CHAPTER TWELVE

Quality Control

AS THOSE industries which use jute undergo economic and technological change their emphasis on reliable yarn quality becomes more insistent. At all times there is a demand for either a better product at the same price or a yarn equivalent to current standards but costing less. In general, quality levels in jute goods are set by the markets in which they are sold and have been evolved over the years through normal commercial usage. But whatever standards are set by the market, the producer must have his own standards of quality. Commercial and production standards should not be far apart for if the quality is lower than the customer will accept there will be loss of markets but if it is much higher than necessary then production costs will be unnecessarily high. To many people, quality control is synonymous with testing carried out by a special department, but this is not so. Quality is decided on the shop-floor by the grade of fibre that is used and the effectiveness with which it is processed. Testing will never control quality, it will merely indicate when the product is off-standard and it is the responsibility of the production staff to maintain quality levels.

Since the quality standards and control requirements vary from mill to mill it is impossible to formulate one scheme which will suit every case, therefore in this chapter a few methods of process control will be discussed, with particular reference to those which can be carried out on the shop-floor. However, it is worth noting that before any scheme can be initiated it is essential that:

(1) The testing methods are sound and designed to yield information that can be acted upon quickly.
(2) Shop-floor tests and record keeping are as straightforward as possible and do not interfere greatly with the manufacturing process.
(3) There is a person in the organization who can interpret the test results and recommend certain courses of action.
(4) There is a genuine desire to achieve a good degree of control over the process and a determination to succeed.

(5) It should be recognized that it may take several years before control is firmly established.

In setting up a control scheme there are five main points which require attention; the manner of using the machinery, the selection of the batch, the amount of moisture and oil present in the product, the count of the slivers and yarns and the running efficiency of the process. Experience with many mills has shown that these factors commonly give rise to trouble and are very often the principal points on which a scheme of process control can be begun.

THE MACHINERY AND ITS USE

Sound maintenance is the basis for good performance from the points of view of production and quality. The machinery makers' recommendations should be examined carefully and a routine for cleaning, lubricating, renovating, and replacing should be organized since it is very often more beneficial to have regular short stoppages for maintenance than one or two long stoppages for expensive repairs. The following points give an indication of the type of work which is required.

In the emulsion plant all pumps, filters, and agitators should be stripped and cleaned at regular intervals. If possible replace all sight-glasses with fluid meters but, having done so, it is necessary to subject them to periodic calibration checks to see that they are maintaining their accuracy. At the spreader all the pins on both chains should penetrate the sliver and broken or bent pins should not be tolerated; pressure gauges or flowmeters require regular attention and all filters in the supply line should be cleaned. One part of the spreader which may sometimes be overlooked is the flex-drive to the gear-box of the feed-indicating mechanism; this requires greasing and should operate with as smooth a line from the spreader to the weighbridge as possible—any kinks or sharp bends in the drive will cause the driven pointer to jerk, making it more difficult for the operative to maintain the proper rate of feed.

At the cards it is necessary to examine the state of the pins on all the rollers from time to time; hooked, grooved, or blunt pins indicating that re-staving is required. In poorly maintained cards complete gaps in the pinning may be seen where all the pins have broken away completely. At regular intervals the roller settings and alignment should be checked.

On the drawing frames correct pinning is essential and at no time should a faller-bar be allowed to work with broken or missing pins. The paths and slides which carry the fallers should be clean and unworn, the rollers should be checked regularly for signs of wear and misalignment.

On the spinning frame the rollers should be checked for alignment; all the spindles should be exactly central to the flyers; the tapes driving the flyers should be tight or there will be an excessive amount of slip at the wharf and the flyers may not rotate at the proper speed and the yarn twist will be low; the slide carrying the builder should be clean and the builder should move evenly up and down—a jerky movement causing irregular spinning tension pulses which will increase the end breakage rate. The rubber covers on the drafting pressing rollers should be true to their rollers for if they buckle there is a tendency for the fibres to work out of the nip and cause a yarn break. The drag-pads should be kept clean and where the four-pad type is used, the pads should be in the same position on all carriers—on the inside for low counts, in the middle for medium counts, and on the outside for high counts. The bobbins themselves should be free from rough or jagged edges that might catch in to the yarn and cause a yarn break.

These are but a few of the types of work needed for good maintenance. A log-book, kept over a period of several months, of the reasons for machine stoppages and of the spares issued will provide a basis on which to build a maintenance scheme.

With regard to the operation of the machinery, perhaps the commonest cause of low-quality work is overloading the machine and running it too fast. At the cards, an excessive weight on the feed sheet will result in frequent chokes and laps, the card efficiency will fall, and proper carding will not be carried out. Sufficient has been said about correct pinning on the drawing frames being essential for good quality work. High speeds not only lead to more wear and tear on the faller-bars but prevent the sliver from being pinned properly. On the spinning frame, excessively high speeds result in greater numbers of yarn breaks and cause the yarn to be 'hairier' than normal (though this last feature depends on twist, fibre quality, moisture regain, etc.).

BATCH SELECTION

The prime factor in setting the level of the batch is the price. It is one of the axioms of jute spinning that the cost of the batch will be as low as is consistent with quality standards. One must examine critically, however, the processing potential of the blend of fibre for unless the material will process without excessive difficulty any price advantage gained from using a cheap batch will be lost in the extra processing costs. The amount of waste which arises at the various stages must be considered too, for this has to be reworked and should be debited against the production line from which it arises. (Incidentally, it is often illuminating to examine those stages in the process where large amounts of waste accumulate—this is sometimes a sign that the machines are poorly maintained or severely overloaded.) Fibre quality has a great bearing on the appearance of the yarn and its strength characteristics. Low grade fibre increases the degree of short-term irregularity (the 'thicks and thins') and produces a weaker yarn. To show this effect, the results of a series of tests, in which pure unblended strains of fibres were spun into 276 tex yarn and tested, are given in Table 12.1.

TABLE 12.1. EFFECT OF FIBRE GRADE ON YARN QUALITY

	Mill Lightnings	*Premium Hearts*	*Mill Hearts*	*Grade Hearts*
Relative price at time of test	100	90	87	69
Fibre diameter (microns)	37	—	—	40
Trash content (per cent)	5	11	13	30
Short term irregularity (per cent)	30	33	39	42
Tenacity (g/tex)	11·9	12·1	10·7	8·9
C.V. of breaking load (per cent)	23	24	26	27

Trash content—Amount of extraneous matter, bark, root, stick, etc., present at the breaker card.
C.V. breaking load—A measure of the spread of the breaking load results, the higher the C.V. the poorer the yarn.
Short term irregularity—Measured on ½ in. lengths of yarn.

Clearly, the grade of fibre chosen has a direct bearing on the quality of the yarn produced—the processing machinery used can only operate on the fibre presented to it and in this way the general quality level is 'built in' at the batch.

MOISTURE AND OIL LEVELS IN THE MATERIAL

Commercially, it is important to dispatch yarn with the correct quantity of oil and water present in order that the maximum profitability may be achieved. Technically, the moisture regain has a great bearing on carding, drawing, and spinning while the oil content of the yarn must meet the end-use requirements. The first control point for moisture and oil is at emulsion preparation. The operative responsible for mixing the emulsions should have clear instructions for the amounts of each ingredient and the method of mixing. In addition, there should be an adequate supply of metering units, gallon and pint measures, scales, etc. The simplest method of checking that the emulsion is being made correctly is to 'crack' a sample, i.e. deliberately break the emulsion so that it separates into two phases which can then be measured.

Method 1—suitable for all types of oil-in-water emulsions. In this test a definite volume of emulsion is cracked with acidified sodium sulphite and the separated oil is measured. A sample of emulsion is drawn off, preferable from the sprays or the weir, some 110 ml being a suitable sample size for routine purposes. The sample bottle is shaken well and 100 ml measured from it into a measuring cylinder and then transferred to a beaker and heated to 90–95° C. 10 ml of 10 per cent sulphuric acid and 5 g of anhydrous sodium sulphite are added to the measuring cylinder and the hot emulsion poured back into it. The contents of the cylinder are stirred well with a glass rod and the oil allowed to separate into an upper layer and its volume measured; if there are v ml of oil in the top layer then the emulsion contains v per cent oil and $(100-v)$ per cent water. After the hot emulsion has been put back into the cylinder never shake or invert the contents since the rapid evolution of gas may force some of the hot acidic solution out of the vessel.

Method 2—suitable for emulsions prepared with ionic or soap-type emulsifiers only. From a well shaken sample of about 110 ml, 100 ml are measured off into a measuring cylinder and 10 g of common salt (or 10 ml of 10 per cent sulphuric acid) is added and the contents shaken and allowed to settle. Again the oil forms an upper layer the volume of which is read off and the oil content calculated in the same way as Method 1. It may help the emulsion to break if the sample is warmed slightly.

Having confirmed that the correct emulsion recipe has been adhered to, the next step is to ensure that the correct amount of emulsion is being applied to the jute. In this respect, flowmeters are especially useful since they show at a glance the emulsion flow rate and it is a matter of a short calculation to arrive at the percentage application rate. There is, however, another method by which the percentage application of emulsion can be found, viz. 'add-on' tests, in which the weight of dry jute fed and the weight of batched jute are recorded, the difference being the 'add-on' of emulsion.

One very useful instrument for monitoring the oil content of the material in process is the ultra-violet lamp. The mineral oils used for jute batching possess the property of fluorescing under ultra-violet light and the amount of fluorescence present depends on the quantity of oil. Thus, slivers with 5 per cent oil show a much stronger violet glow than those with only 1 per cent. This immediately gives a valuable means of distinguishing between normal oil yarn and 'stainless' yarn, indeed, with experience and on the same colour of fibre, two samples can be distinguished from each other even if their oil contents are only 0·5 per cent different. The lamp should be used regularly to see that no 5 per cent oil yarn or sliver becomes mixed with 'stainless' material. Defects in 'stainless' goods arising from oil stains caused by careless use of an oil-can or from oily caddis from the machines falling on to the low oil content jute can be seen easily under the U.V. lamp. Certain highly refined oils, such as 'Odimin' oil do not fluoresce under U.V. and therefore could not be distinguished from 'stainless' material but, in these cases a special fluorescent substance can be put into the emulsion which will show up under the lamp and permit the 'Odimin' jute to be identified. Only extremely small amounts of these tracers are required and they can be obtained to fluoresce in yellow or green to differentiate between the 'Odimin' jute and the normal 5 per cent material.

With the development of electronic moisture meters, the measurement of moisture regain has become much simpler and indeed it may be said that without them it was impossible to sample sufficient material and test it quickly enough to provide an effective means of process control. The B.J.T.R.A. Probe Moisture Meter, Plate VIII, can be used to measure the moisture regain of raw jute, spreader rolls, and card rolls, and other types, such as the Shirley Moisture Meter or the Marconi Moisture Meter can be used for bobbins. The basis for the quantity of moisture in the material is laid at the spreader or the softener and the remarks already made about the emulsion content and application apply equally well to the moisture regain as to the oil content. Before the moisture levels can be brought under control the technique of mixing and correct application must be firmly established. When the jute is in the production line, tests may be made with an electronic meter at each stage but it is usually sufficient to leave such checks until the yarn has been spun. If it is found that the moisture regain of the yarn has changed then concentrated tests can be carried out throughout the process in order to find the cause. Moisture testing at the yarn stage is essential if correct control over the count is to be achieved.

COUNT CONTROL

When a scheme for quality control is introduced into a mill the factor which causes most difficulty is the variability of count in slivers and yarns. It is almost impossible to draw valid conclusions from small samples or short tests. Wherever it can be done it is better to extend special tests over a period of several weeks or even months and to collect small amounts of information at random intervals during that period and consider them as a whole before passing judgement. As far as day-to-day testing is concerned it is essential that statistical control charts be used so that premature action will not be taken on apparently high or low results which arise solely from the natural variations in count. It is usually found that after control charts have been used for some time the number of changes which are made to sliver weights and draft pinions are markedly reduced. (The reader who is unfamiliar with the methods of compiling and using these charts is referred to the 'Further Reading' list at the end of this book.)

Testing the count of jute slivers or yarns is complicated by the presence of variable quantities of moisture—a yarn may be below count or above count simply because of moisture. If accurate count testing is to be done, it is essential that the moisture regain of the material under test is known. Fortunately, with the modern moisture meters available this is comparatively simple. Unless the moisture regain is tested simultaneously with the count the conclusion may be drawn that the count is heavy or light solely because the moisture regain is varying. There are practical difficulties in using some types of moisture meter on finisher drawing sliver but since the main count control point is at the spinning frame this is not a serious disadvantage.

The object of controlling the count at the spinning frame is to produce a yarn with the correct quantity of *fibre* in it, and at no time should the draft be changed to take account of variations in count due to moisture changes. When the count and the moisture regain have been measured the count should be converted to a standard moisture regain. This is commonly 14 per cent (the desorption moisture regain at 65 per cent R.H. and 20° C). Figure 12.1 shows a control chart for

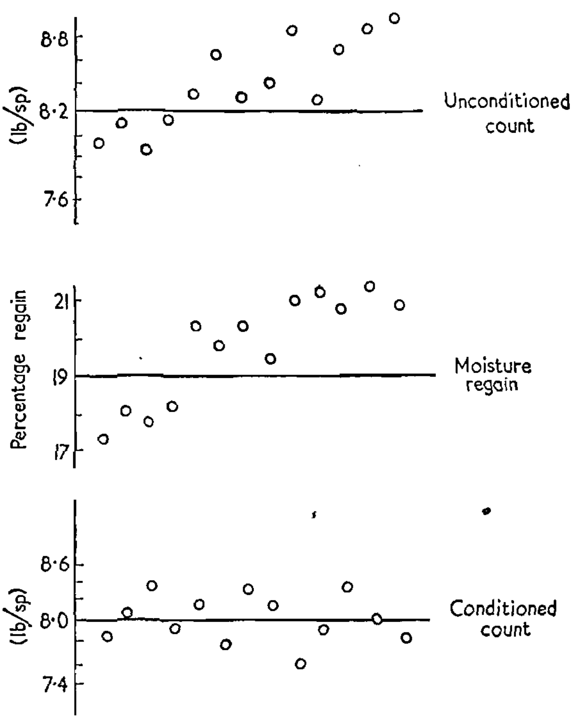

Figure 12.1. Yarn count control charts

yarn count with the uncorrected count, i.e. the count before allowing for the moisture present in the yarn, the moisture regain, and the count corrected to a regain of 14 per cent. The 'uncorrected' chart gives the impression that the yarn is becoming heavier and a draft pinion change is necessary, whereas the real cause of the drift is a change in the moisture regain; if the corrected count chart is examined it will be seen that the yarn count actually remained reasonably constant over the period.

The moisture level at the spinning frame should be such that the yarn leaves the mill with a regain of 13–14 per cent. This requires that the spinning regain at the frame is of the order of 18 per cent to allow for small losses in winding and storage.

TABLE 12.2. SOURCES OF YARN WEIGHT IRREGULARITY

Machine	*Cause of irregularities*	*Effect in yarn*
Spreader	Human error at feed Variations in strick weight Drafting waves Variations in emulsion flow	Long term drifts in count Responsible for 75 per cent of bobbin-to-bobbin variation
Cards	Variations in feed slivers Gulping Missing doublings	Bobbin-to-bobbin variations in count in small samples Responsible for 25 per cent of between-bobbin count fluctuations
Drawings	Variations in feed slivers Missing doublings Faller-bar slubs Bad splices	1st responsible for variations in count of adjacent 100 yd lengths 2nd for adjacent 20 yd lengths and sets pattern for 'thicks and thins' Finisher accentuates pattern for 'thicks and thins'
Spinning frames	Variations in feed sliver Bad splices in sliver and yarn Incomplete draft control	Sets final degree of short-term irregularity

In Table 12.2 a brief summary of the sources of irregularity in jute slivers and yarns is given in which those factors that influence the gross variations in count are differentiated from those that affect the short-term variations. In general the uniformity of the yarn which is seen when a short length is examined is decided by the regularity of the sliver being fed to the finisher drawing and the spinning frame and the efficiency with which these frames control short fibre movement during drafting. The variations which give rise to changes in weight of long lengths of yarn arise much further back in the process.

PROCESS OBSERVATION

In the mill the supervisory staff are continually making assessments of how well the material is processing by subjective judgements. Over the years they have built up experience of what constitutes good or bad machine performance and their evaluations are based on this experience. In process observation the same methods are adopted but objective measurements are made which are then analysed in a logical manner and used to assess the performance of the material, machinery, or the operatives.

At the spreader, cards, and drawing frames, observations of the number of laps or chokes occurring, the frequency of missing doublings, and waste losses may be made. Such tests can be carried out by continuous observation where the number of defects in a certain time is counted and related to some common basis, e.g. laps per 100 lb of sliver, chokes per hour, etc. Alternatively, random observations may be made in which the number of occurrences on which the fault was seen is compared with the total number of observations made. In this method it is important that the observations be random in time and cover the full work-period and that the observations are made instantaneously. For example, a record of the number of laps at a card may be required. The observer will pass the card at random times over a period of perhaps a week or a fortnight, noting whether the card is running or stopped and, if it is stopped, whether a lap has occurred. The record may appear like this:

Total number of observations	3,370
Number of times card stopped	674
Number of times card stopped for lap	220

From this it may be calculated that

$$\text{Card efficiency} = \frac{\text{Number of times observed running}}{\text{Total number of observations}}$$

$$= \frac{(3370-674)\times 100}{3370}$$

$$= 80 \text{ per cent}$$

$$\text{Percentage of stops due to laps} = \frac{220}{674}\times 100$$

$$= 32{\cdot}6$$

At the spinning frames, process observation is usually limited to counting the number of end breaks. This may be done by continuous observation over a long or short period or by random observations. Continuous observation over a long period is the method usually resorted to when comparisons between two types of yarn or processing methods are being made. The observer stands at the frame and counts the number of ends which fall in a given time. If the yarns do not differ in quality markedly this method cannot yield useful results unless several hours are spent observing each yarn type. For this reason it is time-consuming and tedious. For routine purposes continuous observation over short periods may be carried out. In this method of test the observer spends only 5 or 10 min at each frame and counts the number of breaks. In this way many more frames can be dealt with but there is the complication that the diameter of the bobbin has the usual effect on spinning breaks and when this method is used the approximate diameter of the bobbins should be recorded. The results from frames working on the same quality and count of yarn should then be averaged. In both these methods one must expect quite large variations in the number of end breaks from doff to doff. It has been said that the number of ends falling should be counted, but in practice it is easier and less confusing to count the number of ends that the spinner *repairs*, and counting the number of ends which are idle at the start of the observation period and at the end. For example,

Ends down at the start	6
Ends repaired	35
Ends down at the finish	3
Total number of ends down	$35+(6-3)$
	$= 38$

The results of tests of this nature can be expressed in terms of the number of breaks per 100 spindles per hour or of the number of breaks per 1,000 yd or per pound of yarn or some such suitable unit.

If the random method of observation is adopted the observer passes each frame and notes how many spindles are standing idle. After several patrols covering the working period the results are averaged for frames working on the same type of yarn and the average number of idle spindles per frame can be found for that quality. Where the flat contains frames with different numbers of spindles a comparison may be made by calculating the percentage of idle spindles. It is important to realize the fundamental difference between the continuous and random methods of observation. The former shows how the yarn is behaving on the machinery and the latter shows how the spinner is reacting to a certain breakage frequency. The random test is simpler and cheaper to carry out but includes, to a very great extent, the human element and for this reason must be handled circumspectly.

While it is true to say that each mill has a certain degree of quality and process control—otherwise it could not remain an effective production unit—it is equally true that an organized, logical approach to the problem will go far towards solving the difficulties associated with maintaining quality standards in large scale production.