OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

14880

DP/ID/SER.A/626
22 August 1985
ENGLISH

ASSISTANCE TO THE TEXTILE INDUSTRY

SI/SYR/84/801

SYRIAN ARAB REPUBLIC

Technical report: Syria: Assistance to the Syrian public underwear industry*

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

Based on the work of David M. Elson,
Knitting Technologist

United Nations Industrial Development Organization
Vienna

* This document has been reproduced without formal editing.

V.85-30168

CONTENTS

UNIDO Project in the Syrian Arab Republic

Job Description SI/SYR/84/801/11-53/31.7B

INTRODUCTION

The duties of the Knitting Technologist associated with the project were given as follows:-

"As part of a team working in close co-operation with the Technical Director of the Ministry of Industries General Organisation for the Textile Industry, the expert is expected to carry out the following duties at the Orient Underwear Manufacturing Company in Damascus and at the Arab Company for Underwear in Aleppo, to *

- introduce a system of loop length control,
- advise on quality problems related to knitting technology,
- develop commercially acceptable fabrics for the following machine types (plain jersey, body length ladies underwear, plush),
- advise on the selection of the most appropriate technology for the manufacturing of tracksuits.

* This part of the duties was modified by visiting the Aleppo factory to carry out an on-the-spot assessment in relation to the factory at Damascus.

It was felt that the principal areas on which to concentrate were yarn and knitting, together with the provision of assistance to the other experts in the area of their work which is relative to knitting.

Yarn

The principal yarns used at the Orient Underwear Manufacturing Company are, 24/1 cotton count (24.6 Tex) and 32/1 cotton (18.5 Tex). This yarn is delivered to the factory from the spinning mills known as Hama 1 and Hama 2. The 24/1 yarns and the 32/1 yarns are used on the 14 and 20 gauge rib based machines respectively. The 32/1 is used on the 24 gauge plain based machines.

Knitting

The knitting plant of the Orient Underwear Manufacturing Company is situated in a purpose built, well appointed knitting room, comprising mainly of Albi ROJI and RFH machines which produce rib and interlock based fabrics. The production of this type of fabric is augmented by a selection of Bently and Fouquet machines. The machines are of various diameters and gauges. Although the principal gauge is 20 needles per inch, there are machines with 14 needles per inch. In addition, there are a number of other machines of various types and although some have positive feeds fitted, they are to a great extent in a derelict condition.

In addition to the above machines, there are four Albi RCUII PL

20 gauge machines, 13, 14, 15 and 30 inches in diameter suitable for knitting single jersey, plush and 1 x 1 cross tuck fabrics. There are also three Wildt Mellor Bromley RTR MU machines, all 14 gauge and 13, 14 and 15 inches in diameter suitable for knitting body length ladies underwear. Both of these machines types were not in use and it appears that they had not produced fabric for some weeks previously, as suitable yarn is not available (source Production Director, Orient Underwear Manufacturing Company).

It is important to mention that three rib based fabrics were continuously knitting a laid-in elesticated fabric for used in waist bands.

CHAPTER ONE

Yarn

1.0 The yarn is wound on cardboard formers and placed in polythene bags. These packages are transported from the spinning mill, roughly packed in hessian sacks. The yarn is stored in this state until required for knitting. Many of the formers and cones were in a damaged condition when issued for knitting.

In a general examination of the yarn many cones were soft and therefore unstable, particularly when the yarn had almost been removed.

The yarn appeared to contain a high number of neps, as well as thick and thin places.

No routine testing is carried out on deliveries of yarn for count, regularity, moisture content or wax content.

The yarn is issued for knitting on demand, when it is stored on the floor adjacent to the knitting machines. It was observed that little care was taken by the knitter when handling the yarn.

1.1 It was stated by the management that the yarn reputedly from Hama 2 mill gave upto a 15% lower knitting efficiency.

In order to investigate the claim of a difference in knitting efficiency in the yarn, from the Hama 1 and Hama 2 mills, a knitting trial was devised.

Five cone samples of yarn were first analysed and gave the results as shown on next page (Results one).

As can be seen from these results, the yarn from Hama 2 is significantly more irregular and what is more important, it contains more potentially weak places.

The knitting trial was conducted on an Albi 20 gauge, 30" diameter machine producing interlock fabric. The machine had been specially prepared to knit a regular fabric, forty four cones from both Hama spinning mills were consecutively knitted. The number of machine stoppages were counted and their cause determined. They are as follows:-

Hama 1	Hama 2
24 stoppages for 28.4 kg	20 stoppages for 30.7 kg

It was difficult to give precise reasons for the machines stopping, as the majority of stoppages were caused by yarn break down between the cone and the first stop motion. The most likely cause is thin or weak places in the yarn.

RESULTS ONE

TEST (all mean of 5 tests)	Hama 1	Hama 2
Cotton Count	30.8	31.7
% C V Count	0.5	4.4
Turns per meter	752.4	753.2
Yarn Regularity U%	13.5	14.9
Mean Single Thread Strength	2.12g	2.12g
Elongation	5.5%	5.6%
Yarn Strength Divided by Tex	11.6	11.7
Number of neps per km	308.8	366.4
Number of Thick Places per km	643.2	598.4
Number of Thin Places per km	64	104

The rolls of fabric produced from this yarn were examined for knitting and yarn faults and although there was little difference in short term faults, the fabric knitted from Hama 2 appeared to be more irregular overall, with what appeared to be irregularities between and within the cones.

An important observation was made during the knitting trial in respect of the technique used by the knitter to join broken yarn. This consisted of overlapping the broken ends by up to 5cm, twisting them together by rubbing and so introducing into the fabric unnecessary faults.

CHAPTER TWO

The Measurement of Loop Length

2.0 INTRODUCTION

There is no attempt made at Orient Underwear Manufacturing Company to measure loop length in order to provide a fundamental tool of quality control in knitting.

The control of loop length is perhaps the most important control in the knitting process as all other fabric parameters are directly proportional to this, particularly when it is related to the yarn count which is usually a fixed variable. The measurement of loop length ensures the uniform setting of the knitting machine.

It also gives a tight control in yarn utilisation.

The only measurement used in this area is when a machine is changed to a different fabric, when the courses per unit length are counted in unstable machine state fabric. The feeders are levelled by yarn marking. These techniques are accepted as being notorious for introducing inaccuracies. It might be pointed out that all operating machines are fitted with positive feed devices.

2.1 A "crude" cause length tester was constructed in order to be able to measure reliably upto 180cm of yarn to an accuracy of 0.1cm. This apparatus was proved to be reliable by measuring a length of yarn from 200 face stitches through a complete knitting repeat from a number of samples taken from the same fabric. Excellent agreement was achieved, (see results two on next page).

In order to determine the standard loop length of a range of fabrics currently being knitted, a random sample of fabrics made on different machines were tested. The results are as follows:-

Yarn Length in cm/200 Face Wales of Fabrics Taken from Machines at Random.

	Gauge 20		Gauge 20		Gauge 14	
M/C NO	4/2 Interlock Structure		M/C NO	Interlock	M/C NO	Rib
54/30	76.5		39/30	66.5	33/20	61.9
12/18	74.8		11/16	64.3	32/18	63.3
52/30	74.2		20/18	66.4	35/30	62.9
56/30	75.1		38/30	64.3	34/30	65.7
13/18	76.8		38/30	65.3		
Mean	75.5		Mean	65.3	Mean	63.5
Structural loop length	3.78 mm			3.27 mm		3.18 mm

RESULTS TWO

Yarn Length Measurements from 200 Face Loops taken from two Separate Samples of the same Interlock Fabric

Sample 1 (cm)	Sample 2 (cm)
65.8	64.8
64.9	65.9
66.0	65.0
65.0	65.8
66.0	64.4
64.7	66.0
65.5	64.8
64.5	65.2
65.4	65.1
64.4	65.7
65.6	64.4
64.3	64.9
66.2	65.0
66.9	65.2
65.4	65.0
63.8	65.7
65.5	65.0
64.0	65.0
66.9	64.2
64.7	66.1
66.2	65.1
65.0	66.5
66.0	64.2
65.0	64.8
65.6	64.1
64.4	64.9
65.6	65.0
64.2	65.4
65.1	65.0
65.0	66.1
$\overline{1957.6}$	$\overline{1954.3}$
$\overline{X}$ = 65.3cm	$\overline{X}$ = 65.1
Structural loop length 3.27mm	Structural loop length 3.26mm

Although this is not an accurate method of obtaining a definitive standard it is based upon a number of different machines and the agreement is reasonably good (for yarn length measurement see appendix one).

2.2 Measurement of yarn speed to give loop length is a very much quicker method of measuring loop length. A yarn speed meter is used to measure the speed of yarn at each knitting feeder, whilst the machine is knitting normally. This value is directly proportional to the loop length which can be calculated as outlined in appendix two. The advantage of this technique is that it is quick and the values obtained are relevant to the machine knitting in operational conditions. (For use of yarn speed meters, see appendix two).

CHAPTER THREE

Quality Problems

3.0 INTRODUCTION

The quality problems associated with knitting technology are many and varied. It might be helpful to list the practices carried out in the factory which will affect the quality of the knitted fabrics and in consequence the ultimate garment.

3.1 Fabric Control

After the initial set-up as mentioned previously, there is no procedure for ensuring that the knitting machines are knitting the correct fabric to specification when the machine is changed to a new fabric. It should be pointed out that these techniques are crude and cannot be guaranteed. It is therefore recommended that the primary quality control activity is loop length control. This means that each time a machine is changed for whatever reason, for example, fabric structure change, severe breakdown or 'smash', the loop length is measured. This is most conveniently carried out with the aid of a yarn speed meter (see appendix two). Alternatively, loop length can be determined by measuring the yarn length per 200 face stitches through at least one complete machine/feeder repeat (see appendix one). These measurements should be carried out each week and recorded on a proforma as shown in appendix four.

3.2 Positive Feed

i. The Memminger positive feed unit should have at least 10-15 coils of yarn around each feed wheel, it was noticed that some feed wheels at the Orient Underwear Manufacturing Company range from 4-20 plus coils. This does not necessarily mean that the units are ineffective, but it leaves some doubt.

ii. Many of the IRO feed wheels were not parallel to the driving belt, once again casting doubt as to there efficiency. It should be pointed out that the knitters do not always place the yarn behind the driving belt which negates the effect of positive feed at that particular feeder.

iii. It was also noticed that on a number of machines, cotton was wrapped around the drive to the positive feed belt. This increases the diameter of the drive and therefore the belt and yarn speeds. This problem might be responsible for the results labelled two, where alternate courses are clearly longer.

iv. The positive feed devices on each Bently machine are inoperative as a) the yarn is only taken through 180° of wrap instead of 540° which ensures reasonable grippage, b) the surface of these devices are worn, c) the guides are all set at different positions. One or all of these factors negates any attempt at loop length control on these machines.

3.3 One of the features of positive feed is that it allows adjustment to give minimum yarn tension immediately before the yarn feed. This is important in the production of level fabric of good stitch regularity. As a tensiometer was available the tension of the complete feeder repeat of several machines chosen at random was measured (see results three on next page).

As can be seen from the results there is a considerable variation in the tension readings between feeder on the same machine, this can lead to i) variations in yarn relaxation within a course, ii) irregular stitches which can show as fabric deformation, iii) yarn breakage leading to reduction in machine efficiency, iv) premature wear of the knitting elements, particularly needles.

3.4 The state of the cone formers is likely to give rise to variations in quality as the yarn can snag on the rough and buckled surfaces which can give irregular unwinding tension as well as yarn breakages. The buckled cone formers sometimes make it impossible to stand the cone upright allowing the yarn to be trapped between the cone and the surface on which it is leaning, again increasing the likelyhood of yarn breakages.

It is common for a knitter to not only change a cone which has completely run out of yarn, but also to change at the same time any other cone which is almost empty including some with remaining yarn which is up to 1cm thick. This yarn is reclaimed by rewinding which is not only an expensive operation but it is difficult to determine i) the degree of mixing yarn of different batches and ii) the number of knots in each new cone and the subsequent effect on machine efficiency and fabric quality.

3.5 The yarn is stored haphazardly on the floor before knitting which increases the chance of further damage.

3.6 When the completed roll of fabric is removed from the machine, the knitter secures the end of the roll when it is on the floor. The fabric remains on the floor and is often used as a seat by the knitters. These practices will likely result in the fabric being stained, and will no doubt effect the final merchandise.

3.7 Many of the machines have ineffective stop motions, particularly the first stop motion which is preceeded by a yarn clearing device. If the yarn is broken by the clearing device the machine will not stop until the second stop motion so that the knitter will have to rethread the yarn, thus reducing the knitting efficiency.

The clearing devices are often not used, and if they are, the yarn is usually threaded through an incorrect setting, so allowing thick places of the yarn to produce a fault in the fabric.

A problem associated with the malfunction of the stop motion is the large amount of cotton lint in the atmosphere of the knitting room jamming the stop motions.

RESULTS THREE

Tensionmeter readings of the complete feeder repeat of 5 randomly Selected machines (values in grams)

Machine 1	Machine 2	Machine 3	Machine 4	Machine 5
6.0	7.0	5.5	4.0	8.0
5.0	11.0	14.5	6.5	25.0
5.0	8.0	14.0	5.5	11.0
5.0	15.0	18.0	6.0	18.0
4.0	7.0	5.0	9.0	8.0
6.5	20.0	8.0	6.0	20.0
4.5	10.0	5.0	3.0	12.0
5.0	15.0	14.0	3.5	25.0
4.0	5.0	5.0	7.5	15.0
4.0	25.0	12.0	9.5	25.0
5.5	6.0	5.0	7.0	15.0
6.6	15.0	9.0	5.0	25.0
4.5	7.0	5.0	5.0	15.0
4.0	13.0	13.0	5.0	20.0
6.5	5.0	2.5	4.5	15.0
6.5	10.0	15.0	5.0	15.0
6.0	6.0	5.0	4.5	13.0
5.0	15.0	10.0	5.0	20.0
3.0	7.0	10.0	3.0	12.0
6.5	20.0	15.0	8.0	10.0
6.5	11.0	4.0	3.0	25.0
7.5	15.0	14.0	4.0	10.0
4.0	6.0	16.0	2.0	17.0
5.0	18.0	6.5	11.0	7.0
5.5		14.0		17.0
4.5				11.0
				11.0
				24.0
				13.0
				18.0
Range				
7.5 max	25.0 max	18 max	11.0 max	25.0 max
3.0 min	5.0 min	2.5 min	2.0 min	7.0 min

3.8 A function of quality control is to provide a detailed analysis of the machine and the operatives efficiency. This information is available from i) the mechanical machine log which gives the number of machine revolutions for each shift, this value can be compared with an expected value, ii) the faults found at examination are related to the individual machine and operative, iii) a record kept of the daily or weekly number of needles used on each machine, iv) a record of the number and cause of each major machine stoppage.

3.9 There is no apparent procedure for routine and preventive maintenance. This would actively reduce the number of long and expensive machine breakdowns.

A number of machines were not working but no attempt was made to carry out any maintenance, although some had what appeared to be only minor mechanical faults which could have been corrected.

3.10 The working environment and therefore the operative and machine efficiency is severely affected by airborne lint or fly. No real effort is made to extract it from the atmosphere, all that is done in respect of the problem is to blow the accumulations off the machines with compressed air. The effect of this is i) to contaminate the fabric ii) to reduce the efficiency of stop motions and iii) to recontaminate other machines.

3.11 An important aspect of maintaining quality control is the presence of management whose responsibility is the quality of the product. There is no evidence of this at the Orient Underwear Manufacturing Company, with the result that unskilled workers take advantage of the lack of supervision, lowering the quality of the product.

CHAPTER FOUR

Fabric Development

4.0 INTRODUCTION

The development of commercially acceptable fabrics for utilising single jersey and body length machines depends upon the following factors i) the versatility of the machinery, ii) the ability of the technical staff and iii) the quality of the yarn.

Although the garment length machines are veratile, it is doubtful if the technical staff can cope with their complexity.

The single jersey machines are a basic model with the facility to produce plush fabric. During the complete time of the project none of these machines were in production as the management reported that no suitable yarn was available.

4.1 Single Jersey Machines

The versatility of these machines is limited as they are designed to produce plush fabric only. It was decided to carry out a knitting trial to produce the following fabrics: plain fabric, plush fabric, locally called pique fabric (1 x 1 cross tuck with a clearing course) and 1 x 1 laid in fabirc. The three former fabrics have been manufactured by the company previously, but the latter was in the trial to determine its feasability. It could provide a basic tracksuit and/or sweatshirt fabric using either a textured nylon filament or combed cotton yarn for the ground structure with a laid in yarn of a heavy count condensor cotton yarn.

Unfortunately the knitting of this fabric proved to be impossible as the machinery would need a major conversion in order to knit it. The resultant fabric might be limited compared to other laid in structures. If the company want to broaden their merchandise into this area, it is recommended that more versatile machines are purchased.

Tracksuits

With regard to the appropriate technology for tracksuits, it is suggested that the most suitable fabric for this purpose is 3 thread fleecy fabric with a textured nylon/combed cotton basic structure and a condensor cotton fleecy effect.

This fabric is the principal fabric used for this purpose elsewhere. Unfortunatley as has already been described, the Orient Underwear Manufacturing Company does not possess a machine to knit this fabric. The fabric which the company has used for this purpose (interlock single pique) is not altogether suitable as it is too unstable and does not have the necessary absorbant properties.

Of the other three fabrics which were in production, plush fabric was not satisfactory as its technical back was irregular and not smooth. It is suggested that the machine is readjusted particularly with regard to sinker timing and/or yarn tension.

CHAPTER FIVE

Recommendations

5.0 INTRODUCTION

The following recommendations which are based upon the proceeding work carried out at the Orient Underwear Manufacturing Company are divided into the following sections a) yarn as it affects knitting, b) knitted loop length control, c) quality control as it affects knitting and d) fabric development.

5.1 Yarn

i) All incoming yarn must be measured at least for count. If the yarn is giving rise to excessive variation in the fabirc density or is given to high end breakages, it would be helpful to measure its regularity.

In order to measure count it is necessary to purchase a suitable basic wrap reel, (see Shirley Instrument Catalogue).

ii) The yarn must be stored and handled in such a way that no damage takes place to the package or cone formers.

5.2 Yarn Length Measurement

The yarn length or yarn speed of a complete feeder repeat of each machine must be measured i) after each fabric change, ii) after each major machine breakdown, iii) at least once a week.

A record must be kept of the results (see appendix four).

The mean loop length or yarn speed should not vary by more than plus or minus 2% of the nominal value for this particular fabric (see appendix one and two).

In conjunction with loop length measurement, yarn tension on machines using positive feed must be measured. The expected value should not exceed 5g at any one knitting feeder (see appendix three).

5.3 Quality Control

a) All the staff associated in the knitting process must be aware of the quality level required. It would be helpful in this respect if a quality circle could be formed. This should be comprised of all levels of staff from the general director to the knitters.

b) The knitters must ensure that the machines under their control are all fully operational, including the yarn feed path e.g. correct clearing, operational stop motions.

c) All substandard yarn packages must be rejected.

d) Yarn and fabric must be stored off the floor or if the latter is unavoidable it should be protected by placing it on heavy gauge paper.

e) A log of each individual machine must be continuously kept, recording machine efficiency, causes of breakdowns, needle consumption, and the number of fabric faults caused by the machine.

f) Knitters must join broken ends with the correct knot.

g) A system of preventive maintenance must be commenced.

h) Any other area associated with improving quality and identified by the quality circle.

5.4 Fabric Development

a) A policy of knitting single 35's or single 40's cotton yarn on the 20 gauge machines and at provisionally the same loop length at present should be examined.

b) The present body length underwear machines will fulfill the local need for this type of garment using the present design. However, this kind of garment requires minimal making-up, and will be readily accepted in all markets therefore the number of machines could be increased. It must be pointed out that a high quality of yarn is required and skilled technical staff are needed to maximise the potential of this type of machine.

c) The single jersey machines are few in number and are not very versatile. Therefore it is suggested that only one fabric is produced e.g. the 'pique' or 1 x 1 cross tuck is developed. This fabric is widely used as a sports shirt fabric and could form a basis for the Orient Underwear Manufacturing Company to diversify into this market.

Further developments in this area could be based on purchasing machines which can produce 3 thread fleecy fabric which is used in many areas of underwear, sportswear and dresswear in western Europe. Caution however is required when purchasing new machines and it is advised that machinery which can be conveniently and cheaply converted to produce a range of fabrics are purchased in the future.

CHAPTER 6

Visit to the Arabic Knitting Company, Aleppo by Mr J Gordon and Mr D M Elson

This visit took place between the 9th and 10th of June 1985.

This was a brief fact finding mission (see introduction).

The knitting plant is approximatley 2km from the main factory. There are 14 circular rib/interlock machines which are principally 18 gauge although there are two x 13 gauge and one x 15 gauge machines. The machine diameters range from 14 to 16 zoll including 1 x 18 zoll machine and 2 x 16 zoll machines. All the remainder have different diameters. The machines are much older than those at the Orient Underwear Manufacturing Company in Damascus.

Rudementary loop length control is carried out at the factory in spite of the fact that four of the machines are not fitted with positive feed. The techniques which are used are similar to those used at the Orient Underwear Manufacturing Company.

The results of the yarn length measurements taken from 10 machines are as follows:-

Yarn Length in cm of 200 face stitches of different fabrics made on machines at the Arab Knitting Company Aleppo.

Interlock		1 x 1 rib		1 x 1 rib Half Gauge	
	Max 77.8		Max 86.5		Max 96.6
75.9	Min 74.3	82.5	Min 80.0	92.3	Min 81.6
	Max 76.6				Max 96.3
69.9	Min 67.0			92.0	Min 86.0
	Max 79.0				Max 90.5
73.7	Min 72.8			89.4	Min 87.9
	Max 75.6				Max 88.8
75.0	Min 74.4			88.4	Min 81.0
	Max 76.8				
76.3	Min 75.8				

It can be seen that there is an unacceptable variation in these values. This will be reduced by applying a loop length measurement scheme as previously described for the Damascus factory.

There are no formal quality control procedures carried out, but it was felt that the general quality is good. This is probably as a result of it being a small plant, and the undoubted ability of the chief mechanic who is always in the knitting area.

A comparatively wide range of different fabrics are made, because two machines are capable of limited needle selection, the chief mechanic is also well motivated.

The yarn used at Aleppo is principally spun by the Hama Mills in a similar count range to that which is used at the Orient Underwear Manufacturing Company. There are some exceptions:

i) Two 18 gauge are knitting a feeder blend of 1/32 cotton and 20 denier nylon.
ii) In the past experimental fabric has been knitted from 1/40's and 1/60's cotton yarn but no further information is available.
iii) A dyed yarn is inserted on the completion of each roll of fabric so as to identify the shift responsible for its manufacture. This is also valuable as a guide to prevent bowing at calandering.

The knitting section of the Arab Company for Underwear at Aleppo is in many ways the same as the knitting seciton of the Orient Underwear Manufacturing Company in Damascus and the recommendations made for the latter could be applied to the former.

It is evident that the Aleppo factory is better organised, and more versatile in its range of fabric constructions.

It is strongly felt that Aleppo could certainly take advantage of any future developments.

APPENDIX ONE

The use of a Course Length Tester

This instrument is able to measure the yarn length of one knitted course or if required, the length of yarn per fixed number of stitches of a fabric.

Operation

The complete tube of knitted fabric is prepared by cutting accurately down one wale of stitches. A complete knitted course is extracted by unroving and measured on the course length tester to an accuracy of 0.1cm at a tension of 20g. Consecutive courses through one feeder repeat of the machine from which the fabric is taken are measured and recorded in the order of measuring on a prepared data sheet (see appendix four). The measurements are analysed to obtain the average value and the maximum and minimum values and compared with the specified values. The suggested allowed tolerence is $\pm$ 2% of the specified value.

The same procedure may be used to measure the yarn length per fixed number of stitches.

A suitable instrument for this test is the HATRA Course Length Tester which may be obtained from Shirley Developments Limited, PO Box 6, Withamshaw Road, Manchester, M20 8SA, England.

APPENDIX TWO

The use of the Yarn Speed Meter

This instrument enables a direct measurement of loop length to be determined during knitting.

The instrument is used to measure the speed of the yarn immediately before the knitting feeder. From this information the loop length can be calculated as follows:

$$\text{Loop length in mm} = \frac{\text{Yarn speed meter value in meters/min}}{\text{Yarn speed in rpm x by the number of needles knitting in one revolution x 1000}}$$

In addition it is possible to accurately level all the knitting feeders by ensuring that the yarn speed at each knitting feed is the same through a complete feeder repeat.

This instrument is very valuable in fabric development, as well as providing a basis of uniformity between machines. It is without doubt a most important insturment in day to day loop length control.

There are several types of yarn speed meter available, a suitable instrument is a Welmstar yarn length/speed meter RS100 available from Alan Shelton Limited, Winston Avenue, Croft, Leicestershire, LE9 6GQ, England.

APPENDIX THREE

The use of a Yarn Tensiometer

The tension of the moving yarn is measured immediately before the yarn feeder on machines fitted with positive feed.

The values of yarn tension are recorded for each consecutive knitting feeder to an accuracy of 0.5g. The values obtained should be between 3 and 7g. Any variation can be altered by adjusting the relevant stitch cam.

APPENDIX FOUR

Date:

Machine No: Gauge: Number of Needles:

Type of Machine: Diameter: Speed in RPM:

Fabric Type: Yarn Count:

Feeder No:	Tensiometer Reading in gms:	Yarn Speed Meter Reading m/m or Course Length in cm:	Loop Length in mm:
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
ETC			

APPENDIX 5

PROGRAMME OF D M ELSON

Day 1 - Sunday

Travelled to Damascus from England.

Day 2 - Monday

Visit: 1) UNDP, Damascus.
2) The Technical Director of the General Organisation of the Textile Industry.
3) The General Director, Orient Underwear Manufacturing Company .

Day 3 - Tuesday

Visit: 1) UNDP, Damascus.
2) General Organisation Design Centre.
3) All sections of the Knitting Underwear Manufacturing Company.
4) Familiarisation.

Day 4 - Wednesday

General Survey of knitting plant.

Day 5 - Thursday

Identify the requirements of quality control.

Day 6 - Friday

Preparation of Report (rest day).

Day 7 - Saturday

Discussion with production director, commence work on yarn length measurement.

Day 8 - Sunday

Commence measurement of yarn length.

Day 9 - Monday

Visit UNDP, Damascus, plan knitting trial.

Day 10 - Tuesday

Knitting trial, Hama 1 yarn.

Day 11 - Wednesday

Knitting trial, Hama 2 yarn.

Day 12 - Thursday

Analyse results of knitting trial.

Day 13 - Friday

Development of report (rest day).

Day 14 - Saturday

Continue loop length measurement, commence yarn tension measurement.

Day 15 - Sunday

Travel to Aleppo, visit Hama Mill, start survey of Arab Company for Underwear, Aleppo.

Day 16 - Monday

Continue survey of Arab Company for Underwear, Aleppo. Return to Damascus.

Day 17 - Tuesday

Meeting the the General Director, Orient Underwear Manufacturing Company. Commence fabric development.

Day 18 - Wednesday

Continue fabric development.

Day 19 - Thursday

Continue observations on loop length and quality control and fabric development.

Day 20 - Friday

Development of report (rest day).

Day 21 - Saturday

Presentation of interim report to the General Director and his fellow Directors and Managers together with the Technical Director of the General Organisation for Textile Industry and the Director of the Design Centre.

Day 22 - Sunday

Continue meeting with General Director and colleagues relating to garment faults to knitting.

Day 23 - Monday

Preparation of report.

Day 24 - Tuesday

Discussion with colleagues of project.

Day 25 - Wednesday

Analysis of results.

Day 26 - Thursday

Write report.

Day 27 - Friday

Complete report for typing.

Day 28 - Saturday

Return from Damascus to the U.K.