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Expert Group Meeting on New Techniques of Yarn and Fabric Production, organized by the United Nations Industrial Development Organization in co-operation with the International Institute for Cotton

Manchester, United Kingdom, 19 - 22 June 1972

FINAL REPORT 1/

EXPERT GROUP MEETING ON NEW TECHNIQUES OF YARN AND FABRIC PRODUCTION, MANCHESTER, 19-22 JUNE 1972

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NEW TECHNIQUES OF YARN AND FABRIC PRODUCTION

Report of Expert Group Meeting organised by the United Nations Industrial Development Organisation in co-operation with the International Institute for Cotton held at the Shirley Institute, Manchester, United Kingdom

19 - 22 June 1972

Preface

The meeting was one in a series of small meetings on selected topics organised by UNIDO as part of its activities designed to support its technical assistance programme in the textile industry. Other meetings in this series include items on machinery selection in the cotton industry, machinery selection and processing problems in the wool industry, and quality control.

At the invitation of UNIDO, 28 experts from 18 countries participated. (See Appendix I.) They were invited in their individual capacities and not as representatives of their governments or organisations to which they belong. In addition, 18 observers from 7 countries (see Appendix I) representing equipment manufacturers and other interested organisations were invited to attend and participate in the discussions.

Professor H.W. Krause was elected chairman of the meeting and Messrs K.N. Sreenivasan and K. Wassef rapporteurs, assisted by Mr V. Filellini, Dr D.B.F. Peyer, Mr F. Humberston and Mr A. Eräneva.

Mr Antero Eräneva, of UNIDO, participated in the meeting as Officer-in-Charge.

Introduction

1 Recent developments in textile machinery design indicate a trend away from conventional methods of yarn and fabric production. Several machinery makers are including equipment for spindle-less spinning in their production programme and commercial installations have been in operation for several years. Shuttleless looms have become an established feature of the weaving sector over the last ten years, and knitting as a manufacturing process is replacing weaving for many end-uses.

2 These developments have been motivated by the need to offset steadily increasing labour costs through automation and higher machine productivity and by the urge to create new processes and new types of products. The benefits to be derived by manufacturers in industrially advanced countries

are apparent but little has been done to assess the potential application of these methods in developing countries where the circumstances are different. In general, both labour costs and labour productivity in the developing countries are relatively low, although they have recently begun to rise, and at the same time there are strong incentives to produce goods which can compete in world markets.

3 The purpose of these meetings is to formulate practical guide-lines for the benefit of the textile industry in developing countries. The current meeting has reviewed and assessed the suitability of the latest yarn and fabric production techniques for developing countries. The attention of the meeting was focussed on the processing of cotton.

4 The following papers were presented:-

1. 'A Survey of Current Short Staple Spinning Systems'

   by H. Cripps
   Senior Research Officer
   Shirley Institute
   Manchester, U.K.

2. 'Open-end Spinning of Short Staple Fibres - I'

   by R. Greenwood
   Technical Sales Director
   Platt International Limited
   Accrington, U.K.

3. 'Open-end Spinning of Short Staple Fibres - II'

   by S. Kroulik
   The Chief of Spinning Research Dept
   Vyzkumny Ustav Bavlnarsky
   Czechoslovakia.

4. 'Open-end Spinning of Short Staple Fibres - III'

   by T. Konishi
   Director
   Daiwa Spinning Co. Ltd
   Japan.

5. 'Some Special Features of Cotton Open-end Yarns'

   by Dr A. Barella
   Director
   Asociacion de Investigacion Textil Algodonera
   Barcelona
   Spain.

6. 'Prospects of Open-end Spinning in India'

   by K. Sreenivasan
   Director of the South India Textile Research Association
   Coimbatore
   India.

7. 'Study and Comparison of Automated versus Conventional Systems of Modern Spinning Plant with Special Reference to Open-end Spinning System'

by K. Wassef
Technical Consultant to
The General Organisation for Spinning and Weaving
Cairo
Egypt.

8. 'Economic Appraisal of an Open-end Spinning Mill'

by Dr B.V. Iyer
Assistant Director
Ahmedabad Textile Industries Research Association
Ahmedabad
India.

9. 'Recent Developments in Weaving'

by Professor H.W. Krause
Professor
Swiss Federal Institute of Technology
Zürich
Switzerland.

10. 'Recent Developments in the Knitting of Cotton Type Yarns'

by K.P. Molta
Product Development Manager (Knitting)
International Institute for Cotton
Manchester, U.K.

11. 'The Cost of Yarn and Cloth Faults'

by Dr H. Catling
Head of Technical Economy Dept
Shirley Institute
Manchester, U.K.

Note: In the unavoidable absence through illness of Dr Catling, this paper was presented by A.E. Nuttall, a Senior Technical Officer of the Technical Economy Department of the Shirley Institute.

Pre-prints of the paper by Dr B.V. Iyer were not circulated to the participants.

The following statements were also submitted to Mr A. Eraneva of UNIDO, in his capacity of technical secretary to the Meeting:

(i) 'Some Aspects of the Textile Industry in Brazil' by Mr V. Filellisi, Spinning Technical Manager, S/A Moinho Santista-Ind. Gerais, Sao Paulo, Brazil.

(ii) 'Statement on Textile Industry in Egypt' by Mr K. Wassef, Technical Consultant to the General Organisation for Spinning and Weaving, Cairo, Egypt.

5. Mr Eráneva opened the Meeting by welcoming, on behalf of the two conveners, U.N.I.D.O. and the International Institute for Cotton, all those present. The expressed aim of assessing the suitability of the latest yarn and fabric production techniques for the developing countries and the formulation of practical guidelines on their introduction in those countries was emphasized. It was stressed that if UNIDO is to fulfill its mandate of promoting industrial development and assisting the acceleration of industrialization in developing countries, it needs the clearly formulated support of learned opinion on specific issues and problems of industrial development which can be effectively incorporated in its various operational activities. These operational activities, such as policy planning at governmental level, increasing productivity and improving quality control as well as the establishment or re-organisation of textile institutes, constitute the major portion of UNIDO's work programme and the effectiveness of such operations is always dependent upon the availability of properly conceived guidelines and methodologies.

A specific range of topics that have arisen as a result of the restructuring process that is taking place within the textile industry would be discussed. Such subjects as open-end spinning, or the recent developments in knitting and weaving, require careful consideration as indeed do the practical suggestions that would be made about the type of assistance UNIDO should provide to developing countries and the manner in which use can best be made of the latest yarn and fabric production techniques. The Report of the Meeting would provide not only UNIDO with guidance, but it would also provide the developing countries with readily available reference material tailor-made to their requirements. The gratitude of UNIDO was expressed to all who had left positions of responsibility to attend the Meeting.

Chapter 1

RECOMMENDATIONS AND CONCLUSIONS

Open-end Spinning

Economics

6 From the overall standpoint the O-E spinning system appears to be economical up to 16s or 24s count, depending upon local conditions (labour costs, power costs, space, capital resources etc)

Technologically, the present equipment is capable of producing yarns up to 36s count. The major saving is realised through a reduction of labour costs, but there are other useful savings in power, raw material, buildings and possibly capital investment. Overall savings, however, decline progressively as the count becomes finer.

7 Raw material

All regular cottons and blends can be used to produce O-E yarns but at present there are technical restrictions on the spinning of 100% polyester. The fibre length distribution in O-E spinning is less critical than in ring spinning. Good cleaning is important, but prior cleaning is less critical when using O-E machines which incorporate a trash extraction device.

8 Atmospheric conditions

O-E spinning is less sensitive to changes in atmospheric conditions than modern ring spinning systems. Temperatures of 25 - 30°C and relative humidities of from 50 to 70% are regarded as being acceptable.

9 Re-winding

In many cases re-winding can be omitted but where particularly high quality is specified re-winding becomes necessary at the present stage of O-E technology.

10 Properties of O-E yarns and products

It should be recognised from the outset that O-E spinning produces yarns with different characteristics* from those of ring-spun yarns and some of these differences may be reflected in the properties of the end-products. However, a large range of conventional fabrics can be successfully produced from O-E yarns.

It should be noted that O-E yarns do not present any special problems in processing but the special characteristics of these yarns should be borne in mind in order to exploit fully their potential in fabric production, finishing and marketing. It is therefore advisable to conduct trials up to the marketing stage before embarking on full scale production.

*The following are the most important characteristics of O-E yarns:-

(1) Different twist formation, requiring in some cases up to 20% more twist;

(2) Yarn strength 15-25% less but elongation better than ring yarn;

(3) Better regularity and appearance;

(4) Better abrasion resistance;

(5) Improved dye up-take;

(6) Produce fabrics which, in the grey state, generally have a harsher handle.

11 Knitting

Spun yarns are used extensively in weft knitting but hitherto developments in warp knitting have been linked to the use of continuous filament synthetics. It is to be expected that cotton and other spun yarns will be used increasingly in the new types of warp knitting machines (using compound needles) which are now being developed.

Recent experimental work indicates that there are good prospects for the use of liquid ammonia treated yarns in knitted constructions.

12 Weaving

In order to arrive at a meaningful comparison between possible choice of weaving machinery a thorough economical appraisal considering the specific conditions of the particular case is a necessity. In spite of the overall trend toward shuttleless weaving techniques, modern conventional looms still should be considered for economical reasons whenever the labour wages are low and capital resources are limited. For coarser weft yarn counts, however, the economies may shift in favour of shuttleless weaving. Air-jet and multi-phase weaving cannot be considered as applicable to large scale industrial operation at this time.

In the field of multicolour weaving the gripper-shuttle and rapier machines must be given preference over conventional looms. The advantage of any new machinery with increased production rate can only be fully utilised if weft and warp yarns are of adequate standard. A yarn quality that might be acceptable for older, slow speed machinery is possibly not up to the necessary standard.

13 **The Cost of Yarn and Cloth Faults**

Cost/benefit considerations should take account, not only of spinning and weaving costs, but should also include finishing costs and the extra costs incurred by the garment maker as a result of yarn and cloth faults. A high standard of quality control at all stages of cloth manufacture, efficient cleaning systems, and first-class operative training all make a significant contribution towards the reduction of these extra costs incurred by the garment maker.

14 **Recommendations to UNIDO**

It was agreed unanimously that this type of meeting should be repeated at intervals, possibly 1 year after the International Textile Machinery Exhibition or every two years, the decision on frequency to be left to UNIDO.

Suggestions for subjects included

(a) **Ginning**

Many developing countries are also cotton producers. Ginning is very important from the point of view of preserving the cotton quality, therefore considerable technical effort must be put into the improvement of the quality of ginning.

(b) It was suggested that papers on warp preparation, finishing and non-woven techniques should be considered.

Chapter II

15 A survey of Current Short Staple Spinning Systems

Introduction

Highly competitive world markets in textiles have demanded increased productivity and improved product qualities. Reducing the number of machines in the production line, running the remaining machines faster and increasing the package size are all effective ways of achieving higher productivity.

Fibres become hooked during carding and, if a significant loss (up to 10%) in subsequent yarn strength is to be avoided, fibres must enter the drafting system of the ringframe with their hooks trailing; the higher the draft the greater the need for this. An odd number of machines or processes ensures this, and the most common line-up for carded yarns has therefore become two drawframe processes and one speedframe process between the card and ringframe.

Open-end spinning permits further shortening of the spinning sequence since the speedframe process can be omitted. From what evidence is available, when the open-end spinning machine is equipped with a combing roller opener, yarn quality appears to be unaffected by the direction of presentation of the fibres, i.e. whether the hooks are trailing or leading. In open-end spinning, therefore, there are usually just two drawframe processes between the card and the spinning machine.

Improved product regularity needs better engineered machines and machinery makers have not only achieved this but have also satisfied the requirements for increasing machine speeds. A good example of this is the modern drawframe which, with two deliveries instead of the former six or eight, an improved drafting system and better engineering, is capable of producing a substantially more even sliver whilst achieving a ten-fold increase in delivery speed.

Packages have become considerably larger at some processes. For example, the typical card sliver can of ten to fifteen years ago was nine inches in diameter and held about 8 lb of sliver. Today cans 36 inches in diameter holding up to 150 lb of sliver are common.

In some modern spinning plants lap formation has been replaced by automatic feed to the cards. On the other hand, ringframe packages have not greatly increased in size, partly because the maximum traveller speed is reached at lower spindle speeds when larger diameter rings are used and partly because of the disproportionate increase in power needed to rotate larger packages.

16 Opening

For some time the blow room has been a largely automatic sequence and only the initial bale feeding has been done manually. The introduction of bale digesters in the late 1950s meant that this initial feeding can now be done automatically and these machines are becoming a familiar feature of the modern blow room. The earlier digesters were able to deliver the fibre in a very open state and were quite satisfactory for simple cotton blends, but the maintenance of accurate blend proportions was a problem, because bales of different density and size were digested at different rates, the rate of digestion being a function of the weight of the bale. Machinery makers, aware of these shortcomings, have modified their digesters in such a manner that the pressure with which the bales are pressed down onto the pluckers is automatically adjusted in order to compensate for the loss in weight of the bale as it is digested. A feature of some modern digesters is the large numbers of bales which may be held in reserve on the digester lattices, thus permitting the blow room to remain unmanned during the night shift, sufficient bales having been placed in reserve towards the end of the day shift.

In adopting bale digesters the opportunity of using very large mixings can be lost unless simple mixings of one type of bale can be used, or there is pre-blending or the modern equivalent of stack mixing is used.

The techniques of pre-blending used in the USA have given rise to the claim that bale digesters have provided the theoretical equivalent of 1,000 bale mixings.

The modern solution to the old stack mixer, which required a great deal of labour, is the multi-mixer, an automated machine based on the well proven principles of the stack mixer and generally believed to be highly desirable if using different types of cotton. If a simple blend can be maintained, then a multi-mixer does not give a great advantage.

17 Carding

The new high production cards in general principle differ little from cards built 20 years ago. They are more robust and made to much higher standards of engineering, but employ the same principles of carding. Cylinders and doffers are clothed with rigid, sometimes called metallic, wire which requires much less frequent stripping. There is an increasing adoption of flats clothed with semi-rigid wire which can be ground. Very recently stationary carding plates have re-appeared clothed, not with grit as formerly, but with semi-rigid or rigid wire. They are essentially disposable and cannot be ground. When using stationary flats there is a likelihood of neps being formed from the short fibre which has not been removed. Stationary flats have a limited application. If combed the yarn is satisfactory; if not combed, the yarn might well be somewhat irregular.

Higher carding rates give rise to problems associated with stripping the web from the doffer. The most common solution has been to employ a roller take-off mechanism; such devices are able to strip the doffer at the highest current processing rates.

Improved cleanliness in the final yarn arising from use of crushing rollers at the card is comparable to that achieved with three extra beaters in the opening line. Modern coilers of the so-called planetary type are able to coil the sliver at high speed into cans of up to 36 inch in diameter without the need to rotate the can. Tandem cards have been success-fully engineered, producing a much cleaner sliver which is particularly goo[d] for open-end spinning owing to its extremely low trash content.

Dust removal systems have become an essential and often integral part of the high production card. The cardroom now has a relatively clean atmosphere but there is unfortunately, more dust than there used to be liberated at subsequent stages of processing, arising as a result of highe[r] speeds, larger packages and the use of crushing rollers at the card. It i[s] recommended that urgent attention be given to this problem.

In high production carding automatic waste removal is commonly incor-porated. Inevitably card wastes become mixed and have a reduced value.

18 <u>Autolevelling</u>

In order to reduce or minimise the effects of long-term variation in feed to the card it is usually considered desirable if not essential to employ some form of autolevelling. Even when autolevellers are working perfectly, they reduce irregularity in certain wavebands only at the expen[se] of increasing it in others. It is technically desirable and also more economical to autolevel at one of the earlier processes; here fewer machi[nes] are involved and hence fewer autolevelling devices are required.

In practice therefore autolevellers are most usually found at the car[d] or drawframe and occasionally at the comber.

19 <u>Drawframes</u>

The spinner is able to choose a machine which exactly suits his needs from the wide variety of drawframes which are now available. Drawframes producing very small cans have been developed primarily to process sliver intended for open-end spinning.

Except when combing or blending, two passages of drawing, 8 ends creeled at each passage, is normal practice.

20 **Combing**

Improved engineering has resulted in production rates approaching 100 lb/hr. Normally for a combed quality, card sliver is given one passage of drawing followed by a lap forming process and combing; finally, the sliver is given two post comber passages of drawing. The comber may incorporate an autolevelling device.

21 **Blending**

Two machinery makers have recently introduced drawframes which are specifically designed for blending. Both these machines go far towards making blending at the drawframe capable of giving an intimate blend with higher uniformity of composition than blowroom blending.

When spinning polyester/cotton blends the staple lengths of the two fibres must be matched. If the cotton is combed this is an advantage since the short fibre will be removed. It appears the practice in most countries to blend 40 or 38 mm polyester with 40 or 38 mm cotton, although use of a shorter cotton, say 34 or 36 mm, gives a result only slightly inferior. If apron drafting systems are used, it is said that fibre length differences are less important. In one case 40 mm polyester was blended successfully with 31 mm cotton, the difference in staple length being considered of less importance than the differences in elongation and stiffness of the fibres.

In addition to staple length it is very advisable to match the stress/strain characteristics. The fibre extension characteristic is the most important. Man-made fibre producers are aware of this and act accordingly but the extension characteristic of the cotton cannot be changed.

22 **Speedframes**

Although the speedframe is still an essential feature of the vast majority of spinning plants it is inevitable that the increasing use of open-end spinning will gradually reduce the importance of the speedframe whose future will be closely linked with that of the ringframe.

In general flyer speeds are about 1200 to 1400 rev/min although one speedframe has been in commercial use for some years at operating speeds of up to 1800 rev/min.

23 Ringframes

There have been no outstanding developments in ringframes in recent years although ringframes certainly continue to be better engineered. Ringframes are currently available which are technically capable of operating with spindle speeds of 18,000 rev/min although in general it is doubtful if, even with the smallest packages, it would be economical to do so; the power required to rotate a spindle and yarn balloon increases quite disproportionately with increased spindle speed whereas the production of the ring spindle increases only proportionately.

Recent developments include tangential belt drives for ring spindles; ringframe autodoffers which may be of the full frame or patrolling carriage type; automatic end-piecers and end-down detectors, some of which can be linked to a mini-computer which performs any required analysis and presents the results in a type-written form.

Despite all these developments, it is difficult to escape the conclusion that the ringframe has reached the limit of its development. It produces yarn which is good enough for virtually any end-use, but the need to strike the optimum balance between the three major cost components in spinning, i.e. capital, labour and power, limits the speed of spinning that can profitably be used.

The ringframe process is the most costly of any in yarn production. Indeed it costs more than all the other processes put together and accounts for about 60% of the total cost of staple yarn production. Since there has been no likelihood of any significant reduction in ringframe spinning costs, the time has been ripe for a successor.

24 Open-end spinning

A fundamental difference between open-end spinning and ring spinning is that in open-end spinning the collecting package does not need to be rotated in order to insert twist into the yarn. A method of twist insertion which requires less power than that of the conventional ring spindle may thus be used; in consequence it is economical in general to use much higher rates of twist insertion.

The present commercial open-end spinning machines incorporate a system of circumferential fibre assembly, the essential features of which are shown in Figure 1. In such a unit the fibres, probably in sliver form, are fed to an opening device, which may be a succession of drafting rollers but more usually is a single spiked roller, which opens up the sliver so completely that the fibres can be fed forward individually; this is where the break occurs in the spinning system. The break is repaired as the fibres, transported from the opening unit by an air stream, collect on the inner surface of the cup-shaped rotor, which is driven at high speed for each revolution of the rotor, therefore a thin layer of fibre is deposited onto its circumference in the 'collecting groove' and is held there by centrifugal force so that a multi-layer strand of fibres is built up. This strand of fibres is peeled from the collecting groove and twist is simultaneously inserted into it because of the rotation of the rotor; thus the yarn is formed. The yarn is continuously withdrawn from the rotor and the number of fibres in the strand at the point of yarn formation is maintained constant by the continuous deposition of fibres onto the collecting groove.

Open-end spinning machines are currently available which are capable of operating speeds of 45,000 rev/min. In five years since its first appearance rotor speeds have increased appreciably, cleaning devices for cotton fibres have been incorporated into the opening units, package sizes have increased several fold and some machines are even equipped with individual auto-piecing devices for each spinning end.

Open-end spinning has provided a technological break-through which is already beginning to have a tremendous impact on the textile industry.

25 <u>Yarn preparation</u>

Clearers, mechanical.

Assessments of a considerable number of mechanical clearers have shown in general that the efficiency, at a setting of 2 x diam., rarely exceeds 40% and it can be as low as 5%. The ratio of spurious stops (i.e. knots, seed particles or other small obstructions which would give no trouble in subsequent processes) to necessary stops can be as high as 10 : 1.

High quality goods necessitate the removal of faults which might spoil the appearance of the garment and electronic clearers, which can give an efficiency as high as 90% with only a very small number of spurious stops, become essential.

Clearers, electronic.

It is estimated that more than one million electronic clearers are in world-wide use at a cost of between £25 and £40 per spindle.

The latest models of electronic clearers have adaptors for detecting thin places as well as thick places and have special scissors and anvils for dealing with coarse counts. In addition clearers are now available which detect a missing singles yarn in a three-fold or four-fold thread.

In general most clearers will deal with yarns in the range 100 tex - 10 tex i.e. 6s - 60s English cotton counts, but the latest clearers will clear yarns as coarse as 1800 tex (0.3s English cotton counts).

Automatic winders are available for rewinding and electronically clearing open-end spun yarns. The fault rate in open-end spun yarns is stated to average between 2 and 4 per pound.

Rejection of woven cloth because of slubs in warp and/or weft can cost between £1.00 and £4.00 per 1000 yard if not cleared in winding.

26 <u>Fault classification</u>

Several quality control instruments are available which classify faults, consisting essentially of an electronic clearer with the output pulses from the clearer fed to a digital display system where the faults a t different levels (length and mass/diameter) are displayed.

27 <u>Manual Cone Winding</u>

In general where labour is cheap and spinning quality high, manual winders are an economic proposition for medium and fine counts and a comprehensive range of machines is available from all over the world.

28 <u>Automatic Cone Winding</u>

The following features are common to the majority of automatic winders

(a) All will wind cotton yarns and most will deal satisfactorily with other spun yarns.

(b) Yarns of 100 tex (6s c.c. English) to 10s tex (60s c.c. English) can be wound satisfactorily and some manufacturers claim to wind satisfactorily yarns as coarse as 300s tex (2s c.c. English).

(c) These machines will usually only wind from ring tubes but there are indications that this position is changing with the introduction of open-end yarn on spools.

(d) The majority of 'in-line' machines have one knotter per winding head whose chief advantages are increased production, since the head does not have to wait its turn for the knotter and also the ease of replacement of the knotter without having to stop all the winding heads while the replacement is being made.

(e) All machines have a drum drive.

(f) All machines incorporate blowing and suction nozzles to keep important parts of the assembly free from dust, seed, fly etc.

Automatic feed of ring tubes to the small group automatic winders is now well established.

29 <u>Automatic open-end spun spool winding</u>

It has been claimed that the production of open-end spun packages could well eliminate the need for winding and clearing. Clearly the winding machine designers do not share this view and have modified their machines to accept open-end spun spools.

30 <u>Electronic data processing and monitoring</u>

An important feature of any automatic winding installation is the effective utilisation of these expensive machines and a number of different machine manufacturers make equipment for monitoring production. Information such as machine efficiency, slub detection, machine production, cop changes, breakage rates, knotter operations are presented by computer at frequent, regular intervals.

31 <u>Warping and Beaming</u>

Creels:

Disc tension devices in general have been improved. Undoubtedly the most advanced creel development of the last decade is an automatic creel where an automatic knotting carriage does the tying from a fresh truck creel moved by a motor driven chain.

Warping machines for producing back beams for sizing and weaving:

Machine developments in this field include better speed control, slow speed start and provision for making beams up to 40 in. in diameter. Most modern machines will make hard or soft beams by changing the force or pressure applied to the press roller.

One very important feature of modern beamers is the provision of powerful brakes. Photoelectric guards to protect the operatives are regarded as essential.

32 <u>Pirn Winding</u>

Minor improvements to existing machines such as dust removal and automatic pirn replenishment have been made. A loom winder capable of winding up to four colours at higher speeds than formerly is now well established.

CHAPTER III

Open-end Spinning of Short Staple Fibres (i)

33 **The Ring Frame**

The ring frame has certain restrictions which have made it necessary to consider alternative methods of yarn production. In ring spinning the twist is inserted in the yarn by rotating the yarn package and the amount of twist inserted is proportional to the ratio of spindle speed to the front roller speed. It is this high speed rotation of the package for twist insertion that imposes the limits to ring spinning production rates. The high speed combined twisting and winding rotation of the package is fundamental to ring spinning and it is clear that today's maximum speeds are near the economic limit for this machine.

34 **Open-end Spinning**

In Open-end Spinning, the twisting action is separated from the winding action and the yarn package need only be rotated at the relatively low speed required to wind up the yarn. It must be recognised that this is a different physical process to that involved in ring spinning, and as such the yarn produced will have characteristics of its own. The following are said to be the main characteristics of open-end spun yarns:-

1. The twist formation is different.
2. The fibres are less parallel than in the case of ring yarn.
3. Up to 20% more twist is required to spin a yarn.
4. The yarn strength is typically 15 to 20% less than ring yarn.
5. On the other hand, elongation is typically 20% higher than ring yarn.
6. Open-end yarn has better regularity and better appearance.
7. Open-end yarn is cleaner and less neppy.
8. Open-end yarn appears fuller and less hairy than the equivalent ring yarn.
9. Open-end yarn has better abrasion resistance.
10. Open-end yarn has better dye up-take characteristics.

35 **Economics**

There is no doubt at all about the economic advantages of Open-end Spinning for coarse count carded yarns, even in the low labour cost countries. In the count range 6s to 12s (i.e. English) such variable costs as investment, labour, power, raw materials are lower for open-end than for ring spinning and it is possible to make an economic case up to and possibly beyond 24s. As the count becomes finer the speed advantage of the Open-end machine is reduced and consequently there are relatively higher requirements in investment, space and power. This arises because Open-end production is related directly to count and twist, since essentially it is a constant speed machine, whereas, over the range in question, the ring frame spindle speed is increased and twist factor slightly reduced, although this is achieved at the expense of smaller packages.

36 **Machinery investment**

It may be argued that, as Open-end Spinning is a new development, it is subject to rapid further development; hence the investment should be amortized over a shorter life than that for ring frames. This reasoning is contested on the following grounds:-

(a) Operating speeds appear to have settled in the region of 45,000 rev/min and are likely to remain so for some time, especially as the economic advantages of higher speeds will tend to be marginal.

(b) Acceptance by markets of Open-end spun yarn suggests a comparable investment life to that of the ring frame. Subsequent development may reduce the competitiveness of the Open-end machines, but will also make the ring frame even less attractive.

(c) Open-end yarn is not simply a replacement for ring yarn, it possesses characteristics of its own, often to advantage and these, plus economies of production, describe a typical 'early entry' profit making situation.

If developing countries need to minimize investment Open-end machines meet this requirement in the coarse count range.

37 **Building Investment**

The effect of new building charges is to the advantage of the Open-end spinner at the coarser end of the count range, where there is a net saving in floor area when compared with a ring spinning installation.

Labour

Current experience indicates that labour savings of up to 40% may be claimed for Open-end Spinning, mainly due to

(i) The elimination of speed frame labour with savings in machine minders, supervision, maintenance and transportation.

(ii) Reduction in overall labour requirements at the spinning process, due to larger creel and doffed packages.

(iii) Elimination of winding labour.

39 **Power**

The Open-end machine uses less power than ring spinning per pound of yarn up to approximately 17s (c.c. English). The addition of speed frame requirements to those for ring spinning increases this figure to 20s (c.c. English) and the inclusion of automatic winding into the ring spinning system ensures an overall power advantage to Open-end Spinning to about 30s (c.c. English).

Since power is often a restricting factor to industrialisation, this saving, which is substantial when the coarser yarns are spun, could be very important. It would allow a larger textile industry or diversity of industrialization in other directions - both creating more jobs. For example, the saving over a course count ring spinning industry of say, 100,000 spindles on average 12s (c.c. English) yarn, could be more than 2,500 Kw/hr or 15 million Kw per year.

40 **Raw Material**

Waste losses at both speed frame and winding process are usually assessed at about 2% at each machine. There is thus this saving by the use of Open-end spinning and in addition the machinery makers claim a further saving of 1% over ring spinning at the Open-end Spinner itself.

Trash in the input sliver is a source of difficulty in Open-end Spinning. A trash extraction attachment has been developed and it is now possible that some spinners by exploiting this feature could make substantial savings by spinning from lower grades of cotton.

41 **Comparative Economics**

Table 2 shows an economic comparison between the Platt Open-end Spinner (Type 883) and ring spinning on 12s (c.c. English) yarn.

Table 2

Economic Comparison

Count 12s Nc (20.3 Nm)

Production 900 lb/hour, 6,000 hours per year.

Plant Required	**Open End**	**Ring**
Blowroom	1	1
Cards	14	14
Draw Frames:-		
1st Passage	4	4
2nd Passage	4	4
Speed Frame Spindles	-	383
Spin Spindles/Rotors	2,100	9,600
Auto-wind Spindles	-	200
Capital Cost	£637,639	£680,090
Building Area	54,500 ft²	58,500 ft²
Labour		
Number Spinning	85	107
Number Winding	-	32
	85	139
Variable Costs p/lb		
Investment	1.74	1.88
Labour	1.26	2.06
Space	1.01	1.08
Power	0.43	0.66
Others, incl. waste diff.	0.30	0.58
TOTALS	4.74	6.26

In this comparison, the following assumptions have been made:-

Labour £0.4 per hour, with productivity 0.75 x West European Standards.
Machinery depreciation at 10 years and buildings at 20 years with interest at 8%.
Power 0.8p per kw/hr.

42 Scope of Open-end Spinning

A wide range of fibres has been spun on Open-end machines and, within the recommended economic count range, they have been released unconditiona[lly] for cotton. Rayons, polyamides, acrylics and polyester fibres have all be[en] spun on Open-end machines. In general, blends of man-made fibre and cotto[n] give no problems but in the case of 100% man-made fibre caution must be observed. There are many differences to be found in similar fibres suppli[ed] by different producers and this imposes some limitations. It is recommend[ed] therefore, that test spins should be undertaken to prove that these fibres will process satisfactorily.

The open-end machinery is available and proven - it is now up to the developing countries to study the opportunities that this presents. It mu[st] be borne in mind that the Open-end Spinner is not a complete replacement f[or] the Ring Frame. Both machines have a place in the spinning field and each must be judged on its merits.

Open-end Spinning of Short Staple Fibres (II)

43 Introduction

The process of open-end spinning has made a true impact on the fibre-to-yarn technology. An extraordinary feature of this process is that the Open-end spinning machine is often used in lieu of the Ring Spinning frame which has always been the most critical link in staple yarn production influencing the rest of the spinning machinery. For this reason, an increa[se] in production rate at this stage is far more important than any output rise in the preceding operations. Extensive tests by many authorities have resulted in good agreement on the characteristics of Open-end yarns as compared with Ring Spun yarns, emphasis being placed on superior yarn uniformit[y], higher abrasion resistance, better dye affinity, higher yarn bulkiness and reduced number of thick and thin places and neps.

Processing Open-end Spun Yarns

44 Pirnwinding

It is recommended that this operation be performed in a relative humidi[ty] of 65-70% at temperatures of 20 - 23°C. A uniform, rather low yarn tension is recommended.

45 Warping

It is recommended that the yarn should have a regain value not less tha[n] 8.5% and should be warped under conditions of 70% R.H., 20 - 23°C.

Open-end spun yarn, if in the form of flat cheeses, may be warped directly without any rewinding and clearing, providing that the end-breakage rate is commercially acceptable. Special inserts should be used to ensure firm creeling of the cheeses. The yarn should be drawn off exactly over the centre of the package, the recommended distance between the rear of the package and the creel guide being about 450 mm.

Further recommendations

Warping speeds (150-210 m dia. packages)	600 - 800 m/min
Warping speeds from perforated dye bobbins	480 - 640 m/min
Warping tension (single yarns)	10 - 12 g
" " (plied yarns)	13 - 16 g
Beam density (single yarns)	0.40 - 0.45 g/cu.cm
" " (dye beams)	0.30 - 0.32 g/cu.cm

If the above recommendations are met, the quality of warping is satisfactory and the breakage rates are usually lower than those of comparable ring spun yarns.

Sizing

The different structure of open-end spun yarns permits easier penetration of size giving a strength increase, depending on count, in the region of 30 - 40%, which is 5 - 10% more than with corresponding ring spun yarns. Modified starches give solutions of low viscosity which penetrate more readily between yarn fibres. The solutions are easy to squeeze off in sizing and are readily removed in scouring. Sizing speed can be increased by nearly 30%.

Warp waxing

Yarn smoothness can be improved by waxing with a wax which is readily removed in scouring. With sized open-end spun warps that have not been smoothed, the actual capacity of the warp beam is about one twelfth lower than with ring spun yarns.

Sizing conditions for open-end spun yarns

The size concentration should be 25 - 30% lower than normal. This provides a significant saving in starch consumption. The most convenient concentrations of the sizing beck are in the order of 6.5 to 7.5%. It is recommended that the ratio of softener to starch should be increased by 30% to reduce yarn stiffness. The warp should be wet split by means of a 1/1 lease.

Sizing speeds of 90 - 100 m/min are attainable.

- - -

49 **<u>Twist setting</u>**

The higher twist of open-end spun yarns makes them 'lively'. Twist may be stabilized by several methods:-

(i) Moistening the yarns using a hygroscopic mixture

(ii) Storing the yarns for about 3 days in a conditioned room

(iii) Steaming by conventional methods.

50 **<u>Weaving</u>**

Recommended atmospheric conditions are 21 - 23°C and 74 - 78% R.H. The general conditions such as careful preparation, lowest practicable tensions, which give good results with ring-spun yarns apply equally to open-end spun yarns. In general it may be noted that open-end spun yarns show a lower breakage rate by 15 - 20% than corresponding ring-spun yarns.

51 **<u>End-uses of open-end spun yarns</u>**

Open-end spun yarns can be used in a wide range of fabrics with pleasing appearance and handle. As far as fabric appearance is concerned, open-end yarns can compete successfully even with cotton combed yarns.

Fabrics requiring yarns of high regularity are the natural choice and in designing fabrics the bulkiness of the yarn should be taken into account Applications of particular suitability include loop terry fabrics, shirting handkerchiefs, damasks, printed fabrics, pile fabrics and in short, all fabrics that should have a full handle and a high degree of evenness.

52 **<u>Properties of fabrics made from open-end spun yarns</u>**

<u>Dyeing and printing</u>

The fabrics have brighter colour shades, this being particularly appreciate in prints.

<u>Fabric strength</u>

For identical constructions the fabric using open-end spun yarns has a lowe strength by some 15 - 25% than that using ring-spun yarns.

<u>Fabric appearance</u>

A smoother, more settled appearance due to low occurrence of neps.

<u>Mercerising</u>

Open-end spun yarn fabrics are about 5% less lustrous than conventional fabrics treated under the same conditions.

<u>Abrasion resistance</u>

On average 20 - 30% more resistant than corresponding fabrics from ring-sp yarns.

Raising

Fabrics from open-end spun yarns are easier to raise, the raised fabric is less damaged and the pile is uniform.

Cover

The covering capacity of fabrics f om the coarsest count open-end spun yarns is high, from the finer yarns not quite so good.

Chapter IV

Prospects of Open-end Spinning in India

53 **Introduction**

In a country where labour is abundant and can easily be trained and where wages are low in comparison with affluent societies, investment in sophisticated technology is not always economical. For example, although the advantages of introducing automatic looms in terms of cost reduction have been well known for a long time, their introduction into India has been extremely slow. The number of automatic looms is only about 18% of the total and the rate of increase during the past 15 years is less than 1% per year. Similarly, the advantages of high production carding have been well known for nearly a decade and yet there are very few high production cards in India. Therefore, one should be very careful in fore-casting the rate of introduction of such a revolutionary development as open-end spinning.

54 **Economic studies**

The studies reported so far compare only the cost of production; th fact that the capital investment for the same volume of production, would be much higher in the case of open-end spinning and consequently the retu on capital would be lower has not been taken into account.

55 **Economics**

For the purpose of evaluating the economics of open-end spinning, t following factors have been considered:-

(i) The capital investment for a given production
(ii) Optimum speed for minimum cost
(iii) Optimum speed for maximum return
(iv) A comparison of the cost of production with ring spinning
(v) A comparison of return on investment with ring spinning.

The following broad assumptions have been made:-

(i) The capital cost per drum will be the same irrespective of the rotor speeds
(ii) Power costs will increase as the square of the rotor speed
(iii) Labour cost per unit production would be the same for all speeds
(iv) There will be no change in raw material and maintenance costs between ring spinning and open-end spinning.

56 Capital Investment for a Given Production

In a developing country like India where there is a shortage of capital resources, even if the economic advantages of cost are overwhelming, the investment in new technology may not be made if adequate capital is no available. The capi al required is 1 0 to 300% more in the case of open-end spinning than in ring spinning, and not many mills in India can afford investment of that order. Unless the price of open-end spinning machines comes down in the near future, the initial investment alone may act as a major inhibitive factor.

57 Optimum Speed for Minimum Cost

On the basis of the total cost per 100 kg of 20s yarn and a machine life of 15 years on three-shift working, it is found that the optimum speed for minimum cost is about 38,800 r.p.m. However, if the machine life increases, because of a net reduction in the annual capital charges, the optimum speeds are found to be lower. It is found that, though the optimum speed decreases as the machine life increases, it is not very sensitive, particularly for a life beyond 15 years.

The extent to which the speed of the machine would affect the capital and power costs as well as capital investment is more important than considering optimum speed alone. However, it has been found that over a range of speeds from 30,000 to 50,000 r.p.m. there is little change in operating costs.

58 Optimum Speed for Maximum Return

The optimum speed for minimum cost is about 39,000 r.p.m. For a return of 10% at optimum speed for minimum cost, the optimum speed for maximum return is 73,000 r.p.m.

60 Comparison of the Cost of Production

In comparing the cost of production between open-end and ring spinning, the following assumptions were made:-

Rotor speed	:	30,000 r.p.m.
Cost per drum of open-end spinning	:	£120
Cost per ring spindle	:	£15
Machine life at three shift working	:	15 years

In estimating ring spinning costs, conditions existing in high productivity mills in India were taken into consideration and also the tax concessions for depreciation as permitted in India.

Open-end spinning is very economical in 10s count, the cost being lower by about £8 per spindle per year. The difference between the two is considerably narrowed in 20s count to about £2 per spindle and almost disappears in the 30s being only £0.5 per year. In 40s count, open-end spinning costs are higher by about £1 per spindle per year.

The significant advantage in 10s count in open-end spinning is due mainly to the large reduction in labour cost when compared to ring spinning. The number of workers for a 25,000 spindle mill for three shift working is reduced by 996, while in the case of 40s count this reduction is only in the order of 254 workers.

In the case of a new mill, the cost of ring spinning would increase because of the additional cost of new fly frames and cone winding machines while the labour cost for these machines would be reduced slightly. The cost for open-end spinning would be practically the same.

The conclusions arrived at in the case of an existing mill seem to apply in the case of a new mill also, though the savings in open-end spinning are somewhat lower.

One can therefore safely conclude that from the point of view of cost of production, open-end spinning is highly advantageous in 10s count, but the advantage rapidly deteriorates with increase of count and the break-even point is reached somewhere around 32s count.

60 <u>Comparison of Return on Investment</u>

In 10s counts, open-end spinning is highly profitable. The rate of return for both systems is the same somewhere around 16s count. In counts finer than 16s, open-end spinning does not yield as high a return as ring spinning.

61 <u>Future Prospects</u>

Under the present circumstances, though the cost of production in open-end spinning is lower than ring spinning up to 30s count, from the point of view of return on investment, it is not economical beyond 16s. If the machine cost could be lowered or if the power cost could be reduced, the machine could become economical for counts up to 30s. It is also evident that from the point of view of the economics of the Indian Textile Industry, it seems to be more important to reduce machine and power costs than to aim for very high speeds. Wages in India are expected to go up by about 40% in the next seven years. If this happens, then open-end spinning would become economical up to 20s. If at the same time machine speed could be increased to 48,000 r.p.m., then its economic use could be extended up to 30s.

At present in India there are about 1.5 million spindles between the count range 10s - 20s. These are probably spread over 350 mills, most of which wil not be in a positio to make the nece sary investment. It is estimated that during the next 5 years, assuming that the open-end spinning machines will be manufactured within the country, about 250 machines are likely to be installed in about 100 mills.

Compensation would have to be paid to workers who might be rendered surplus as a result of the introduction of open-end spinning. Apart from the difficulty of retrenching workers in India, this compensation is a fairly heavy burden which depends on a number of factors and is difficult to estimate beforehand. Not the least important factor is the fact that the Indian Government does not permit the free import of machines. Therefore, a pre-requisite for the introduction of open-end spinning machines would be their manufacture within the country either independently or in collaboration with a foreign manufacturer.

Chapter V

Open-end Spinning of Short Staple Fibres in Japan

62 **Historical**

In May 1966 a leading textile company in Japan obtained drawings of the BD200 machine. By December 1966, in co-operation with a Japanese loom company, 40 sets had been made, described as 'Type A'. After extensive trials Type A did not achieve satisfactory results and in 1967 40 sets of a modification known as Type B were made. The same year these were replaced by Type C and then by Type D.

The main problems to be overcome were:

(i) To reduce the yarn breakage rate

(ii) To increase yarn quality, particularly in strength

(iii) To produce a machine capable of spinning yarns of a commercial standard from a variety of cottons, for example, from Pakistan, American and Brazilian cottons and from man-made fibres.

Type A machines gave a yarn breakage rate of 50 breaks per 200 spindles per hour.

Type D machines gave a yarn breakage rate of 5 breaks per 200 spindles per hour.

One hundred machines of Type D were put into commercial production. At this stage the idea of automatic piecing had been abandoned as being too costly an investment and efforts were concentrated on automatic doffing.

In 1967, the company had spun 10 million pounds of open-end spun yarn but, because of its disadvantages in comparison with conventional yarns, the company made a decision not to sell the yarn and it was burned.

By 1972 the company had installed 250 sets of the BD200 machine and their competitors a further 450 sets, making 700 machines in all in Japan.

About 50 sets of other types are currently going through the test stages.

63 **Types of product**

The company that first introduced open-end spinning in Japan has a current production of 60% all cotton open-end spun yarns and 40% man-made or man-made and natural blends. Their market has expanded to the knitting trade and at present 50% of their product is directed to knitting and 50% to weaving. By 1973-1974 they expect that this ratio will change to 60-70%

knitting and 30-40% weaving. Greater profits are expected from the sales of yarns to the knitting trade. Yarns up to 36s counts are spun commercially. Counts up to 40s can be spun but are less sound economically.

64 Spinning conditions

When considering the cost of power in Japan, speeds of 30-35,000 r.p.m. are the most economical. (In the U.S.A. these speeds could be increased without economical difficulties because of the lower power costs.) There is no real mechanical problem in achieving a speed increase up to 45,000 r.p.m., but higher speeds than this would necessitate new machinery design. The most suitable humidity in their experience is the range 60-70% and the temperature must not exceed 30°C, cooling power being necessary to ensure this.

In Japan some open-end spun yarns have a good reputation, some a bad reputation even when spun on the same machines. The cause of this, it is believed, lies in the preparation of the sliver. Carding machines have been specially developed for use in open-end spinning. These remove more trash than the conventional cards by the use of crushing rollers and other modifications.

65 Machine development

Experiments are in progress in an effort, by suitable modification to the rotor, to reduce the twist multiplier to that normally used in ring spinning. Patents are pending on this modification. One of the biggest problems is the accumulation of fly, honeydew and dust in the rotor developed for lower-twist spinning. Work on rotor design is proceeding.

At present 70% of the company's production is delivered directly to the weaver, the remaining 30% being re-wound before delivery. The re-wound yarn is for customers who demand a very high quality standard.

An automatic winding machine to be integrated with the open-end spinning machine is under development.

66 Fabric end-uses

In woven fabrics, excellent results have been achieved with sheetings, flannelettes, terry towelling, lenos, canvases, poplins, velveteens and corduroys, dress prints. The excellent dyeability of open-end spun yarns enables very brilliant printed fabrics to be made and there is a thriving export market for these, particularly to the U.S.A.

In knitted fabrics excellent results have been obtained with rib and interlock underwear. The typical harshness of the open-end spun yarn may be eliminated, should it be desirable, by appropriate soft finishing.

In the field of outerwear, products from open-end spun yarns, particularly from acrylic fibres (which give the least problems of all the man-made fibres spun by this method) are contesting the markets for jersey fabrics for children and infants, circular knitted sweaters etc. and yarn dyed jacquard jersey fabrics.

67 **Conclusions**

Because of the higher cost of open-end spinning machines in comparison with ring frames at the initial stage of the installation there will be an economic disadvantage in consideration of machinery depreciation. However, assuming a wage increase in each year, the production cost will be lower than that of the ring spinning frame after about four years of operation. Furthermore, in Japan there is a labour problem in that the number of young operatives is decreasing year by year. It is therefore believed that the age of Open-end Spinning will be realized much sooner than at first expected. Moreover, the fact that the operative force required is less than half that required for a conventional ring spinning installation will never make the spinning industry a declining one.

In the countries with lower wages, the ring spinning frame will still be profitable, but in high wage countries such as U.S.A. and Europe, if the open-end spinning machine is operated as in Japan, it is firmly believed that the progress of open-end spinning will be much quicker than in Japan. There are still many innovations to be made and these, in conjunction with the progress of related technology will result in increasing the production rate and enlarging the count range of open-end spinning.

Chapter VI

Some Special Features of Open-end Spun Cotton Yarns

68 **Introduction**

There are numerous publications on the comparison of the physico-mechanical properties of open-end spun yarns and of conventionally spun cotton yarns. Most of the work has been concerned with what are considered to be the more practical parameters such as tensile properties and regularity although other properties have been considered. However, certain interesting characteristics such as hairiness and friction have been somewhat neglected. Also little literature is available on twist-strength and twist-elongation-to-break curves of open-end yarns.

The following points have now been considered:-

(i) Nature of hairiness
(ii) Variability of hairiness
(iii) Co-efficient of friction
(iv) Twist-breaking-strength and twist-breaking-elongation curves
(v) Twist-resistance-to-repeated-extension curve and twist elongation
(vi) Twist-abrasion-resistance curves

A total of 18 yarns were used in the experiments, 6 from Russian cotton, 3 from Giza (Egyptian) and 9 Spanish cotton.

69 **Nature of hairiness**

It was established that the nature of hairiness of open-end spun yarns differs from that of conventional spun yarns. In open-end spun yarns, short ends are more abundant than long ends, giving a lower visible hairiness for the yarns.

70 **Variability of hairiness**

A methodical study, using the electronic hairiness meter developed by Barella and Viaplana, showed that irregularity of hairiness is greater in open-end spun yarns than in conventional yarns.

71 **Co-efficient of friction**

The results showed that the coefficient of friction is slightly less in open-end spun yarns than in conventional yarns even at the same twist value. In practice this is rarely noticed as the difference is too small.

72 **Twist-breaking-strength and twist-breaking-elongation curves**

The saturating twist multiple in the tensile test is about 14% greater in open-end spun yarns than in conventional yarns. The twists utilized in practice are from 6% to 20% below saturating twist in open-end spun yarns and from 7% to 22% below saturation in conventional yarns. The maximum value of the twist-elongation curve coincides, for both types of yarn, with that of the twist-strength curve.

73 <u>Twist-resistance-to-repeated-extension curve and twist-elongation</u>

In the resistance-to-repeated-extension test, saturating twist is abou 13% higher than in tensile strength tests for conventional yarns, and 12% higher for open-end spun yarns. Conversely, the maximum value of the twist-elongation-to-break curve is 20% below the saturating twist multiple in the tensile test for conventional yarns and 10% below that of open-end spun yarn

It is interesting to point out that the maximum value of twist-elongation-to-break curve, whether for conventional or open-end spun yarns, coincides with the twist values used in industrial practice for warp yarns.

74 <u>Twist-abrasion-resistance curves</u>

A great deal of the literature on open-end spun yarns points out that these yarns are more resistant to abrasion than conventional yarns. However, other studies show the contrary. This contradiction can be attributed to the type of abrasion tester which is being used. With the apparatus used in this study (the 'Abrafil') the yarn is subjected to considerable tensile force in conjunction with the abrasion effect. This force modifies the results as compared with other instruments in which there is no such circumstance.

The results showed that the maximum value of the curve for both conventional and open-end spun yarns attains values nearing those found in the resistance-to-repeated-extension test.

Chapter VII

Study and Comparison of Automated versus Conventional Systems of Modern Spinning Plant with special reference to Open-end Spinning System

75 **Introduction**

On April 30, 1970, on behalf of the General Organization for Spinning and Weaving, Alexandria, enquiries were sent to five leading spinning machinery manufacturers in Europe to quote for a Spinning Plant of about 30,000 spindles based on both:

(a) The Automated system
(b) The Conventional system

with the very latest machinery to process middle staple cotton 26 - 34 mm producing an average count of 24s carded yarn with a twist factor of 3.4. The machinery makers were also requested to give power consumption for both systems and also the operative force necessary to run the spinning plant based on operatives of average skill. In addition a spin plan was required for each system based on round-the-clock operation, 3 shifts daily.

76 **Plant details**

(i) Spinning machinery, and in addition the necessary spinning workshops, spinning accessories such as cans, bobbins etc. and a testing laboratory.

(ii) Power Supply Installation including illumination.

(iii) Air Conditioning Installation.

(iv) Sprinklers and Hydrants Installation

(v) Transport equipment (Internal)

(vi) Mechanical and Electrical Workshops.

The building to be of the closed, windowless, double roof arch type in pre-stressed concrete.

77 **Comments on Quotations**

With the exception of one machinery manufacturer, who offered open-end spinning machines, it was noted that there was no fundamental change in the machinery whether in using:

(a) Automated System or
(b) The Conventional System

In connection with the Blow Room machinery, Bale Pluckers can be used instead of the ordinary Bale Breakers. Automatic feeding of the cards, by Chute Feed, can be used in place of laps produced from lap forming machines and the manual transportation of laps onto the cards.

In some instances the method of using the ordinary Bale Breakers with automatic feeding of cards may be more suitable especially if the bales are not highly pressed.

Previously, a prevailing theory of the automated system was to provide automatic sequencing of machine units and handling of stock from the opening section to the finisher drawing section. Another method was to connect automatically all machines up to the first draw frames, the latter being fitted with automatic levelling devices. One line of drawframes would be used, the speedframes being fed by double cans to improve the regularity.

With high production carding and using very large card cans, the latter considerably reducing the work load, it has been possible to do without automatically combining carding processes with drawing processes. Also the use of these big cans at the first draw frame eliminates the need to combine automatically the first draw frame with the finisher draw frame. If one is limited to relatively small diameter cans for the creel of the speed frame an automatic can changing unit can be used at the finisher drawframe.

It is evident that there is no difference between the two systems so far as the speed frames and ring frames are concerned, except that automatic ring frame doffers can be used.

It is advantageous, especially in countries where labour tenters standards are not very high, to use automatic winding machines in order to avoid faulty and hidden defects in the produced packages.

At this stage none of the machinery manufacturers were in a position to offer machines other than their own, i.e. spinning machinery only.

Since there were no fundamental differences between the automated and conventional systems, discussions and comparisons were limited to:

(i) Spinning Plant with Ring Spinning System
(ii) Spinning Plant with Open-end Spinning System.

A complete Ring Spinning Plant of 30,192 spindles was compared with a complete Open-end Spinning Plant of 10,000 spindles, the former producing 15,600 Kg/day (24 hrs), the latter 15,000 Kg/day (24 hrs) of 24s counts.

78 Conclusions drawn from the comparison

The Open-end Spinning System appears to be commercially more profitable and advantageous. Assuming the yarn produced on the Open-end Spinning System is to be used on cheeses without rewinding, the advantages over the Ring-Spinning System are:

(a) Less capital invested due to elimination of speed frames and winding machines.

(b) Less power, space, labour and cotton factor.

(c) More profit.

Although the Open-end Spinning System appears to be more attractive than the Ring Spinning System, the matter requires a more careful approach. The end uses of the yarn produced on the Open-end spinning machines are the decisive factors since they are limited. This yarn has been used successfully for domestic fabrics, sheeting, pyjama cloths, towelling, blankets and some other fabrics, but in other fields, such as knitted fabrics, very fine fabrics normally using combed yarns, the open-end spun yarn is not entirely satisfactory. The Open-end machines require further development with a view to producing a yarn equal in all respects to that produced by the Ring Spinning System.

To what extent Open-end Spinning will replace Ring Spinning is a question left open to the machinery manufacturers. The future of the Open-end Spinning machinery depends on the degree of perfection they will attain for the satisfaction of spinners in the different fields of the textile industry.

Chapter VIII

Recent Developments in Weaving

79 **Introduction**

The drastic changes that textile manufacturing methods have undergone during the past decade have had the following consequences for the textile industry:

(i) Increased productivity per manufacturing unit (through introduction of high speed machinery)

(ii) Higher capital investment per operative (more complex equipment)

(iii) Fewer man-hours required for a given output (through automation)

(iv) Diversification into special purpose techniques (with some loss of versatility)

An economic appraisal of the first three points may normally be made, but it is often difficult for the potential buyer of the equipment to evaluate the merits of a newly developed technique which, in its initial stages, may seem limited in its versatility.

In weaving the requirements as specified by the desired properties of the end product vary within rather wide limits. The state of today's technology enables machinery to be designed which will perform a specific operation much better, faster and at lower cost than an all-round type of equipment could possibly do. Thus in order to make a meaningful comparison of equipment, mill management must have a clear concept of the type of product it desires to manufacture.

80 **Weaving v Knitting**

In 1970, on a world-wide basis, 81% of all cloth was produced by weaving technique and 13% by knitting. It is expected that by 1975 these figures will be 77% and 16%. This shift from weaving to knitting is very pronounced in the United Kingdom and some forecasters have gone so far as to predict that by 1980 as much as two-thirds of the cloth production in Great Britain will be supplied in knit-goods. However, practical experience has shown where the limitations of knitting are and today it appears very unlikely that knitting is on its way to replace fully the weaving technique. There is no doubt, however, that the availability of smooth, low count, high-strength man-made filament yarn has made it possible for the circular and warp-knitting machines to be operated at ever-increasing machine speeds. Furthermore the consumer demand for easy-care garments served as an additional promoting factor for the knitting technique. A vital difference between woven and knitted structures is that by the weaving technique it is possible to produce a cloth of entirely closed structure with warp and weft yarns touching each other along their full length. On the other hand the knitted cloth is essentially a loose, porous structure with a high degree of flexibility. Since the thickness of a knitted material is very pronounced, due to the yarn folding into three-dimensional loops, considerably greater yarn length must be worked into the knitted structure, in order to obtain a similar coverage as compared to a woven cloth. If equivalent cloth weight is needed, then knitting requires finer yarn count and thus a higher raw material cost. It may be said that in many cases, where knitting appears to be attractive by virtue of its higher production speed, the economic advantage may actually be rather small or nil due to higher material costs.

4.1 Survey of Weaving Techniques

The typical feature of the conventional automatic loom is the shuttle carrying the weft supply in quill form, the latter being changed by the loom when exhausted of yarn at no loss of production time. The battery containing the weft supply requires labour to ensure that it is kept loaded. In looms fitted with box loader mechanisms, several kilograms of weft yarn on quills is supplied to the loom at infrequent intervals, the mechanism removing the quills from the container and presenting them as required to the shuttle. Less labour is therefore required than with the conventional battery loom.

The next step, which enables the loom to be operated with a stationary weft supply, is the loom winder technique, first introduced in early 1950 as the 'UNIFIL' or individual loom winder, a highly successful innovation which can be fitted to most major types of conventional looms. The chief advantages are the elimination of a central quill winding department and a great reduction in the number of quills in circulation. On the other hand, competent mechanics are required to maintain the equipment.

The latest development in weaving technology, first shown to a greater public at the ITMA 1971 in Paris, is the multiphase or wave-shed weaving machine which utilizes many yarn carriers travelling one behind the other across the weaving width, each depositing one length of weft yarn. An ingenious winding device is incorporated to provide each yarn carrier with an exact yarn length. It is estimated that at least 5 years will be necessary to provide mill experience before this machine becomes a viable commercial proposition.

The largest and constantly growing group of non-conventional weaving machinery is usually put under the heading of 'shuttleless looms'. A common factor in this group is the stationary weft-yarn supply from which without further winding process the yarn is directly inserted into the shed. Today it is estimated that about one-third of new installations are of the shuttleless type and by the end of this century will probably grow to two-thirds.

Shuttleless looms, according to their system of weft-yarn insertion, are usually grouped as follows:

(i) Gripper-shuttle machines
(ii) Rapier machines - flexible or rigid, single or double rapiers
(iii) Water jet (or hydraulic) machines
(iv) Air jet (or pneumatic) machines

82 **Recent developments in weaving machinery**

Conventional looms

In general the following changes and improvements are noted:

(i) Enlarged weaving width, up to 450 cm., whereby two or three fabrics may be woven simultaneously side by side.

(ii) Electronic sensing mechanisms to control shuttle flight, push-button control for early operation.

(iii) Improved shuttle-checking by means of hydraulic stop devices.

(iv) Better warp let-off systems offering more uniform yarn tensioning and a moderate tension level even at high machine speeds.

(v) The factors above mentioned combined with materials of higher strength and durability have once more enabled the production rate of the conventional loom to be increased.

If the factor of productivity is considered in terms of weft insertion rate then the determining factors are loom speed and weaving width. Although it is technically possible to run looms of relatively small width at speeds unthinkable just a few years ago, the probable wear and tear on mechanisms such as the picking motion and the excessive noise level suggests that a better solution is to use a large weaving width at reduced loom speed, bearing in mind that if possible the total reedwidth should be used otherwise economic advantage is lost. The loom speed cannot be adjusted to correlate with the actual cloth width and here the conventional wide-width loom suffers a serious handicap that cannot be corrected technically.

83 Gripper shuttle looms

With over 25,000 machines now in operation, undoubtedly the gripper shuttle loom manufactured by Sulzer provides the greatest experience among non-conventional machinery. Originally designed as a high-production cotton weaving machine, its industrial success began in the wool industry where it replaced heavy multi-shuttle looms. The main advantages were the weaving of multi-colour pick-and-pick fabrics at a considerably higher production rate and a significant improvement in cloth quality due to the use of long lengths of knot-free weft yarn resulting in lower mending costs. Today Sulzer machines are offered in five widths ranging from 85 in (216 cm) to 213 in. (541 cm). The wide machines offer great flexibility as to cloth width at high production rates. If several cloths are woven side by side, their widths need not be the same. The cloths are woven with a smooth tuck-in selvedge on both sides, sufficiently strong for the handling in any standard finishing operation.

84 Rapier machines

In this weaving technique weft insertion is achieved by rigid or flexible rapiers which always remain mechanically coupled to the driving mechanism, resulting in considerably smaller acceleration and deceleration forces, an advantage over systems with a picking motion and free flying projectiles. However, the rapier machine is not, and will never be, a truly high production machine. The increase in production over the conventional single shuttle loom, for the same cloth width, is in the order of 10%. A more significant advantage is achieved in multicolour weaving since the weft colour change is achieved with no loss of production speed. Pick-and-pick weaving does not require any special mechanism. Other advantages are the elimination of quill winding and the possibility of working with large packages and long knot-free lengths of weft yarn. Several makes are well established in the mill today.

85 Jet weaving machines

The water-jet loom has already gained a significant place in the synthetic weaving sector. For obvious reasons, water as a carrying medium at present restricts its use to the hydrophobic fibres, although experiments are being undertaken with polyester/cotton and other blends.

The first airjet weaving machine built in Sweden had a working width of 60 cm and it was thought for quite some time that large weaving widths could not be obtained by this technique because of the diffusing air stream. It is interesting to note that a single airjet machine has been designed in Czechoslovakia to work over a weaving width of 2.3 m. at 380 picks per minute. The result is the astonishing weft insertion rate of 875 m/min.

One of the most interesting new developments in the field of shuttle-less weaving is no doubt the multi air-jet machine from te Strake. With 180 cm working width and 400 picks/min, the machine attains the high weft insertion rate of 720 m/min.

It may be said that air-jet looms for cotton weaving, once they have passed their prototype state, may well be qualified as high-speed equipment for simple mass production fabrics.

86 Multiphase weaving machine (wave-shed machine)

Weaving techniques whereby a multiplicity of weft yarns can be inserted simultaneously are theoretically best suited to obtain maximum productivity. This technique is now accomplished in the so-called 'turbo-weaving machines' in which a number of small weft carriers are propelled across the machine, one after the other, by means of individually actuated reed bars. With a working width of 230 cm and 23 shuttles operating simultaneously, a weft-insertion rate of approximately 1000 m/min may be achieved. Several machines are now being evaluated under industrial conditions and it will depend upon the experience gained in these tests as to how fast the multiphase weaving machine can find acceptance on a larger scale.

87 Comparison

Economical comparisons are very sensitive to assumptions made such as wages, space, power etc. In order to arrive at a meaningful comparison between types of weaving machine a thorough economical appraisal considering the specific conditions of the particular case is a necessity. Such appraisals must also include factors for which there exists no quantitative measure, such as reliability and durability, the spare part and servicing situation.

While it is true that the weft insertion rate of the conventional shuttle loom may be significantly less than that of some shuttleless looms, productivity alone does not determine the suitability of a certain weaving technique for a given purpose. Higher machine speeds may give rise to increased weft breaks; greater weaving width will tend to raise the chances for machine stops due to warp yarn breaks. Large width machinery requires adequate handling equipment in the warp preparation department and the total down time of a machine for beam change is inevitably higher. In spite of these problems it is considered that low priced, mass produced, single colour fabrics should, for economic reasons, be produced on machines of at least 230 cm weaving width.

Among shuttleless machinery there are a number of alternatives other than production rates that must be weighed against each other:-

(i) <u>Weft yarn transport</u>

When the yarn tip is gripped, twist cannot be lost and the system can deal with a larger variety of weft yarn types. The pulling of a weft loop on the other hand enables the formation of a regular selvedge at one side.

(ii) <u>Guide system</u>

There exists the danger of streakiness due to lubrication marks, particularly on delicate fabrics.

(iii) <u>Selvedges</u>

The choice must be made between 'fringe' selvedges or the tuck-in type, although the finishing industry has learned to handle satisfactorily most types of selvedge.

Depending upon the method used to form the selvedge, a certain yarn loss usually occurs which does affect the economics of the process.

In view of the indisputably growing importance of the various shuttleless looms it may be asked why the conventional looms are still considered at all. The following reasons can be given:-

(i) Relatively low investment costs

(ii) Productivity - with respect to investment - at a reasonable level

(iii) No selvedge problems

(iv) Possibility of eliminating quill winding department through the use of UNIFIL

(v) The operating personnel is familar with the system.

In the western countries developments that enable a reduction in the number of personnel are generally adopted quickly in spite of higher capital cost. In 1955 the labour costs to produce woven cloth amounted to about 60%, while capital costs were only 20%. Today, the investment portion amounts to approx. 50% and labour costs have shrunk to 40%.

88 Table 3 gives a comparison for equal production of five types of machinery. The fabric is a cotton cloth of 48 in. width, 68 warp threads/in. 60 picks/in., counts of warp and weft NE 30.

The five weaving machines are:-

(i) Shuttle loom, non-automatic, 180 picks/min
(ii) Automatic loom with battery, 248 picks/min
(iii) Automatic loom with UNIFIL, 248 picks/min
(iv) Rapier loom, 260 picks/min
(v) Gripper shuttle loom, weaving double width, 255 picks/min

Table 3

Comparison for equal production

Machine Type	Investment	Personnel	Space	Power
	Machine Type 1 = 100			
1	100	100	100	100
2	126	70	86	76
3	142	54	86	86
4	135	51	79	80
5	180	39	61	53

89 **Summary**

For the manufacture of single colour, simple cotton fabrics, large width weaving equipment - for productivity reasons - should be considered. This might be either conventional shuttle looms, rapier or gripper shuttle machines (and air-jet machines once these are industrially viable). In the multicolour and pick-and-pick weaving sector the rapier and gripper shuttle machines must be given preference. In industrial countries with considerably higher labour wages, the replacement of conventional equipment with machinery of highest productivity (high capital investment) is mandatory. For developing countries the economic appraisal of different weaving systems may well lead to the conclusion that modern conventional looms can compete with shuttleless weaving machinery.

Chapter IX

Recent Developments in the Knitting of Cotton Type Yarns

90 Introduction

Initially cotton and wool were the natural choice for raw materials in knitting; cotton in the underwear field, wool in outerwear. The end of the Second World War saw an enormous demand for all kinds of textiles; knitters began to produce outerwear fabrics on machinery which up to that time had been used exclusively for underwear fabrics. These machines had a high production rate but very limited scope for patterning.

Both polyamides and polyester yarns were introduced and expansion in both machine and yarn development was extremely rapid, largely to the detriment of the wool industry. Cotton played but little part in the fashion field for weft knitted fabric, but the comfort of cotton underwear could not easily be challenged by synthetics.

The interest of warp knitters was aroused, especially as synthetic continuous filament yarns were ideally suited and it was not long before warp knitting machines were constructed to knit at 1000 courses per minute and at these speeds cotton yarns virtually disappeared from the scene. Machine development continued but none of the machines were really suitable for cotton unless extremely high quality yarns were used and even then at reduced speeds. Now, however, the profitability of the warp knitting industry has dwindled to a very low level; manufacturers are seeking new products and cotton is a fibre which has caught their imagination. The trend away from synthetics has been just as marked in weft knitting as in warp knitting. It is a trend which comes at just the right moment to correspond with other technical developments. The new Prograde (liquid ammonia treated) cotton yarns are providing all the properties for easy-care which have been sought, and recent modification of the process promises much cheaper installation costs for plants capable of treating this type of yarn.

91 The Knitting of Cotton Yarns

The problem to be considered is the feasibility of knitting cotton yarns on modern machines. Good quality cotton yarn, either single or folded, creates no real problem in weft knitting. Most modern machines include some device to deal with fluff and lint. One thing in cotton's favour is the prolonged wear life for the needle in the knitting machine as compared with that of machines knitting synthetic yarns.

In warp knitting the case is entirely different. Polyester and polyamide yarns are ideal due to their smooth, even surface and high breaking strength. Spun yarns invariably have thick and thin places and fluff protruding from the surface. At high speeds such flaws in the yarn invariably cause faults and to reduce speed is often a great drawback from an economic point of view. Fashion (or indeed the customers' wishes) does not take production problems into consideration. Concurrently with the low profitability in warp knitting is a marked trend towards a 'spun' look in warp knitted fabrics.

Investigations into the warp knitting of cotton

92 The International Institute for Cotton, when examining the potential for cotton in the warp-knitted field, chose the COPCENTRA machine (built by Platt International in the U.K. and by Liba in Germany) because of the sturdily constructed compound needles with which it is equipped. This needle has proved to be very resistant to needle deflection and lint and fluff do not easily block the needles or interfere with their normal movement. A combed American cotton yarn of 2-fold 60s Ne, treated with liquid ammonia was knitted on a 21-gauge machine running at 780 courses per minute. At this speed the fault rate recorded was as low as only one per 100 yards of fabric. It was felt that acceptable fault rates on this machine with such a yarn could be obtained at even higher speeds.

In view of the limited availability of liquid ammonia-treated yarns and the encouraging results of the trials, a conventionally mercerised single yarn of 60s Ne American combed cotton, mercerised in a continuous operation by an American company, wa knitted on a 28 gauge COPCENTRA machine at 1000 courses per minute. Surprisingly, no real problems occurred, although the fault rate was considerably higher than for the twofold yarns. The conclusion was reached that cotton can perform quite satisfactorily in warp knitting. Other types of machine are under investigation.

Weft insertion in a knitting context

93 Weft insertion is a combination of knitting and weaving. In addition to the conventional knitted loops a weft yarn is placed across the entire width of the machine and is locked-in between the loops. This gives a fabric with a fair degree of rigidity, similar in many ways to woven cloth.

There seems to be a marked tendency for the weaver to attempt to imitate knitted fabrics and also for knitters to imitate woven cloth, a situation which can restrict the development of new ideas. A typical example would be the slow penetration of knitted fabrics into the men's-wear field. Here, not only do the knitters copy woven designs; they also copy the conventionally tailored suits for which weft knitted cloth is not by any means the most suitable.

At this stage of development, it does appear that weft insertion possibilities exist in specialized cloth constructions, but users should be warned against any over-enthusiasm for these machines until their potential can be more fully evaluated. To date, with weft insertion processes, one or two bars have been knitting synthetic yarns and the weft used has been cotton. However, trials are being negotiated for the construction of 100% cotton weft insertion fabrics which incorporate PROGRADE yarns. Encouraging results from these trials are anticipated.

The possibility of increasing the supply of mercerised yarn together with the development of mercerising knitted fabrics in fabric form (which produces fabrics very stable to washing, with a high degree of lustre, enhanced drape and increased affinity for dyestuffs) may herald the beginning of a welcome comeback for cotton in the apparel field. It does seem likely that cotton will gain a real stronghold in the knitted outerwear field.

Cost Comparisons

94 Direct cost comparisons between weaving, weft and warp knitting are very difficult for many reasons. Prices of machinery vary considerably according to machine type. A weft knitting machine can cost from a few hundred pounds to the teens of thousands. Warp knitting machines fall into a price range between two-and-a-half and ten thousand pounds. Weaving machinery also varies according to type but is usually cheaper on a unit basis.

An exercise based on two similar cloths, one weft knitted, one woven, each weighing 235 grammes per square metre, for a yearly production of 2.5 million metres shows machine requirements as follows:-

Weaving - 48 looms, 85 in. wide with a production rate of approx. 9 metres per hour.

Knitting - 28 circular machines, 48 feeders, with a production rate of approx. 13.7 metres per hour.

Capital investment

Although a smaller number of circular knitting machines are required the cost per machine is considerably higher than the cost of a loom. Machine costs are therefore about the same. However, if beaming and finishing equipment, plus the cost of buildings are taken into account then the investment cost for the weaving installation would be 67% higher than that for the weft knitting installation.

Production costs

Actual production or manufacturing costs are dependent on a whole series of factors which differ from country to country because of such items as depreciation time allowance for the machinery, labour costs, taxation on capital investment, ground rents, rates and a number of other factors. However, costings based on conditions in Switzerland (which would be fairly representative for a European country) show that calculated production costs for knitted fabrics represent only a slight increase above woven cloth.

If manufacturing costs for woven cloth are taken at a figure of 100%, the following cost breakdown may be made:-

	Woven fabric	Knitted fabric
Production cost	10.3%	10.5%
Finishing cost (including dyeing)	41.3%	38.9%
Raw materials	48.4%	53.8%
Total	100.0%	103.2%

The total manufacturing cost works out at 3.2% to the advantage of the woven fabric.

Productivity

Although the linear production rate of weft knitting machines may well be 75% higher than that of weaving looms, for a similar production there is little difference in the labour force required for each system.

It may be concluded that, comparing the two systems, i.e. weft knitting and weaving, there is little difference from the point of view of production, productivity or investment savings. The reason for the increased popularity of knitted fabrics must therefore be sought elsewhere.

Comparison of weaving and weft knitting

95 Recent years have seen a growing demand for quick-changing fashion. There is considerable preparatory work in the weaving industry and therefore long runs are desirable. In the colour-woven section careful choice of designs and colours must be made since it is difficult and expensive to make any changes after the coloured yarns have been run on to the beam. Weaving, however, has a distinct advantage in the wide range of counts with which a loom can cope; in weft knitting the count range is far more restricted and the yarns much finer.

In weft knitting changeover from one quality to another or from one design to another can be quickly carried out and virtually all preparatory work, with the exception of changing the cones, is eliminated. Pattern scope on modern weft knitting machines is wide but the range of suitable yarn counts is small, resulting in the production of fabrics which are very similar in weight and character.

In circular knitting, fabric width is limited to the circumference of the knitting machines which are also sensitive to such factors as yarn twist, slubs and other yarn impurities to a greater degree than in weaving.

The increasing complication of modern weft knitting machines calls for higher skills from maintenance staff and the high wages paid for these skills must to some extent influence production costs.

<u>Warp knitting and Raschel knitting</u>

6 To compare costings for fabrics made on warp knitting machines and Raschel machines with those produced on weft knitting machines and weaving looms is rather difficult since in general fabrics from these machines are entirely different in character.

From Raschel machines the bulk of production has been used for foundation garments and for lace fabrics whereas on conventional warp looms, nets and ladies' underwear fabrics have been the dominating outlets. The shirting market which experienced a boom some five years ago has virtually collapsed.

An immediate breakthrough into outerwear on these machines cannot be expected although with the search for new markets to replace those of shirtings it is possible, especially with the introduction of PROGRADE or similarly processed yarns, that the growth potential is greatest in the outerwear field. Although fabrics made from spun yarns may be the obvious choice, it is no simple task to change completely from continuous filament man-made fibres to spun yarns. The problems of fine gauge machinery used in conjunction with spun yarns are formidable where bearded needles are concerned. Some manufacturers have rebuilt their existing machines in coarser gauge; the use of 18 needles to the inch permits the efficient use of spun yarns on these machines.

Other solutions have been to modify machines by adding new features, the most significant of these being the weft insertion technique. A weft insertion device may be fitted to either a Raschel or a warp knitting machine and of the several types of weft insertion, all seem to be performing satisfactorily.

Weft insertion does allow a variety of yarn types and yarn counts to be used and as the laid-in yarn does not take part in the actual loop formation, thick and thin places in the yarn are of minor significance. Lack of uniformity can actually be turned to advantage inasmuch as fancy yarns can be used for special effects.

Opportunities for Cotton

97 It is known that cotton creates no real production problem in weft knitting and weaving. It is also known that certain types of warp knitting machines are quite acceptable to cotton. It is believed that when liquid-ammonia treated yarns become readily available most of the existing types of warp knitting machines will be able to cope with natural spun yarns, even at high speeds.

Special considerations must be taken into account when establishing a textile manufacturing unit. Weaving and warp knitting require preparatory processes such as beaming, winding, and often sizing. Finishing equipment to give easy-care performance is essential. Controlled humidity and temperature are desirable but there are many situations where existing conditions will suffice.

The choice then is rather one of market analysis, availability of capital and, possibly of equal or even greater importance, technical skill in operating machines.

New Machinery Developments

98 There has been a real breakthrough utilising electronic patterning devices with a pattern area limited in width only to the circumference of the machine and in depth can exceed 62 in. Other machines with mechanical patterning devices include those which in addition to conventional jacquard patterning can also produce plush jacquard. In the warp knitting field a machine has been introduced which operates with a swinging needle bar to reduce the time needed for the guide bars to pass through and clear the needles. Improved weft insertion machines which reduce the danger of weft breakage have been introduced.

Technical Research

99 Mention must be made of some of the work carried out at the Technical Research Division of the International Institute for Cotton. A major effort has been made to introduce liquid ammonia-treated yarns into the knitting industry. Successful methods of knitting and finishing for these yarns have been established in the whole field of weft knitting and also two-fold yarns

in warp knitting. New trials are being carried out with single-end PROGRADE yarns for both warp and weft knitting sections.

The use of conventional ring spun yarns for ladies' knitted dresswear and men's shirts is being stimulated and exploited. Open-end spun yarns have been used quite extensively on single jersey and interlock machines of 18s gauge. Ladies' dresswear and jumpers were excellent, with good colours and a crisp, pleasant handle. Other activities include fabric mercerising and the knitting of twistless yarns.

Polyester/cotton blends were not so satisfactory as ordinary cotton and gave rise to pilling problems.

Methods of bulking cotton yarns for knitting are to be investigated.

<u>Conclusion</u>

100 The problem of recruiting qualified technical staff is acute, particularly outside traditional textile areas. When a decision has been made as to the type of fabrics to be produced, the simplest kind of machine available which is capable of doing the job should be chosen. This will enable the operators to get acquainted with the equipment and, given time, they will progress towards the more sophisticated types of machinery which will follow.

Chapter X

The Cost of Yarn and Cloth Faults

101 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.

The Cost of Cloth Faults in Garment Manufacture

102 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, Manchester, England 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

103 Investigations were carried out in five shirt factories and in five rainwear factories. A batch of cloth, never less than 1000 yards and sometimes as much as 3000 yards was obtained from each factory and examined at the Shirley Institute. The faults observed were recorded and frequent 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. Each 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. The costs included labour and materials involved in cut-outs and re-cuts as well as lost revenue from sub-standard garments.

Cloth examination

104 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. All faults observed were recorded, there being more than forty different types.

The amount of cloth inspection by the garment maker varied considerably. Of the five shirtmakers two examined one piece in 10, the other three none at all. Further examination, prior to sewing, but after cutting, was confined to collar tops and front panels. The factory making boys' shirts from the Tattersall check and the one making the warp knitted nylon shirt inspected nothing. In the case of the Tattersall check faults were relatively unimportant and in the case of the warp knitted shirts faults were significantly fewer.

The value of inspection by the garment makers during the early stages of garment manufacture is well illustrated by the results. For example, one rainwear maker who had 14% reject garments inspected only 5% of the fabric in roll form with no subsequent inspection, but another with 1.5% rejects inspected 100% in roll form and 100% of the panels after cutting out. A shirtmaker with 6.9% rejects inspected only a small sample of shirt fronts and yet two-thirds of the rejects were rejected on account of faults in the front panels.

Cost of faults

105 The average cost per fault in woven shirtings was 2.5p with an average of 906 faults per 1000 yards - about 2.25p per yard of cloth. In rainwear fabrics the average cost per fault was 5.6p with 930 faults per 1000 yards - about 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.

The cost per garment of cloth faults, based on the total costs of quality control systems, in which the labour cost is higher than the material cost, and the cut-outs and re-cuts, where the material costs more than the labour, varied considerably but the range was as follows:-

Shirts	1.6p to 12.[illegible]p.	Mean 6.0p
Rainwear	8.5p to 42.6p.	Mean 23.6p

On this basis the annual cost to the rainwear industry in the United Kingdom is £1,292,000 and to the shirt industry £1,434,000.

On a similar scale the annual excess cost for the whole United Kingdom garment industry would be approximately £30 million of which duplicated labour and wasted materials would account for 60%.

The cost per loom per year of a particular fault may be evaluated from this type of investigation.

The cost per loom per year of all faults is as follows:-

Lashing-in	£ 5.1
Starting place	£10.8
Broken picks	£12.6
Ends down	£12.6
Stains	£ 8.6
Weft slubs	£10.6
All other faults	£14.3

<u>Barriness Caused by Yarn Count Variation</u>

106 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

107 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 occurring 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.

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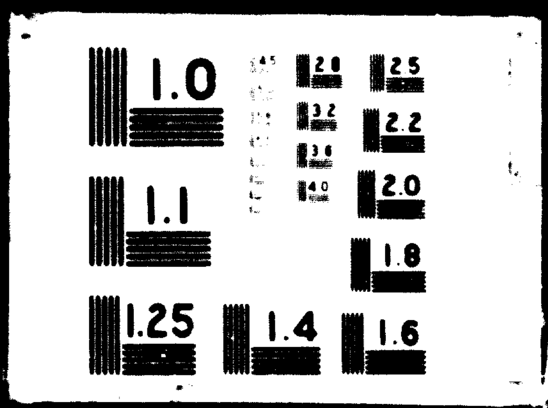

Chapter XI

Development in Progress

108 The following processes, still under development, were briefly described and discussed:-

Electrostatic spinning
Pavena-Pavil and Pavena-Paset processes
Twistless spinning
Self-twist spinning
Bobtex spinning
Aero-dynamic spinning
Fasciated spinning

109 The following points were brought out in discussion:

Electrostatic spinning

Yarns spun on this system were said to be almost equal to ring spun yarns at spinning speeds up to 25,000 r.p.m. Above this figure the quality falls dramatically, the aero-dynamic forces becoming far greater than the electrostatic forces.

Pavena system

The evenness of yarns spun on this system was alleged to be rather better than that spun by conventional methods. The appearance of the yarn is less affected by staple distribution. It is believed that, for a given yarn, it may be possible to use a cheaper cotton than that required for conventional spinning methods.

Twistless Spinning

At the present stage of development the economic advantage is said to be in counts of 35s Ne and finer where the saving of the cost of twist insertion is the greatest. The low extensibility of the yarn gives rise to no problems so far as weft knitting and its use as weft in weaving are concerned, but there is some difficulty in its use as warp in weaving. Once fabrics have been produced from twistless yarns they are quite durable and satisfactory. Cover is excellent and strength losses due to resin finishing treatments are less than with conventionally spun yarns.

Self-twist spinning

This system appears to be successful for long staple yarns but the fibre length is critical in short staple yarns. The short staple will not always bridge the gap of the low twist region.

Fasciated spinning

The yarns in the count range 80 - 100 decitex were claimed to be of much higher strength, free from snarls, have improved cover and lustre, than yarns spun by conventional methods. This yarn is said to have a silk-like handle.

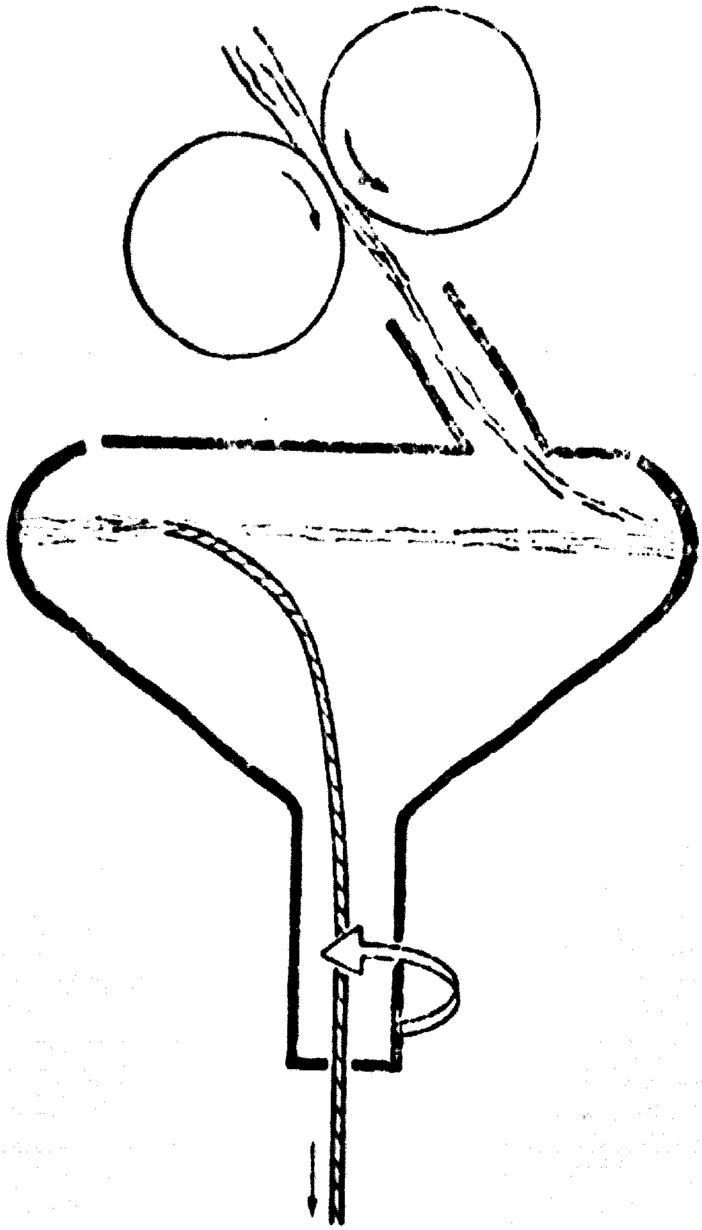

Fig 1

Appendix I

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