Knitting Scheme Development - From Art to Science

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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 would affect the final fabric dimensions in terms of knitting tension and machine gauge. Tightness factor is a good indicator to predict different machine gauge and fabric loop length. Construction of knitting scheme must take into account of textile fibres and knitting tensions.

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.

The earlier work conducted by present authors found that commercial knitting scheme using different knitting tension has a significant effect on fabric dimension, thickness and extensibility (6). This knitting tension will affect the fabric loop length and fabric cover factor. As a result, the present research explores the effect of tightness factor to different knitting tension and different knitting variables namely machine gauge (5G, 7G and 12G), fibre type (cotton, prima cotton, wool, acrylic) and yarn linear density. Further work will be conducted on their effect on fabric pilling and dimensional stability. Commercial knitting scheme, therefore, must take into account the effect of fibre and knitting tension for fabric production.

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.

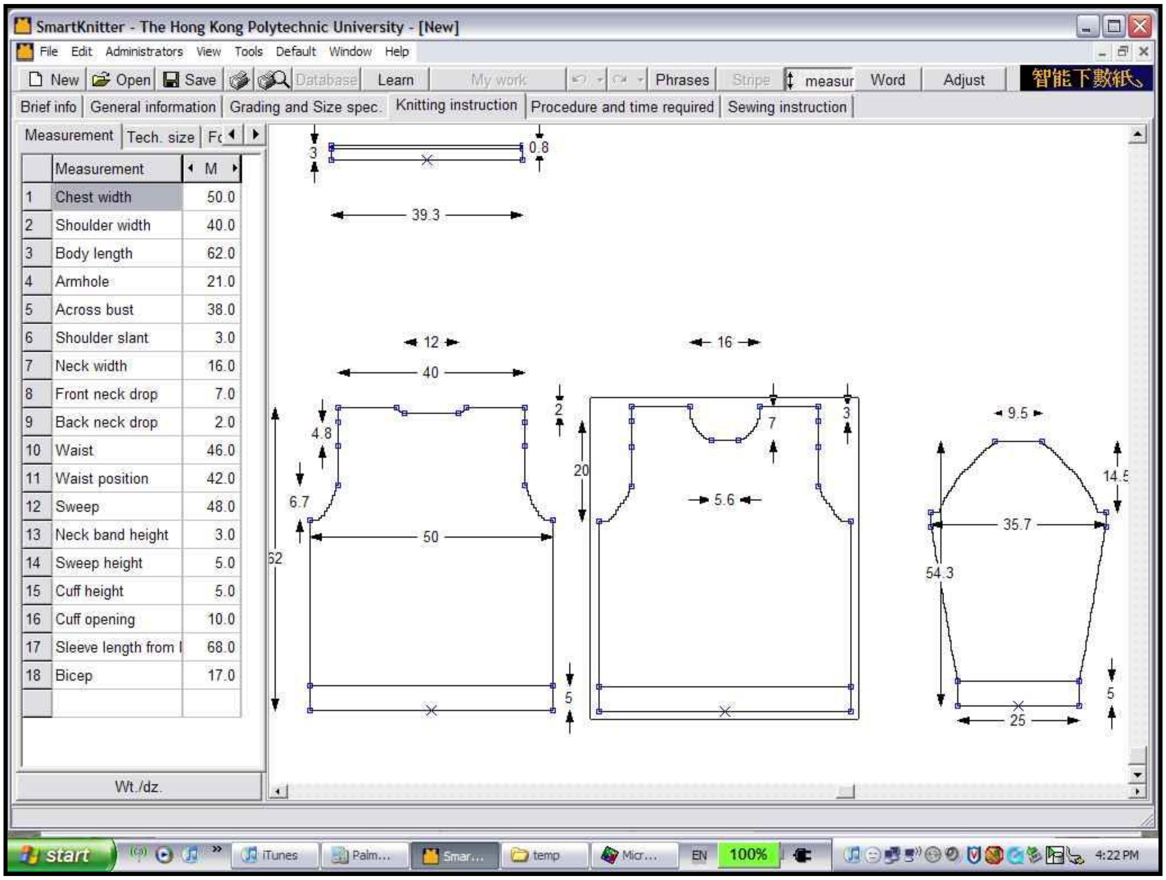

Figure 1 Typical knitting scheme on fully fashion panel

Knitting scheme is the statement used to knit the garment parts which are expressed in terms of courses (fabric length), needles (fabric width) and fashioning frequencies. A swatch (a small piece of fabric) in correct knitting instruction & knitting tension is normally prepared before bulk production. One of the useful methods to determine the stitch tension by the knitting industry is to stretch the fabric widthwise to its utmost limits manually and measure the dimension of 10 wales board. The fabric samples were knitted into three different tightness as suggested by the industry & shown in Table 1.

Table 1 Fabric density and tightness.

Machine Gauge	Knitting Tension	Tightness (measured in 10 wales)	Tightness (measured in 10 wales)
5G	Tight	3-4/8”	8.09 cm
5G	Normal	3-7/8”	9.84 cm

5G	Loose	4-2/8"	10.79cm
7G	Tight	2-4/8"	6.35 cm
7G	Normal	2-6/8"	6.98 cm
7G	Loose	3-0"	7.63 cm
12G	Tight	1-3/8"	3.49 cm
12G	Normal	1-4/8"	3.81 cm
12G	Loose	1-5/8"	4.12 cm

By using five different materials and three different knitting tensions and three different machine gauges, total of 45 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 and machine gauge will affect the final fabric dimensions and fabric appearance. Results will be discussed in the next section.

3. Results and Discussions

The three different knitting tensions (tight, normal and loose) for three different machine gauges (5G, 7G and 12G) for five materials (acrylic, cotton, pima cotton, cashmere and wool) were converted into tightness factor so that fabric dimensions (wales per cm and course per cm) and fabric density can be compared. Table 2 shows the result for acrylic fibre.

Table 2 Knitting tension, loop length and tightness factor for acrylic fabric

Machine Gauge	Knitting Tension	Yarn Tex	Average loop length (mm)	Tightness factor
5G	Tight	285.6	15.90	1.06
5G	Normal	285.6	16.47	1.03
5G	Loose	285.6	16.62	1.02
7G	Tight	142.8	9.65	1.24
7G	Normal	142.8	10.57	1.13
7G	Loose	142.8	10.77	1.11
12G	Tight	71.4	5.80	1.46
12G	Normal	71.4	5.86	1.44
12G	Loose	71.4	6.27	1.35

3.1 Fabric dimensions and knitting tightness

Figure 1 and 2 show the fabric density (wales per cm and courses per cm) against loop length under three different knitting tensions for 5G machine with different textile materials.

Figure 1 shows that courses per cm decrease if the average loop length increase. In other words, the three different knitting tensions (tight, normal, loose) will affect the fabric course density. The higher is the knitting tension (tight knitting), the smaller is loop length and higher is the courses density. However, textile materials will affect the course density as well. Cashmere fiber seems to have higher course density compared with other fibres.

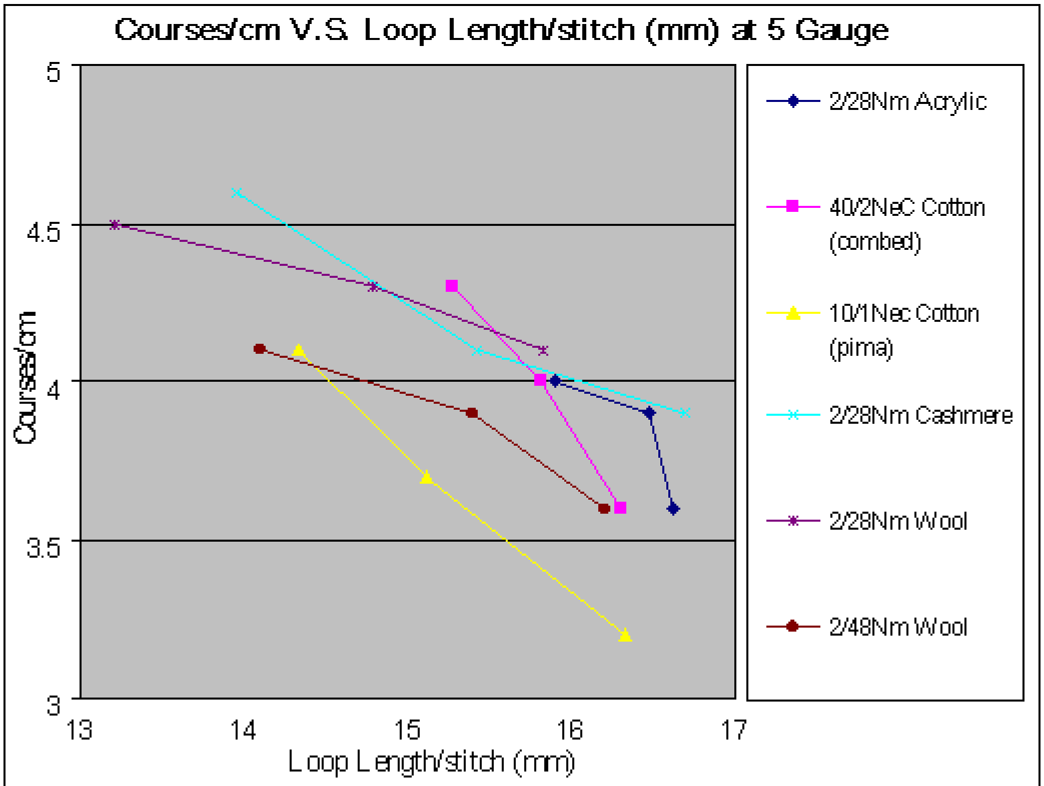

Figure 1: Courses per cm and loop length on 5G machine

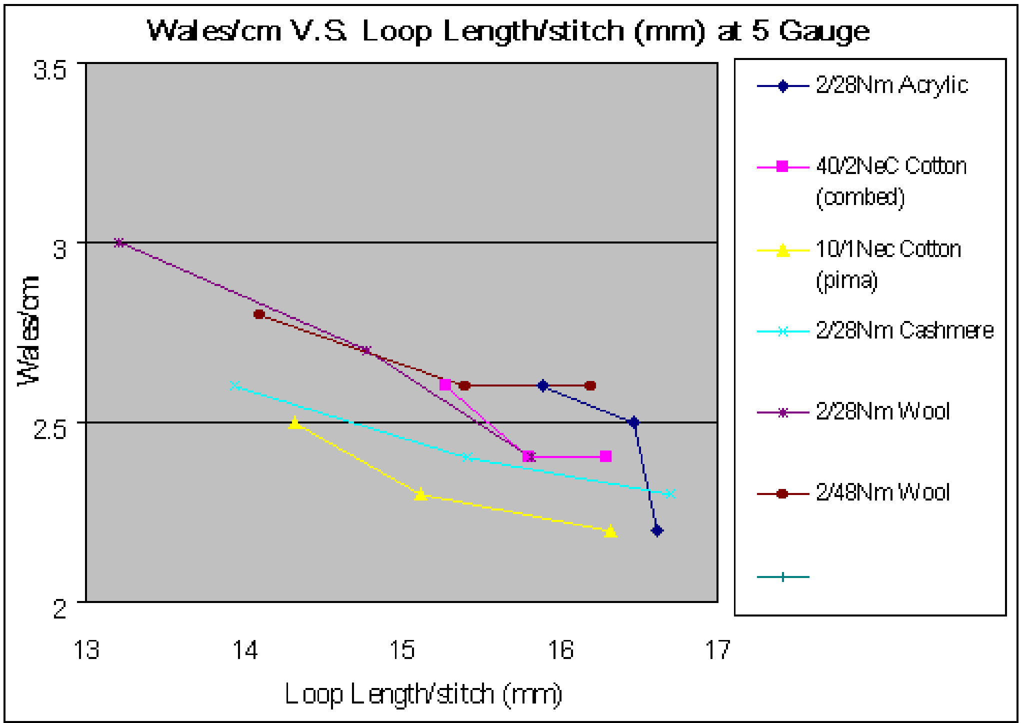

Figure 2: Wales per cm and loop length on 5G machine

Similar relationship also shows in the wales density. The higher is the knitting tension (tight knitting), the lower is the loop length, the higher is the wales density. However, wool material seems to have higher wales density compare with other fibres.

3.2 Fabric Dimensions and Machine Gauge

The fabric dimensions (wales and courses per inch) will be affected by machine gauges under different knitting tensions. The fabric samples prepared by the industry with standard knitting scheme for different machine gauges are plotted with their courses density and the result is shown in Figure 3.

It can be seen that both coarse and fine gauge (5G and 12G) fabric samples show inversely relationship between loop length (tight, normal and loose knitting) and courses per cm. The relationship for the middle gauge (7G) between loop length and courses per cm is not so obviously.

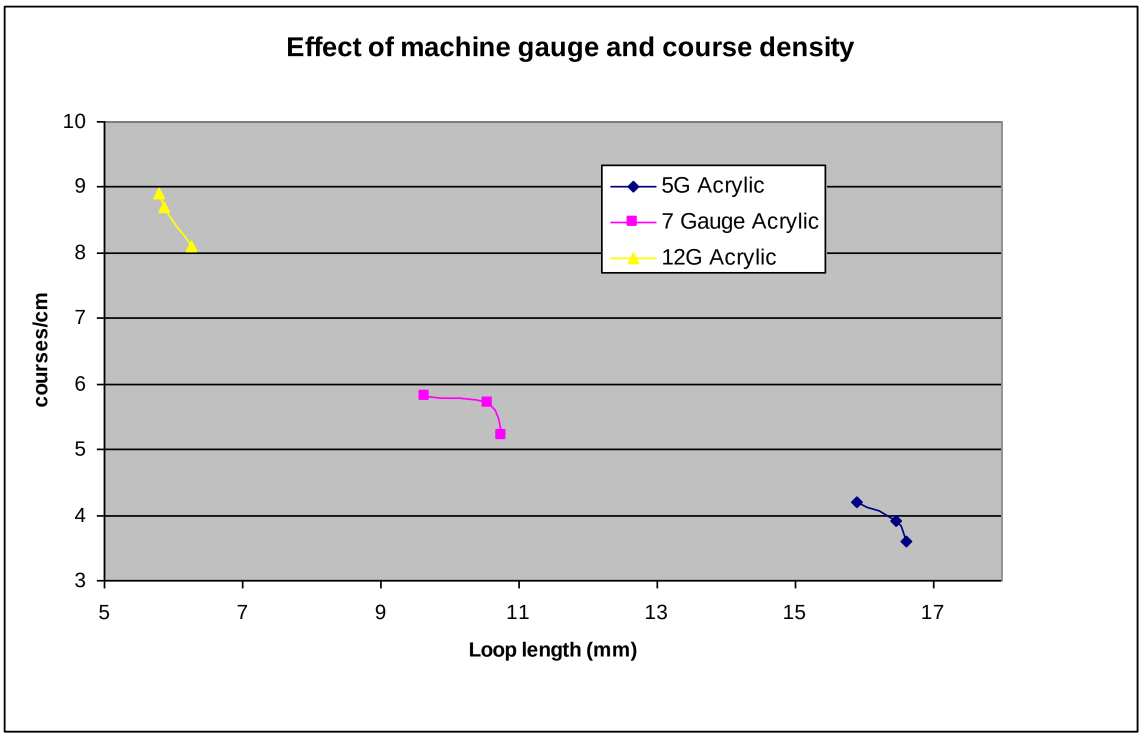

Figure 3: Relationship between courses per cm and loop length on acrylic fabric

3.3 Fabric dimensions and tightness factor

To find out the relationship between different knitting tensions and machine gauges, cover factor or tightness factor is used. The formula for tightness factor is defined as follows:

$$\text{Tightness Factor} = \sqrt{\text{Tex}} / l$$

where l is fabric loop length in mm.

As different machine gauge requires different yarn linear density (Tex), tightness factor provides a simple relationship between machine gauge and fabric loop length under different knitting tension.

Figure 4 shows the relationship between different tightness factor and courses per cm on acrylic fabric. It can be seen that the higher is the tightness factor, the higher is courses per cm. This relationship is applied for all different gauges of knitting machine (5G, 7G and 12G respectively).

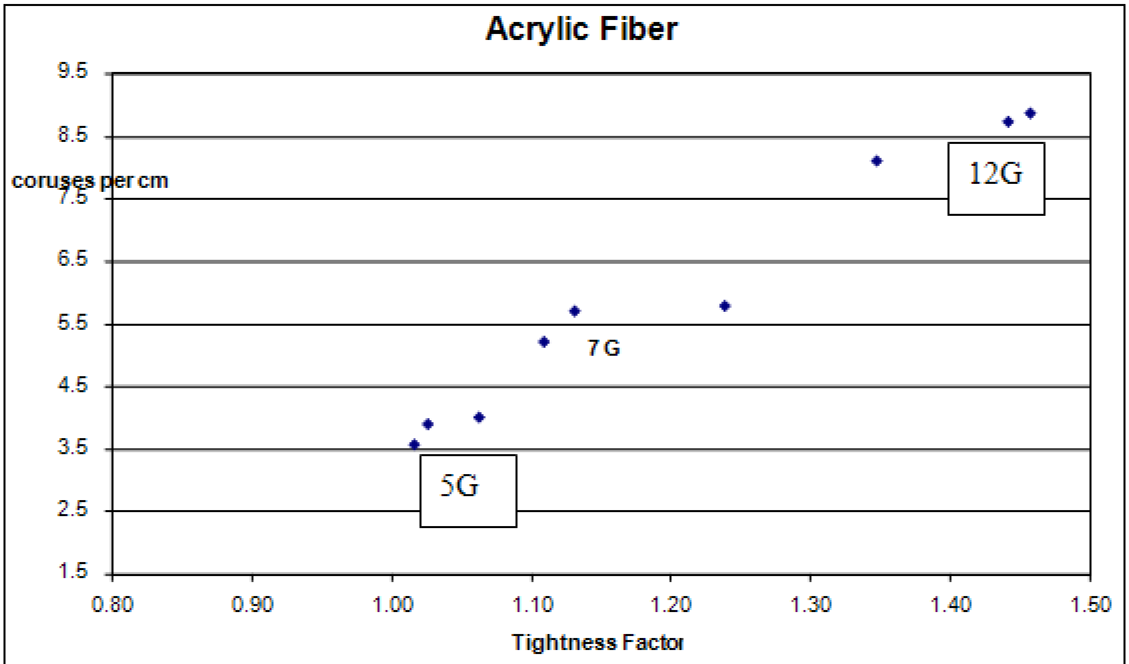

Figure 4: Relationship between courses per cm to tightness factor for acrylic fabric

3.4 Fabric Pilling and Textile Material

One of the important quality attributes for knitwear fabric is pilling. Pilling is a fabric surface fault in which "pills" of entangled fibres cling to the cloth surface, giving a bad appearance to the garment. The entanglements of loose fibres that appear on the fabric surface are called "pills". The International Fabricare Institute defines pilling as "the formation of small tangles of fibres or balls on the surface of fabric". Pilling changes the appearance and texture of the fabric.

Figure 5 shows the effect of fabric pilling for different textile materials on different machine gauges. It can be shown that textile materials play an important role on fabric pilling. The wool fibres give a lower pilling rate because of the scales nature of wool material which will trap the loose broken fibres on the fabric surface. Both the cotton and cotton pima fibres give a higher pilling rate because of the smooth and fine surface of these cotton fibres. Only a small amount of broken fibres are shown on the fabric surface and these loose fibres are easily fall off from the fabric surface. The relationship between pilling and machine gauge is not obviously to determine. For wool fabric, the coarser is the machine gauge (5G), the lower is the pilling rate as the open structure of coarse gauge will increase the number of broken fibres on fabric surface.

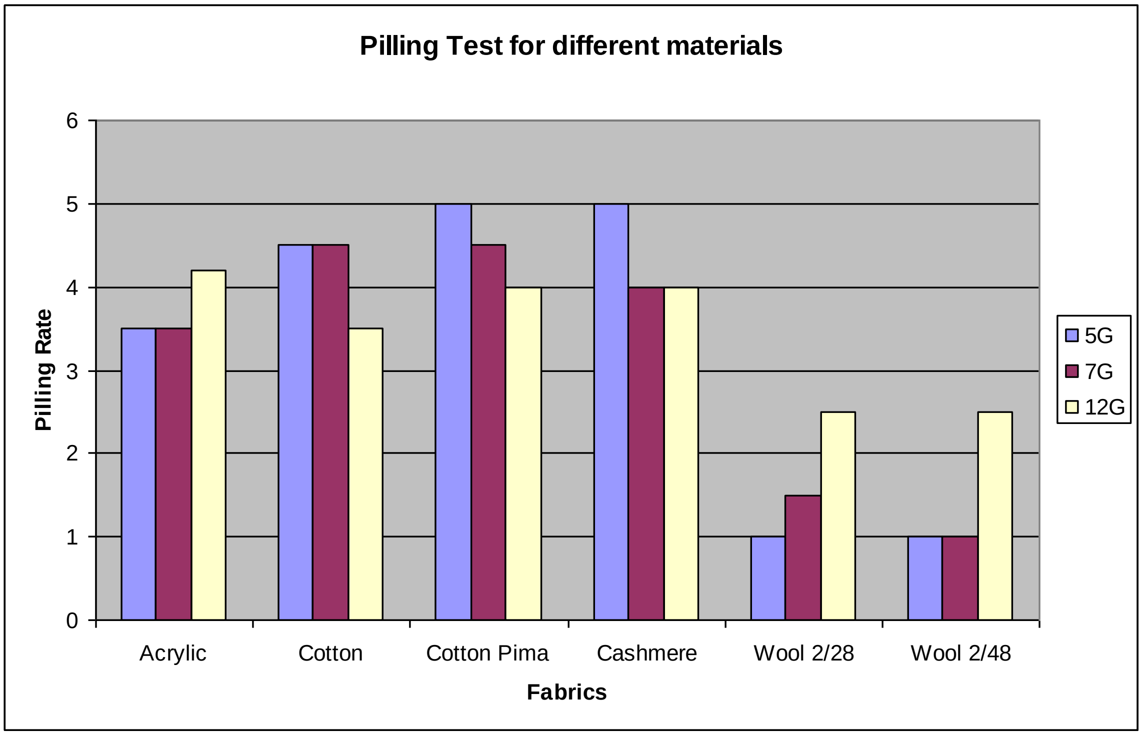

Figure 5: Fabric pilling and textile materials under different machine gauge.

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 knitting tensions (tight, normal and loose) and machine gauge. Tightness factor is a good indicator to predict different machine gauge and fabric loop length. Fabric pilling is directly affected by different textile fibres and wool fibres show a poor pilling than cotton fibre. However, no direct relationship between fabric pilling and machine gauge is found.

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