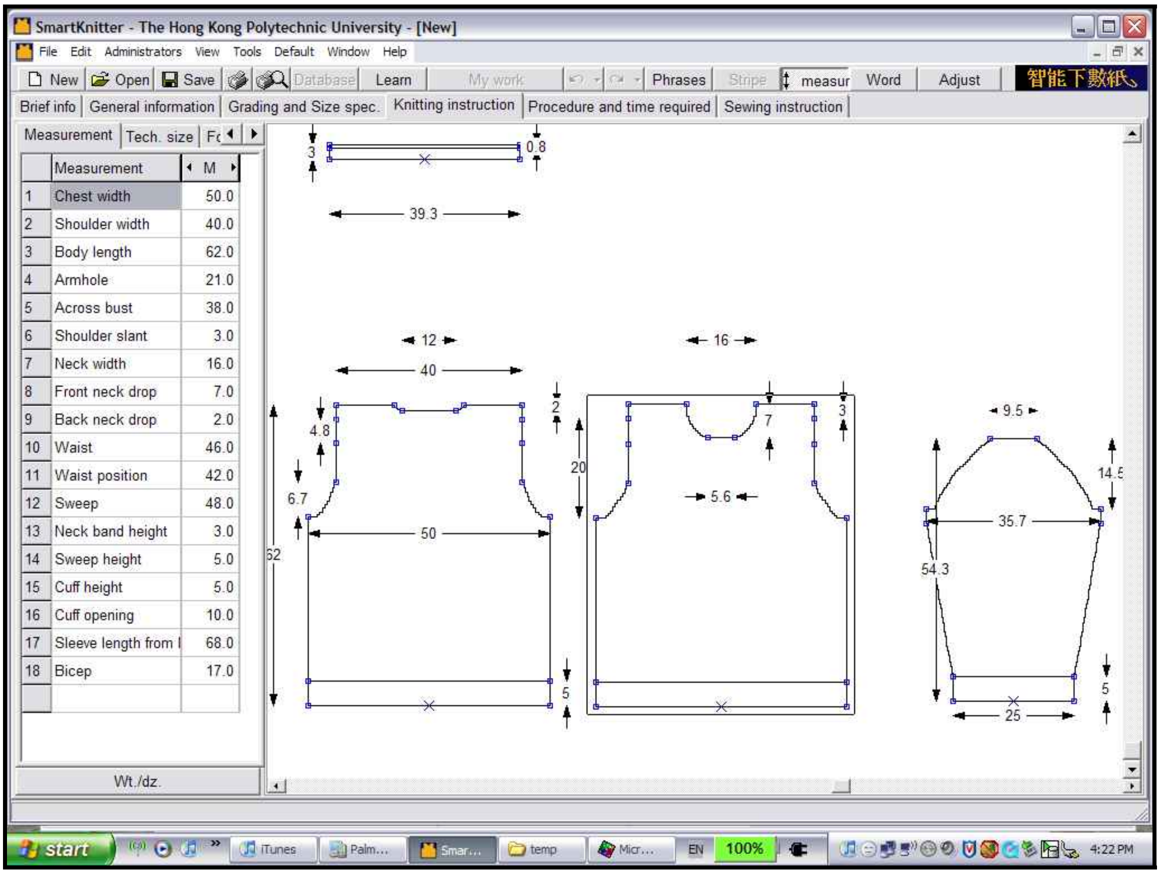

Figure 1 Typical knitting scheme on fully fashion panel

B-A1 - IN 100% ACRYLIC (字碼10支拉) IN 1-3/8									
	BEFORE WASH			AFTER WASH				SHRINKAGE %	
	CPCM	WPCM	THICKNESS (MM)		CPCM	WPCM	THICKNESS (MM)	CPCM	WPCM
BA1A1	9.23	6.46	1.16						
BA1A2	9.23	6	1.295						
BA1A3	9.23	6.46	1.19						
BA1A4	9.23	6	1.15						
BA1B1	8.77	6	1.19						
BA1B2	9.23	6	1.2						
BA1B3	9.39	6	1.185						
BA1B4	8.77	6.46	1.24						
BA1C1	9.23	6	1.14						
BA1C2	9.23	6.46	1.15						
BA1C3	9.23	6.46	1.17						
BA1C4	9.23	6.46	1.13						
BA1D1	9.01	6	1.12	BA1D1W	9.5	6	1.16	-5.2	0.0
BA1D2	9.43	6	1.19	BA1D2W	9.5	6.46	1.2	-0.7	-7.1
BA1D3	9.06	6	1.16	BA1D3W	9.23	6.46	1.23	-1.8	-7.1
BA1D4	9.23	6	1.12	BA1D4W	9.23	6	1.2	0.0	0.0
BA1E1	9.23	6	1.17	BA1E1W	8.98	6.46	1.17	2.8	-7.1
BA1E2	8.96	6.46	1.09	BA1E2W	9.23	6.46	1.16	-2.9	0.0
BA1E3	8.77	6.46	1.1	BA1E3W	9.23	6	1.15	-5.0	7.7
BA1E4	8.77	6	1.07	BA1E4W	9.23	6.46	1.19	-5.0	-7.1
	9.12	**6.18**	**1.16**		**9.27**	**6.29**	**1.18**	**-1.5**	**-1.6**

Figure 2 Fabric density measured in 1-3/8” on 100% acrylic fibre

Similar result was obtained for this 100% acrylic fibre measured in 1-4/8” as shown in Figure 3.

B-A1 - IN 100% ACRYLIC (字碼10支拉) IN 1-4/8"									
	BEFORE WASH			AFTER WASH				SHRINKAGE %	
	CPCM	WPCM	THICKNESS (MM)		CPCM	WPCM	THICKNESS (MM)	CPCM	WPCM
BA2A1	8.77	6	1.15						
BA2A2	8.77	6.46	1.11						
BA2A3	8.77	6	1.12						
BA2A4	8.77	6	1.1						
BA2B1	8.59	6	1.185						
BA2B2	8.77	5.54	1.13						
BA2B3	8.77	6	1.125						
BA2B4	8.77	5.54	1.19						
BA2C1	8.54	6	1.235						
BA2C2	8.77	6	1.18						
BA2C3	8.3	6	1.195						
BA2C4	8.77	6	1.145						
BA2D1	8.58	6	1.23	BA2D1W	8.94	6	1.165	-0.04027	0
BA2D2	8.77	5.54	1.1	BA2D2W	8.99	6	1.13	-0.02447	-0.07667
BA2D3	8.77	6	1.07	BA2D3W	8.77	5.54	1.16	0	0.083032
BA2D4	8.63	6	1	BA2D4W	8.77	6	1.13	-0.01596	0
BA2E1	8.3	6	1.11	BA2E1W	8.77	6	1.19	-0.05359	0
BA2E2	8.77	6	1.09	BA2E2W	8.77	6	1.18	0	0
BA2E3	8.43	6	1.15	BA2E3W	8.77	6	1.22	-0.03877	0
BA2E4	8.77	6	1.12	BA2E4W	8.77	6	1.21	0	0
	8.67	**5.95**	**1.14**		**8.82**	**5.94**	**1.17**	**-1.7**	**0.2**

Figure 3 Fabric density measured in 1-4/8” on 100% acrylic fibre

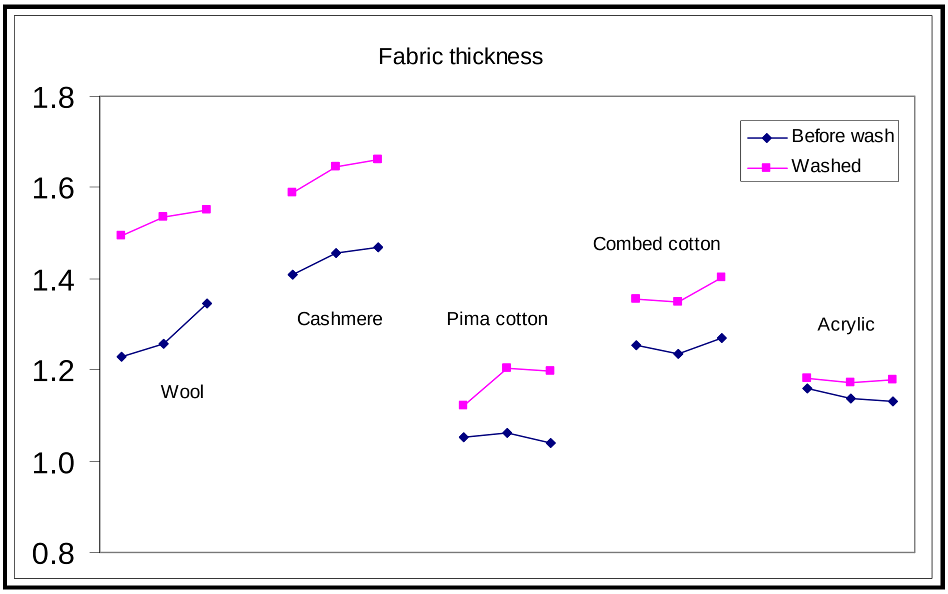

Figure 4 Fabric thickness and materials

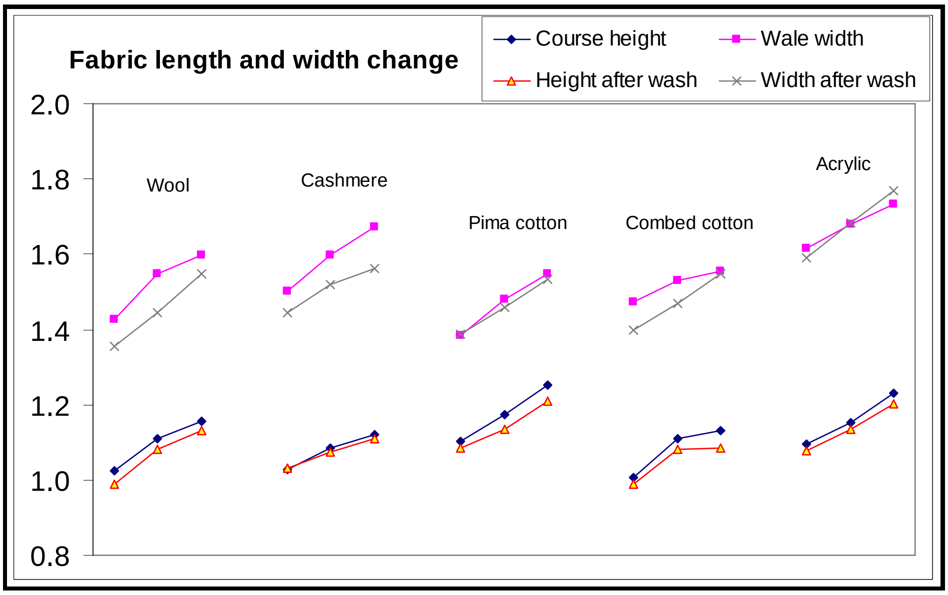

Figure 5 Fabric length and width

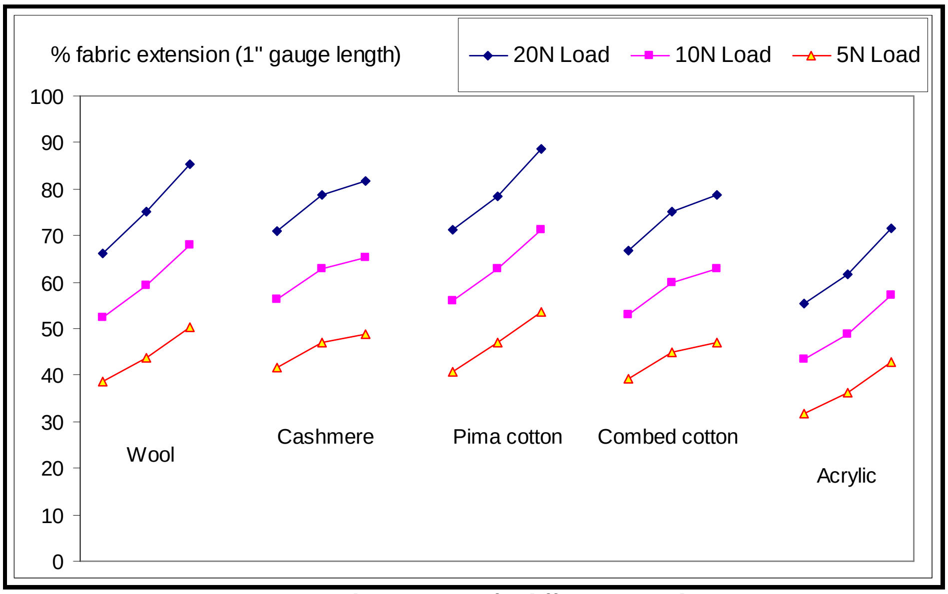

Figure 6 Fabric extension for different materials.