1. Woollen and worsted weaving yarns

1.1 Introduction

Some knowledge of yarns and yarn counts would appear to be a prerequisite in any study of woven fabric design and manufacture and this first section starts with a brief account of the yarn manufacturing processes of both woollen and worsted systems.

There are two yarn numbering systems, the Indirect system which is seldom used now and the Direct system. Very few spinners today will be familiar with the Indirect Galashiels and Yorkshire woollen yarn systems, but it is quite likely that in many mills in Scotland and Yorkshire, records still exist of past successful cloths containing yarn details in these old systems. So if for no other reason, an ability to convert these yarn counts to the present day Direct system would be useful.

Methods of calculating the average yarn count (where more than one count is used), and the resultant yarn count (when different yarn counts are twisted together) are provided in this section. Examples are given in both Direct and Indirect yarn numbering systems.

1.2 Woollen and worsted systems

The basic difference between the two is that in the *Worsted* system all short fibres are removed and the remaining long ones are aligned parallel. In the *Woollen* system there is no removal of short fibres, so some fibres lie parallel and others randomly.

The following from *Textile Terms and Definitions* (10th edition)[1] describe differences between the two systems:

- *Woollen, woollen yarn* or *woollen fabric* is descriptive of the fibre – that is wool fibre spun on the woollen system.
- *Woollen spun, woollen type fabric* or *condenser spun* is descriptive of the system – that is any fibre spun on the woollen system.
- *Worsted, worsted yarn* or *worsted fabric* is descriptive of the fibre – that is wool fibre spun on the worsted system.
- *Worsted spun* or *worsted type fabric* is descriptive of the system.

Some would say that the terms 'woollen' and 'worsted' have become system descriptive, with 'wool' being added to describe content – for example, 'wool worsted'. Woollen yarns being so rarely 100% wool, a description of the blend is usually used if required – for example, 100% wool woollen spun or 100% wool woollen.

1.3 The woollen process

A woollen fabric (as distinct from a worsted one) is made from yarns comprising of wool fibres of variable length, which have been spun on the condenser or woollen spun system. The fibres are allowed to lie haphazardly in spinning and the resultant yarns have a roughish appearance and full handle. Although the raw material for both woollen and worsted yarns is wool fibre, there are important differences. In woollen spinning a wide range of shorter wool types can be used in varying proportions in a blend, together with a limited amount of re-processed or re-used wool in order to reduce the cost. In worsted spinning only pure new wool fibres of the longer type are used. Certain man-made fibres such as polyester can be blended in varying proportions with pure new wool and spun on either woollen or worsted systems, but such yarns will be neither 'woollen' nor 'worsted'.

The main processes in woollen yarn production are described briefly as follows:

Sorting: This was at one time a highly-skilled manual operation to select and divide the fleece into different qualities. It is now rarely used for that purpose, but occasionally to remove heavily contaminated, matted or weathered wool and heavily stained or pigmented patches.

Scouring: Wool in its raw or greasy state is cleaned by mechanically passing it through a series of scouring bowls containing hot water and detergent, then rinsing and drying. The main contaminates removed during this process are wool grease (lanolin), animal sweat (suint), animal wastes and mineral dirt picked up from the grazing area. Depending on the country of origin, sheep wool type, fibre length and fineness, a minimum of 20% of the greasy wool weight will be lost during scouring. In extreme cases only 20% of the greasy wool weight might be wool fibre. The average Australian wool yields 65% clean, but this figure is slowly rising as farming methods improve.

Carbonising: After scouring some wools contain seeds previously picked up by the sheep and these are removed by carbonising. This is a process that carefully treats the scoured wool with acid, dries it and then crushes the seeds or burrs into a powder that falls from the wool. As carbonising tends to weaken and discolour wool, it is processed as a small percentage of a blend.

Blending: This describes the mixing of different fibre lots, which will provide the required quality and performance characteristics of the end product, at a specific price. Fibre lubricants are added at this time to improve processing performance. Depending on blend and end product, between 2% and 15% oil and anti-static additives may be applied.

Carding and Condensing: The blended wool fibres are disentangled and mixed by passing through a series of large cylinders and rollers clothed with wire teeth. As the fibres pass along the card, spacing between the rollers is reduced, the wire teeth become finer and roller speeds increase. The material is transformed into an even web of fibres which is split lengthways into strands of untwisted slubbing, then wound onto spools in preparation for spinning.

Spinning: Twist is added to the untwisted slubbings to convert them into strong, single yarns on the spinning machine. The mule spinning machine has a complex working action and is now more or less obsolete after the arrival of the more productive ring spinning frame. The mule consists of a carriage that travels backwards and forwards across the floor, drawing out the slubbing to the required thickness of yarn, whilst rotating spindles twist and wind the yarn onto tubes. Ring spinning frames have a higher production rate and larger take-up packages and perform the same functions as the mule, but on a faster and continuous basis. However, the mule produces a better yarn than the ring frame for a given raw material and quality requirement. Improved production speeds gained from more sophisticated engineering methods and computer control has resulted in a renaissance for mule spinning.

Twisting: The resultant spun yarn can be used in single form, or folded with itself (or other yarns) for increased thickness, strength or effect.

Dyeing: This may be carried out on loose fibre, spun yarn or woven cloth, depending on the type of fabric required.

1.4 The worsted process

A worsted fabric is an all wool cloth made from yarns produced on the worsted spinning system. This system for producing yarns from staple fibres has many more operational stages than those required for woollen yarn spinning. In worsted yarn spinning the drawing out operation to form yarn employs several stages of drafting, together with a combing operation. This produces a yarn in which the fibres lie as parallel to each other as possible, after removal of the shorter fibres. The resultant yarn has a smooth, slick handle and appearance as well as good strength. Worsted yarn spinning produces lighter and finer yarns and fabrics than woollen yarn spinning from the same fibre micron. Wool can be blended with selected man-made fibres and the resultant yarns combine the desirable properties of the components. For example, in a blend of wool and polyester, the fabric would have the superb handle and drape of wool, plus the easy care properties of the polyester.

The early processes in the manufacture of worsted yarns are basically the same as for woollen yarns, namely blending, scouring and carding. There is however one difference in the blending process. The components in a worsted blend are combined in their greasy state and are usually of a similar quality, unlike a woollen blend, so no special blending is necessary since adequate mixing takes place in subsequent processing.

The extra processes in worsted yarn spinning after carding are described briefly as follows:

Preparatory Gilling: The carded slivers are prepared for combing by drawing out a group of them between two pairs of rollers, to straighten the fibres. Between the pairs of rollers are pinned bars known as fallers, which control the fibre during drafting and improve the parallelism of the fibre.

Combing: This process is critical in the production of worsted yarns. Between 20 and 30 slivers are fed into a combing mechanism, which removes most of the short fibres (noils) and further straightens the fibres, making them lie parallel to each other. The combed slivers are thereafter referred to as 'tops'.

Finisher Gilling: By using further gill stages, the tops are blended and arrive at a specified and uniform linear density. They can then be sold to spinners for drawing and twisting into yarn.

Dyeing: If coloured tops are required, they must be dyed before drawing and spinning, by forcing a dyeing solution through them. After further gilling and combing they are ready to be drawn and spun into yarn.

Drawing: The main objective in the drawing process is to gradually reduce the thickness of the top in three or four stages, to a roving from which yarn is spun. This is done by gill box drawing. The roving frame, the intermediate stage between gilling and spinning, drafts a fine sliver to a thickness which is suitable for the spinning frame and either adds a few turns of twist, or lightly rubs the sliver with a rolling action before winding the fibre onto a large bobbin. The twisting or rubbing action gives the fine fibre assembly some cohesion so that it can be pulled from the bobbin as it feeds into the spinning machine.

Spinning: The last processing stage where drafting is used to reduce the thickness of the fibre strand. In worsted spinning the material will be drafted at a ratio of 20 – that is, the fibre assembly will be 20 times longer at 20 times thinner when it leaves the delivery rollers, than it was when it entered the feed rollers. This is the highest draft the fibre will experience. Gill boxes usually have a draft of about 8 and roving frames 12. It is also much higher than woollen spinning where the draft is often less than 2, the final count being fixed at the card. The final count has some bearing on the spinning draft used, as will the type of fibre used – for example, coarse counts spun from synthetic fibre may be drafted at 35 or more. Once the fibre has been drafted, the strand is then twisted and wound onto a package by the ring and traveller unit.

Final yarn processing: Winding machines are fitted with devices for detecting and removing faults in the yarn, such as thick and thin places and this operation is known as clearing.

Nearly all single worsted yarns are subsequently two-folded and this gives excellent performance in cloth production. The folding of single yarns of different colours can add to the aesthetic features of the yarn.

1.5 Micron suitability for woollen apparel end use

Table 1.1 Micron suitability for woollen apparel end use

Microns	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**
Lambswool fabrics	X	X							
Flannels	X	X	X						
Meltons	X	X	X						
Blankets	X	X	X	X	X	X	X	X	X
Velour coats and jackets		X	X						
Heavy coatings			X	X	X	X	X	X	
Sports jackets			X	X	X	X	X		
Trousers and slacks			X	X					
Scottish tweeds			X	X	X	X			
Donegal tweeds					X	X	X	X	
Cheviots					X	X	X		
Harris tweeds					X	X	X	X	X

Wool fibre diameter is usually expressed in microns (one micron = 1/1000 mm) and is expressed by the Greek letter μ

e.g. 20 μ = 20 microns = 20/1000 mm or 1/50 mm fibre diameter.

Table 1.1 shows that low micron number wools are used for the finer and lighter weight types of fabrics and the medium to higher numbers for the coarser and heavier types.

1.6 Number of fibres in yarn cross-section

In drafting and spinning, the number of fibres in the cross-section of a yarn is a factor of great importance. Table 1.2 shows typical numbers of fibres per cross-section in worsted yarns and how they are calculated.

It is rare to see wool worsted single yarns with more than 42 fibres in the yarn cross-section due to the high cost of finer wool fibres. Only at microns greater than about 24, where the differential between microns is small, would more than 42 be used. In synthetic yarn production, where the raw material is relatively cheap and finer fibres have a smaller price ratio, then higher numbers of fibres in yarn cross-section may be seen.

$$\text{Number of fibres per cross-section} = \frac{916.9 \times \text{Tex}}{\text{micron}^2}$$

Table 1.2 Worsted yarn fibres per cross-section

Fibre diameter (microns)	**Yarn count (Tex)**	**Average number of wool fibres**
19	14	35.6
	20	50.8
	25	63.5
	30	76.2
	35	88.9
22	20	37.9
	25	47.4
	30	56.8
	35	66.3
	40	75.8
25	25	36.7
	30	44.0
	35	51.3
	40	58.7
	45	66.0
	50	73.4

1.7 Twist in single and folded worsted yarns

Table 1.3 Twist classification

Classification	**Approximate folding twist in relation to single twist**
Balanced twist	0.67 × single spinning twist
Hosiery yarns	0.50 × single spinning twist
Suiting yarns	1.00 × single spinning twist
Marl yarns	1.50 × single spinning twist

The following formula is used to calculate the number of turns per metre to be inserted in a single or two-fold worsted yarn.

Turns per metre $= \propto \sqrt{\text{Resultant yarn count (nm)}}$

Single yarn $\propto$ = 85 to 95 } for plain yarns
2 fold yarn $\propto$ = 100 to 130 } in pure new wool — e.g. 2/60 nm

Single yarn turns per metre $= 95\sqrt{60} = 735$

2 fold yarn turns per metre $= 120\sqrt{30} = 657$

Most two-fold worsted yarns have the folding twist inserted in the opposite direction to single spinning twist. Although there are many exceptions, table 1.3 gives a guide to the twist classification of various yarn types.

1.8 Direct yarn numbering system

In the Direct system, the yarn count number refers to *'the weight in grammes of a given length of yarn'*. This means the higher the yarn count number, the heavier or thicker the yarn.
In the Direct universal Tex system, yarn count number indicates *'the weight in grammes of 1000 metres of yarn'*.

e.g. 30 Tex indicates that 1000 metres of yarn weigh 30 grammes,
e.g. 50 Tex indicates that 1000 metres of yarn weigh 50 grammes,
e.g. 70 Tex indicates that 1000 metres of yarn weigh 70 grammes.

In the Direct denier system, the yarn count number indicates *'the weight in grammes of 9 000 metres of yarn'*.
Decitex (or Dtex) yarn count number indicates *'the weight in grammes of 10 000 metres of yarn'*.

1.9 Calculate Direct count from a given length and weight of yarn

C = yarn count
L = length of yarn sample (metres)
Wt = weight of yarn in units of the system at official regain
L1 = unit of length of the system

$$C = \frac{Wt \times L1}{L}$$

Example 1 weight of yarn sample = 1.67 grammes
length of yarn sample = 100 metres
unit of length (Denier) = 9000 metres

$$C = \frac{1.67 \times 9000}{100} = 150.3 = 150 \text{ Denier}$$

Example 2 weight of yarn sample = 1.75 grammes
length of yarn sample = 90 metres
unit of length (Tex) = 1000 metres

$$C = \frac{1.75 \times 1000}{90} = 19.44 \text{ Tex}$$

1.10 Convert Direct (Tex) to Direct Denier

Multiply Tex count by 9

Example 1 30 Tex = 30 × 9 = 270 Denier

Example 2 40 Tex = 40 × 9 = 360 Denier

Example 3 60 Tex = 60 × 9 = 540 Denier

Conversely, to convert Direct (Denier) to Direct (Tex), divide Denier count by 9

Example 4 180 Denier = 180 / 9 = 20 Tex

Example 5 450 Denier = 450 / 9 = 50 Tex

Example 6 225 Denier = 225 / 9 = 25 Tex

1.11 Convert Direct (Tex) to Indirect

To convert Tex to any in the Indirect system, the following constants may be used:

$$\frac{1000 \times 12 \times 454}{\text{Tex} \times 11 \times 840} = 590 \text{ Cotton constant}$$

$$\frac{1000 \times 12 \times 454}{\text{Tex} \times 11 \times 560} = 884 \text{ Worsted constant}$$

$$\frac{1000 \times 12 \times 454}{\text{Tex} \times 11 \times 496} = 1000 \text{ Metric constant}$$

$$\frac{1000 \times 12 \times 454}{\text{Tex} \times 11 \times 256} = 1935 \text{ Yorkshire woollen constant}$$

Tex to Cotton $= \frac{590}{\text{Tex}}$ e.g. 45 Tex $\frac{590}{45} = 13.1$ Cotton

Tex to Worsted $= \frac{884}{\text{Tex}}$ e.g. 50 Tex $\frac{884}{50} = 17.7$ Worsted

Tex to Metric $= \frac{1000}{\text{Tex}}$ e.g. 20 Tex $\frac{1000}{20} = 50$ nm Metric

Tex to Yorkshire $= \frac{1935}{\text{Tex}}$ e.g. 100 Tex $\frac{1935}{100} = 19$ sks Yorkshire

Tex (2ply) to Worsted (2ply)

R38 Tex / 2 $= \frac{884}{38} = 23.26 =$ 2/46 worsted

R42 Tex / 2 $= \frac{884}{42} = 21.05 =$ 2/42 worsted

R48 Tex / 2 $= \frac{884}{48} = 18.42 =$ 2/36 worsted

R52 Tex / 2 $= \frac{884}{52} = 17.00 =$ 2/34 worsted

R56 Tex / 2 $= \frac{884}{56} = 15.78 =$ 2/32 worsted

1.12 Calculate average yarn counts in the Direct system

To determine the average yarn count of two or more yarns, calculate the arithmetical mean as follows:

Example 1 1 thread of 30 Tex
1 thread of 60 Tex
2 threads = 90 Tex

Average yarn count $= \frac{90}{2} = 45$ Tex

Example 2 1 thread of 17 Tex
1 thread of 20 Tex
<u>1 thread of 50 Tex</u>
3 threads = 87 Tex

$$\text{Average yarn count} = \frac{87}{3} = 29 \text{ Tex}$$

Example 3 2 threads of 20 Tex
1 thread of 30 Tex
<u>1 thread of 35 Tex</u>
4 threads = 105 Tex

$$\text{Average yarn count} = \frac{105}{4} = 26.25 \text{ Tex}$$

Example 4 1 thread of 40 Tex
2 threads of 25 Tex
<u>3 threads of 30 Tex</u>
6 threads = 180 Tex

$$\text{Average yarn count} = \frac{180}{6} = 30 \text{ Tex}$$

1.13 Resultant yarn counts in the Direct system

Example 1	75 Tex / 45 Tex	=	R120 Tex / 2
Example 2	60 Tex / 30 Tex	=	R90 Tex / 2
Example 3	60 Tex / 40 Tex / 30 Tex	=	R130 Tex / 3
Example 4	20 Tex / 20 Tex / 40 Tex	=	R80 Tex / 3
Example 5	30 Tex / 30 Tex / 30 Tex	=	R90 Tex / 3
Example 6	50 Tex / 25 Tex	=	R75 Tex / 2

Percentage take-up has not been allowed for in the above samples

2 threads of 30 Tex are written as R60 Tex / 2

2 threads of 20 Tex are written as R40 Tex / 2

3 threads of 100 Tex are written as R300 Tex / 3

2 threads of 300 Denier are written as R600 Denier / 2

1.14 Indirect yarn numbering system

Table 1.4 Indirect yarn numbering systems

Name	Area	Length unit	Weight unit	Standard no.
Worsted	Universal	Hanks of 560 yards	Per 1 lb.	560
Cotton	Universal	Hanks of 840 yards	Per 1 lb.	840
Galashiels	Scotland	Cuts of 300 yards	Per 1.5 lbs.	200
Yorkshire	Yorkshire	Skeins of 256 yds.	Per 1 lb.	256
Metric	Europe	Metres	Per gramme	496

Table 1.4 shows the various Indirect systems, most of which (with the exception of Metric) are hardly ever used today.

The number given to a yarn is an indication of its thickness and is referred to as the yarn count. In the Indirect system, yarn count number refers to *'the number of length units in a given weight of yarn'*. The higher the yarn count number, the finer or thinner the yarn.

1/20 worsted indicates 20 × 560 yards of yarn weigh 1 pound.
1/40 worsted indicates 40 × 560 yards of yarn weigh 1 pound.

1/30 cotton indicates 30 × 840 yards of yarn weigh 1 pound.
1/48 cotton indicates 48 × 840 yards of yarn weigh 1 pound.

15 cut Galashiels indicates 15 × 200 yards of yarn weigh 1 pound.
28 cut Galashiels indicates 28 × 200 yards of yarn weigh 1 pound.

16 skeins Yorkshire indicates 16 × 256 yards of yarn weigh 1 pound.
24 skeins Yorkshire indicates 24 × 256 yards of yarn weigh 1 pound.

30 nm Metric indicates that 30 × 496 yards of yarn weigh 1 pound.
50 nm Metric indicates that 50 × 496 yards of yarn weigh 1 pound.

1.15 Calculate Indirect count from a given length and weight of yarn

C = yarn count
L = length of yarn sample (yards)
W = unit of weight of the system
Wt = weight of yarn sample in units of the system at official regain
S = standard number of the yarn system

$$C = \frac{L \times W}{Wt \times S}$$

Example 1 Weight of yarn sample = 50 grains
Length of yarn sample = 120 yards
Standard no. (worsted) = 560 yards
Unit of weight (1lb.) = 7000 grains

$$C = \frac{120 \times 7000}{50 \times 560} = 30 = 2/60 \text{ worsted}$$

Example 2 Weight of yarn sample = 90 grains
Length of yarn sample = 75 yards
Standard no. (Yorkshire) = 256 yards
Unit of weight (1lb.) = 7000 grains

$$C = \frac{75 \times 7000}{90 \times 256} = 22.79 = 23 \text{ sks Yorkshire woollen}$$

1.16 Convert Indirect to Indirect

Example 1 Convert 2/48 worsted to Metric

$$\frac{48 \times 560}{496} = 54.19 = 2/54 \text{ nm}$$

Example 2 Convert 24 sks Yorkshire woollen to Worsted

$$\frac{24 \times 256}{560} = 10.97 = 2/22 \text{ worsted}$$

Example 3 Convert 2/40 cotton to Metric

$$\frac{20 \times 840}{496} = 33.87 = 2/68 \text{ nm}$$

Example 4 Convert 15 cut Galashiels to Yorkshire woollen

$$\frac{15 \times 200}{256} = 11.7 = 11.7 \text{ sks Yorkshire woollen}$$

Example 5 Convert 16 sks Yorkshire woollen to Metric

$$\frac{16 \times 256}{496} = 8.3 = 8.3 \text{ nm Metric}$$

Example 6 Convert 2/20 cotton to Galashiels woollen

$$\frac{10 \times 840}{200} = 42.0 = 42 \text{ cut Galashiels}$$

1.17 Calculate average yarn counts in the Indirect system

Example 1 1 end of 2/40 worsted (20s)
1 end of 2/30 worsted (15s)

60 units of 20s = 3 × 1 = 3.0
60 units of 15s = 4 × 1 = 4.0
2 = 7.0

$$\text{Average count} = \frac{60 \times 2}{7.0} = 17.14 = 2/34 \text{ worsted}$$

Example 2 1 end of 20 sks Yorkshire woollen
1 end of 30 sks Yorkshire woollen
2 ends of 18 sks Yorkshire woollen

30 units of 20 sks = 1.50 × 1 = 1.50
30 units of 30 sks = 1.00 × 1 = 1.00
30 units of 18 sks = 1.67 × 2 = 3.34
4 = 5.84

$$\text{Average count} = \frac{30 \times 4}{5.84} = 20.55 = 20.5 \text{ sks Yorkshire woollen}$$

Example 3 1 end of 40s cotton
1 end of 16s worsted

$$1/16 \text{ worsted to Cotton} = \frac{16 \times 560}{840} = 10.67\text{s Cotton}$$

16 units of 10.67 = 1.50 × 1 = 1.50
16 units of 40 = 0.40 × 1 = 0.40
2 = 1.90

$$\text{Average count} = \frac{16 \times 2}{1.90} = 16.84 = 16.8 \text{ Cotton}$$

1.18 Resultant yarn counts in the Indirect system

The resultant yarn count is the count of two or more yarns twisted together.

Example 1 24 sks Yorkshire / 16 sks Yorkshire

24 units of 24 sks = 1.00
24 units of 16 sks = 1.50
24 units of 'x' = 2.50

$$\text{Resultant count} = \frac{24.00}{2.50} = 9.6 \text{ sks Yorkshire}$$

Example 2 24 worsted / 32 cotton

$$\text{First convert 32 cotton to worsted} = \frac{32 \times 840}{560} = 48 \text{ worsted}$$

48 units of 24s = 2.00
48 units of 48s = 1.00
48 units of 'x' = 3.00

$$\text{Resultant count} = \frac{48.00}{3.00} = 16 \text{ worsted}$$

Example 3 56 worsted / 48 worsted / 2/80 cotton

$$\text{Convert 2/80 cotton to worsted} = \frac{40 \times 840}{560} = 60 \text{ worsted}$$

60 units of 56 = 1.07
60 units of 48 = 1.25
60 units of 60 = 1.00
60 units of 'x' = 3.32

$$\text{Resultant count} = \frac{60.00}{3.32} = 18.07 = 18 \text{ worsted}$$

Percentage take-up means extra length of single yarns per unit length of folded but has not been included in the foregoing examples. However it must be allowed for in any such calculations, in order to give an accurate resultant count.

Take-up is variable and depends on the thickness of the component yarns and the number of turns per inch inserted in the twisting operation. The more turns per inch inserted, the greater percentage take-up and thicker resultant count.

1.19 Yarn twist calculations

A much used calculation is the one to determine the unknown component yarn count in a two ply twist yarn, when the other single component yarn count and the resultant count are both known.

Indirect system:

Example 1 A two ply twist yarn of 8 metric resultant count is composed of one thread of 24 metric count and one thread of an unknown count. What is the unknown yarn count?

24 units of 24 metric = 1
24 units of 'x' metric = ?
24 units of 8 metric = 3 so 24 units of 'x' metric = 3 – 1 = 2

Therefore the unknown yarn count is equal to 24 divided by 2 = 12 metric

Example 2 A resultant two ply yarn count of 16 worsted has one component yarn of 36 worsted. What is the count of the other component?

144 units of 36 worsted = 4
144 units of 'x' worsted = ?
144 units of 16 worsted = 9 so 144 units of 'x' worsted = 9 – 4 = 5

Therefore the unknown yarn count is equal to 144 divided by 5 = 28.8 worsted.

Direct system:

Example 1 A two ply yarn in Tex (Direct system) is composed of one thread of 40 Tex, one thread unknown count and has a resultant count of 100 Tex. What is the count of the other component yarn?

The simple answer to this one is 100 minus 40 which is 60 Tex, the count of the unknown yarn.

Example 2 A three ply yarn in Tex (Direct system) is made up of one thread 50 Tex, one thread of 70 Tex and one unknown Tex count. The resultant count is 150 Tex.

The unknown yarn count this time is 150 minus 50, minus 70 which gives the count of the third component as 30 Tex.

1.20 Yarn testing

In industry today, sophisticated apparatus and methods are used to test and assess the various properties of yarns. Whilst it is not within the scope of this publication to deal with such apparatus and test results, it is relevant to list the properties:

- Yarn count
- Count variation between bobbins
- Mean breaking strength
- Mean elongation at break
- Breaking strength variation
- Elongation at break variation
- Evenness
- Number of thick and thin places and neps
- Faults (slubs, fly, piecings etc.)
- Hairiness
- Twist
- Twist variation between bobbins.

This chapter has fulfilled the need for knowledge of yarns, yarn counts and yarn manufacturing processes mentioned in the introduction. It has presented a general understanding of the subject without an in-depth study as woven fabric designers are unlikely to be asked to solve carding and spinning problems as there are others better qualified to do so.

The study of both Direct and Indirect yarn numbering systems has concluded that the Direct system is the simpler and more straightforward of the two to use. Calculations for average yarn count, resultant yarn count and yarn twist are much easier to determine in the Direct system.