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# IMPROVEMENT OF PROCESSING METHODS AND PRODUCT QUALITY IN SELECTED TEXTILE FACTORIES

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CUBA

Technical report: Assistance to the textile industry*

Prepared for the Government of Cuba
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of
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## 1. Astract

Four large Cuban textile factories are reviewed by a team of three consultants: specialists in spinning, dyeing and finishing, and quality control, respectively. Recommendations are made for the solution of specific problems at each mill. These include: blending on the cotton system, dyeing and printing of polyester/viscose blended fabrics, production of towels and the production of denim. The consultants also make observations and recommendations on plant conditions and utilisation, productivity and product quality, and conclude that with existing raw materials and equipment substantial improvements could be made. Overall, the most urgent need is for better training at all levels and improved control over all aspects of manufacturing.

### Key Words

Cuba : textiles : cotton system : spinning, dyeing, printing : finishing : quality control : training.2.

Introduction

2.1. Background

The annual production of the Cuban textile industry is 250 million $m^2$, valued at 270 million Pesos, (315 million US dollars). Much of the installed capacity is relatively new; several major factories have been established during the last few years, with equipment from various sources, including Japan, Belgium, Holland, Soviet Union and Czechoslovakia. Despite the relatively modern machinery, quality and efficiency levels are low and raw material wastage in production is excessive.

2.2. Objectives

The aim of the project is to help solve specific production problems in selected factories; these problems are defined as follows:-

- The dyeing and finishing of polyester, viscose blends at textile factory "Desembarco del Granma" Villa Clara.

- Blending of polyester and viscose in spinning at textile factory "Celia Sanchez Manduley", Santiago de Cuba.

- Production of denim at textile factory "Ariguanabo", Havana.

- Production of towels at textile factory "Hilatex", Havana.

In Cuba, the Union Textil, the central organisation which, under the Ministry of Light Industry, is reponsible for the running of the textile industry, was also particularly intersted in comments and recommendations on the overall condition and performance of each of the four selected factories.

2.3 Activity

Three textile specialists: E Bernkopf (F.R.G. Spinning), A.H.A. Hassan (Egypt, Dyeing and Finishing), and L.J. Gibson (UK Quality Control), reviewed the operations in each of the four selected factories and each in his own speciality made recommendations relevant to the specified problems and also on the general condition and performance of the factory as a whole. The conclusions and recommendations of these three specialists are consolidated in the subsequent sections of this report.

At each mill, and at the Union Textil, verbal recommendations were made, in discussions with Directors, Managers and Technical Staff, for direct action on a wide range of problems: in some instances it was possible to demonstrate at the factory, for example improved methods of materials handling, new bleaching and dyeing recipes, and statistical methods for quality control.

The report should be used as an effective guide and check list for further action by the Union Textil and by the factories concerned in improving their efficiency, productivity and quality, and in formulating a policy for the overall improvement of the Cuban textile industry, and its contribution to the Cuban economy.

2.4. Distribution of the Report U.N.I.D.O

U.N.D.P.

Cuban Government.

## 3. Summary of Conclusions and Recommendations

The four factories reviewed in this project are all large installations. each is well equipped for production and quality control and each has extensive social and welfare facilities for its workforce of several thousands. Although there are marked differences between the factories. all four share the following characteristics:-

- Low productivity and low efficiency: each factory is working well below its rated capacity.

- A high proportion of substandard products.

- High labour turnover.

- Excessive process waste.

- Poor supervision. particularly in the control of labour.

- Ineffective quality control.

- Unduly protracted and largely inefficient training programmes.

Most of the yarn produced is below international and Cuban standards: this is mainly the result of poor workmanship in cleaning. maintenance and machine operation combined with a lack of supervision and quality control. Poor yarn makes a major contribution to low weaving efficiencies: frequent stopping of the looms gives low output and excessive cloth faults.

In quality control there is a propensity for testing and for classifying defects. in products and in operative performance. unfortunately this effort does not often produce the approriate remedial actions.

There is very low utilisation of dyeing and finishing plant and of the technical scope for variety in colouration and quality of finish that the plants afford.

<u>However. with the existing machinery and current raw materials there is the capability to produce much better quality goods. and the potential to substantially increase production and productivity</u>.

The specific problems nominated for each of these four factories have been addressed and detailed recommendations for their solution are made in Section 4 of this report.

The following general observations and recommendations apply to all four factories. and are considered to be of vital importance to the development of the Cuban textile industry as a whole.

The greatest single need is for improved training at all levels. from managers to machine operators. in the main. the industry in Cuba is young: there is no tradition of manufacturing industry. no fund of experience and no reservoir of skilled hands. Young graduates who have received technical training abroad. but no industrial apprenticeship are ill-equipped to manage without further tuition and guidance.

There are four areas of particular importance:-

- The training and retraining of machine operators by modern methods. to develop the good working habits. skills and confidence to handle a full workload with competence and a minimum of defects and waste.

- The training and retraining of maintenance workers. particularly in specific specialised tasks such as card clothing. grinding and setting. or loom tuning.

- To extend and improve the general standard of technical knowledge of materials. machines and processes.

- The development of supervisory and management abilities in every grade from foremen to top executives.

The first essential is the training of trainers: there is a need for experienced professionals first to train trainers and then to design courses for other grades of staff.

Quality control requires a fundamental shift of attitude and emphasis. Quality control. by definition must involve all those with managerial and supervisory responsibility for the product. and this involves production. technical and maintenance management as well as the department of Normalisation. Metrology and Quality Control (N.M.C.C.) and laboratory technicians. Management. through training and supervision should ensure that machine operators and service workers are equally concerned with quality. not only through quality circles but also in their attitudes and working habits. The notion that product quality is the proper concern of everyone should be actively promoted: Similarly. the idea that 'Grade I' should be the norm for all goods delivered by the factory.

The current policy of 'planning' for large quanitities of second and third grade products is a negative and defeatist policy which invites failure. Currently the bias of quality procedures is towards the measurement and classification of defects. This must be complemented by the identification and elimination of these defects: a task which demands the cooperation of N.M.C.C. with production and maintenance sections. under a quality-conscious management. positively directing the whole team towards a better end product.

The utilisation of existing dyeing and finishing capacity could be extended by developing new products. designs and styles and by offering improved finishes on existing fabrics.

<u>Any significant improvement in the performance of these four factories will depend upon the intent and ability of their managements to exercise more effective control over all aspects of manufacture. Initiatives in this respect will be entirely dependant upon the active support of the Union Textil and the Ministry of Light Industry</u>.

A prime opportunity to demonstrate the implementation of these general recommendations exists at the Textile factory 'Celia Sanchez Manduley' at Santiago de Cuba. This is the largest textile factory in Cuba: a truly massive investment. comprising 167.500 spindles. 1900 looms with 8300 employees and a rated capacity of 80 million $m^2$ per year. It is also the factory which is most critically in need of a 'renaissance'. In the six years since production was started output is currently some 46% of capacity and its rate of growth is slowing down.

This factory has excellent physical facilities for training in the form of a school on site. with class rooms and workrooms well equipped in a building with approximately 5200 $m^2$ of floorspace: an ideal place to set up a training and retraining programme to meet the factory's immediate needs and a possible location for a centre of excellence which could. in time. serve the whole industry.

One suggestion is to set up a modern training establishment in the existing school at 'Celia Sanchez' and at the same time to take one line of production in the factory. from opening to finished product:to systematically upgrade machine condition. settings. technological parameters. and to drive this one line to the performance and quality standards of the original plan. In addition to the technical improvements. better working methods and operationals controls would be introduced to increase machine and operative productivity. This line would then serve as the proving ground for the first waves of the re-trained workforce and also as a model for the correction of other lines. First class trainers, and technical and managerial assistance would be needed for such a scheme and the whole hearted involvement of the Government, particularly in matters of executive control, incentive and motivation, would be essential.

In the event that such a project were to be considered with the assistance, through U.N.D.P, of U.N.I.D.O., the following conditions should be among the <u>essential prerequisites</u>:-

- A total commitment on the part of the Government to the implementation of the project: this could take the form of a high level committee, empowered to commit and maintain the agreed resources and to authorise the agreed activities.

- That in matters of accomodation, transportation, communication and travel, expatriate consultants, advisers and technicians should be independent of the Union Textil and the Ministry of Light Industry.

- That expatriate's salaries and allowances in Cuba should be paid in useable currencies (Cuban Pesos and US Dollars) and not restricted to exchange certificates.

## 4.1 Textile factory "Desembarco del Granma", Villa Cara

This factory is the outcome of a Japanese project started in 1974, with mainly Japanese machinery and technology of that era.

Concept, construction, layout and machinery are good, and although this is not the newest factory in Cuba the technology and equipment are the most advanced of all the mills visited.

The plant came into production in 1979: designed for an annual output of 60 million m² woven fabrics in cotton and blends on the cotton system: delivering apparel fabrics in bleached, dyed and printed styles.

Unfortunately, due to logistical difficulties, the visit to Villa Clara was curtailed to only 1½ days from the 3 days originally scheduled at the factory. A formal request for a return visit by one member of the consultant team was ignored by the Union Textil. Accordingly, figures for production and product quality classification, which were promised, were not delivered.

The particular problem associated with this factory is described as "dyeing, printing and finishing of polyester/viscose blend fabrics", and this is certainly one of a number of problems with which the factory has to contend. There are three separate problems associated with the processing of polyester/viscose blends after weaving:-

- The effects of inadequate blending which contribute to streaky and uneven dyeing.

- Uneven fabric tensions at the loom which produce waves or ripples in the cloth, and, since all subsequent processing is in open width, the fabric is difficult to handle at all stages through inspection bleaching, dyeing and printing.

- Poor fastness to rubbing in polyester/viscose fabrics printed with pigment colours.

Considering the first of these problems and quoting the team's spinning consultant, "Blending uneveness occurs from too few doublings in the preparation for spinning. Normally the total number of doublings should be two or three times the number of fibres in the yarn cross-section. In this instance the minimum doublings should exceed 300. It is recommended that an extra passage of drawing, feeding eight ends, should be introduced.

Thus the total doublings would become. 3 (at the opening line) x 8 x 8 x 8 = 1536. Even this number is not excessive and checks should be made using differential dyeing of the components in the final yarn to judge the effects of the proposed change in the process on the uniformity and intimacy of the fibre mixture.

The wavy fabric problem has two sources. The first concerns fabrics woven on the Picanol MDC looks at 'Desembarco'. Here the difficulty appears to arise in the lack of uniformity of the grip which the take-up roller exerts on the fabric during weaving. There is. apparently. variation in the degree of frictional force experienced by the fabric at different parts across its width. such that some parts are strained more than others. The problem arises when the fabric is relaxed from the constraints of the cloth roll during examination. and waves develop in the over- strained sections. In the first place such cloth cannot be sheared of its loose threads because of the risk that the shearing blades will cut the ripples and totally ruin the cloth. Polyester/viscose fabrics are not usually heat set on a stenter until after dyeing - consequently the waves and ripples are a source of difficulty throughout open width preparation and dyeing. causing particular problems with uneven padding. and with creasing. Efforts are already in hand at 'Desembarco' to improve the loom take-up of polyester/viscose fabrics by re-covering the loom rollers with a high friction surface to give better and more uniform control. Trials are being made and early results show promise.

The second source of wavy fabric is at the selvedges of polyester/viscose fabrics which are produced at 'Celia Sanchez' in Santiago de Cuba. and sent to Villa Cara for dyeing and finishing. There the difficulty is a selvedge which is substantially thicker than the body of the cloth so that. as the cloth is rolled under tension the selvedge areas are overstrained and subsequently develop waves. This fault must be cured by redesigning the structure of the selvedge. The persistance of this particular fault appears to stem from a too rigid adherance to the 'Project' specifications and/or a lack of knowledge in fabric design. It also illustrates the ineffectiveness of quality control at "Celia Sanchez".

The third polyester/viscose problem is the poor rub fastness of pigment prints. To alleviate this difficulty it is recommended that the quantity of emulsifier in the print paste should be reduced.

Excessive amounts of emulsifier can lead to instability of the emulsion and subsequent poor fastness to rubbing. It is also suggested that an addition of urea and a cross linking agent be made to the print paste; this will increase absorption as well as fixation of the binder to the fabric. However, printing pastes containing such cross linking agents should not be stored for more than ten hours before use.

### 4.1.1. Spinning

The spinning section of this factory has 114,048 ring spindles operating an estimated running efficiency of 85%. In the main the machinery is in fair condition.

The yarns in regular production are:-

| | |
|---|---|
| Nm 68 | 100% Combed Cotton |
| Nm 37 | 100% Carded Cotton |
| Nm 68 | 65% Polyester/35% Carded Cotton |
| Nm 68 | 65% Polyester/35% Viscose |

| Flow Diagram | Nm 68 Cotton | Nm 37 Cotton | Nm 68 PE/Po PE | Nm 68 PE/Po Cotton | Nm 68 PE/Vis |
|---|---|---|---|---|---|
| Opening | x | x | x | x | x |
| Card | x | x | x | x | x |
| Pre-comber drawing | x | | | | |
| Lap forming | x | | | | |
| Comber | x | | | | |
| Drawframe | | | | | |
| 1st Pass | x | x | x | | x |
| 2nd Pass | x | x | x | | x |
| Roving | x | x | x | | x |
| Ring Spinning | x | x | x | | x |

Note that the polyester and cotton blend is made from carded slivers, blended at the drawframe with five ends of polyester to three of cotton at the first passage. Thus the total number of blending doublings is only 8 x 8 = 64, which is insufficient to produce a good fibre blend.

Polyester and viscose are blended from the bale on a Hergeth/Ohara opening line which incorporates a special blending unit. However, although this procedure probably ensures good control in the long term of the proportions of the components it does not guarantee an intimate fibre mix: this is dependant upon the blending capacity of the card and two subsequent drawframe passages each of eight ends into one. Spindle speeds in spinning range from 12.800 to 13.500 rpm with a 44 mm ring.

Average count is Nm 58 and the average twist factor (alpha metric) is 118.

Machine allocations in spinning are nominally:

Nm 68 - 5 machines per spinner
Nm 37 - 3 machines per spinner

However at the time of our visit the allocation of spindles in Nm 37 was reduced to one machine per spinner because of abnormally bad running conditions.

Automatic doffers were in use to doff the ring frames.

<u>Observations</u>

Three particular difficulties were mentioned by the spinning mill staff:

Uneven blends in polyester/viscose - this has already been treated in Section 4.1 above.

Excessive neps in cotton, and

A mysterious twist variation in some cotton yarns.

The cotton in use was indeed excessively neppy: this was without doubt due to a very low maturity ratio. Efforts had been made to measure maturity using the 'Causticaire' method with a quoted result of '0.74', although no-one was very clear about the precise significance of this value. Nevertheless the nep count made on cotton from the bale showed 350 neps per gramme. The Uster figure for neps per 1000 m of yarn was 2300 in Nm 68, this corresponds to 156 neps per gramme of yarn. According to the uster experience values this is still excessively high - despite the fact that over one half of the neps were removed in carding and combing. The root cause of the problem lies in the raw cotton, and there appeared to be no solution available other than trying to improve carding by closer attention to maintenance and settings.

An inexplicable variation in spinning twist was reported from 855 to 1020 T/m in Nm 68 100% cotton yarns. Examination of the spinning machines, drives and twist gearing indicates that the only possible explanation for this mysterious phenomenon is the method of testing. Greater care in testing procedure is recommended, cross checks between instruments and between operators should be made.

- opening and 'blooming' of the bales takes place in a very humid environment. RH 90-95%.

- the feeding of waste at the opening line is spasmodic and the amounts fed at any one time are too large.

- there is no magnet in the cotton opening line.

- too much good fibre in the waste extracted during opening and cleaning.

- many of the cards have damaged clothing, particularly on the doffers.

- can handling in preparation is not satisfactory; cans are, in general, packed too tightly with sliver and handled roughly and carelessly causing disturbance to the outer layers and unecessary waste.

- front top rollers, particularly at ring frames require more frequent maintenance and greater care in use: many are damaged and/or uneven surfaces.

- spindles, rings and yarn guides are often out of proper alignment and concentricity.

- operators do not collect and separate different grades of process waste.

- ring travellers are changed arbitrarily without reference to their condition or rate of wear.

- in automatic cone winding there are too many 'red light' faults, ie. repeated breaks or machine malfunctions, and the amount of bobbins 'rejected' by the automats is excessive.

- the overall waste percentage, at 15%, is too high.

Recommendations

Training methods should be completely redesigned. Labour turnover is 49% per annum. Only by having a well trained staff - management, supervisors and operators, properly motivated and well paid according to an incentive, will productivity and quality be improved. At present, training periods are too long and clearly do not produce the attitudes and skills needed to operate a factory of this calibre. With well trained operatives and supervision the spinning efficiency should reach 90 to 92% and work allocations almost double their present levels.

Training in particular is needed in the care and maintenance of cards; this is a critical operation in any spinning mill, requiring special skill and care. Once the cards are allowed to deteriorate, product quality will of necessity follow and it is a difficult and expensive business to recover from such a position. Shift the magnet from the PE/Vis line to the cotton line, it will be of greater use there.

Training, again combined with supervision, is the answer to poor can handling and excessive process waste in preparation. Step up maintenance, re-grinding of rollers and re-setting of spindles at the ringframe.

4.1.2.

The 'Desembarco' factory has a particularly good collection of equipment for bleaching, dyeing, printing and finishing as well as yarn dyehouse with a capacity for some 10 tonnes per day. Most of the machinery is of Japanese origin, with printing equipment from the Netherlands.

In preparation there are continuous production lines for scouring, bleaching, mercerising and heat setting. The dyeing section has a continuous line for Thermosol plus pad steam fixation, for Polyester/Cotton blends with disperse and vat or reactive dyestuffs: also a continuous Thermosol range for Polyester/Viscose blends: four jet dyeing machines and two jigs. The jigs and jets are rarely used. For printing, 3 Stork RD<u>IV</u> rotary screen machines with all requisite fixation, washing and drying facilities, served by a well equipped design studio and screen engraving unit.

<u>Observations and Recommendations</u>

A persistant and widespread problem throughout the finishing plant is that caused by wavy cloth - dealt with in 4.1 above. This fault and uneven blending contribute to uneven and streaky dyeings. Shade variations in blends could be further reduced:-

- in Polyester/Cotton blends, by allowing heat setting prior to dyeing. If the cotton component is overdried

- as it inevitably is at heat setting temperatures - its absorbancy is impaired. It is essential to leave the goods to ensure that they are uniformly cooled and at equilibrium with the ambient atmosphere before padding with dye.

- for Polyester/Viscose fabrics it is adviseable to carry out heat setting only <u>after</u> dyeing. this avoids the risk of over- drying before dyeing.

In the preparation of white fabrics a double bleach is used. and the expensive chlorite has been replaced by locally made and less expensive hypochlorite. This is a commendable change which might well be improved by the addition of 2 to 3 g/l of sodium bisulphite to the cold hypochlorite bleaching bath to protect against possible tendering of the fabric.

Yarn bleached on package. sometimes shows a yellowing after treatment with optical whitening agents or softeners. To avoid this effect the compatibility of the whitening agent and the softener should be tested in the laboratory to avoid precipication from incompatible components. It is also adviseable to dry the yarn at temperatures below 120°C. because some optical whiteners go yellow when exposed to high drying temperatures.

Variation in shade between the inside and outside of yarn packages is caused by uneven package density and must be cured by better control at the winding stage. When using vat dyes on cotton it is often better to reduce the extremes of package density by using smaller (20% less yarn) and softer packages. When attempting compound shades. laboratory trials should be made to check the compatibility of the component dyes. Wetting agents. retarding agents and levelling agents are often a great help in package dyeing - when used according to the makers recommendations.

Particular care is required when washing off prints made with reactive dyes on cottons: staining of the white ground is being caused by the faulty operation of the very efficient washing machine. To avoid this staining it is recommended that the following washing sequence is set up on the successive compartments of the machine:-

| Compartment | Treatment |
|---|---|
| 1 and 2 | Cold rinse |
| 3 | Hot rinse |
| 4 and 5 | Boiling water, detergent and soap |
| 6 and 7 | Hot rinse |
| 8 | Cold rinse |

At all costs avoid the use of counterflow between the different sections of the machine - in this way any unfixed colour released in one section cannot be re-deposited as a stain on pale or white parts passing through the preceding section.

All in all, much better use could be made of the excellent facilities and layout at 'Desembarco'. At present only about one third of the available capacity is used. Much more interesting and attractive prints could be produced, particularly by printing with dyes instead of pigments, and a range of easy-care and special finishes could be developed which would enhance the quality and value of the whole range of finished goods.

4.1.3 Quality Control

Quality control both in concept and in practice is an important part of the organisation at the 'Desembarco' factory. Well equipped laboratories are staffed by qualified and enthusiastic textile engineers and technicians.

All grey cloth is examined, at a low speed and with care. Fabric faults recorded are according to type and probable cause, quite recently computer analysis of the inspection reports has been introduced to breakdown the various identifiable defects by loom, by cloth type, and by weaver. Loomstate fabrics are visually examined and classified according to Cuban standards.

N.B. Copies of Cuban standards for yarn and cloth classification were formally requested from the Union Textil but these were not delivered. An extract from the standards for fabric classification is reproduced below and an extract for the yarn classification scheme is given in 4.4.3 'Hilatex'.

Fabrics are grouped according to end use as follows:-

Group A. Export and/or aparell fabrics

B. Workwear and/or uniform fabrics

C. Auxilliary fabrics for the garment industry for example linings and pocketings.

Within groups, pieces are graded according to a points system based on fabric faults: a major fault such as a missing pick rates 2 points and a minor fault such as a short slub rates 1 point. Grades are based on the average points per 10 metres of cloth as follows:-

| | Points per 10 m | |
|---|---|---|
| Grade | Group A | Group B |
| 1st | up to 3 | up to 5 (including up to 2 major faults) |
| 2nd | up to 5 | up to 7 |
| 3rd | up to 8 | up to 10 |

Figures for the proportions of each grade in current production for both yarn and fabric were requested but these were not available during a short visit. A request for a return visit by one member of the consulting team was ignored.

Finished fabrics were tested for width, area density, construction warp and weft strength, colour fastness to washing, perspiration and rubbing, and for residual shrinkage. These tests are required for certification of all deliveries of group A and B fabrics under Cuban Standards. Since deliveries are frequently made in small lots the rules for certification place a very high load on testing facilities which could be reduced by allowing certification of whole production batches.

A particularly troublesome and common fault in polyester/viscose blended fabrics is waviness in the grey fabric which creates difficulties at all processes after weaving from shearing to finishing. This fault has been attributed to lack of uniform control of cloth tension at the take-up roller on the loom. Trials are already in hand to improve the uniformity of take-up tension.

One quality of cotton is issued to this mill. a class II cotton from the Soviet Union, with the following nominal characteristics.

| | |
|---|---|
| Staple length (mm) | 39 to 40 |
| 2.5% span length (mm) | 35 - 37 |
| Short fibre < 25 mm (%) | 15 |
| Micronaire | 3.4 to 3.6 |
| Maturity | Not known |

This cotton although reasonably clean, had a stringy appearance in the bale (as if it may have been ginned with too high a moisture content) and it was certainly very immature and neppy. Cotton from this particular batch was the source of an epidemic of neps in all cotton and cotton blend yarns. The quality control department made two categories by selection of 'better' lots from within the bulk deliveries, but were otherwise powerless to 'control' the situation. The otherwise well-equipped laboratory does not have a modern maturity tester, nor apparently the means or experience to apply the Cuban standard test which is the classical method of counting the 'normal' and 'dead' fractions of a sample of fibres treated with caustic soda.

The cards are chute-fed, and each card has a regulator which can be adjusted by hand. the quality control section in spinning is making a special study of the cards with a view to improving regulation and control at the card and to minimising the variation in the sliver linear density.

The laboratories at 'Desembarco' are particularly well equipped, for example in the physical testing laboratory there are two Uster Evenness Testers, two Uster Dynamats, two Micronaire testers, Fibrograph, Pressley tester, and all the usual wrap reels and blocks, balances, microscopes and twist tester. The chemical laboratory is equipped with all the necessary analytical equipment for materials and process testing and control, and in a finishing laboratory all the equipment for fastness testing, three washwheels, Xenon light tester, crockmeter and a full set of pilot scale equipment for the development and checking of recipes.

In addition to the laboratory facilities, peripatetic quality controllers make the rounds of the production departments, observing and noting any abnormalities in the condition and performance of machines, working procedures and atmospheric conditions. All machines are checked each week and reports are made to the head of each brigade.

It is difficult to make a fair assessment of this system in a short visit but the prevailing impression is that checking, testing, recording and classifying absorb the greater part of the effort and correction and actual control are relatively rare occurrences.

Although a major product of the NMCC department is an extensive and detailed range of quality statistics, there are signs that practical control, stimulated by the quality control department is developing.

## 4.2 Textile factory "Celia Sanchez Manduley", Santiago de Cuba.

Combinado Textil "Celia Sanchez" is a vertically integrated company. making finished fabrics in 100% cotton, and a blend of 65% Polyester/35% Viscose rayon for the Cuban market. This is a large and ambitious project consisting of five plants two each for spinning and weaving (with a total of 167,500 spindles and 1900 looms), and one for finishing. The project was conceived and planned in the last decade and production machinery and technology are of early 1970's vintage. Production was started in 1983 with a view to reaching the planned output of 80 million m$^2$ in five years. Now, after six years operation, actual output is some 46% of the planned value.

Reasons for this disappointing performance include late and partial delivery of some machines, and a chronic lack of spare parts (despite the in-house capability for casting and machining up to 750 Tonnes per annum of machine parts). However, even in those plants which have a complete inventory, efficiencies and productivity are less than 50% of the level's required to meet the production target. The main reason for this is a general lack of experience and training on the part of managers, supervisors, technical staff and operatives. Not only has this vast complex been built on a 'green field' site, it has been located in a region which has no tradition or previous experience in textile manufacture. The total number of employees is 8300 of which 800 are currently in training. Young engineers who have received academic training abroad, but no practical apprenticeship under factory conditions are, in general, ill-equipped to manage effectively. Supervisors and technical staff have only superficial knowledge and understanding of the technology and machinery and this knowledge is strictly limited to their particular section of "the Project": that is, of the conditions laid down in the original plan. Judging by observed performance and by product quality, most operators are inadequately trained and/or poorly motivated.

The rate of increase of production appears to have slowed to the point where there is a serious risk that it will settle at the current level, or possibly even begin to wane unless prompt and positive action is taken to raise efficiency and productivity.

The first general recommendation is for better training and re-training of all levels from managers to operators.

The complex has excellent physical facilities in the form of a school on site, with classrooms and fully equipped workrooms in a building with approximately 5200 $m^2$ of floor space. The need is for experienced specialists in training methodology, initially to train trainers and to set up a training programme to meet the factories needs.

The second major recommendation is a plan for the renaissance of the factory's production facilities with the aim of reaching target efficiencies and outputs with the existing machinery. The suggestion is to take one line of production, from opening through to finishing and to systematically upgrade machine condition, check settings and technological parameters and to drive this line to the performance and quality standards required by the original plan. In addition to technical improvements, working methods and operation controls should be introduced to increase machine and operative productivity. This line will serve as the practical proving ground for the first wave of the retrained workforce, and as a model for the systematic correction of other lines as the benefits of retraining, and upgrading make themselves felt. First class technical and managerial assistance should be directed to this scheme to supplement the efforts of the specialist trainers, and the whole hearted support of the Union of Textiles and of the Ministry, particularly in matters of executive control will be essential for the success of such a scheme.

The specific production problem cited for this factory, "The blending of Polyester and Viscose in spinning", pales almost to insignificance when compared with the sum of the other difficulties which this massive installation presents, however, blending is in fact limited by the number of 'doublings' in the process and this limitation is aggravated by the prevailing practice of overloading the manually-fed hopper feeders and by the irregular feeding of reprocessed waste. The process comprises four hopper feeders, two for polyester and two for viscose, and these are set to deliver continuously, without weighing, each fibre type in the required proportions (65% Polyester 35% Viscose): a fifth hopper feeds recycled waste, already blended. Thereafter the only doublings are at the drawframe; two passages each of six ends into one. Thus the total number of doublings (D) is 4 x 6 x 6 = 144, which barely exceeds the number of fibres in the cross-section (N) of the coarsest count spun (Nm 27). The theoretical minimum number of doublings, when D=N, applies to 50/50 blends and assumes total separation of individual fibres and completely random fibre movement.

In practice, as a safety factor, D is chosen to be very much greater than N, even for 50/50 mixtures, and greater still for biased blends. It is recommended that at least one further passage of drawing be introduced and if possible, that the number of ends fed at each passage be increased from 6 to 8. Operators feeding the hoppers must be required to put in smaller quantities and to do so more frequently: This will require more attention and effort, and training and supervision will be needed. The feeding of waste should be limited to 5% of the total and it is particularly important that this small amount be introduced at a constant rate.

### 4.2.1 Spinning

There are two spinning plants at Celia Sanchez, one for cotton only and the other for Polyester/Viscose yarns.

Each is briefly described below:-

**The Cotton Mill**

Count Range Nm 40 and 50 carded and 61 combed, also
Nm 40/2 : 50/2 and 60/2 produced on spin-twisters.

Flow Diagram

| Process | Nm 61/1 & 60/2 | Nm 40/1 & 50/1 & 40/2 & 50/2 | Numbers of Machines |
|---|---|---|---|
| Opening | x | x | 6 lines each with 3 feeders + 1 waste hopper |
| Scutchers | x | x | 12 |
| Cards | x | x | 162 |
| Pre-comber drawing | x | | 6 |
| Lap former | x | | 6 |
| Comber | x | | 30 |
| Drawframe 1st pass | x | x | 14 x 4 deliveries |
| 2nd pass | x | x | 14 x 4 deliveries |
| Roving | x | x | 20 |
| | | | Spindles |

The Cotton Mill cont.

| Process | Nm 61/1 & 60/2 | Nm 40/1 & 50/1 & 40/2 & 50/2 | Numbers of Machines | |
|---|---|---|---|---|
| Ring Spinning | x | x | 134 | 57.888 |
| Spin Twisting | x | x | 75 | 23.400 |
| | | | Total spindles | 81.288 |

Spindle speeds r.p.m. Spinning 9800 ring 45 mm
Spin Twisting 8000

End breaks/1000 sp hr 90-120 in spinning
70-80 in twisting

Alpha metric 115 to 120

Machine allocation per spinner:
Nm 61 - 4 machines
Nm 40 or 50 - 3 machines

Two fold yarns - 1 machine

## The Polyester/Viscose Mill

Count range: Nm 25 : 40 : 60 } 65% Polyester
also 60/2 : 40/2 + 25/2 } 35% Viscose

Fibre dimensions. Length 38 mm. 1.7 d tex.

| Flow Diagram | All Counts | Numbers of Machines | Spindles |
|---|---|---|---|
| Opening | x | 6 Lines, each with 4 feeds and 1 waste hopper. | |
| Scutchers | x | 12 | |
| Cards | x | 135 | |
| Drawframe | | | |
| 1st pass | x | 15 | |
| 2nd pass | x | 15 | |
| Roving | x | 18 | |
| Spinning | x | 154 | 64.296 |
| Spin twisting | x | 55 | 17.160 |
| | | Total spindles | 81.456 |

Spindle speeds r.p.m. 8500 in spinning
9200 in spin-twisting

Ring frames:
123 (P66-SM) 432 spindles each 45 mm ring
31 (P83-SM) 360 spindles each 51 mm ring

End breaks/1000 spindle hour:
35-70 in spinning
70-80 in spin twisting

Alpha metric 115 to 120

Machine allocation per spinner

| | | |
|---|---|---|
| Nm 60 | = | 4 machines |
| Nm 40 | = | 3 machines |
| Nm 25 | = | 2 machines |
| Spin twisters | = | 1 machine |

Average yarn count = Nm 49

Observations

In the main, most of the following observations relate to both spinning plants: where specific comment is intended particular reference is made.

Throughout the whole process from opening to spinning and twisting, there is a lack of well trained operators: most appear to have scant knowledge of how to do their work properly and levels of manipulative skill and work rate are low. Operators, foremen and managers alike appear to be unaware of the importance of keeping machines clean, particularly the drafting elements.

Training facilities are well equipped, but training methods should be redesigned, to provide more comprehensive and effective training. The maximum number of trainees per trainer should be limited to eight and the training given should be shorter, more thorough and more intensive.

On the whole the pace of work is slow, really skilled operators are very few and there is little awareness of the need to keep machines clean and to keep waste to a minimum.

- The feeding of waste fibre is irregular and too much waste at a time is introduced.

- In PE/VIS blending, the hoppers are overloaded.

- None of the opening lines incorporate magnets to remove metal

objects which can cause fire and damage to machinery.

- Off-standard laps are allowed to go forward to carding.

- Cards are generally in poor shape. dirty and frequently with damaged surfaces on cylinders and doffers. Cleaning and grinding. particularly of flats is required.

- At the drawframes there is an excessive quantity of fly, mostly between the drafting zone and the coilers.

- At the roving frames. irregular settings prevail, the distance between rollers varies, between frames and even within frames.

- The roving frames are particularly dirty. especially in the drafting zones where accumulations of fly. roller laps. and fibre tufts on clearers appear to be totally ignored. All these interfere with smooth operation and good quality and this is reflected in the excessive breakage rate of 10 to 15 breaks per 100 spindle hours.

- Top drafting rollers from drawframe to ringframe and spintwister are dirty. uneven in diameter and surface finish.

- As a general rule breakdrafts are too high.

- The same Nm of roving is used for all yarn counts.

- Ring frames and spintwisters alike are very dirty, frequently with mis-aligned rollers, spindles and yarn guides.

- Pneumatic broken end collectors are often out of line and/or blocked with waste: this aggravates a poor spin by creating roller laps.

- The whole spinning system, in both mills, is producing unsatisfactory yarn because operatives are not well trained. because cleaning and maintenance is neglected and because supervision and control are lax.

- A combination of inadequate machine maintenance, poor settings and careless working habits is causing excessive waste.

- Machines are supposed to run and to produce, even during breaks for lunch. From 1200 hours to 1615 most machines are stopped because of

- lunchtime
- machine cleaning?
- shift change

The other shift changes at 2000 hours and 0400 hours seem to have a similar effect because the overall efficiency of the spinning plants is in the range 37 to 42%

Recommendations

- Waste Control

| | Waste (%) | | | |
|---|---|---|---|---|
| | Cotton | | Polyester/Viscose | |
| | Actual | Recommended | Actual | Recommended |
| Opening | 8.6 | 3.5 to 4.0 | 7.9 | 1.0 to 2.0 |
| Card Strips | 2.9 | 2.8 to 3.0 | 0.9 | 0.6 |
| Roving | 2.4 | 1.0 ) | ) 6.7 | 1.0 |
| Sliver | 3.7 | 0.5 ) | | 0.6 |
| Pneumafil | 5.7 | 2.7 to 3.0 | 2.8 | 2.2 |
| Thread | 0.9 | 0.2 | 0.7 | 0.1 |
| Other | 6.5 | nil | 3.0 | nil |
| | 30.7 | | 22.0 | |

These excessive waste levels must be rectified by training, supervision and better process control.

- In the Polyester viscose plant the spin plan should be changed to make different counts of roving for the different yarn numbers. The aim is to optimise drafting at the ringframe, particularly by reducing breakdrafts which are generally too high and contributing to yarn irregularity by permitting uncontrolled fibre movement. The following scheme has been suggested to the manager of the PE/V spinning plant.

| Roving Nm | Yarn Nm | Spinning Draft | Breakdraft | |
|---|---|---|---|---|
| 1.8 | 61 | 33.3 | 1.8 } | All P66-5M Machines |
| 1.5 | 51 | 33.3 | 1.8 } | |
| 1.2 | 40 | 33.3 | 1.8 } | |
| 0.8 | 25 | 33.3 | 1.4 | P83-5M Machines |

- Operators at the opening lines must be taught to feed properly

- frequent small amounts and waste only at a low constant rate. This will require extra effort and increased supervision and control.

- Install magnets in all opening lines.

- Increase frequency of card cleaning and inaugurate a card reclothing and refurbishment programme. Again training is essential in the crafts of card clothing. grinding and setting which are highly specialised tasks and their proper function is vital in any spinning mill. Without this effort cards will continue to deteriorate and with them yarn quality will also deteriorate.

- The passing forward of off-standard laps should not be tolerated: a special effort is required to bring lap weight variation under close control.

- Cleaning and maintenance of drawframes, roving frames and ringtwisters should be stepped up - dirty frames can only make dirty and uneven yarn. It should be noted that the spintwister works with uncleared yarn, and preserves the spinning faults of both components of the resultant yarn by twisting them in.

- Make trials to reduce the free fibre liberated at the drawframe for example, increase the sliver count, say to Nm 0.22 or 0.20: Try a higher humidity in the area.

- Separating the drawframes with plastic curtains from the rest of the preparation space: and/or slow down the delivery from 135 to about 110 m/min.

- Increase frequency of cleaning and grinding and replacement of top roller cots: operators in the roller grinding shop require retraining.

- The guiding principles must be:-

  Improve training

  Increase machine cleaning and maintenance standards

  Upgrade supervision and control.

4.4.2 Finishing

The nominal capacity for bleaching, dyeing, printing and finishing woven fabrics at "Celia Sanchez" is 80 million $m^2$ per annum, plus a dyeing capacity for 5000 tonnes of yarn on cone.

Grey fabrics are:- 100% cotton in a range of weights, all 120 cm in width and:- 65/35 Polyester/Viscose fabrics, 160 cm wide

Only 20 to 30% of the total capacity for bleaching, dyeing and finishing of woven fabrics is utilised.

After weaving, fabrics are sheared to remove loose ends, inspected, and classified and batched for transfer to the finishing plant.

The finishing plant has the following equipment:-

Preparation

2 Singeing machines with desize baths.

4 Continuous bleaching ranges, of which

  1 is a single stage process for narrow cotton fabrics.

  1 is a two stage (Benteler system) for narrow cotton fabrics.

  1 is a two stage (Benteler system) for narrow polyester/viscose fabrics and

  1 is a single stage process for wide polyester /viscose fabrics.

1 Mercerizing range - not in use

3 Heat setting stenters - of which 1 is not in use

2 Continuous dyeing ranges, both for 120 cm wide fabric

One of which is a universal continuous dyeing system consisting of two padder. loop dryer. pad-steam. washing and drying. Each unit can be operated independantly.

The other is a Thermosol dyeing range. with two padders. infra-red pre-dryer. drying zone. Thermosol unit. a pad-steam unit and washing and drying.

5 Jet dyeing machines. each with a 200 kg load capacity.

4 Jigs. enclosed type. each with a 250 kg load capacity.

4 shearing and brushing machines and one tenter frame for batching fabrics for printing.

4 eight-colour rotary screen printing machines.

A design studio. and fully equipped screen making section.

1 double-width high-temperature steamer for print fixation

1 continuous washing and drying range with 10 wash compartments

2 continuous finishing ranges one for fabrics up to 180 cm in width and one for narrow (120 cm) fabrics. Both ranges have after-washing. final drying and stentering facilities

2 finishing ranges for 120 cm wide fabrics. consisting of pad. pre-dryer. setting stenter and batcher

3 Sanforizing machines for 120 cm wide fabric

1 Three-bowl Calender for 120 cm wide fabric

1 Embossing Calender for 120 cm wide fabric

1 decatizing machine for 120 cm wide fabric

The yarn dyeing plant is a separate facility with its own winding and rewinding. 12 cone dyeing machines and 4 drying machines each of 500 kg capacity. The unit is capable of dyeing 25 to 30 tonnes per day.

However the yarn dyehouse has never been properly used. daily output never exceeded 2 tonnes and the unit has been closed down since December 1988.

Observations and Recommendations

The finishing plant inherits many fabric faults from spinning and weaving - chief among these are:-

- uneven blending in polyester/viscose blends which causes uneven dyeing.

- Wavy selvedges in polyester/viscose fabrics which are a persistantcause of trouble throughout bleaching. dyeing. printing and finishing.

[It should be noted that a great deal of polyester/viscose fabric is sent to the Desembarco del Granma factory at Santa Clara for dyeing and finishing. where difficulty in dyeing polyester/viscose is cited as their specific problem].

- loose threads hanging from the selvedges of cotton fabrics: this is another endemic problem at Celia Sanchez. arising from the fact that most of the cotton looms are without pirn-end cutters. The loose ends are supposed to be trimmed off by hand before inspection but enough are allowed through to present problems in finishing.

Cloth inspection is carried out at three inspection tables arranged in series behind each shearing machine. The cloth is inspected once. but on its way from shearing to batching it must pass over all three inspection tables. Each inspector has to wait until her reservoir of cloth is filled before she can start inspecting. and when all three have inspected their quotas. all wait again as the fabric moves forward to batching. this appears to be a particularly inefficient system. Faults are noted and classified. but not marked; there is no segregation of 1st. 2nd or 3rd grades; all go forward to finishing without comment. Most of the shearing machines are not working. either because they cannot cope with the wavy selvedges of the polyester/viscose blends or because the cutters are in need of sharpening and re-setting.

Preparation and bleaching

The four continuous bleaching have a combined capacity of over 100 million linear metres per year. however they are stopped for most of the time. waiting for grey fabrics or for lack of chemicals. In the interest of economy and to increase production the following recipes are recommended.

- for a single stage scour and bleach of cotton fabrics intended for dyeing or printing in pale shades:-

after desizing and washing the fabric should be treated with a solution containing:-

| g/l | |
|---|---|
| 35 | Caustic Soda |
| 5 | Sodium Carbonate |
| 30 | Hydrogen Peroxide |
| 20 | "Foryl" |
| 2 | Wetting agent |

- or a double bleach for cotton fabrics to be finished white:

Procede as above and treat in the second stage with solution containing:-

3 g/l Sodium hypoclorite.
adjust pH to 10.5 to 11.0 by adding caustic soda.

The fabric should be kept in the J box for one hour at room temperature: Heating will tenderise the fabric.

The operation of the mercerising machine is vitally important for the production of bright colours with vat and reactive dyes in dyeing and printing of cotton fabrics. It is also important for economic reasons: mercerized cottons require less dyestuff to produce a given shade. This machine has been installed for four years and is not yet operational. It's complete commissioning should be a matter of priority.

Production problems throughout bleaching. dyeing printing and finishing are created by inadequate and fluctuating steam supply. This is a basic design fault in the layout of the whole complex and in the selection of boilers. Consistant performance in all finishing operations depends upon its prompt solution.

Dyeing

Since most Polyester/viscose fabrics are made in 160 cm width, the Thermosol dyeing range cannot be used to dye them. Even narrow polyester/viscose fabrics cannot be dyed on this range at present because the maximum temperature attainable in the Thermosol section is 160°C which is insufficient for the thermofixation of disperse dyes on polyester fibres. Steps are being taken at the moment to raise the temperature to the necessary 180 to 200°C: This involves moving the circulating hot-oil heater and pumps much closer to the dyehouse. The pad-steam section of this range is also affected by poor and fluctuating steam quality and produces uneven dyeings on the cellulosic fabric components. As a result of these difficulties. most of the polyester/viscose fabrics. and their associated problems. are sent for dyeing printing and finishing to Desembarco del Granma at Santa Clara.

Shade variation between batches and examples of uneven and patchy dyeing were observed in polyester viscose fabrics dyed on the jet machines.

Cottons. vat dyed on the continuous range exhibited listing and tailing faults. It is important that concentration of the hydrosulphite reducing bath is checked and corrected frequently to avoid shade variations.

The capacity for dyeing wide fabrics containing polyester is limited by the jet machines which together could only handle between 3 and 4 million meters of the 20 to 25 million meters required each year. Production could be increased by dyeing both components of the blend from a single bath: this would increase output by about one third. Alternatively the viscose component could be dyed by the pad-steam technique. leaving only the polyester part to be dyed on the jet. Padding and drying could be done on a stenter and steam fixation in the print ager.

Printing

95% of all prints are made with pigment colours. Printing designs are very similar in style: some show poor edges and close-ups. In some pigment prints. white specks and uneven colour distribution were evident.

For cottons the printing department is not yet in a position to improve quality by switching to reactive colours because of the lack of mercerising and suitable thickeners: C.M.C. - used in lieu of sodium alginate produces poor prints.

However. reactive/disperse prints could be used to advantage on polyester/viscose blends. and the printing section has all the necessary facilities to make this change from pigment colours.

Finishing

Most fabrics are given only a temporary finish using starch/softener mixes. the use of glyoxal resin type finishes is very limited.

General

The major restraints on the proper and full use of the dyeing and finishing facilities at Celia Sanchez are:-

- The lack of adequate facilities for dyeing 160 cm wide polyester/viscose fabrics.

- The inavailability of the mercerizing range.

- Inadequate and fluctuating steam supplies.
- Inadequate stocks of suitable dyes and chemicals.

- Cloth faults originating in spinning and weaving.

- Inadequate maintenance which is causing deterioration of the machinery. - Lack of work for the printing section and in particular for the yarn dyeing section.

- Lack of knowledge, experience and training of most of the technical staff.

- Ineffective quality control - despite having a very well equipped laboratory. Quality control should not be under the direction of the production department.

4.2.3 Quality Control

Quality control is organised on a large scale, at 'Celia Sanchez' but is singularly ineffective. A total of 148 people, of which 15 are graduate engineers are engaged in the quality control function: in addition some 'quality control' tasks are carried out by technicians from the production departments.

There is a Central NMCC office in which the firms chief of quality control with a small staff, supervises the compilation of quality statistics for the combine as a whole and advises on test methods, and the interpretation of results. This office is responsible for normalisation and metrology and it's chief reports directly to the General Director.

Each of the five plants has a quality centre headed by an engineer who is answerable to the plant manager. There are three laboratories, one for each spinning plant and one for finishing. The quality centres in each plant operate the laboratories and also deploy peripatetic controllers who patrol the production areas checking on selected mechanisms, for example the operation of stop motions, and noting the performance of machine operators in relation to product quality.

The emphasis of these observations at 'Celia Sanchez' appears to be on the counting of the workers' misdemeanours.

Measurements and tests are made. results recorded. yarn and cloth parameters are classified according to Cuban Standards and statistics compiled of the proportions of yarns which fall into 1st. 2nd and 3rd grade. (Regular checking of the faults in finished fabrics has lapsed; occasional checks are made on a random basis).

Classification of yarns and fabrics is limited to the statistical requirement to set an 'actual' value against the 'plan' value in the official returns: no attempt is made to segregate the different grades. For example. a group of spinning machines producing a given count will be sampled and tested. and. the yarn will be classified according to the test results: it may be grade III or even below grade III but no further analysis or action occurs - the product from these machines goes forward with the rest. contributing to an overall reduction in yarn quality. Only the figures are separated in the report which eventually reaches the plant manager. the Central NMCC office and the upper echelon of management. Similarly in grey cloth faults are counted and recorded (not marked): each piece is graded according to a standardised points system. in due course the scores are analysed by cloth type. by loom. by weaver and by type of fault. but no actual segregation of the pieces takes place. all go forward to finishing without comment on their condition or recommendations for processing.

'On the spot' control in the weaving shed concentrates on recording the weavers' faults as they occur. but without the exercise of any effective control.

A typical example of the style of quality control at the shop floor is described below:-

Scutcher laps are produced on twelve machines. Each complete lap is weighed and accepted or rejected according to whether or not it's weight falls within fixed tolerance limits. Laps which are accepted are placed on a conveyor for transport to carding: those rejected are supposed to be recycled. There is no record of the numbers of good or reject laps. nor is any attempt made to relate lap weights on a sequential basis to the machines on which they were produced. however. for two hours on each shift a quality controller randomly samples laps which have already been passed. and records the numbers of laps which each operator should have rejected. but which have been allowed to go forward as 'good'.

Thus the quality centre. and the plant manager have no information about the day-to-day performance of the scutchers or of their regulation. but they do have regular estimates of the lack of integrity of the operators. The fact that such a method of control continues month after month demonstrates it's ineffectiveness and the lack of discipline in the plant.

The latest available figures for irregularity (U%) refer to the polyester/viscose blend and are now some months old:-

| Process | Nm | Range of U% |
|---|---|---|
| Card | 0.22 | 3.7 to 5.5 |
| Drawframe 2nd passage | 0.26 | 5.5 to 6.5 |
| Roving | 1.60 | 6.3 to 10.0 |

No values for yarns were available.

The following figures were extracted from recent yarn test results on polyester/viscose yarns:-

| Nm | Cv of Nm (%) | Yarn Strength g (force) | Cv of Strength (%) |
|---|---|---|---|
| 60/1 | 3.7 to 7.4 | 301 to 340 | 16 to 23 |
| 40/1 | 3.1 to 7.8 | 346 to 371 | 10 to 22 |
| 60/2 | 3.6 to 5.0 | 707 to 775 | 13 to 22 |

The general level of these results places them in the category of the world's worst 25%. It was noted that the values for CvNm are based on samples of different size: in the main the samples are adequate in size to obtain accurate estimates, however the lack of awareness of the effect of sample size on the statistical significance of the results, reflects a weakness in the procedure and a lack of knowledge of basic statistical principles.

Laboratories had originally been well equipped. The cotton spinning laboratory had Fibrograph, Micronaire, Pressley fibre strength tester, Uster Evenness Tester and Uster Dynamat. of these the Fibrograph and Uster Evenness tester are out of action 'awaiting repair': the Pressley equipment is not used for lack of knowledge and the Uster Dynamat is in need of attention.

Similarly the Uster Evenness tester in the polyester/viscose spinning laboratory is 'under repair', together with the lap variation tester.

Apart from these deficiencies both spinning laboratories have an adequate supply of wrap reels and wrap blocks, manual single thread strength testers, skein strength testers (not used), balances, moisture oven, and microscopes. Information on fibre properties is limited to that given by the suppliers and these data are in general not well understood.
No checks are made on cotton fibre length, length distribution, trash content, fineness or maturity. Cotton fibre strength is measured on a fibre dynamometer of Russian origin which registers the force to break a bundle of known <u>number</u> of fibres. The result is expressed as breaking load in grammes (force) per fibre.

The finishing laboratory has regular equipment for chemical analysis, plus fastness testing: Xenon testers (2), wash wheel, crockmeter, even a colour computer (although this has never worked properly and is deemed 'defective'). A second laboratory has a comprehensive collection of pilot-scale dyeing and finishing plant, ideal for the development of recipes, the specification of process conditions, and for trouble shooting. This installation includes miniature jigs, winch, steamer, print ager, and jet dyeing machine, together with pad mangles, laboratory ovens, and washer. This facility is little used, and there was very little checking on the shop floor (to control the strength of process solutions, the regularity of pad pressures, or the accuracy of process times and temperatures). The quality control staff in finishing do not have the knowledge and experience to control such a large and sophisticated plant.

Further training is essential.

Sizing was uncontrolled, the temperature and viscosity of the size in the sizebox is left to the operator. The variable quality of steam for drying, and the use of direct steam in the size box itself are constant sources of difficulty. One exception to this general dismal picture of quality control was the control of the linear density of drawframe sliver. This was carried out by technicians of the production department in each spinning mill. the testing of the sliver was done close to the machines and the results were quickly made available for action. Each machine was checked on each shift and the technician who made the test was empowered to order the changing of draft gears if necessary - checking immediately on the effect of any change. This procedure could be streamlined by the use of a control chart constructed on a proper assessment of the actual variability of the sliver. This technique was demonstrated at the factory and is recommended to simplify the testing and recording method and to improve communication and understanding by displaying the charts.

Technicians in the production departments also check the end breakage rates by observing one spinner at work for a two hour period.
The cause, and location of each break is recorded: here again the method could be made more effective - by a slight modification in technique and a major change in intent, which would transform counting breaks into a continuous campaign to eliminate 'rogue' spindles.

<u>Recommendations</u>

1. Product quality is the proper concern of all engaged in the manufacturing process: managers, supervisors, engineers, technicians, mechanics and machine operators should all contribute. As a general recommendation, the concept of quality management should be extended from the current limited notion of testing and grading, to include the rigorous search for the causes of faults and their prompt correction.

2. Although process control data should be collected close to the process in space and time and promptly transmitted to production staff for <u>action</u>. Quality control centres should report <u>directly</u> to Managers who have overall responsibility and not through those whose main concern is production.

3. Education and training of all those concerned with the interpretation of trial and test results, in statistical methods of analysis and control, is urgently needed. An understanding of sampling and the significance of results is essential.

4. Missing instruments, (Fibrograph, Uster Evenness Testers, and Lap Variation Tester) should be repaired or replaced: quality control staff and production technicians should be thoroughly schooled in the meaning and value of the results from these instruments, for regular monitoring and for trouble shooting.

5. Cotton fibre testing instruments should be supplemented by the addition of a Lint/Trash Analyser and Fineness and maturity tester.

6. Quality Control. technical and production staff. working together should mount a series of separate campaigns. each with a well defined but limited objective. designed to improve one aspect of product quality. Small teams. working intensively on one topic. should be used. with a strictly defined time scale and reporting deadline. Subjects which are suitable for such treatment are:-

6.1. A comprehensive audit of process waste and the development of better waste control procedures.

6.2. A comprehensive survey of scutcher lap weight variation. analysing the sources of variation. by line and by scutcher: minimise variations within and between machines. recalculate control limits: devise a system of weighing and recording which detects machine variation (variations culpably introduced by operators should not be tolerated).

6.3. Eliminate 'rogue' spindles in spinning. The aim is to establish an effective procedure to detect and repair defective spindles - (as an alternative to simply taking them out of production when they become troublesome).

6.4 Set up a control scheme to monitor the size content and moisture content of sized warps.

6.5 Survey the causes of downtime in weaving: investigating systematically the effects of yarn quality. size type and quantity. loom conditions. fabric construction. and weaving room atmospheric conditions.

7. Begin the systematic introduction of weft mixing on profectile looms.

8. Introduce control charts for the control of drawframe sliver count. This technique may also be used with advantage in other applications. for example in the control of lap weights. and/or in end break control or for count control generally.

9. Segregate fabrics for finishing by grade of grey cloth.

10. Overall education and training of technical staff. including quality controllers is an essential part of any campaign to improve quality in the Celia Sanchez complex.

## 4.3 The Textile Factory 'Ariguanabo'

The Ariguanabo Complex is the oldest of the four factories reviewed, and unlike the others it has evolved by extension and re-equipment, from a American owned weaving mill in the early 1950's to a completely vertical organisation with an annual capacity for 60 million $m^2$ of woven cottons: drills, denim, sheeting, printcloth and industrial fabrics.

The particular problem specified for this factory is the production of denim. This centres on the processing of the denim warp yarns, which is done in the classical manner by continuous indigo dyeing: the crux of the problem is in the frequent breakages which bedevil the warping process after dyeing. Two basic causes are identified: on the one hand, irregular yarns, in particular those with a relatively high coefficient of variation of strength: and on the other hand the operation of the indigo dyeing range is itself creating difficulties. As a result of infrequent running and relatively long stoppages, the dyetanks are encrusted with a thick layer of dense foam consisting of re-oxidised indigo dyestuff. When the machine is running this foam, which has a tacky consistancy, contaminates the warps and the squeeze rollers at the exit of each tank. This not only interferes with the uniform distribution of dyestuff, it also helps to make the yarns within each strand adhere to each other, with the subsequent difficulties in dressing and beaming. The combination of uneven yarns and frequent breaks in warping lead inevitably to frequent stops in weaving and excessive cloth faults. In normal, non-stop processing, with regular and frequent topping up of the dye tanks with vatted colour, regular and frequent feeding of a 'springer' solution of caustic soda and sodium hydrosulphate solution, and good circulation of the reduced liquor, the formation of an oxidised foam scum is inhibited: even so, tanks are sometimes covered and the warp strands withdraw through tubes which penetrate the surface of the liquor. At Ariguanabo, the following recommendations should help:-

- Arrange two sheets of stainless steel to form a narrow slot across each dye bath through which all the warps can exit without coming into contact with the foam. This slot should extend below the surface of the reduced dye.

- Add a third wash tank at the exit end of the range to give a final rinse in clean water at 60°C.

- Partially cover the tanks, maintain the dye in the reduced state, and improve the circulation within the tanks.

The question of producing yarns of more uniform strength must be tackled in spinning. As a rule, denim warps are made from ring-spun singles yarns and in this respect a level, well cleared single yarn is better than a two-fold yarn produced on the spintwister from poor quality singles components. Such folded yarns contain the spinning faults of both components and are particularly ill-suited for denims whose surface appearance is determined at the loom.

- As a general rule, the appearance of denim fabrics is markedly improved by the use of a single, rotor spun weft.

4.3.1. Spinning

Two mixings of cotton are used: 100% 2nd Grade Russian cotton for carded Nm 37 and 48 with trials in Nm 64; and a 65/35 blend of 2nd and 3rd Grades Russian cottons is used to spin carded yarns in the range Nm 16 to 30.

The machines are of Russian origin and between 15 and 20 years old. Cards in particular are in poor condition, cylinder, doffer and flat surfaces are damaged and card webs are uneven and frequently broken. Drawframes and roving frames, although very dirty are in fair condition; ringframes also are in fair condition and noticeably cleaner than the rest of the spinning plant.

Flow diagram

| | Nm<br>16/1 : 64/1 | Nm<br>25/2 : 37/2<br>48/2 : 64/2 | Nm<br>16/3 : 16/4<br>37.4 |
|---|---|---|---|
| Opening | x | x | x |
| Cards | x | x | x |
| Drawframe 1st Pass | x | x | x |
| 2nd Pass | x | x | x |
| Roving | x | x | x |
| Ring Spinning | x | x | x |

Flow diagram cont.

| | Nm | Nm | Nm |
|---|---|---|---|
| | 16/1 : 64/1 | 25/2 : 37/2<br>48/2 : 64/2 | 16/3 : 16/4<br>37.4 |
| Spin twisting | | x | |
| Assembly winding | | | x |
| Ring twisting | | | x |

Average yarn count Nm 33.7

End breaks

| Nm | Breaks/1000 spindles/hour |
|---|---|
| 64 | 55 |
| 48 | 40 |
| 37 | 50 |
| 25 | 30 |
| 21 | 30 |
| 17 | 30 |

Spin Plan

| | | | | | | |
|---|---|---|---|---|---|---|
| Yarn Count (Nm) | 64 | 48 | 37 | 25 | 21 | 17 |
| Roving | 2.7 | 1.8 | 1.8 | 1.35 | 1.35 | 0.9 |
| Draft | 23.7 | 26.7 | 20.6 | 18.5 | 18.5 | 18.9 |
| Spindle rpm (1000) | 7.3 | 8.1 | 7.1 | 6.4 | 6.1 | 6.3 |
| Ring dia (mm) | 51 | 51 | 51 | 55 | 55 | 57 |
| Alpha metric | 145 | 147 | 149 | 125 | 134 | 121 |
| Tpm | 1160 | 1048 | 906 | 625 | 614 | 499 |
| g/sp/hr | 5.88 | 9.91 | 12.73 | 24.48 | 32.28 | 44.54 |
| Running efficiency (%) | 93 | 88 | 94 | 93 | 90 | 90 |

Process Waste %

| Process | 100% 2nd Grade Cotton | 65/35 2nd & 3rd Grade Cotton | Recommended range |
|---|---|---|---|
| Opening | 6.5 | 8.9 | 4.0 to 4.5 |
| Cards | 7.6 | 7.8 | 3.0 to 3.5 |
| Drawframe 1st pass | 0.2 | 0.2 | 0.4 to 0.6 |
| 2nd pass | 0.2 | 0.2 | 0.4 to 0.6 |
| Roving | 0.5 | 0.5 | 0.4 to 0.6 |
| Spinning | 2.8 | 2.8 | 2.0 to 3.0 |
| Total | 17.8 | 20.4 | 10 to 12.8 |

Running efficiency based on actual yarn weights is 93%, however there is some doubt about the accuracy of this figure because of errors in the precision and consistancy of the tare weights, which could reduce the estimated efficiency to 90 to 91%.

Observations and recommendations

Training and supervision in opening and cleaning is needed to ensure proper feeding of the bale openers and waste hoppers. in general, feeding is irregular and the amounts fed at one time are too large. Bales are not properly stripped of their packings, shreds of which are sometimes passed forward with the lint.

Card clothing and settings, particularly flat settings are not satisfactory; considerable effort will be needed to bring the cards up to an acceptable standard and this is an essential pre-requisite for improving yarn quality.

The cleaning of cards, drawframes and roving frames needs to be improved, more frequent cleaning and more stringent supervision of cleaning teams are needed. Sliver cans are overfilled and handled without due care, this creates unnecessary waste and reduces the quality of the sliver.

Machines in ringspinning are noticeably cleaner and in better condition than those in preparation, however spindles, rings and yarn guides are frequently out of line and require resetting by the method demonstrated.

All-in-all the pace of work is very slow: this is largely due to inadequate training. and methods of training need to be revised and updated. Training and supervision is also required to reduce the quantity of waste produced and to separate the different grades of waste.

The weighing system for spun yarns needs to checked and corrected. Errors of 0.5 to 1.5% of production are being introduced by incorrect tare allowances.With well trained operators, properly maintained machines and revised technology there is the opportunity to increase output by about 20 to 22% in spinning.

### 4.3.2 Dyeing and Finishing

On average. during the first four months of 1989 the monthly production of the Ariguanabo finishing mill was 3.319 million $m^2$: of which about one half was printed and the rest finished as white or dyed fabrics. About 54 tons per month of yarn is dyed for denim warps. Actual production of fabrics represents some two thirds of the installed capacity of the finishing plant.

#### Preparation

The mill does not have a shearing machine, and loose threads and hanging ends cause many faults, particularly in printing. Although there is a singeing and desizing machine, it is not in use for lack of parts to complete its connection to the gas supply. Thus singeing and desizing are omitted and the fabric enters directly into the scouring process. The mill has three continuous scouring and bleaching ranges: two of these process the fabric in rope form and the other in open width, is used mainly to prepare fabrics for dyeing.

The feeding of chemicals and bleaching agents is done manually and fluctuations in the concentration of the impregnation baths are apparent from the results of hourly checks. Such differences cause varying degrees of absorbency in the treated fabric and hence variation in subsequent dyeing and finishing. To maintain closer control of the concentrations it is recommended that each impregnation bath is sharpened by continuous addition of concentrated stock solution regulated through a flowmeter. and that control checks are made on a half hourly basis.

Dyeing

The dyehouse is equipped with one pad-dry machine: one pad-steam range with washing and drying: one pad-skying range with washing and drying and four covered jiggers. The first two of these machines are used to apply vat colours on a continuous basis.

Economies in the cost of dyestuffs could be realised by:-

- replacing most vat colours by reactive dyes

- by using solubized vat colours for fast pale shades

  and

- by using naphthol dyes for specially deep shades:

colour yield of these dyes can be increased by intermediate drying and the pad-dry machine would be ideal for this purpose.

Shade variations and tailing were observed in fabrics dyed with vat colours on the continuous range.
It is paricularly important that the concentration of the reduction bath should be more closely controlled.

Some of the furnishing fabrics produced could be dyed and finished in one operation by the application of pigment colours in a continuous process, giving savings in labour and power costs. With the development of binders which form stable emulsions in water, the system of applying pigments by the pad-dry-bake process is made possible.

Printing

The mill has five roller printing machines and one flat bed screen printing machine on which up to seven colours may be used. 90% of all prints are made with pigments and prints are mostly very simple designs with up to four colours.

Two thirds of the faults in printed fabrics are attributed to spinning and weaving faults, the main ones being due to poor selvedges and unsheared threads on the surface of the cloth. Common printing faults include; colour variation across the width due to unequal pressures on the ends of the printing rollers; doctor blade streaks; white spots due to insufficient depth of engraving; and poor fitting due to lack of precision in transfering the design components to the print rollers.

In addition to the correction of these faults the following recommendations are made for the general improvement of print quality.

- Care should be taken that the fabric is uniformally dried. and allowed to cool and condition before printing starts. Avoid overdrying which causes yellowing of the substrate.

- Alkaline residues on the cloth reduce the brilliance of pigment prints: their presence must be checked and all traces removed during preparation.

- A high quality apirit should be used in preparation of the print past. The high sulpher content associated with the lower grades of white spirit cause a reaction which reduces the colour yield.

- After printing the goods should be thoroughly cleared before padding with any finishing agent.

Caustic Soda crepe effect

It is well known that conc. Sod. Hydroxide causes swelling of cellulose and shrinkage takes place particularly when the operation is carried out without tension. In this case. the printed part shrinks and the unprinted part remains unaltered; giving a crepe effect. Printed stripes in the warp direction are the most common way to produce a caustic crepe effect.

Printing Paste

5.75 parts British gum

5.75 parts Hot water

1.90 parts Cold water

1.90 parts Maize starch

- To this mixture 28 parts of caustic soda 45° Baumé should be added very slowly and carefully using a mechanical stirrer (the worker wears gloves and glasses).

- Depending on the width of the stripe a further 40-60 parts of caustic soda 46° "Be" should be added to the previous mixture. The narrower the stripe the less caustic soda must be added.

Working Procedure

- The goods are printed with a stripe-engraved roller with the above mentioned printing paste. stored without drying for 1/2 to 1 hour in wet condition.

- Wash on winch with cold water. acidified with 2 g/l sulphuric acid for neutralisation.

- In the last wash. add 2 g/l starch to obtain better handle.

- Centrifuge and dry on a pinstenter with overfeeding.

- It is important that all operations be done without tension and suitable dyes to be selected which can stand such strong alkali.

At present finishing consists only of the application of starch and softening agent. Easy-care finishes and special finishes to suit particular end uses could and should be tried to improve the range and value of the manufactured goods.

4.3.3 Quality Control

Normalisation. Metrology and Quality Control (NMCC) at Ariguanabo has an establishment of 98 people. of which 8 are graduates and the rest technicians (technico medio). The department which is answerable to the General Director. operates two laboratories and deploys quality checkers who operate within each production department. There is only partial examination of woven fabrics in the grey state: those pieces which are destined for sale in loomstate are inspected and classified for certification according to Cuban standards. Other grey fabrics are sampled and inspected mainly for the purpose of the statistical record. Dyed finished and printed fabrics are also inspected and classified: a calculation based on the records of the finishing department for the first four months of 1989 shows 60% grade I. 20% grade II and 22% grade III: this excludes denim fabrics and fabrics sold in the grey state. 100% inspection and grading of grey fabric is scheduled to begin in 1990. The introduction of shearing. singeing and desizing would all contribute to improved quality in finished fabrics. Figures for yarn quality classification were promised but not delivered. In the event. such figures would have been a partial guide only: the Cuban standard calls for an assessment of yarn appearance in addition to the physico-mechanical tests. and. like the other mills visited. Ariguanabo omitted the appearance test although it was equipped to do it.

The physical laboratory which served the spinning and weaving departments was equipped to assess yarn count, strength, twist and visual appearance, as well as cloth construction, strength and resistance to abrasion. In the fibre laboratory cotton fibre length parameters were determined by comb sorter, fineness by the gravimetric method and maturity by a Russian technique in which untreated cotton fibres were classified into ten groups between dead and fully mature: the modal value of the frequency distribution obtained by microscopic examination of some 250 fibres per sample, was quoted as the maturity count. The significance of the test result is a matter of experience and the use of this rather difficult test is questionable, particularly in view of the fact that the Cuban Standard is based on the classical microscopic examination of fibres after treatment with 18% Caustic Soda solution. There was also a lint/trash analyser and Micronaire instrument. The fibre laboratory was assisted by having a trained cotton classer to check on bales in the delivered batches.
Since the cotton was issued to the mill, their efforts were limited to shuffling bales within a batch in an attempt to get even-running mixings.

The laboratory had no Fibrograph, no Fineness and Maturity Tester, no Uster Evenness Tester and no Dynamat. The acquisition of these instruments is strongly recommended.

The laboratory in the finishing department has basic equipment for chemical analysis.

- colorimeter

- refractometer

- photometric titrimeter

- pH meter

- a viscometer for lubricants, but no viscometer for printing pastes

This equipment was complemented by some simple chemical laboratory apparatus and a few small scale dyeing machines and ovens. There was a miniature jig, winch and pad-steam unit, all old but in working order. The wash wheel was under repair and the laboratory dyeing machine in very poor condition.

Considerable effort is devoted to on-the-spot checking by quality controllers who patrol the production departments observing and recording the condition of machines and the frequency of faults and breakages. This is a formalised procedure: The observer checks according to a schedule and records in a standardised format, faulty machines or production units, together with the indentication of the operator, the brigade and the mechanic responsible. These observations are notified to the production and technical departments for action.

The operation of this system appears to be singularly ineffective. Although the reports of the quality checker are in the main accurate and detailed, they are no more than one could expect from the observations of well trained operators and supervisors. Unfortunately they appear to evoke relatively little response in terms of remedial action. Product Quality is given less importance than production and a major problem is teaching an awareness of the importance of quality. This problem is aggravated by an annual turnover of the workforce of 30%.

Arguanabo has a small nucleus of older, skilled and experienced staff and this shows to advantage in some areas, for example in finished cloth inspection, in the cleanliness of the spinning room and in the fibre laboratory. Efforts are being made to involve staff at all levels in Quality Circles: however it is the managerial and supervisory skills in teaching and directing good working habits and organising prompt remedial actions that are most urgently needed.

## 4.4 'Hilatex'

The Hilatex factory, which started production in 1985 was intended primarily to supply cotton yarns to weavers and knitters in the Western provinces of Cuba. About one half of the originally planned spinning capacity of 95.000 spindles is at present in production. There is a considerable capacity for dyeing, both loose stock and yarn on package: only a small fraction of this capacity is utilised. 90% of the yarn produced at Hilatex is sold cleared on cone, the remainder is used in- house for the manufacture of towels. The towel weaving plant, consisting of 150 Russian KM3 looms, was formerly operated by another company 'Antex' and was absorbed into Hilatex in 1983.

The particular problem specified for Hilatex, - the production of towels - has two aspects: yarn quality and finishing. Of the 150 looms installed, 115 were in operation at the time of our visit. The running efficiency was in the region of 50 to 53%. Of the towels produced, 25% were rated 1st grade: no more than 3 minor faults per small towel: 67% in 2nd grade which permits up to 3 major faults per towel and 8% in 3rd grade. Analysis of the loom inspection reports, made on every shift by a patrolling quality controller, revealed that some 70% of the faults occurred in the warps, due to poor yarn quality or to very bad warp production. Inspection at the looms revealed an abundance of warping faults, crossed ends, missing ends, unecessary spare ends. Both ground warp and pile warp are Nm 37/2 produced on spintwisters. This technique yields a particularly unsatisfactory yarn since one end of 37's direct from ring cop is twisted with a drafted roving using the hollow spindle principle: the resultant twofold yarn is collected directly on a small cheese package. Thus the final yarn contains all the spinning faults of both components, bound in by the doubling twist so that they effectively resist the subsequent clearnign in cone winding. Moreover, the single Nm 37, a carded cotton yarn produced at Hilatex, is of itself a poor yarn; U% between 14 and 18.5, Cv of Nm from 4.0 to 7.0% and Cv of yarn strength from 15 to 19%. The weft, a Nm 20's cotton yarn comes from another spinning plant and is of similar poor quality and very dirty, that is with a high level of trash, leaf and seed.

In warping, the majority of faults registered in the quality control check are classified as winding faults, loose knots, cones sloughing off, stitches and damaged cones. The frequency of stoppages about 16 to 20 per million in of yarn, reduces warping efficiency to less than 20% and many of the stoppages result in faulty beams.

Thus, the first recommendation to improve towel manufacture must be to improve yarn quality and the quality of the warp beams which are issued to weaving. This is a long-term remedy and it would be adviseable to consider the substitution of the spin-twisters by regular ring twisters with the singles yarns being first cleared at cone winding, then assembled two ends into one, before twisting. Increased and improved control of machine and operative performance in winding and warping is essential.

About 10% of the towels and woven from dyed yarn either in striped or jacquard design (two out of fourteen jacquard machines were in operation). These yarn dyed qualities, are ispected in loomstate, hemmed and made up for sale without any further treatment. 90% of the output is sent out for bleaching and/or dyeing in the piece and returned to Hilatex for making up. Ideally, new machinery is needed at Hilatex for the bleaching, dyeing and finishing of towels; existing plant, designed for loose fibre and yarn on package is not really suitable for modification. With improved loomstate material attention should be paid to enhancing the absorbancy and handle of the finished product, including the yarn dyed fraction.

A small part of the towel production, after bleaching, is printed by the hand screen method with pigment colours. It is consieered that the pigment/binder system is not suitable for towels, because it creates a harsh handle. With simple modifications (described in 4.4.3 Finishing) reactive dyes could be used instead to give better quality printed towels.

### 4.4.1. Spinning

The plant came on stream, by sections, starting in 1985 and is yet not in full planned production.
Of 249 spinning frames, only 123 are actually in use; and 26 of the 36 spin-twisters are currently operational. The machinery is of Russian origin and the technology is of the late 1960s. The plant has the capability to produce acceptable yarns.

The factory spins mainly four counts:-

Nm 34/1 and 51/1 from 100% Grade I Cotton, combed,
and
Nm 25/1 and 37/1 from 50% Grade I and 50% Grade II Cotton, carded.

There is also a separate condenser spinning plant which was not included in our survey.

The total number of employees in spinning. dyeing and towel manufacture is 4365. Labour turnover is at a critical stage. about 29% per annum.

Machinery

Opening and Cleaning

7 opening lines for Cotton. APK-3-USSR 1976; each line with three automatic feeders each with six bales. ie. 18 bales in one mixing. plus one hopper feeding up to 20% waste. (The plan stipulates not more than 4%).

1 line for Polyester and Viscose blends - this was not in use.

12 Scutchers with Automatic ,Doffing: laps are manhandled from Scutcher to weighing scale - automatically weighed and placed on an overhead conveyor which transports them to the cards. 150 Cards. 125 CHMM-14 USSR 1976 and 25 CHMM-14T

Drawframes. LNS-51-24 USSR 1976. Two passages each with four deliveries. and six doublings at each pass.

Roving. R-192-5 USSR 1976-78. 132 spindles per machine.

Ring Spinning:

P.76-5M4 USSR 1976. 384 spindles. 54 mm Ring.
and
P.83-5M4 USSR 1976. 360 spindles. 57 mm Ring.

Spin-twisters. PK-100 USSR 1976 with 312 spindles.
Lap Formers and Combers from Textina. The spinning equipment at Hilatex is identical with that at 'Celia Sanchez' and very similar to that at 'Ariguanabo'.

During our visit the mill was not in full production. trainees were working in the spinning room and the number of machines in use at any one time was varying. Recorded output month by month for 1989 shows an increase for most yarn counts. however. running efficiency was very low. being estimated at 65 to 70%.

| Yarn Count Nm | | Production in tonnes/month - 1989 Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|
| 25 | Carded | 110.4 | 139.2 | 175.1 | 158.0 |
| 37 | Carded | 1.5 | 18.9 | 58.1 | 64.7 |
| 51 | Combed | 4.7 | 2.9 | 0.7 | 5.9 |
| 31 | Combed | 13.1 | 11.7 | 16.1 | 11.4 |
| 34 | Combed | 0.0 | 1.5 | 4.4 | 11.1 |
| Totals | | 142.8 | 174.2 | 254.4 | 251.1 |

Spinning Parameters

| | | | | |
|---|---|---|---|---|
| Nm | 25 | 34 | 37 | 51 |
| Spindle rpm | 5750 | 7087 | 7087 | 5770 |
| Alpha metric | 117 | 125 | 124 | 95 |
| T/M | 585 | 740 | 760 | 680 |
| Planned efficiency %. | 74 | 80 | 73 | 80 |

All spindle speeds are exceptionally low!

End breakage rate is quoted at between 80 and 120 breaks per 1000 spindles per hour. This is excessively high in view of the very low spindle speeds.

For combed yarns. one spinner tends four frames and for carded yarns three frames.

The whole process produces uneven yarns.

Observations

- There was uncontrolled. spasmodic feeding of waste into the opening line.

- The lap weight control was not working.

- Card Clothing surfaces damaged and uneven.

- A high level of fibre contamination (loose fly) at every stage of production.

- All ring spinning machines were particularly dirty. with fly. roller laps and missing or overloaded clearers.

- Roller settings were irregular. within and between frames.

- Frequent uneven wear of top roller covers.

- 85% of travelling overhead clearers are not working.

- Many spindles are not centred in their rings. and similarly

- Yarn guides (pigtails) are out of alignment.

- Different travellers on the same spinning machine.

- No optimisation of cop dimensions. different frames produce different sizes of cop in the same count.

- Waste is not seperated by grade. Most spinners have no waste bags and reusable soft waste is downgraded by being allowed to fall to the floor.

- The cleaning brigate for one shift consists of:-

1 brigade chief and 23 machine cleaners
plus 4 roller pickers
4 brush cleaners
2 ring and traveller cleaners

the efforts of this team appear to be totally ineffective.

All machines in the ring spinning department are in a poor condition and not able to produce good, clean and regular yarns.

In general. drawframes, lap formers, combers and flyer frames are in a better state than the spinning machines - both with regard to cleanliness and settings. (Machines stopped for any appreciable period should be covered.) More frequent superficial cleaning of sliver guides and feed tables would be advantageous.

Recommendations

- Feed not more than 6% recycled waste, and do so on a continuous basis.

- Reinstate lap weight control, laps which are outside the weight limits must be recycled.

- Can doffing and can handling throughout preparation should be changed (as demonstrated to the supervisor) to reduce disturbance of the outer layers of coiled sliver.

- Thoroughly clean and re-set all ring frames.

- Check and reset the yarn path on all spin twisters.

- Issue waste bags to all persons in spinning and insist on proper waste separation.

- The soft package winders (for dye packages) require modification to reduce the hardness at the edges of the package by reducing the angle between the yarn guide and the winding drum. Variations in package density are a basic cause of uneven dyeing.

- Training throughout the factory should be improved and greater control exercised over operators and auxiliary workers.

Conclusion

In this brief summary there were apparently no major faults, but rather an accumulation of a large number of small faults which combine to produce unsatisfactory yarns. Better supervision and control is needed to ensure that work is done properly, better quality control with the accent on problem analysis, information feedback and the elimination of the causes of faults.

- Inaugurate a 'waste reduction brigade' to wage a campaign on the excessive waste which is currently 25% of total fibre usage.

Note on Quality Circles

The factory has implemented quality circles; 41 groups in all with a total of 268 volunteers. The idea is good and could turn out to be very helpful, although at present they may be hampered by lack of industrial experience.

### 4.4.2 Finishing

The Hilatex factory is equipped for the bleaching and dyeing of yarn on package and of loose stock fibre. Dyed yarns are sold, or used in towel weaving, stock dyed cotton and polyester fibres are used in the condenser spinning unit which makes Nm 6 for the carpet trade. Planned output of the dyehouse is 1300 tonnes per annum, of which cotton yarns constitute 600 tonnes and polyester fibre 700 tonnes. Total production in 1988 amounted to 1059 tonnes. The annual capacity of the installation is 5900 tonnes per annum.

The dyehouse is equipped with 8 pressure vessels each of 500 kg capacity for loose fibre dyeing, 4 pressure drying machines for packages, four loose fibre drying machines, two centrifuges and two continuous dryers.

## Observations and Recommendations

In yarn dyeing 18% is deemed to be faulty and 97½% of this faulty yarn is downgraded and sold as second or third grade. Only 2½% is repaired by redyeing. This is a high proportion of faulty work and with care it could be minimised and most remaining faults mended by redyeing.

Most of the faulty dyeings are caused by:-

- differences in density within the yarn packages; this leads to channelling of the dyeliquor instead of a uniform flow through the package. This problem must be solved in the winding department by better control of yarn tension variation.

- distorted stainless steel centres must be repaired before winding and care taken to ensure that the yarn covers the perforations in the tubes.

In package dyeing of cotton with vat dyes, and of polyester at high temperature, the yarn is liable to shrink during the process; this consolidates the inner layers of yarns, rendering them resistant to penetration by the dyeliquor. At present this difficulty is only partly solved by winding up to 20% less yarn on each package. The answer is in using slit tubes or cardboard liners which permit yarn shrinkage without compacting of the inner layers. It is also recommended that stainless steel seperator discs should be inserted between adjacent cones; these discs which have a slightly bigger diameter than the dye packages are a further guard against channelling of the dyes.

When dyeing polyester in loose stock, it is recommended that the fibre be sprayed with hot water as it is packed into the basket of the dyeing machine, this helps to ensure the dense and uniform packing that is essential for even circulation.

The pressing mechanism of the loose stock packing machine frequently suffers mechanical failure. These failures would be largely eliminated by changing to a pneumatic pressing device.

Separation of colours in compound shades can be avoided by selecting component dyes with similar dyeing properties; the use of retarding and levelling agents is also recommended for better dyeing.

When using reactive colours, the addition of sodium sulphate rather than common salt is to be preferred.

The common salt in current use is not of high purity and causes precipitation and filtration of the dye inside the inner layers of the yarn package.

The following double bleach procedure is recommended to give a better white and more absorbant cotton yarn.

Stage 1 Wetting, using a bath of:-

2 g/l sodium carbonate
1 g/l efficient wetting agent
1 g/l detergent
Boil for 30 minutes and wash

Stage 2 Bleaching with hypochorite:-

3 g/l sodium hypochlorite (a local product)
1 g/l caustic soda
1 g/l sodium bisulphite
Treat at room temperature for 40 minutes and wash

Stage 3 Bleaching with peroxide:-

3 g/l hydrogen peroxide
2 g/l caustic soda
Boil for 30 minutes and wash

Stage 4 Apply optical whitener and a softener

Some towels after cutting and hemming are printed in one, two or three colours, by hand screen printing with pigment colours. The colours are fixed by dry heat in an electrically heated oven of local manufacture. For better registration and to avoid over- lapping of colours, it is recommended that the screen size is standardized and the print table fitted with a side rail with adjustable stops, to facilitate positioning of the screens and ensure more precise register.

The overall quality of printed towels will be improved by using reactives instead of pigment. This will retain the soft full texture of the towel and give bright fast colouring. The only change in method is the addition of a cottage steamer to fix the prints, and washing and drying equipment.

For the piece dyeing of towels, which is now done outside, new facilities should be introduced at the factory for dyeing and finishing. This gives better control over the quality of the finished towel, and reduces the costs of dyeing and transport.

### 4.4.3 Quality Control

Normalisation, metrology and quality control (NMCC) employs 150 people, of which 15 are graduates and the remainder technicians.
Fibre and yarn testing laboratories are very well equipped and fully staffed. Sampling and testing is planned to an adequate schedule but the degree of real control exercised over yarn production, in view of the quality and sophistication of the resources available, is minimal.

Laboratory equipment includes:-

| | |
|---|---|
| Fibrograph | out of action now for over three months for lack of spares. |
| Comb Sorter | |
| Lint Trash Analyser | |
| Laboratory Fibre Opener | |
| Microbalance | |
| Micronaire | |
| Pressley Fibre Strength Tester | |
| Several Balances | |
| Microscopes (2) and Lamp | |
| Oven for Moisture | out of action, in need of repair |
| Measurement | |
| Uster Yarn EvennessTester | use limited by shortage of chart paper and ink. Used mainly for diagnostic tests and trouble shooting. |
| Uster Dynamat | use limited by shortage of chart paper. |
| Wrap Reels (2) | |
| Skein Strength Tester | used only for Nm 6 Condenser Yarn |

Manual Single Thread Tester - not used

Laboratory Equipment cont.

Twist Testers (2)

Blackboarding Machine - not used

Scutcher laps are supposed to be weighed - but some of the scales are not working. No record is made of lap weights nor is any attempt made to relate lap weight variation with individual machines. Scutcher regulation is supposed to take place if the operator notices that successive laps from one machine are falling outside the control limites. The control limits and the operator's estimate as to whether regulation is needed, are both arbitrary. Observation showed that some out of limit laps and many badly formed laps are passed forward to carding.

Each finisher drawframe is checked for count twice per day, each roving frame once per day and a selection of ring frames tested for count, twist and yarn strength. Cleared yarn on cone is sampled and tested at the packing stage for classification and certification of the delivery. 20 cones for every 900 despatched are tested: three skeins per cone are tested for count and five strength tests are made on each package.

The following table, which is an extract from Cuban standard NC-40-119 gives some of the values used in the 'physico-mechanical' classification of cotton yarns.

| Nominal Count Nm | Minimum Strength g(f) | | - Variation - | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | CV Nm 60 tests | | | CV strength 100 tests | | |
| | | GRADE | I | II | III | I | II | III |
| 20 Carded | 495 | Warp | 4.0 | 5.6 | 6.9 | 15.0 | 16.2 | 17.5 |
| | | Weft | 4.4 | 5.6 | 6.9 | | | |
| 25 Carded | 400 | Warp | 4.6 | 5.6 | 6.9 | 15.0 | 16.2 | 17.5 |
| | | Weft | 4.4 | 5.7 | 6.9 | 15.0 | 17.5 | 18.7 |
| 37 Carded | 285 | Warp | 4.0 | 5.6 | 6.9 | 15.0 | 16.2 | 18.5 |
| | | Weft | 4.4 | 5.6 | 6.9 | 15.0 | 17.2 | 19.3 |
| 31 Carded | 451 | Warp | 3.7 | 4.4 | 6.2 | 13.8 | 16.2 | 18.3 |
| 34 Carded | 279 | Warp | 3.7 | 4.4 | 6.2 | 13.8 | 16.2 | 18.3 |
| 50 Carded | 187 | Warp | 4.4 | 5.6 | 6.0 | 13.8 | 16.2 | 18.3 |

A tolerance of $\pm$5% on nominal count is permissable.

These are hardly stringent requirements and even the Grade I yarns in this classification would hardly be deemed satisfactory for most apparel fabrics. However. under this standard Hilatex claim to produce 90% Grade I yarn. It should be noted that the final classification according to the standard is the combination of the 'physico mechanical' grade and a subjective rating of yarn appearance. Hilatex maintain their 90% rating by quoting only the former and tacitly ignoring the latter.

On a universal scale the regularity of Hilatex yarns are intermediate products rates very low. for example typical values from current production are:-

| | |
|---|---|
| Card sliver | U% 6.4 |
| Drawframe sliver | |
| 1st passage | 6.5 |
| 2nd passage | 6.6 |
| Roving | 9.8 |

and for yarn irregularity:-

| Nm | U% Worst | U% Best |
|---|---|---|
| 20 Carded | 15.6 - | 12.9 |
| 25 Carded | 16.1 - | 16.1 |
| 37 Carded | 18.5 - | 14.0 |
| 34 Combed | 12.9 - | 11.5 |
| 50 Combed | 20.8 - | 14.6 |

These values together with those recorded on the Uster tester for 'Imperfections' place Hilatex yarns in the bracket of the world's worst 15% and support the firm's wisdom in overlooking the yarn appearance rating in its commercial classification.

The quality control department is in fact trying hard. with the help of its Uster machine to lcoate serious periodic faults which frequently occur in slivers and rovings. However they have little success in persuading the technical and production departments to take remedial action. During our visit several glaring examples of mechanical faults were reported without response.

In addition to the laboratory tests which are completed for each day within the day shift. peripatetic 'quality checkers' are allocated to each department to observe. assess and report on specific machine and operator functions which have a bearing on 'quality'.

A snap tour of opening carding and spinning failed to locate even one of these 'controllers'. Later, experience showed that it was adviseable to give notice of one's wish to interview shop floor quality control staff, but to judge by the condition of the machinery in the spinning factory their efforts were singularly effective.

End breaks in spinning are recorded, usually on the basis of a two hour observation of one spinner. The breaks are classified according to cause but no attempt is made to locate rogue spindles for remedial action.

The typical values recorded dui ng recent months and representing 20 to 40 hours of observation in each instance are:-

| Yarn Count Nm | Ends down per 1000 spindle hours Average | Range |
|---|---|---|
| 25 Carded | 91 | 73 to 112 |
| 37 Carded | 85 | 60 to 137 |
| 34 Combed | 100+ | |
| 51 Combed | 60 | 45 to 110 |

There are some difficulties arising from the raw materials. Two types of Soviet cotton are used, their nominal values are:-

| | Class I | Class II |
|---|---|---|
| Staple length (mm) | 31 to 32 | 31 to 32 |
| Short fibre (%) | 15 to 19 | 22 to 23 |
| Micronaire | 5.2 | 4.8 |

'Staple length' and short fibre content, from the quality certificates which are issued by the suppliers with each batch of cotton, agree with laboratory measurements by the comb sorter method. Unfortunately, fibre parameters within a class are not always consistant from batch to batch and despite the quality control department's ability to measure most of the important fibre properties, these are not taken into account by the production section as an aid to blending to get even running mixings. At the time of our visit a new batch of class I cotton, with a Micronaire value of 6.0 was brought into use, full scale, without reference to NMCC.

Unfortunately the laboratory was not able to decide whether the shift in Micronaire value was due to a change in fibre fineness or a change in fibre maturity: in any event the cotton was already in full production. with no assessment of its effect on yarn properties.

## Recommendations

Effective quality control is everyone's business: unless machines are properly set, maintained and cleaned all the laboratory can do is to record and classify. With cooperation between designated quality controllers. technical ard production staff there may be some possibility of achieving a semblance of real control.

It is recommended that a joint campaign. production and quality control departments working together. launch a blitzkrieg on the control of lap weights. systematically investigating the contribution of each scutcher to the overall variation. and by repair. regulation and statistical analysis re-set the go-nogo limits on a realistic basis. Set up a sensible scheme for regulating the scutchers and refuse to tolerate the passing of substandard laps.

It is also recommended that. having got lap weights under control - a similar campaign is launched on the control of drawframe sliver count and regularity. Count should be checked. twice per shift. close to the machines and the test results and pinion changing decisions based on a control chart - information transfer between testing and production departments should be virtually instant.

All flyer frames and ring frames require scouring. resetting and top rollers tested and replaced as necessary: this is a massive but essential chore.

Supervision and control of all maintenance and cleaning should be tightened up and new schedules set to keep the machines in good working order.

The quality control department should be encouraged to develop and extend its skills in diagnostic and trouble-shooting techniques and be taken into active participation with the technical and production departments on schemes to improve every aspect of product quality.