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THE COST OF YARN AND CLOTH FAULTS[1]

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SUMMARY OF "THE COST OF YARN AND CLOTH FAULTS"

Industrialization has led to horizontal stratification of the processes of textile manufacture. The resulting specialization has greatly reduced the cost of textiles, but has weakened the technological links between those responsible for process specifications and the ultimate users of textile products. For example, a spinner and a weaver may co-operate to achieve a yarn specification which minimises the combined costs of spinning and weaving, but this is not enough. The cost/benefit consideration of end breakage rate during spinning (amongst other factors) should take account not only of spinning and weaving costs, but include also finishing and garment making costs.

CLOTH FAULTS AND THE GARMENT MAKER

Imperfections in finished cloth give rise to excess costs in garment manufacture. Although these costs make a significant contribution to the total cost of factory made garments there is a lack of detailed knowledge of the cost of particular types of faults. To remedy this deficiency an investigation was conducted by the Shirley Institute into the cost of fabric faults in the manufacture of shirts and raincoats. The main aims were to discover the kinds of faults causing excess costs, the frequency of these faults, the costs incurred per single fault and the total cost of each type of fault.

Investigations were carried out in five shirt factories and five rainwear factories. In each case a batch of cloth was given a detailed examination in the laboratories of the Shirley Institute before delivery to the garment factory concerned. The batch of cloth was then followed through the complete manufacturing process and all costs incurred as a result of cloth faults were assessed and noted. The costs included labour and materials involved in cut-outs and re-cuts as well as the lost revenue from sub-standard garments.

The average cost per fault in woven shirtings was 2.5p with an average of 906 faults per 1,000 yards – c. 2.25p per yard of cloth. In rainwear fabrics the average cost per fault was 5.6p with 930 faults per 1,000 yards – c. 5.2p per yard of cloth. The total costs per type of fault varied greatly. In the shirting fabrics stains, soiled weft and soiled warp accounted for almost 35% of the total excess costs. The other faults of major importance were foreign bodies 13.9%, broken/double picks 10.6%, weft slubs 10.1%, ends-down 7.4% and knots 6.4%. The most important type of fault in rainwear manufacture was broken/double picks and this fault alone accounted for 20% of the total excess cost.

It was concluded that the high cost of such loom faults as broken picks and ends-down was sufficient to warrant a technical investigation into the causes of these malfunctions. It was also felt that the excess costs attributable to stains and soiling are on a scale large enough to justify a major effort towards the reduction of these faults.

BARRINESS CAUSED BY COUNT VARIATION

In the study of the cost of cloth faults it was found that, after slubs, barriness caused by yarn count variation was the second most costly type of yarn fault. Given a particular level of count variation in the yarn barriness in woven cloth can be reduced by pirn winding at the loom, by direct insertion of weft and by programmed weft mixing. In weft knitted fabrics the extent of barriness increases as the number of feeders on the machine is increased.

A more radical approach to the problem is reduction of the degree of counts variation. Autolevellers and the use of continuous sliver monitoring equipment can greatly reduce counts variation. An assessment of (a) card, and (b) drawframe autolevellers has been made under normal mill operating conditions. Continuous monitoring equipment has been assessed under laboratory conditions.

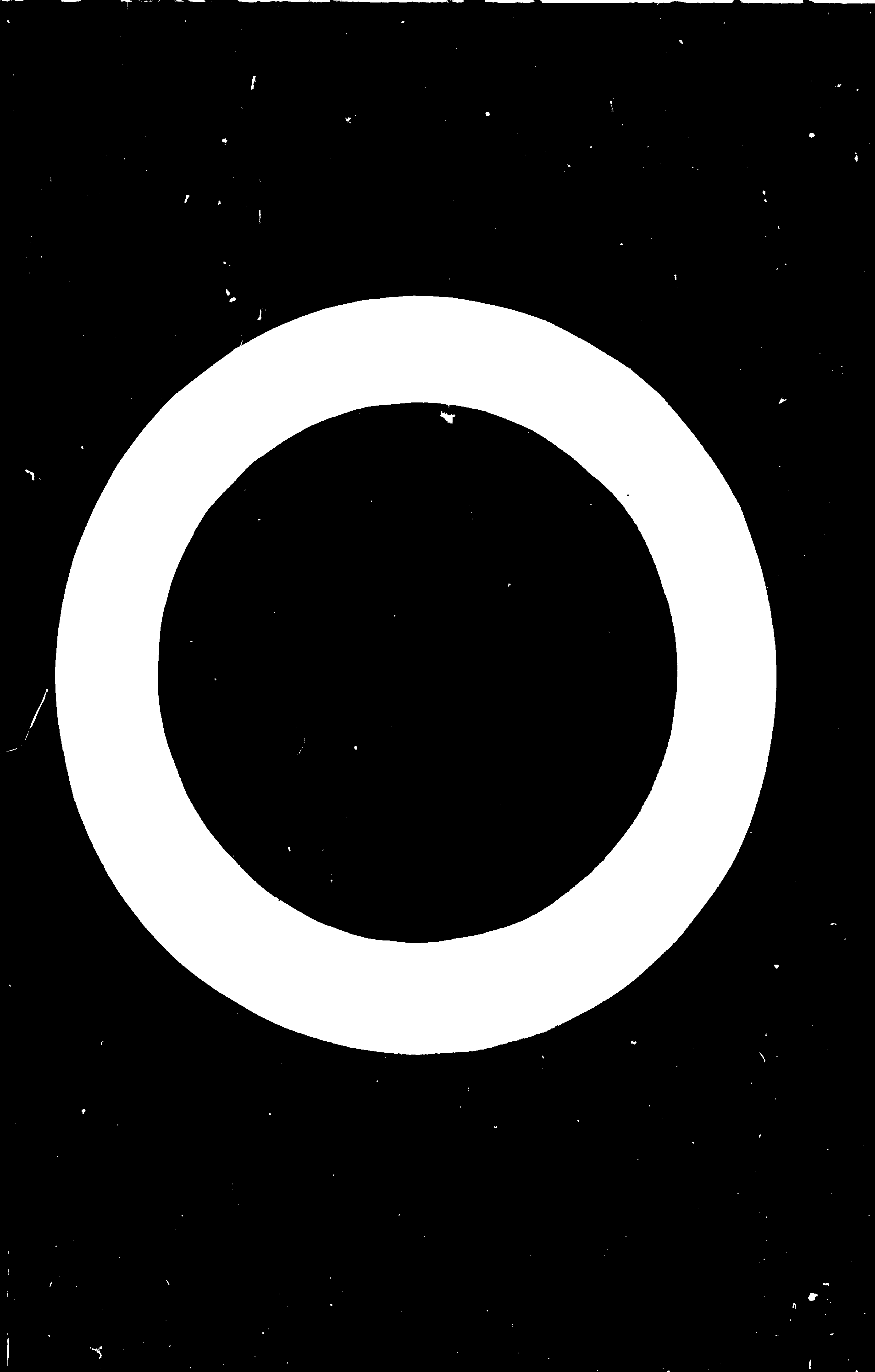
Both types of autoleveller gave significant reductions in count variation. The continuous monitoring equipment gave a performance adequate for sliver irregularity control by pinion changing techniques and could usefully supplant the conventional quality control procedure based on periodic wrappings.

ANALYSIS OF YARN FAULTS IN THE DELIVERIES FROM A MODERN SPINNING UNIT

A comprehensive analysis was made of all the yarn faults which were the subject of customer complaint during 12 months operation of a modern spinning unit in Britain.

The most frequently occuring fault was mixed yarn, resulting from unsatisfactory 'housekeeping" practices. Of actual spinning faults slubs, unevenness and counts variation were the most serious. These, together with faulty cone winding and knotting accounted for 70% of all faults complained of by customers.

The causes of each type of fault have been determined and general guidelines for reduction of fault incidence are drawn.



THE COST OF YARN AND CLOTH FAULTS

INTRODUCTION

Although in primitive times the crafts of spinning, weaving, finishing and garment making were often practised within a single household, the tasks and skills required had (and still have) very little in common. It is not surprising, therefore, that industrialization led inevitably to horizontal stratification of the processes of textile manufacture. As a direct outcome of the resulting intense specialization, machine and operative productivity has been enormously increased and the cost of textiles has been so dramatically reduced that fabrics once the prerogative of princes are now enjoyed by ordinary people.

This is, of course, a very satisfactory outcome but there is, unfortunately a side effect of specialization which is insidiously adding unnecessarily to manufacturing costs. As specialization proceeds each specialist tends increasingly to regard his own speciality as an end product complete in itself, and to establish his own criteria of excellence without taking due account of the needs of the ultimate consumer. This situation is slowly but inexorably widening the gap between the assumed and the real needs of the specialist consumer of each speciality.

As a simple example of this you will often find a spinner doing all he can to produce a strong yarn and his customer, the weaver, insisting that his need is a strong yarn, when the real need is not strength but, perhaps, freedom from local irregularities which are adding to weaving costs and detracting from the appearance of the finished cloth. Other things being equal a relationship undoubtedly exists between yarn strength and freedom from local irregularities, but mere insistence on strength can easily add to costs without necessarily giving the required freedom from local irregularities.

Studies undertaken by the Shirley Institute point to poor technological communication between those responsible for process specification as the cause of the difficulty and for some years now we have been working to establish rational criteria of product and intermediate product appraisal. In practice this means assessment of the ultimate value - positive or negative - of quality features in relation to the cost of these features. For example, consider end breakage rate in spinning in a situation where there is a direct relationship between spinning speed and end breakage rate per pound of yarn.

END BREAKAGE IN SPINNING

The spinner is strongly tempted to optimize spindle speed by balancing the increased machine productivity at high speed against the reduced operative productivity which results from a higher end breakage rate. In this situation one can put a cost figure to the production of yarn having fewer spinners piecings per pound.

Now the weaver will certainly appreciate that it is easier and cheaper to weave yarns with fewer spinners piecings in them and he may even be able to quantify this factor. If so he and the spinner can sensibly get together and arrange that the spindle speed used by the spinner is optimum in relation to the sum of spinning and weaving costs and agree a mutually equitable price for the yarn.

So far, so good, but it is necessary to go a great deal further if overall costs are to be minimised. Loomstate cloth may be an end product to the weaver, but it is virtually a raw material to the finisher and without a shadow of doubt finished cloth is raw material to the garment maker. What then is the economic significance of spindle speed, and hence number of spinners piecings, to the garment maker? It depends, of course, on the type of cloth, how it is finished and the sort of garment which is being made. Let us consider a specific situation. In a recent cost study carried out in four shirt making factories it was found that the average cost of dealing with knots in the warp of the cloth being used was approximately 4p (£0.04) per knot. If the spinner were required to reimburse the garment maker to the extent of 4p for every knot introduced on the removal of a spinner's piecing his view of the economics of end breakage rate would be materially affected.

YARN COUNT VARIATION

There are many other ways in which the spinner can unwittingly detract from the value of the ultimate cloth and increase the cost of garment making. Count variation, from whatever cause, leads to some measure of weft barriness and to either the rejection of cloth or the waste of both time and materials in the garment making factory. There is a reliable statistical relationship between counts variation and weft barriness and this and the interaction of some other process variables is treated in some detail in a paper 'Yarn Quality – Specification and Control by A. H. Bowles*. In this paper, which is given in an abridged form below, it is shown that the weaver can do a great deal to reduce the degree of barriness resulting from a given degree of yarn counts variation.

However, prevention is better than cure and a great deal can be done by the application of sound statistical control methods by the spinner. It is less well known that block-creeling technique at the cards and drawframes can make a useful contribution. With shute fed cards this is not a consideration, but let us study what happens when cards are fed by 40 lb laps and the resulting sliver is given two passages of drawing with eight ends up at each stage.

Suppose the card laps to be creeled randomly and a mean overlap of 2" to occur at the joint when creeling. Although the inherent smoothing power of the card prevents a short length of sliver being made twice the correct thickness, typically about 10 yards of sliver is made with a mean thickness 50%

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* Published in 'Control for improved quality and lower production costs'. Shirley Institute, 1972.

greater than the correct thickness. This means that, on average, in every 4,000 yards of card sliver there will be a 10 yard length which is 50% too thick.

The first drawframe has a further smoothing effect with the net result that every 4,000 yards of first head (or breaker) sliver contains an 80 yard length of sliver 6% thicker than it should be. This sort of assessment can be continued and the effect of overlapping slivers during drawframe creeling can be included. It is a complex situation but it is clear that creeling practice, both at cards and at drawframe, can materially influence counts variation and the consequent level of weft barriness. When a spinner considers the economics of block creeling he should include not only the direct costs and savings within the spinning mill, but in addition should take objective account of the value of reduced barriness to the ultimate user of the cloth.

DYE AFFINITY

The blending of different growths of cotton, normally the responsibility of the spinner, can also lead to difficulties later. With natural fibres such as cotton the maintenance of a completely uniform blend can be very difficult indeed. A spinner's first concern is to control staple length and fibre fineness so as to maintain consistent spinning conditions and standard yarn properties. His second concern is generally with yarn appearance - in particular, colour. He will do his best to ensure that when yarns from different deliveries are compared the weaver will not be able to see any difference between them. This is understandable as there can be no doubt that the purchaser of grey cloth will insist that all pieces in one delivery be of the same shade. Unfortunately there is little correlation between the colour of unbleached cotton and its dye affinity after scouring and bleaching. It would therefore be much more sensible for the spinner to blend for consistent dye affinity after scouring and bleaching rather than for colour in the grey stage. This however would involve the difficulty of convincing both the weaver and the finisher that apparently dissimilar cottons will dye to the same shade. In a rational industry this should give less trouble than that which arises when the finisher and the garment maker find that they have appreciable shade difference between pieces within a batch which, in the grey state, appeared to be completely consistent.

THE NEED FOR QUANTIFICATION

Clearly there are many functions in spinning and weaving which are important in relation to later processes, but in which insufficient attention is paid to their ultimate significance. It is an easy matter to discuss them in general terms but the real need today is for quantification in a form meaningful to those responsible at each stage of manufacture. The Shirley Institute, in co-operation with some of the most progressive companies in Britain, is active in this field. Three separate investigations, which were recently reported and which indicate the potential benefit obtainable from such work, are given in an abridged form below.

1. THE COST OF CLOTH FAULTS IN GARMENT MANUFACTURE*

SCOPE OF THE INVESTIGATION

An important aspect of the value of fabric is its freedom from faults which give rise to excess costs in garment manufacture. Although these costs make a significant contribution to the total cost of garments, there is a lack of detailed knowledge of the cost of particular types of faults, and their relative importance.

To remedy this deficiency an investigation was conducted by the Shirley Institute into the cost of faults in shirting and rainwear fabrics. The main aims were to discover the kinds of faults causing excess costs to the garment manufacturers concerned, the frequency of the faults, the cost per single fault, and the total cost of each type of fault.

METHOD OF APPROACH

Investigations were carried out in five shirt factories and in five rainwear factories. A batch of cloth was obtained from each factory and examined at the Shirley Institute. The faults observed were recorded and checks were made on the width of the cloth and for shading within the piece.

After examination the cloth was returned to the garment factory for manufacture into garments. During the course of manufacture costs were incurred because of the presence of faults in the cloth, and because it was necessary to do certain things to safeguard against the possibility that faults might be in the cloth, e.g. inspection. The batch of cloth was followed through the manufacturing process and a record was made of those costs, of the types of faults responsible, and of the organizational procedures employed for dealing with cloth faults.

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* An abridged account of a research project carried out by R. Grills of the Shirley Institute on behalf of the Clothing Institute and the Directors of Textile Research Associations.

In all, 14,341 linear yards of cloth were dealt with in the ten factory investigations, from which was produced 6,829 garments. Table 1 lists the quantities observed in each factory, the types of garments produced, and their retail price range.

CLOTH EXAMINATION

Woven fabrics were observed in nine of the ten factory investigations and a warp knit nylon shirting in the tenth. Of the four woven shirtings, two were polyester/cotton, one a cotton poplin, and one a raised cotton Tattersall check. Four of the rainwear fabrics were polyester/cotton gaberdines or poplins, whilst the fifth was a cotton gaberdine. Details of the cloth constructions, together with their prices per yard, are given in Table 2.

Faults were identified under the descriptions listed below. The list is not a technical definition of the various types of cloth faults but is a brief description of their appearance for the guidance of people working in the clothing industry.

Fault No.	Name of fault	Description
	WOVEN FABRICS	
1	Lashing-in	Two or more strands of unwanted weft woven into the same warp shed. They may be several inches long and always start at the battery side selvedge.
2	Catching-weft	Similar in appearance to lashing-in but may occur at either selvedge and is not associated with the pirn change mechanism.
3	Starting place	A variation in the number of weft threads per inch, usually for $\frac{1}{4}$ - $\frac{1}{2}$ inch, giving the appearance of a bar running across the cloth.

Fault No.	Name of fault	Description
4	Broken pick	Part of a pick missing in the cloth. The length of the fault can vary from a few inches to the full width of the cloth. Remnants of weft yarn may be present in the same shed.
5	Double pick or broken pattern	Two picks in the same shed extending across the full width of the cloth.
6	Weft float	Incorrect lacing of a weft thread with the warp, leaving the weft thread to ride loosely over the surface of the cloth. Usually ¼ - ½ inch or so in length.
7	Weft displaced	A distortion of the weave for an inch or so, caused by localized variations in the warp tension.
8	Held place	Similar in appearance to 7. 'Weft displaced'.
9	Slough-off	Extra coils of weft from the pirn woven into the cloth giving a thick slub-like appearance for about an inch.
10	Soiled weft	Soiling of the weft yarn usually appearing as a number of short linear stains running across the cloth.
11	Wrong weft	Weft of a wrong count giving a clear impression of a bar across the cloth. In thickness the bar may measure as little as ½ inch or as much as 18 inches.
12	Burst weft	Breaks in the weft thread without any missing yarn.

Fault No.	Name of fault	Description
13	Weft slub	Short thick places in the yarn, usually measuring from ½ inch in length up to about 3 inches, and up to several times the normal yarn diameter in thickness.
14	Count variation	Variation in the diameter of the yarn above or below its nominal diameter. The cloth is given an uneven appearance and sometimes bars are formed across the cloth when the fault is in the weft.
15	Bad mixing	Inadequate mixing and blending of fibres in spinning preparation leading to unwanted colour in short lengths of yarn in cross-dyed fabrics.
16	Slubby weft	Continually recurring slubs in the yarn.
17	Doubling fault	Thick or thin places in a doubled yarn due to 'singling', 'threeing' or 'fouring'.
18	End down	A warp break leaving a small hole at the point of break, or a warp thread missing for several inches or longer.
19	Reed marking	Local irregularities in the spacing of the warp threads due to a damaged reed.
20	Warp stitching	An individual warp thread floating for a pick or two at regular intervals and giving the impression of a sewing stitch.
21	Soiled warp	Soiling or staining of one or more warp threads, usually for an inch or so along each thread.

Fault No.	Name of fault	Description
22	Wrong draft	A break in the pattern similar in appearance to a missing warp thread. The fault may last for several yards.
23	Smash	A large group of warp threads broken together.
24	Knots	Warpers or weavers knots appearing as small, hard protuberances on the surface of the cloth. Diameters are usually about 1/32 inch.
25	Reppiness	Repeated bars across the cloth caused by variations in the warp tension.
26	Warp slub	See 13. 'Weft slub'.
27	Diamond barring	Unwanted pattern effect due to variations in the diameter of the weft. It usually lasts for 1 - 6 inches.
28	Burst selvedge	Selvedge threads broken and torn.
29	Crease	A hard crease the effects of which cannot be removed by pressing.
30	Pressure mark	Patches of cloth with an unduly smooth appearance.
31	Patchy dyeing	Localized patches of colour variation, each patch having a diameter of about 6 inches.
32	Soiled cloth	Dirty of soiled areas of cloth.
33	Stains	Marks due to contamination by oil, grease or other substances. Most are less than 1 inch in diameter but some may take the form of streaks up to several inches in length.

Fault No.	Name of fault	Description
34	Foreign bodies	Pieces of unwanted material in the yarn or cloth. In the yarn the foreign body may be isolated fibres of a different colour to the rest of the yarn, or large pieces of cotton seed casing. In the cloth they are usually small bunches of fibre or short pieces of yarn about 1 inch in length.
35	Specks	Very small marks on the cloth with diameters of about .02 inch. Usually caused by small particles of cotton seed casing and minute oil and grease stains.
36	Seams	A sewn seam across the cloth where two pieces of cloth have been joined together.
37	Cloth abrasion	Small areas of cloth damaged by friction, usually several inches in diameter.
38	Snarls	A short loop of weft twisted on itself and woven into the cloth. A part may protrude from the cloth.
39	Holes	Usually caused by piercing of the cloth by a sharp instrument, or a space left between the threads after removal of some large foreign body or slub. Diameters about ½ inch.
	WARP KNITTED FABRICS	
40	Stop lines	A narrow line extending across the full width of the fabric.
41	Ladders	Thread missing along the length of the cloth usually for an average distance of about 12 inches.

Fault No.	Name of fault	Description
42	Pinholes	Small holes in the fabric.
43	Chatter lines	Weft bars across the cloth occurring with a high frequency.

The numbers of faults observed in the woven fabrics are shown in Table 3 (shirtings), and Table 4 (rainwear), whilst Table 5 lists the faults seen in the warp knit nylon shirting. In both Tables the fault frequencies are expressed in numbers per 1,000 linear yards of cloth.

Amongst the shirting the most numerous faults were specks in the two polyester/cotton fabrics. All were extremely small with diameters of about .02 - .04 inches, and most were caused by cotton seed particles or minute oil stains.

Warp and weft slubs were also numerous with the weft slubs predominating in the shirtings, and the warp slubs in the rainwear fabrics. In the cross-dyed polyester/cotton gaberdine, (firm R1), most slubs were yellow and, therefore, prominent against the overall colour of dark green. Analysis of the fibres in the slubs showed that they were composed almost entirely of cotton fibres. Some were a part of the yarn itself, whilst others were loosely connected to one of the component yarns and appeared to be loose cotton fly picked up by the yarn spinning and doubling.

The rainwear fabrics at firms R4 and R5 contained many warp knots and piecings, and doubling faults also in the case of R4 where the cloth was yarn-dyed. These faults were made particularly prominent in the latter case, by what appeared to be localized variations in the colour of the yarn. Further examination revealed that the apparent variations in colour were due to differences in the construction of the yarn itself. In some cases component yarns had less twist than the nominal 30 turns and were bulkier and lighter in colour as a result. Other faults were 'four-folding' and variation in count of one of the component yarns.

Foreign bodies were usually small pieces of yarn or of fly woven into the fabric, or isolated fibres in the yarn that were of a different colour to the cloth. Foreign bodies of this latter type were visible in cloth of light shades only and were confined almost entirely to the polyester/cotton blends. The large number of foreign bodies recorded in the Tattersall check (S4) were large pieces of cotton seed in the grey weft (i.e. unbleached and undyed).

This last cloth was woven on non-automatic multi-box looms and contained a large number of lashings-in, or catching weft. Many lashings-in were present also in the polyester/cotton poplin at firm R5, but no information is available on the type of loom concerned.

Amongst the woven fabrics the total faults per 1,000 yards ranged from 294 to 1,622 with overall averages of 906 for the woven shirtings and 930 for the rainwear.

In the warp knitted nylon fabric (Table 5) faults were fewer but they were individually larger. The most frequent fault was creasing (41 per 1,000 yards) although, as will be shown later it was not serious in cost terms. Stop lines (18), and ladders (14), were the only other faults of any importance. Total faults per 1,000 yards were 108.

Cloth width

All the pieces were measured for width every ten yards. On the great majority of occasions the actual width was equal to or above the stipulated width, usually by $\frac{1}{4}$ - 1 inch. In a few cases the actual width fell below that stipulated, usually for a part of a piece and by about $\frac{1}{4}$ inch. One piece only was seriously narrow and this by $\frac{1}{2}$ - 1 inch for 60 yards of its length. A number of recuts became necessary because of this, which was the only occasion where costs were affected by narrow cloth.

Effect of colour on frequency of faults

In those cases where a light and a dark shade was available in the same fabric, the lighter shade invariably displayed more faults than the darker. From the cloth examination results it was clear, and expected, that the cause of difference should lie in such faults as stains and soiling. Two examples are shown below. In each case the fabrics are different in shade only. Both are polyester/cotton rainwear fabrics and the fault frequency quoted is in numbers per 1,000 linear yards.

Factory:	A		B	
Shade:	Light	Dark	Light	Dark
Soiled weft	23	-	62	-
Soiled warp	17	-	-	-
Stains	34	-	13	-
Specks	17	-	14	-
Dirt	62	-	14	-
Foreign bodies	254	-	155	-
Total	407	-	258	-
All faults	1,044	543	1,130	916

METHODS OF DEALING WITH CLOTH FAULTS

The way in which a garment maker deals with the problem of cloth faults has an important bearing on the extent of the extra costs incurred by the presence of faults in the cloth. Therefore, in order to understand the significance of the costs quoted later it is necessary to have some idea of the various organizational procedures employed in the factories visited. Table 6 lists the relevant activities in their proper sequence, starting with cloth inspection and finishing with reject garments.

Cloth inspection was normally carried out in six of the ten factories. In four cases it was a sampling inspection only, involving 5 or 10% of each batch of cloth delivered, and was done for the sole purpose of deciding on the acceptability of the batch. In the other two cases (the rainwear firms R1 and R4), all the cloth was inspected to decide whether the cloth was of acceptable quality and to assess how much cloth from each roll should be reserved for recuts.

It was the practice in eight of the firms to cut out major or gross faults when making the lay. The exceptions were the two rainwear firms, R1 and R4, where all faults were left to be removed after cutting. Table 6 shows the numbers of cut-outs per 1,000 yards for each of the firms. At firm S4 there were no cut-outs, although a number of major faults were present in the cloth, whilst only one fault was cut-out at firm S5 (warp knit nylon). In the remaining firms the number of cut-outs ranged from 8 to 59 per 1,000 yards.

To guard against the mixing in a garment of panels drawn from different rolls, with consequent shade differences, all firms used some method of bundle identification, and in some cases of individual panel identification also. The usual method of bundle identification was by docket, or ticket, which often included a number of tear-off tickets for use as a record of work done by individual machinists. Thus, the bundle docket served also as a means of production control and earnings assessment. Where the bundle was identified by docket only, no account has bee taken of the cost of the procedure. But in those cases where individual panels were marked by ticket or by stamp, the cost has been taken into account because it is considered that the main purpose was to guard against shade mixing.

In half the firms visited some inspection of cut parts was carried out in the cutting room. In three of the shirt factories, collar tops and shirt fronts were inspected for cloth faults, whilst two rainwear firms inspected all garment panels. In all five cases many of the recuts originated from this cutting room inspection; the actual numbers are given in the Table.

Where no inspection or screening was done prior to sewing, all the recuts originated from the machine room sub-assemblies, usually after some work had been done on the affected part before the fault was detected. In two of the shirt firms, (S1 and S3), the machine room recuts were mainly of completed collars and cuffs which were damaged by cloth faults not detected in the cutting room screening.

The proportion of completed garments classed as sub-standard ranged from 0.3 - 14.0%. In those cases where the proportion was low there were two main reasons, namely most faults had been detected in the early stages of manufacture and had been removed by cutting-out or recutting; or the required quality standards were such that many of the cloth faults were acceptable in the finished garment. Where the proportion of sub-standard garments was relatively high there was usually an obvious explanation. At factory R3, 14% of coats were sub-standard, because whilst the required quality standards were high, there was no proper system for the detection and elimination of cloth faults in the early stages of manufacture. At another rainwear factory (R2), 7.7% of coats were sub-standard, the majority because of shading. There is some doubt whether the cause was shading in the cloth or mixing of cut parts in the factory. If the latter was the real cause it is one that would be cured by some system of individual panel identification.

A shortage of cloth for recuts was responsible for the bulk of the 7.5% rejects at factory S3. The shortage was caused by the loss of cloth in the many cut-outs due to cloth faults.

At factory S1 two thirds of the 6.9% sub-standard shirts were rejected for faults on the shirt fronts. The inspection of fronts prior to sewing was made on a sampling basis only. With a 100% inspection the majority of the defective fronts would have been detected and replaced before leaving the cutting room.

THE COST OF CLOTH FAULTS

The items of cost taken into account in assessing the cost of cloth faults include labour, materials, overheads, and the loss on sub-standard garments.

In Table 7 the costs are summarized for each factory under four main headings, namely (1) Quality Control Procedures; (2) Cut-outs, (3) Recuts, and (4) Loss on Sub-standard Garments. Costs shown under the first three headings are divided into labour costs and material costs. A single figure is given for the loss on sub-standard garments.

The term 'quality control procedures' means those activities which are carried out by the garment maker to guard against the effects of cloth faults. These include:

1. Cloth inspection.
2. Insertion of paper in the lay to separate the plies drawn from different rolls of cloth.
3. Soabar ticketing or stamping of individual panels.
4. Screening or inspection of garment panels before sewing.

5. Intermediate inspections of work in progress.

6. Final inspection.

The whole of the cost of items 1 - 4 is included in the figures given in Table 7. Of items 5 and 6, a part only of the cost has been taken into account because the inspections are for garment-making faults as well as cloth faults.

Cut-out costs cover the cost of the labour time involved in cutting-out faults whilst making the lay, and the cost of the cloth wasted in the process.

The labour cost of making recuts includes the labour involved in finding the right shade of cloth and making the recut, and the time of other people responsible for requesting recuts. It also includes the cost of labour already expended on a panel before the fault was detected. The material cost shown is the cost of the cloth used in making the recut plus the cost of any resultant waste. Also included is the cost of linings and thread when the recut was to replace a completed collar or cuff.

The loss on sub-standard garments is the difference between the amount the garment maker would receive for a first quality garment and the amount he would get for a sub-standard. At one rainwear firm manufacturing specific orders for export, rather than standard lines for stock, each sub-standard garment was replaced on a 'one-off' basis to make up the order. Extra manufacturing costs were incurred because of this and they have been taken into account.

Overhead costs were allocated as a proportion of direct labour costs and are included in the labour costs shown.

The extra costs from cloth faults are summarized in Table 7 in pence per garment produced. There are considerable differences between the cost values given for the separate firms, many of which are explained by the information contained in Table 6 and the comments on that Table.

Shirt firms

Amongst the shirt firms cloth faults had their smallest cost effect (1.60p per garment) at firm S5 producing warp knit nylon shirts. At firm S4, the cost per garment was also comparatively low at 2.14p, most of which was due to the labour cost of stamping panels as a safeguard against shade mixing. Costs due to faults in the cloth were negligible because the quality requirements of the market dealt in were apparently lower than those supplied by the other shirtmakers. Firms S1, S2 and S3 catered for markets of good quality standards. The difference between them in the extra costs per garment was due to differences in the price of the cloth used, in the numbers of faults in the cloth, and the shortage of cloth for recuts at firm S3.

The average cost of faults per garment for all five shirt factories was 6.04p, which represented 11.1% of the average price of the various fabrics used.

Rainwear firms

The pattern of costs amongst the rainwear firms clearly reflects the differences in their methods of dealing with cloth faults. Thus, firms R1 and R4 incurred high costs from their practice of 100% cloth inspection, 100% screening and consequent high numbers of recuts, but a compensating small loss from substandard garments. The total extra cost from cloth faults was highest at firm R4, but this must be viewed in the light of the fact that the cloth value was also higher than elsewhere, and their loss on a substandard garment was two to four times that of the other rainwear manufacturers.

The high proportion of substandard garments at firm R3 resulted from the maintenance of high quality standards in the finished garment, unsupported by adequate methods of detecting and removing cloth faults in the early stages of production. The effect of this situation is shown in Table 7. Whilst the costs of dealing with cloth faults at firm R3 are lower than elsewhere, the loss on substandard garments is higher, with a net total result that is relatively unfavourable.

For the five rainwear firms the average extra cost resulting from cloth faults was 26.61p per garment, or 12.7% of the average value of the cloth.

ANALYSIS OF COSTS BY CLOTH FAULT TYPE

Average cost per fault

The costs due to cloth faults shown in Tables 8, 9 and 10 include those of labour and materials involved, in cut-outs and recuts, and the loss on substandard garments except those rejected for shading. Other costs not included are those associated with general cloth quality-control procedures which cannot be attributed to specific faults. All three Tables quote the average cost per single fault. The significance of the cost figures shown is to a large extent determined by the number of faults on which the cost value is based. For this reason each cost, (columns 'B'), is accompanied by the relevant number of faults per 1,000 yards, (columns 'A').

The average costs quoted for the shirt fabrics in Table 8 are biased by the effect of factory S4 where the majority of faults were apparently acceptable. The average cost of lashing-in is particularly affected by this. If factory S4 is excluded from the calculation, the average cost per lashing-in rises from 0.6p to 13.5p.

Weft slubs caused extra cost at one rainwear factory only, R1, and this was due to the cross-dyeing effect. Warp slubs, on the other hand, led to considerable extra costs.

Faults with both a high average cost and high frequency were broken picks, ends down, knots, stains, and foreign bodies. Starting places varied in importance between the shirt makers, but were consistently a high cost fault in the rainwear firms.

The average cost per fault in the woven shirting fabrics was 2.5p, with 906 faults per 1,000 yards, and 5.6p in the rainwear with 930 faults per 1,000 yards.

In the warp knitted nylon the most important faults from a cost point of view were stop lines and ladders. Creases were the most frequent type of fault, but their cost was low at 1.2p per fault. The average cost per fault in the warp knitted nylon was 2.8p with a total of 108 faults per 1,000 yards.

Summary of costs per 1,000 yards per type of fault

A summary of costs per type of fault in the woven fabrics is given by Table 11. The costs quoted are the average figures for (a) firms S1 - S4, and (b) firms R1 - R5. Firm S5 making warp knit nylon shirts is dealt with in Table 12.

The relative importance of certain faults differs in Table 11 between the shirtings and the rainwear because of differences between the two groups of fabrics in shade, width, cost, and construction. Thus the lighter shirt fabrics had as their most serious faults stains and foreign bodies, which were far less prominent in the darker rainwear fabrics. Faults which affect cloth across its width were more serious in the wider and more expensive rainwear; examples are broken/double picks and starting places.

In the shirting fabrics, stains, soiled weft and soiled warp accounted for almost 35% of the total costs due to individual cloth faults. The other types of faults that were of major cost importance were foreign bodies (13.9%), broken/double picks (10.6%), weft slubs (10.1%), ends down (7.4%), and knots (6.4%). These faults, together with stains and soiled yarn, accounted for over 80% of the total cost of faults in the shirtings.

The most important type of fault in the rainwear fabrics was broken/ double pick, which was responsible for 20% of the total cost of individual cloth faults. Weft slubs appear as the second most serious fault (9.5% of the total costs), but this is misleading for the whole of the cost of this fault occurred in a single cross-dyed fabric.

In the warp knitted nylon shirting stop lines caused 40.6% of the cost of faults, and stop lines with ladders a further 22.7%. Creases were responsible for 18.5% of the cost.

CONCLUSIONS AND RECOMMENDATIONS

If the excess costs from cloth faults found by the investigation are typical, then the totals for those sections of the garment industry making (a) formal woven shirts, and (b) chemically proofed rainwear, are more than £1 million per annum in each case. On a similar scale the annual excess cost for the whole UK garment industry would be approximately £30 million, of which duplicated labour and waste materials would account for 60%.

In individual factories the extent of the excess costs is determined by several factors, the most important being the quality standards of the retail market dealt in; the measures adopted to detect and remove faults; the cost of the cloth; and the pattern of faults which varies considerably between different types and colours of fabric. For example, warp knitted nylon shirting has far fewer faults than woven shirtings and, therefore, lower excess costs.

The types of faults responsible for most of the excess costs are broken picks, oil stains, foreign bodies, slubs, knots and broken warp threads.

Costs due to stains and soiling are on a scale large enough to justify a major effort towards their reduction in the weaving and finishing sections of the industry.

Fabrics containing polyester fibres were badly affected by the presence of foreign bodies, usually fibres or bits of yarn, either spun into the yarn or woven into the cloth. Polyester/cotton fibres are known to be prone to this type of fault, and from the high number of examples observed it is clear that there is much scope for its reduction. Wherever practicable, polyester/cotton fabrics intended for light shades should not be woven in sheds containing looms weaving dyed yarns.

The consistently high cost of broken picks and ends down would seem to justify further technical investigation into the causes of those faults. Their incidence varies widely between cloth manufacturers, which suggests that the main causes of difference may lie in the types and ages of looms employed, and on the quality of loom maintenance.

Within some garment firms there is scope for reduction in the cost of cloth faults through improved procedures for dealing with faults. In some cases the standard of pre-sewing inspection is low and many faulty panels are not detected until they reach an intermediate inspection point in the sewing room, or the final inspection of the finished garment. In other cases, where the amount of pre-sewing inspection is inadequate, costs would be reduced by the introduction of inspections for those garment panels that are prominent in the completed garment, and in which faults are unacceptable to the customer.

The particular set of measures that a garment maker should adopt to safeguard against cloth faults and shade-mixing are those which will reduce his costs to a minimum. Whilst those measures can be established for individual firms in which all the relevant factors are known, it is not possible at this stage to arrive at the minimum cost by a general expression applicable to all firms. It should be possible to obtain such an expression, and it is suggested that the likely benefits to the industry justify further work towards that end.

TABLE 1

AMOUNT OF CLOTH AND NUMBER OF GARMENTS OBSERVED

Firm Code No.	S1	S2	S3	S4	S5	Total
Type of garment observed	Men's shirts	Men's shirts	Men's shirts	Boys' shirts	Men's shirts	
Length of cloth observed (linear yards)	1,004	1,503	2,987	3,100	1,245	8,594
Number of garments produced	481	610	1,234	1,800	540	4,125
Retail price range (per garment)	£2 - £2.50	£2.50 - £3	£2.50 - £3	£1 - £1.25	£1.20 - £1.50	-

Firm Code No.	R1	R2	R3	R4	R5	Total
Type of garment observed	Men's coats	Ladies' coats	Ladies' coats	Men's coats	Ladies' coats	
Length of cloth observed (linear yards)	1,313	1,081	1,044	1,290	1,082	5,747
Number of garments produced	520	432	492	450	510	2,704
Retail price range (per garment)	£13-£15	£8-£10	£6-£8	£21-23	£10-£12	-

TABLE 2

CLOTH PARTICULARS

Firm code number	S1	S2	S3	S4	S5	R1	R2	R3	R4	R5
Weave	Poplin	Plain	Plain	Tattersall check (raised)	Warp knit	Gaberdine	Poplin	Gaberdine	Gaberdine	Poplin
Fibre	Cotton	Polyester cotton	Polyester cotton	Cotton	Nylon	Polyester cotton	Polyester cotton	Polyester cotton	Cotton	Polyester cotton
Shade	Light, piece-dyed	Bleached	Light, piece-dyed	Bleached warp, grey weft, dyed check	Light, piece-dyed	Dark, cross-dyed	Light, medium, dark, piece-dyed	Light and dark, piece-dyed	Dark, yarn-dyed	Light and medium, piece-dyed
Cloth width (inches)	42	42	42	36	37½	60	59	59¾	60	59
Warp count	36s	40s	40s	22s ring	40 denier 13 filament	2/40s	20s	30s	2/80s	2/40s
Weft count	32s	32s	32s	16s mule	Dull and semi-dull	2/40s	20s	30s	2/80s	2/40s
Ends/inch	122	90	90	55	Wales/inch 35	98	96	148	178	96
Picks/inch	70	75	75	50	Courses/inch 77	62	52	78	104	52
					Weight/yd^2 3.2 oz					
Cloth price per linear yard (p)	18.3	22.5	31.7	16.7	16.7	78.3	55.8	67.5	111.3	65.0

TAPLE 3

CLOTH FAULTS PER 1,000 LINEAR YARDS - WOVEN SHIRTINGS

Firm Code No.	S1	S2	S3	S4	Mean
FAULT					
Weft - weaving					
Lash in	2	11	11	75	38
Starting place	83	19	30	3	23
Broken/double pick	43	26	22	8	19
Weft float	5	4	1		2
Weft displaced	4	14	17		7
Slough off		4	8		3
Soiled weft	2	13	17	2	8
Wrong weft		1		1	1
Burst weft			2		0
Irregular cloth width				1	0
Weft - yarn					
Weft slub	39	202	230	92	138
Count variation	2	17		4	5
Bad mixing					
Slubby weft			1		0
Doubling fault					
Warp - weaving					
End down	29	43	49	3	25
Reed marking					
Stitching	2	5	1	1	2
Soiled warp	3	1	8	3	4
Uneven warp tension	4			1	1
Wrong draft					
Smash			4		1
Knots	12	70	61	13	35
Reppiness	2				0
Warp - yarn					
Warp slub	19	102	55	56	60
Count variation		1			0
Bad mixing					
Doubling fault					
Diamond barring			2		0
Finishing					
Burst selvedge			4	1	1
Crease					
Pressure mark					
Patchy dyeing					
Miscellaneous					
Soiled cloth	2	5	10	13	9
Stains	24	83	77	22	47
Foreign bodies	4	41	63	170	98
Specks		905	744		350
Seams					
Cloth abrasion	4				1
Snarls	1	52	57		23
Holes	0	3	12	1	5
Total weaving	191	211	232	111	169
Total yarn	60	322	288	152	203
Total finishing	0	0	4	1	1
Total miscellaneous	43	1,089	963	206	533
Grand total	294	1,622	1,487	470	906
Length examined (yards)	1,004	1,503	1,677	3,273	7,457

TABLE 4

CLOTH FAULTS PER 1,000 LINEAR YARDS - WOVEN RAINWEAR

Firm Code No.	R1	R2	R3	R4	R5	Mean
FAULT						
Weft - weaving						
Lash in		3	1		55	11
Starting place	19	57	20	4	3	19
Broken/double pick	15	9	21	25	3	15
Weft float	2	4		4	4	3
Weft displaced	2	4	4	30		9
Slough off						
Soiled weft		1	6	16	2	5
Wrong weft			4	4		2
Burst weft						0
Irregular cloth width						0
Weft - yarn						
Weft slub	91	184	74	220	191	152
Count variation	10	22		12	3	9
Bad mixing	5					1
Slubby weft						
Doubling fault				1		0
Warp - weaving						
End down	9	18	22	87	53	39
Reed marking				3		1
Stitching	2	53	5	4	8	13
Soiled warp			6	1	6	2
Uneven warp tension		39	17	7	18	15
Wrong draft		1				0
Smash						
Knots	2	19	4	434	330	166
Reppiness						
Warp - yarn						
Warp slub	295	306	149	334	89	241
Count variation		2		2		1
Bad mixing	14					3
Doubling fault				77		18
Diamond barring						
Finishing						
Burst selvedge				2	4	1
Crease		3		2		1
Pressure mark				2		0
Patchy dyeing		8				1
Miscellaneous						
Soiled cloth	1	14	34	12	4	12
Stains	11	16	19	70	28	30
Foreign bodies	10	129	127	25	313	112
Specks		9	9	126	26	37
Seams		5	1			1
Cloth abrasion			2			0
Snarls	1	5	6	27	4	9
Holes	1	2		4		1
Total weaving	51	208	110	619	482	300
Total yarn	415	514	223	646	283	425
Total finishing	0	11	0	6	4	3
Total miscellaneous	24	180	198	264	375	202
Grand total	490	913	531	1,535	1,142	930
Length examined (yards)	1,133	1,018	1,044	1,324	1,082	5,781

TABLE 5

CLOTH FAULTS PER 1,000 LINEAR YARDS - WARP KNIT NYLON

Fault	Faults per 1,000 yards
Stop line only	18
Ladder plus stop line	10
Warpway faults	3
Ladder with large holes	1
Chatter lines	3
Holes	2
Holes at selvedge	3
Holes and cut edge	1
Seams	5
Dirt	4
Stains	15
Abrasion	2
Creases	41
Total	108

TABLE 6

METHODS OF DEALING WITH CLOTH FAULTS WITHIN FIRMS

Firm Code No.	S1	S2	S3	S4	S5	R1	R2	R3	R4	R5
Percentage of cloth inspected	10	Nil	10	Nil	Nil	100	10	5	100	Nil
Cut-outs during laying-up (per 1,000 yd)	20	34	58	Nil	1	Nil	59	10	Nil	8
System of bundle identification	Docket	Docket	Docket & front stamping	Docket & stamping of all panels	Docket	Docket & Soabar ticket on all panels	Docket	Docket	Docket	Docket
Screening prior to sewing	Collar tops and sample of fronts	Collar tops and fronts	Collar tops and fronts	Nil	Nil	All panels	Nil	Nil	All panels	Nil
Recuts from cutting room (per 1,000 yd)	44	117	21	Nil	Nil	66	Nil	Nil	255	Nil
Recuts from machine room (per 1,000 yd)	53	Nil	32	13	5	Nil	17	12	3	7
Percentage of completed garments rejected for cloth defects	6.9	1.6	7.5	0.3	2.6	2.3	7.7	14.0	1.5	0.8

TABLE 7

COST SUMMARY IN NEW PENCE PER GARMENT PRODUCED

Firm Code No.		S1	S2	S3	S4	S5	Mean	R1	R2	R3	R4	R5	Mean
Quality control procedures	Labour	0.57	0.35	1.20	1.50	0.60	1.07	7.70	1.15	1.04	8.83	3.30	4.44
	Materials	0.10	-	0.07	0.03	-	0.04	0.02	-	-	-	0.04	0.01
Cut-outs	Labour	0.08	0.02	0.06	0.06	0.02	0.05	-	0.59	0.09	-	0.05	0.13
	Materials	0.17	2.16	3.93	0.17	3.17	1.42	-	6.70	1.70	-	1.30	1.83
Recuts	Labour	0.77	0.06	0.83	0.05	neg.	0.32	1.93	0.45	0.17	2.67	0.22	1.08
	Materials	1.11	4.46	1.20	0.23	0.02	1.10	4.87	0.48	1.78	21.01	0.24	5.49
Total	Labour	1.42	0.43	2.09	1.61	0.62	1.44	9.63	2.19	1.30	11.50	3.57	5.65
Total	Materials	1.38	6.62	5.20	0.43	0.19	2.56	4.89	7.18	3.48	21.01	1.58	7.33
	Total	2.80	7.05	7.29	2.04	0.81	4.00	14.52	9.37	4.78	32.51	5.15	12.98
Sub-standard garments - loss		2.30	1.25	5.70	0.10	0.79	2.04	6.93	9.63	23.49	10.11	3.29	10.63
Total extra cost per garment produced		5.10	8.30	12.99	2.14	1.60	6.04	21.45	19.00	28.27	42.62	8.44	26.61
Total extra cost as % of retail price of garment		2.3	3.0	4.7	1.9	1.2	2.6	1.5	2.1	4.0	1.9	0.8	2.1
Total extra cost as % of cloth price		13.2	15.0	16.9	7.3	4.2	11.1	10.8	14.4	19.7	13.3	6.1	12.7

TABLE 8

COST OF CLOTH FAULTS IN WOVEN SHIRTINGS - NEW PENCE PER FAULT

Firm Code No.	S1		S2		S3		S4		Mean	
	A	B	A	B	A	B	A	B	A	B
FAULT										
Weft - weaving										
Lash in	2	42.1	11	4.7	11	0.0	75	0.0	38	0.6
Starting place	83	0.6	19	5.1	30	2.5	3	0.0	23	2.0
Broken/double pick	43	14.3	26	13.3	22	16.5	8	0.0	19	12.7
Weft float	5	9.3	4	0.0	1	15.3			2	4.2
Weft displaced	4	31.5	14	3.8			17	2.9	7	4.7
Slough off			4	0.0	8	0.0			3	0.0
Soiled weft	2	7.7	13	14.8	17	8.4	2	0.0	8	9.3
Wrong weft			1	0.0			1	0.0	1	0.0
Burst weft					2	0.0			<1	0.0
Irregular cloth width							1	13.1	<1	13.1
Weft - yarn										
Weft slub	39	3.9	202	0.5	230	2.8	92	0.0	138	1.7
Count variation	2	9.3	17	5.0			4	0.0	5	3.5
Bad mixing										
Slubby weft					1	14.2			<1	14.2
Doubling fault										
Diamond barring					2	0.0			<1	0.0
Warp - weaving										
Ends down	29	4.4	43	5.6	49	8.3	3	0.0	25	6.8
Reed marking										
Stitching	2	9.3	5	0.0	1	7.2	1	0.0	2	2.2
Soiled warp	3	6.2	1	15.8	9	7.3	3	0.0	4	5.5
Uneven warp tension	4	34.7					1	0.0	1	19.8
Wrong draft										
Smash					4	9.9			1	9.9
Knots	12	9.3	70	0.9	61	6.7	13	0.0	35	4.2
Reppiness	2	12.7							<1	12.7
Warp - yarn										
Warp slub	19	8.1	102	0.8	55	3.7	56	0.0	60	1.7
Count variation			1	0.0					<1	0.0
Bad mixing										
Doubling fault										
Finishing										
Burst selvedge					4	0.0	1	0.0	1	0.0
Crease										
Pressure mark										
Patchy dyeing										
Miscellaneous										
Soiled cloth	2	6.0	5	0.0	10	0.0	13	0.0	9	0.2
Stains	24	13.4	83	16.0	77	18.2	22	2.4	47	14.8
Foreign bodies	4	8.5	41	7.8	63	11.2	170	0.0	98	3.2
Specks			905	0.2	744	0.2			350	0.2
Seams						28.3				28.3
Cloth abrasion	4	9.3							1	9.3
Snarls	1	0.0	52	0.2	57	0.0			23	0.1
Holes	8	6.4	3	0.0	12	9.8	1	8.8	5	8.5
Totals	294	7.2	1622	2.0	1487	3.2	470	0.5	906	2.5

Note: Columns 'A' show the numbers of faults found per 1,000 linear yards of cloth, whilst columns 'B' give the average excess cost in new pence per single fault.

TABLE 9

COST OF CLOTH FAULTS IN RAINWEAR FABRICS – NEW PENCE PER FAULT

Firm code No.	R1		R2		R3		R4		R5		Mean	
	A	B	A	B	A	B	A	B	A	B	A	B
FAULT												
Weft – weaving												
Lash in			3	0.0	1	0.0			55	8.3	11	7.8
Starting place	19	3.1	57	9.5	20	2.3	4	72.3	3	25.7	19	10.5
Broken/double pick	15	128.7	9	82.3	21	11.0	25	60.0	3	143.7	15	69.[illegible]
Weft float	2	0.0	4	0.0			4	24.8	4	0.0	3	7.8
Weft displaced	2	300.0	4	31.8	4	0.0	30	10.1			9	28.1
Slough off			1	0.0	6	1.1	16	0.0	2	0.0	5	0.2
Soiled weft					4	10.5	4	142.4			2	83.8
Wrong weft												
Burst weft												
Irregular cloth width												
Weft – yarn												
Weft slub	91	5.3	184	0.0	74	0.2	220	0.0	191	0.0	152	3.3
Count variation	10	55.3	22	8.0			12	0.0	3	0.0	9	29.8
Bad mixing	5	28.2									1	28.2
Slubby weft							1	712.0			<1	712.0
Doubling fault												
Diamond barring												
Warp – weaving												
Ends down	9	6.6	18	21.7	22	10.8	87	10.5	53	5.6	39	10.0
Reed marking							3	31.0			1	31.0
Stitching	2	0.0	53	8.0	5	1.3	4	25.8	8	9.6	13	8.9
Soiled warp					6	2.3	1	0.0	6	25.7	4	9.1
Uneven warp tension			39	0.0	17	1.5	7	24.1	18	2.9	15	3.5
Wrong draft			1	52.5							0	52.[illegible]
Smash												
Knots	2	0.0	19	11.0	4	13.9	434	1.7	330	1.7	164	1.8
Reppiness												
Warp – yarn												
Warp slub	295	2.0	306	1.9	149	0.1	334	1.3	89	0.0	240	1.4
Count variation			2	0.0			2	113.6			1	68.2
Bad mixing	14	30.7									3	30.7
Doubling fault							77	8.8			17	8.8
Finishing												
Burst selvedge							2	0.0	4	0.0	1	0.0
Crease			3	94.6			2	216.7			1	155.6
Pressure mark							2	0.0			<1	0.0
Patchy dyeing			8	0.0							1	0.[illegible]
Miscellaneous												
Soiled cloth	1	0.0	14	0.0	34	1.0	12	0.0	4	0.0	12	0.5
Stains	11	5.3	16	17.9	19	43.8	70	13.0	28	16.0	30	12.3
Foreign bodies	10	18.2	129	0.0	127	1.9	25	21.6	313	0.1	113	1.9
Specks			9	0.0	9	0.0	126	0.0	26	0.0	37	0.0
Seams			5	52.5	1	7.3					1	44.[illegible]
Cloth abrasion					2	0.0					<1	0.0
Snarls	1	39.4	5	10.5	6	0.0	27	0.0	4	0.0	9	14.0
Holes	1	0.0	2	0.0			4	31.0			1	20.[illegible]
Totals	490	10.7	913	4.5	531	2.0	1533	7.4	1140	2.1	929	5.6

Note: Columns 'A' show the numbers of faults found per 1,000 linear yards of cloth whilst columns 'B' give the average excess cost in new pence per single fault.

TABLE 10

COST OF CLOTH FAULTS IN WARP KNIT NYLON SHIRTING - NEW PENCE PER FAULT

Fault	Faults per 1,000 yards	Cost in new pence per fault
Stop line only	18	
Ladder plus stop line	10	5.9
Warpway faults	3	
Ladder with large holes	1	
Chatter lines	3	
Holes	2	1.8
Holes at selvedge	3	
Holes and cut edge	1	
Seams	5	
Dirt	4	6.1
Stains	15	0.1
Abrasion	2	
Creases	41	1.2
Average cost per fault:	108	2.8

TABLE 11

SUMMARY OF COSTS IN NEW PENCE PER TYPE OF CLOTH FAULT (per 1,000 yards of cloth)

Fault	Woven shirting		Rainwear	
	Pence per 1,000 yards	%	Pence per 1,000 yards	%
Weft - weaving				
Lash in	22	1.0	86	1.7
Starting place	46	2.0	200	3.8
Broken/double pick	242	10.6	1,042	20.0
Weft float	8	0.4	23	0.4
Weft displaced	33	1.4	253	4.9
Slough off				
Soiled weft	75	3.3	1	0.0
Wrong weft			168	3.2
Burst weft				
Irregular cloth width	2	0.1		
Weft - yarn				
Weft slub	230	10.1	494	9.5
Count variation	18	0.8	268	5.1
Bad mixing			28	0.5
Slubby weft	2	0.1		
Doubling fault			143	2.7
Warp - weaving				
Ends down	170	7.4	388	7.5
Reed marking			31	0.6
Stitching	5	0.2	116	2.2
Soiled warp	22	1.0	36	0.7
Uneven warp tension	20	0.9	53	1.0
Wrong draft			10	0.2
Smash	10	0.4		
Knots	146	6.4	287	5.5
Reppiness	3	0.1		
Warp - yarn				
Warp slub	103	4.5	340	6.5
Count variation			68	1.3
Bad mixing			92	1.8
Doubling fault			149	2.9
Diamond barring				
Finishing				
Burst selvedge			155	3.0
Crease				
Pressure mark				
Patchy dyeing				
Miscellaneous				
Soiled cloth	2	0.1	6	0.1
Stains	697	30.5	368	7.1
Foreign bodies	318	13.9	212	4.1
Specks	58	2.5		
Seams			45	0.9
Cloth abrasion	9	0.4		
Snarls	2	0.1	126	2.4
Holes	43	1.8	21	0.4
Total weaving	802	35.2	2,694	51.7
Total yarn	353	15.5	1,582	30.3
Total finishing	0	0.0	155	3.0
Total miscellaneous	1,129	49.3	778	15.0
Grand total	2,284	100.0	5,209	100.0

TABLE 12

SUMMARY OF COSTS IN NEW PENCE PER TYPE OF FAULT - WARP KNITTED NYLON

Fault	Cost per 1,000 yards	Percentage
Stop lines only	106	40.6
Ladder plus stop line	58	22.7
Warpway faults	18	6.8
Ladder with large holes		
Chatter lines		
Holes	3	1.3
Holes at selvedge		
Holes at cut edge		
Seams		
Dirt	25	9.5
Stains	2	0.6
Abrasion		
Creases	48	18.5
Totals	260	100.0

2. BARRINESS CAUSED BY YARN COUNT VARIATION*

In the study of the cost of cloth faults in shirt and rainwear manufacture described above it was found that the most costly yarn fault was slubs, with barriness from counts variation second. There is little that a weaver can do about slubs other than clearing them. He can, however, do some things to minimise the ill effects of counts variation and quantitative appraisal of the situation has, therefore, been made.

BLOCK BARRING IN WOVEN CLOTH

A visible weft bar occurs in a fabric if the mean count of the weft inserted immediately before a cop change differs by more than a critical amount from that inserted after it. This critical or limiting difference in count depends upon the shade and construction of the fabric. A range of cloths submitted to the Shirley Institute because of unacceptable barring, showed that a 7% difference in count is sufficient to cause a bar in a sensitive construction and that a difference of 10% will cause a visible bar in most constructions. From these observations, and the assumptions that the mean count of yarn on pirns for weaving is normally distributed and that pirns are randomly selected for weaving, one can calculate the incidence of weft bars arising as a result of yarn count variation. The result is shown in Figure 1.

The yarn on a single pirn may provide enough weft for, say, 50 cm of fabric. A piece of 100 m will then contain 200 pirn changes so that we can readily interpret Figure 1 to give the incidence of block bars in pieces of fabric.

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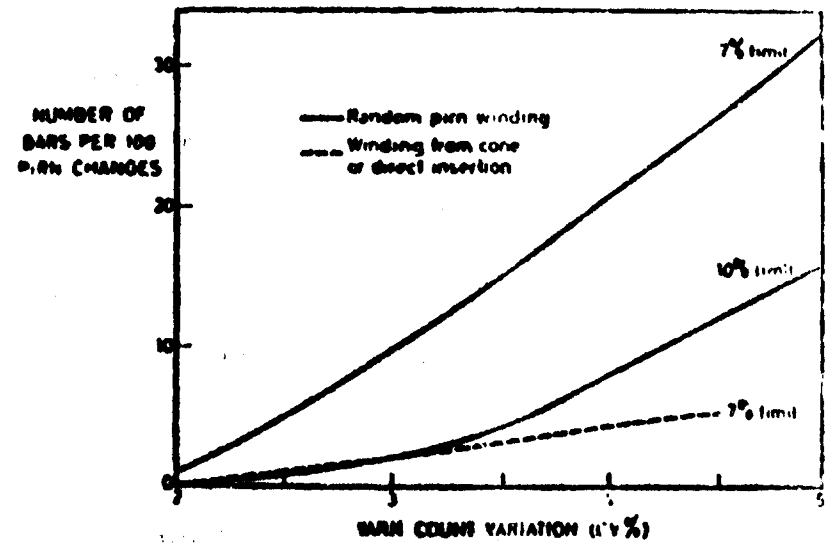
* A shortened version of a paper presented by A. H. Bowles of the Shirley Institute at the Shirley Institute/Intertac Conference 'Control' in February 1972.

Figure 1. Incidence of weft bars with respect to the count variation between pirns and between ringframe bobbins.



If the weaver winds his pirns from cone at the loom then all of the yarn spun onto each ringframe bobbin is kept together as weft in the cloth*. The length of cloth made from each bobbin of yarn is some 5 times greater than that woven from a pirn. This method of weft supply therefore reduces the incidence of block barring per piece of fabric of a given length by a factor of 5 from the case of randomly wound pirns. Much the same improvement is obtained by the direct insertion of weft from cones or cheeses using rapiers, gripper shuttles or the like.

A further method of reducing the incidence of block barring is to insert weft from two sources, pirns or cones, one or two picks from each alternately. The eye is unable to pick out the contributions of the individual threads to the cover factor of the cloth, which is thus determined by the mean count of the two yarns. The effective relative variance of the weft supply is thereby reduced by a factor of 2 below the bobbin-bobbin relative variance of the yarns as spun.

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* When a visible bobbin change occurs within a pirn, 3 adjacent bars are formed within the length of cloth woven from one pirn, i.e. a stripe and a bar. These are counted as a single fault for our present purposes.

From the simplest yarn preparation procedure with separately wound pirns supplied to the loom at random, through pirn winding at the loom and the direct insertion of weft, to weft mixing we have seen how cloth appearance can be improved by the adoption of different weaving strategies.

The costs of these strategies in terms of capital, mechanical reliability weaving speed and the number of looms per weaver have to be balanced against the costs of spinning to a tighter or looser specification for yarn count variation and the reliability with which it can be maintained.

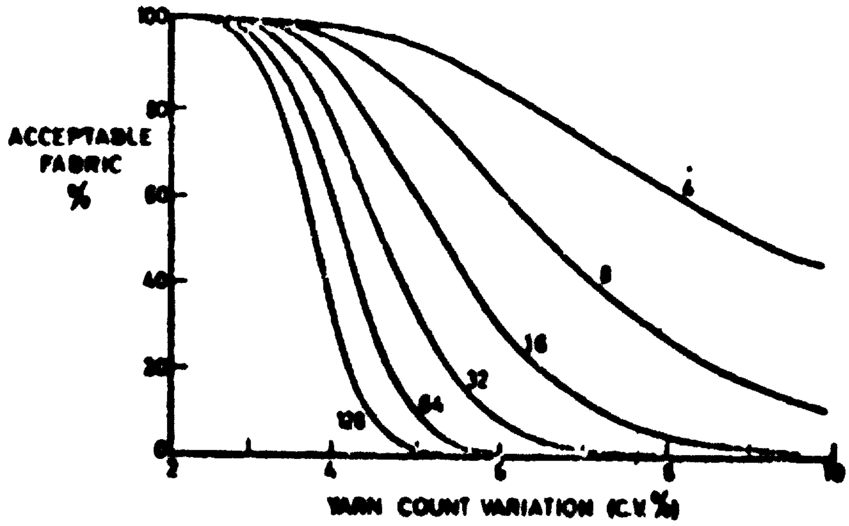
STRIPINESS IN WEFT KNIT CLOTH

Examination of knitted fabrics submitted as faulty because of stripiness has revealed that if one end is 7 - 10% heavier or lighter than its neighbours it causes an unacceptable visible stripe. Thus for the purpose of calculation we may suppose that a visible stripe will be produced when one feeder on a knitting machine is delivering yarn which is 7 - 10% from the average of the other yarns being fed at that time. More than one stripe may actually be formed at a given time. Since the stripiness repeats as a spiral in the fabric and the presence of more than one stripe is as equally unacceptable as a single stripe, for our purpose multiple stripes are counted as a single fault.

The incidence of stripes depends upon the number of feeders used in the knitting machine producing the fabric. Each feeder takes yarn from a cone assembled from a random supply of ring bobbins with a given variability of count. The frequency with which one or more stripes occur in a randomly chosen creel of yarn for knitting machines having various numbers of feeders in a creel has been computed assuming a level of 10% for stripe visibility. The resulting family of curves is shown in Figure 2 and relates yarn count variation to the proportion of fabric produced without stripes.

Length examined (yards) 1,133 1,018 1,044 1,324 1,082 5,781

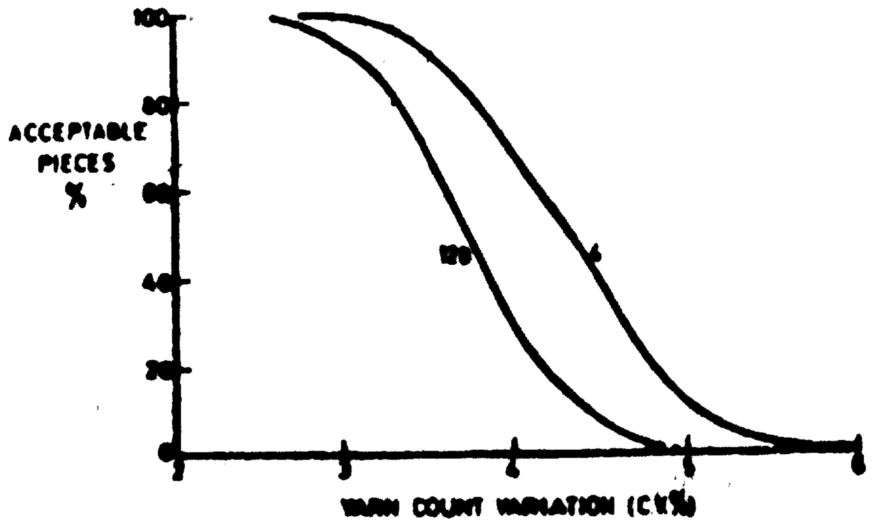
Figure 2. Proportion of fabric produced without stripes on machines with various numbers of feeders related to the count variation of the yarn. Critical level of stripe visibility = 10%.



These curves show that with high yarn count variation it is impossible to knit a reasonable proportion of acceptable fabric on large multifeeder machines. Machines with a small number of feeders require frequent re-creeling and have, of course, the disadvantage of lower production rates and higher production costs.

If we extend our consideration to cover the requirement of makers-up who wish to have large lays of fabric for economical cutting, we find that the apparent freedom of the knitter to balance yarn quality against production costs largely disappears. A large length of cloth without stripes can be obtained by knitting from a large number of feeders and a single creel of yarn or from a small number of feeders and a number of successive creels of yarn. Thus if one creel of yarn on a 128 feeder machine produces a given length of fabric, 2 creels on a 64 feeder machine, or 4 creels on a 32 feeder machine will be required to produce an equivalent length of fabric. On this basis one can calculate the proportion of such lengths of stripe-free fabric which will be produced from yarns having different count variation. The relationship is shown in Figure 3.

Figure 3. Proportion of complete pieces of cloth produced without stripes on machines with various numbers of feeders related to the count variation of the yarn. Critical level of stripe visibility = 10%.



REDUCTION OF COUNT VARIATION

Various means of improving the control of yarn count variation are at present being offered to spinners, including autolevellers and continuous monitoring equipment. The performance of two commercial types of auto-leveller and a continuous monitoring system for sliver is discussed below.

Autolevelling was studied in mills operating under normal commercial conditions using (a) the card autolevellers made by Carding Specialists Limited, and (b) Platt International's pre-drawframe autoleveller. Continuous monitoring of finisher drawframe sliver was studied experimentally using Zellweger's Uster Tex Alarm.

AUTOLEVELLERS

Both of the autoleveller spinning sequences were fed from Trutschler equipped blowrooms and chute fed high production cards. The cardrooms were organised as shown in the flow diagrams in Figures 7 and 8.

Figure 7. Layout of cardroom showing division of process used to investigate performance of Carding Specialists Limited card autoleveller.

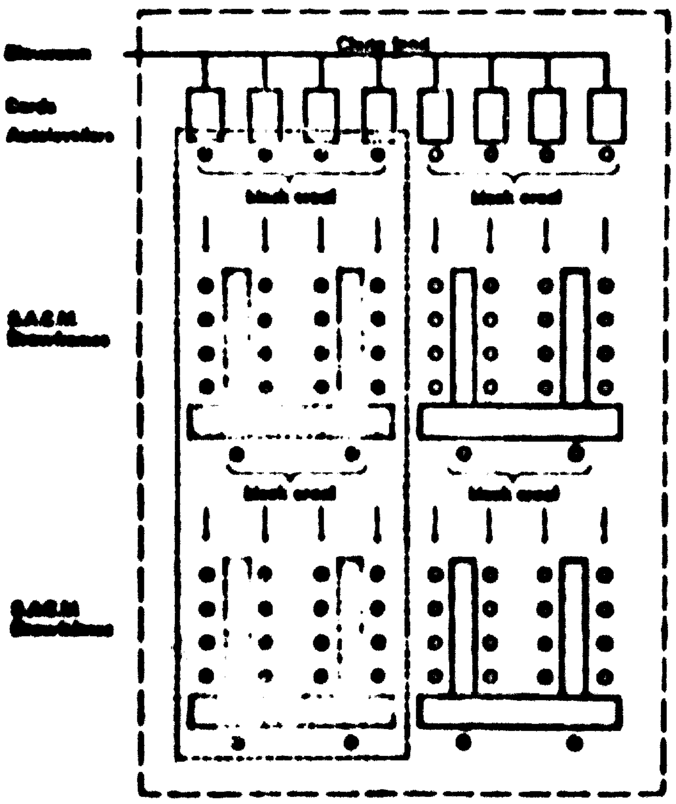
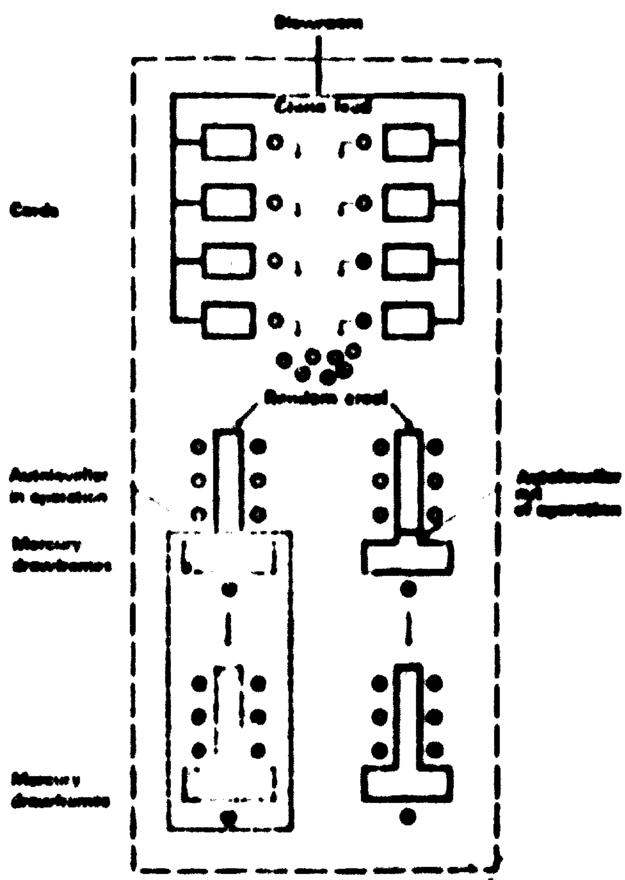


Figure 8. Layout of cardroom showing division of process used to investigate performance of Platt International pre-drawframe autoleveller.



In both cases the presence of the autoleveller gave a significant improvement to the regularity of the finisher drawframe sliver as is illustrated by the variance/length curves of Figures 9 and 10.

Figure 9. Variance-length curves of finisher drawframe sliver delivered by cardroom sequences shown in Figure 7, with and without card autolevellers.

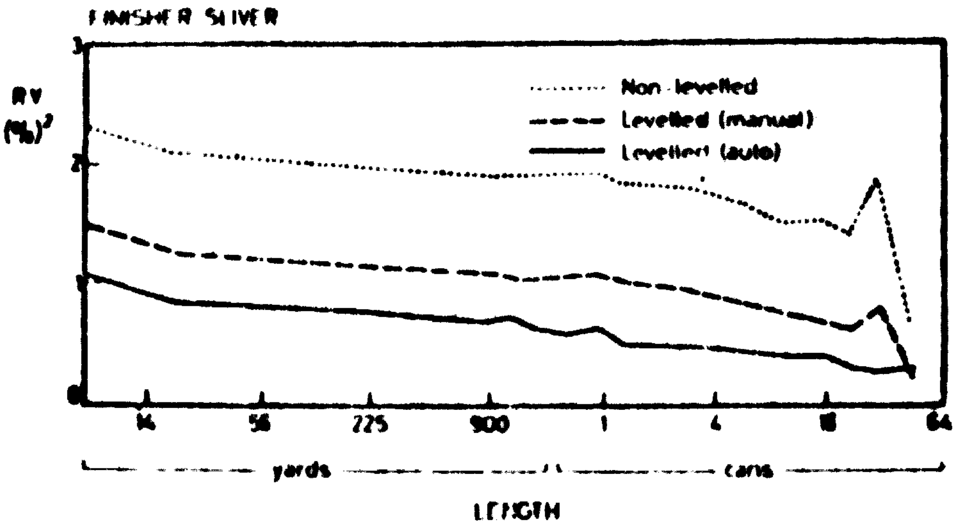
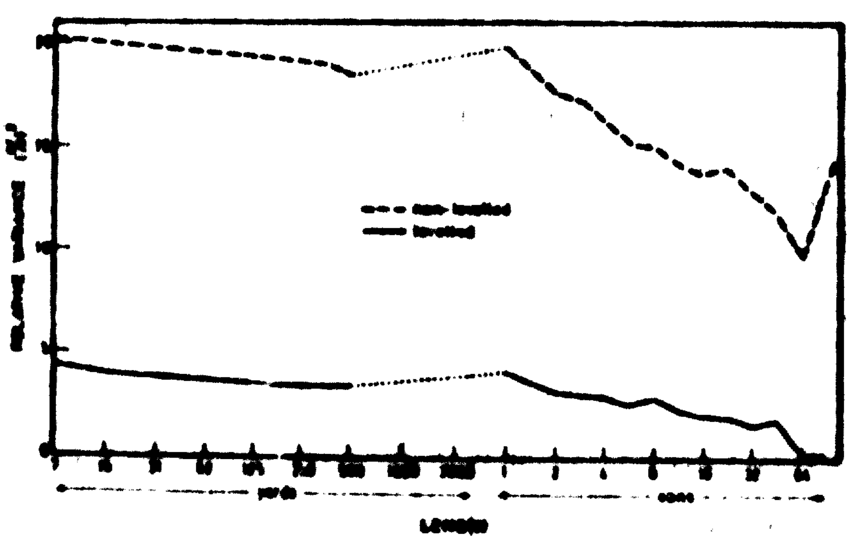


Figure 10. Variance-length curves of finisher drawframe sliver delivered by cardroom sequence shown in Figure 8, with and without pre-drawframe autolevellers in action.



In considering these curves we first notice the marked difference in the two cases of the irregularity without a leveller. This is partly explained by differences in performance of the control rollers fitted to the chute feeds to the cards but is also affected by the operational practices of the mills. One operated with random sliver creeling while the other used block creeling to the drawframes.

The levels of irregularity of the slivers produced by the above sequences will, of course, be degraded by spindle to spindle differences at the speedframes and ringframes as low bobbin-bobbin yarn count variation in a spinning mill depends upon the combination of regular sliver and consistent subsequent drafting. Degradation due to differences in draft at spindles can be controlled economically only by high quality maintenance of machinery and accurate, precise setting.

CONTINUOUS MONITORING

The traditional method of control of finisher sliver is by the periodic wrapping and weighing of lengths of sliver delivered by the drawframe, reference to a control chart and pinion changing. This procedure is valid only for the control over periods longer than about 10 times the period between wrappings. It leads to the accentuation of irregularities of lengths in the range 1 - 10 times the length of sliver delivered between wrappings.

A considerable improvement over this situation can be obtained by the use of a continuous monitoring device which will stop the drawframe for pinion changing or other attention whenever control limits are exceeded. The utility of such a system depends critically upon the accuracy and reliability with which the measurement can be made and the cost of the apparatus. The Uster Tex Alarm has been introduced to satisfy the requirements of this method of control and its action has been studied. In the study the instrument was used to monitor 100% cotton, 5.8 kilotex finisher sliver produced at 220 m/min. The instrument responded well to irregularities having wavelengths greater than 200 m while it was insensitive to wavelengths shorter than 30 m. This performance is adequate for the control of finisher drawframe sliver irregularity by changing drawframe pinions. Furthermore the instrument was found to be ideally suited to act as a sliver quality assurance device in a cardroom producing close tolerance sliver with the aid of autolevellers. Used in this way the monitor can supplant many conventional quality control procedures and check the occurrence of rare hazardous phenomena such as the loss of part of a web or sliver in a drawframe into air suction equipment.

CONCLUSION

Calculable relationships between a few parameters of cloth quality and yarn irregularity have been put forward as an aid to the quantification of benefits which could accrue from improved yarn regularity. The improvements required in yarns are technically attainable. For them to be achieved in commercial practice the spinner, cloth manufacturer and maker-up must all become aware of the related costs and benefits.

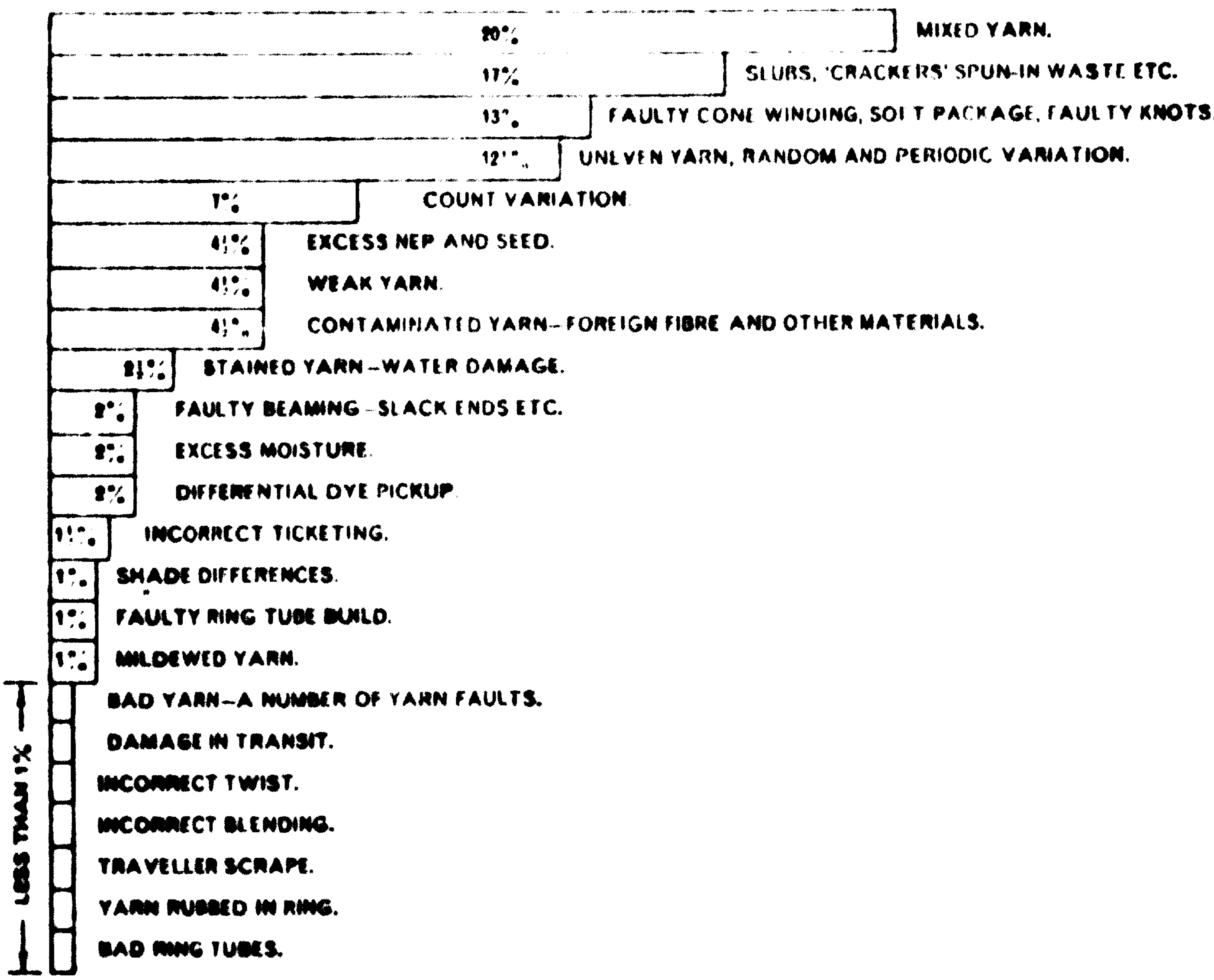
Higher standards of finisher drawframe regularity can be achieved with card or drawframe autolevelling apparatus than can be obtained by traditional control practices. The adoption of control by autolevellers normally reduces the need for frequent manual checking of delivered finisher sliver regularity. Automatic monitoring of the finisher sliver regularity may then be adopted to assure high regularity with very infrequent manual checking and intervention.

Lower values of yarn count variation follow from higher standards of finisher drawframe regularity in a spinning mill. The magnitude of the improvement will depend also on the proper operation of speedframes and spinning frames. In the special case of weft knit fabrics, judged on the aesthetic grounds of stripiness, improvements are likely to be particularly valuable. Any assured reduction of yarn count variation can be followed immediately by a reduction in short-term yarn irregularity using known spinning techniques. The consequence of both these changes will then be more regular fabric knitted from stronger yarns with fewer ends-down during knitting.

3. ANALYSIS OF YARN FAULTS IN THE DELIVERIES FROM A MODERN SPINNING UNIT*

In addition to counts variation there are many other yarn faults which can lead to cloth faults and involve the garment maker in unnecessary expense. One of the leading British spinners recently made a comprehensive analysis of the yarn faults which were the subject of customer complaints.

The following Pareto Chart was prepared from details of customer complaints over a 12 month period. The spinning unit concerned operates



* A shortened version of a paper originally presented at a Shirley Institute conference, 'Faults in yarns spun on cotton-type machinery' by W.R. Pomfret, Production Director of Combined English Mills (Spinners) Ltd, in October 1970.

round the clock, is well managed, and has an efficient Quality Control Department. The complaints were classified into the categories shown and the percentage of each category was calculated against the total number of complaints. This information is of particular value to management, in that it shows the main areas requiring attention.

For instance, it is very significant that the first four categories of yarn fault account for more than 50% of the total faults.

We will now consider the main yarn faults and many of the causes.

1 SLUBS

Slubs can be caused by many different faults in the machinery or fibre; examples are given below:

(a) Rough or damaged surfaces or a build-up of wax or fibre finish may cause the accumulation.

(b) Incorrect settings of rollers, aprons, and pressure bars, causing a momentary hesitation in the fibre flow; or ringframe drafting aprons brushing the front rollers.

(c) Cracked and damaged rollers, hollowed rollers, causing fibre accumulation or uneven drafting.

(d) Drafting apron faults, such as damaged aprons, worn aprons, leather aprons which have perished and formed scales on the surface.

(e) The generation of static, particularly between drafting aprons, causing the fibres to fold back upon themselves and create 'hair pin' slubs. It is common practice to use a combination of leather and synthetic aprons in order to minimize the amount of static generation. Synthetic anti-static aprons have recently become available.

(f) The use of wrong apron settings relative to the bulk of fibre being processed.

(g) Incorrect roller weighting and faulty roller bearings.

(h) Where many of the above conditions are on the border line, unsuitable temperature and humidity conditions can 'trigger off' the formation of slubs, by creating static and drafting problems.

2 CRACKERS

These are similar in appearance to slubs but contain long fibres with shorter fibres twisted around them and are distinguishable from slubs by the fact that they may be pulled out, whereupon the longer fibre snaps, hence the name - caused by fibres in the mixing which are too long for the roller settings.

3 SPUN-IN FLY

These are fibre accumulations from such points as ringframe creels, roller beams, behind spindles, or from the floor or ceiling, which are disturbed by air turbulence, possibly from travelling blowers, and spun into the yarn. They are distinguishable from slubs by the fact that they may be pulled off the yarn leaving the yarn intact.

4 DIRTY FLY AND LOOSE WASTE

Accumulations of fly which have been contaminated by oil or dirt from such places as roller necks, behind roller beams, or fallen from the ceiling, over-head pipes, lamp shades, or picked up from felted aprons,

5 COUNT VARIATION

Abnormal variation in weight per unit length extending over one lea or more. The main causes of count variation are:

Incorrect feeding of opening lines.

Irregular feeding of 'turn-back' waste.

Incorrect setting or malfunctioning of regulating motions; lack of a proper system of dealing with laps which are outside the tolerance, machines running 'single', due to failure of knock-offs and break-draft failure.

6 MEDIUM AND LONG TERM VARIATIONS

(10 inches → 100 inches and 100 inches → 120 yards)

Usually arise from faults at the speedframe and drawframe in the form of drafting faults, defective cone drums, cone drum belts and differentials; sticking bobbin rail, machine vibration, and faulty gearing, or rollers.

7 SHORT-TERM VARIATION (up to 10 inches)

Mainly caused by roller faults at the ringframe, although short-term irregularity in the roving, as a result of roller vibration at the speedframe, can give a similar effect. This fault is accentuated by the inherent drafting wave, and is usually increased when using cut regular staple.

8 THICK AND THIN PLACES/CORDS

Apart from the forms of variation already described, other types of thick and thin can be created by cr[illegible]l piecings, incorrect tension drafts, problems associated with traverse mechanisms, and intermittent break draft failure.

9 NEP, LEAF AND SEED

In the case of nep, there are two main sources: raw material containing natural nep, and nep formed during processing, which, in turn, can be influenced by the amount of immature fibre in the stock. Incorrect beater speeds and settings, incorrect carding speeds, card settings and unsuitable wire can fail to remove sufficient nep, leaf and seed, and at the same time create nep. Nep can also be made by using drafts which are too high, or excessive drafting speeds in relation to the material being processed.

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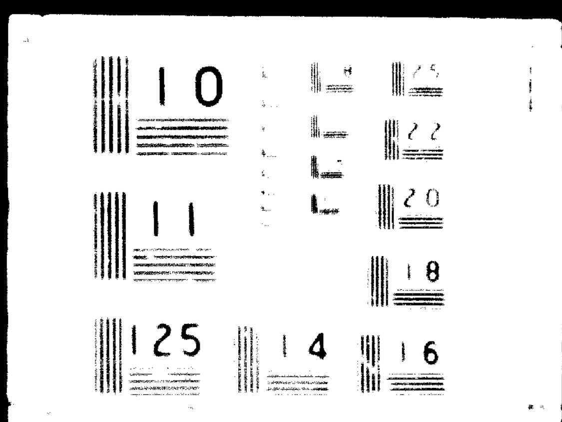

10 FOREIGN FIBRES

Unfortunately raw cotton, and even occasionally synthetic fibres, contain foreign materials. These range from animal hair; often from the crude plaited twine used to bind the 'country' bales, lengths of which get into the gin; pieces of cloth (sometimes coloured) and more recently pieces of plastic which, when shredded by the machines become fibrous; bast fibres and pieces of string from the tares. As long as the extraneous matter is fibrous, the processing machinery cannot discriminate and therefore the yarn is contaminated.

The practice of stamping letters and numbers on bale tares can also create difficulties due to the dye penetrating onto the contents of the bale. Foreign fibres can also be introduced from operatives' clothing, such as pullovers and sweaters and, of course, where more than one type of fibre is being processed in a mill, great care must be exercised to prevent mixing and contamination. One coloured fibre, or fibre which dyes differently, may stand out prominently in the finished fabric and ruin a garment.

11 TWIST VARIATION

Twist runs into thin places in a yarn and, up to a point, serves a useful purpose by adding strength to an otherwise weak place. Too much twist, however, reduces the strength and also makes the yarn brittle and liable to form snarls. Spindle-to-spindle variation also occurs due to differences in spindle speed as a result of driving-tape slippage, misalignment of tapes and faulty spindle bearings or inadequate lubrication. Twist variation can, of course, cause weft bars, particularly in dyed fabrics.

12 INCORRECT BLEND

Whether the mixing be a blend of natural fibres, man-made fibres or natural and man-made, the consistency of blend is all important. Unless uniformity of blend is maintained, almost every feature of the yarn will vary with almost certain repercussions in the finished article.

13 HAIRY YARN

Yarn hairiness is governed by many factors:

1 The nature of the raw material.

2 Temperature and humidity during processing.

3 Type of ring and traveller.

4 Size of spinning balloon relative to the distance between separators.

5 Spindle speed.

6 Setting of spindle and lappet.

7 Type of drafting system used; total draft and draft distribution.

8 Type of roller covering and drafting aprons.

9 Condition of rings.

10 Traveller clearers not operating.

The degree of hairiness may vary from spindle to spindle and at different parts of the build, which can lead to weft bars, especially where the cloth is dyed.

Yarn hairiness is also affected by winding and pirning and there is always a danger in 'back-winding' piece cones, as the additional winding process and reversal of yarn direction may result in a different degree of hairiness.

14 ABRADED YARN

Yarn abrasion can occur in spinning, winding, pirning, and weaving. In spinning the causes are similar to those associated with yarn hairiness. The most important factors are, travellers, spindle and lappet settings, together with temperature and humidity. With anti-wedge rings the basic problem is lack of clearance between ring and traveller; clip and spiv travellers were developed to give increased clearance.

Abrasion usually occurs where the yarn path is deflected through a sharp angle with the yarn under tension. These are the parts which are subject to most wear, and as wear increases so does yarn abrasion. Traveller life should be determined and changes made before yarn quality starts to deteriorate. Wherever possible ceramic guides should be used; on modern high-speed machinery acute angles are avoided. Fibres such as polyester are more prone to abrasion than cotton and require greater care. In addition to the style of traveller, the correct cross-section of wire should be chosen. To minimize abrasion in weaving, the healds and reeds must be in good condition, warps should be well sized, and looms set correctly. It should be remembered that, apart from the removal of slubs and similar faults during winding, yarn deteriorates as a result of all processing after spinning.

15 CONDITIONING FAULTS

Under-conditioning obviously results in a commercial loss to the spinner and the user will have difficulties due to 'lively yarn'. Over-conditioning gives a commercial loss to the user and there is also the possibility of mildew and staining.

16 TWIST SETTING FAULTS

Some synthetic and blend yarns require twist setting to stabilize the twist and, unless the degree of setting is uniform, dyeing and shrinkage problems can be created in the fabric. Staining can also occur at this process, which involves heating the yarn by steam.

17 WEAK YARN

Besides the obvious causes such as incorrect blend, yarn irregularity and incorrect twist, there are numerous other causes, such as problems associated with the basic fibre, spinning conditions, irregular feeding of 'turn-back' waste, fibre damage due to excessive speeds, beater blades in bad condition, too little twist, too much twist, twist variation and so on.

18 FAULTY KNOTS

The two main types of knots used in winding are weaver's and fisherman's. The weaver's knot is most suitable where slippage does not present a problem. For certain synthetic and blend yarns the fisherman's knot must be used and this can create difficulties owing to its size. Long-tailed knots are objectionable, especially in finer fabrics, and, of course, there are restrictions on the shortness of tails imposed by the knotting mechanism and the possibility of very short tails pulling out when the yarn is under tension in subsequent processing. There are many knotting faults associated with incorrectly set knotters on automatic winders; the most common are three-tailed knots, caused by blocked yarn traps, damaged cutter and shears etc. Naturally too many knots are undesirable and are an indication either that the yarn contains too many faults when spun, or that the clearers are too sensitive or not uniformly sensitive.

19 TWO-FOLD

Again, with automatic winding, it is possible for lengths of two-fold to be wound on to a cone of 'single'. The possibility of this happening depends upon the type of winding machine, and the likelihood of its detection, upon the type of clearer and the setting of the clearer. The 'rogue' end may be drawn from a reserve ring tube or from the adjacent winding head.

20 LOOSE YARN WASTE

This occurs mainly on manual winding and the usual source is from the waste yarn which operatives have a habit of winding around their heads.

21 COLOUR VARIATION OR STRIPING

Variation of colour in both undyed and dyed yarns can cause endless trouble. In yarn form, shade variation may be detected on ring tube, cone, beam and pirn. The effect may, or may not be, transferred from the undyed state to the dyed state as the pre-dyeing processes will, in some instances, rectify the situation. On the other hand, shade differences may appear after dyeing, in what appeared to be a perfectly satisfactory yarn.

Shade variation during spinning may arise from basic mixing problems, changes in raw material colour or micronaire value, and incorrect blending; also from differences in yarn hairiness, twist, contamination by oil, dust or metallic particles, carbon from roller cots and the degradation of process stocks whilst standing in creels.

Subsequent to spinning, yarn abrasion, variable heat setting, staining during conditioning, reversal of yarn direction as a result of back-winding, inadequate scouring, variation in density of dye package and faulty yarn dyeing, will all give shade variation. Finally, there are many sources of shade variation in fabric which can be caused by weaving, knitting, and finishing faults.

22 FAULTY PACKAGES

Whilst faulty packages may not be considered to be yarn faults, they do, nevertheless, detract from yarn performance, and, should, therefore, be taken into account. Faulty ring-tube build, bad gaiting, double gaiting, excessive winding-down coils, should all be avoided. Ridged, stitched, and slack cones, beams with crossed ends, slack sides and unequal diameter all give rise to defects in subsequent processing and impair fabric quality.

23 DAMAGE IN TRANSIT

From the aesthetic point of view, packaging is obviously not as important as at the retail end of the textile trade. However, insufficient attention is often given to the packaging of materials for movement between plants, yarn and fabric being no exception. Good presentation does mean something to the user and unless adequate protection is provided during transit, damage can occur which may affect the yarn's performance and therefore the quality of the end-product, and will certainly give increased waste losses.

24 MIXED YARN

It may be argued that mixed yarn should not be strictly classified as a yarn fault. Nevertheless, as shown by the chart, it is one of the most common forms of complaint and should therefore be included. It is most regrettable that, assuming all the other bad faults have been avoided, we should fall down as a result of inadequate organization and carelessness during processing and yarn handling.

A clear system of identification should be used from raw material through to delivery package, and staff and operative should be made fully aware of the serious consequences of both process and yarn mixings.

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