RESEARCH RECORD NO: 191

AN INVESTIGATION OF THE WINCH DYE ROUTE AT SPRINGFIELD DYERS (NOTTINGHAM) LIMITED AND THE ACCURACY OF STARFISH IN PREDICTING FOR THIS ROUTE

AUTHORS: ROBERT D. LEAH/JAMES T. EATON

DATE: MARCH 1985

CLASSIFICATION: FABRICS/KNITTED/PROCESSING

KEY WORDS: INTERLOCK, STARFISH, SPRINGFIELD DYERS, GB TEXTILES, MARTINS (LEICESTER), REFERENCE STATE

C O N T E N T S

A P P E N D I C E S

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1. INTRODUCTION

In early 1984 at a meeting requested by GB Textiles of Nottingham, which was attended by representatives of GB Textiles, Springfield Dyers (Nottingham) Limited and IIC, a question was raised about the accuracy of STARFISH predictions.

In brief, a quantity of 20 gauge interlock fabric was knitted by GB Textiles based on a STARFISH prediction given in 1982. It was dyed and finished at Springfield Dyers (Nottingham) Limited and subsequently made up into garments by GB Textiles. These garments were eventually shipped to the USA and became the subject of a complaint.

The garments were body fit and therefore were knitted on machines of different diameter to give a range of garment sizes. Following garment makeup and shipment to the USA the garments lost width, indicating that excessive amounts of width shrinkage had been built into the fabric. This report outlines a limited study carried out to try to determine whether the complaint arose due to the inaccuracy of the prediction or whether other factors were responsible for the complaint.

2. BACKGROUND

The original request for a STARFISH prediction was given, based on the winch dye, Hunt & Moscrop route and the main concern was to produce a range of garment sizes using the knitting machines available at a commercially desirable weight. This quality was apparently produced for some time, since the prediction was given in 1982 and the present problem came to light in 1984. Since there was no close contact with GB Textiles during this period, nothing is known about the success or otherwise of this quality during the interim period and whether the prediction was followed precisely. All that is known is that the present finisher of the quality is Springfield Dyers (Nottingham) Limited and that fabrics finished by them have led to complaints.

Much of the information available to us on previous production is at the very least vague, and therefore, for the purpose of this investigation has been ignored.

The facts which are known for certain relate to two garments which were returned from the USA which were undersize due to creep-back. The garments were tested at TRD and gave the following information:

	Yarn Tex (BW)	Stitch Length (AW)	Courses/3cm		Wales/3cm	
			BW	AW	BW	AW
Yellow	15.3	0.374 cm	35.7	42.1	38.1	44.8
Wine	15.6	0.377 cm	37.7	43.4	41.3	45.0

SHRINKAGE (5 CYCLES)

	LENGTH	WIDTH
Yellow	15.7%	12.7%
Wine	14.5%	8.6%

The following points can be made from these results:

1) since these shrinkages are based on garments, the fabric shrinkage must have been higher

2) the shrinkages measured were on garments which had reportedly exhibited creep-back and therefore the width shrinkage of the fabric prior to creep-back must have been very high, particularly in the case of the yellow garment which still had almost 13% residual width shrinkage present

3) if it is assumed that yarn shrinkage during processing will have been approximately 2%, the knitted stitch length appears to be correct (0.131 inches finished - 0.135 inches knitted).

   This stitch length was originally suggested from a STARFISH prediction.

If the original prediction is compared with what was actually found in the garments, we have the following estimates of the fabric reference state:

	Yarn Tex as knitted	Stitch Length as knitted(inch)	C/3cm	W/3cm
Prediction	15.5	0.135	45.1	43.2
Yellow garment	15.6	0.135	42.1	44.8
Wine garment	15.9	0.135	43.4	45.0

If the two garments are averaged, STARFISH would appear to be over-estimating courses/3cm by approximately 5% and underestimating wales/3cm by approximately 4%. This means that fabric width would have been predicted too wide and therefore under some circumstances width creep-back might be expected.

To try to overcome the width problem, GB Textiles took the decision to increase the knitted stitch length from 0.135 to 0.140 inches.

Springfield obviously worried by the situation carried out a finishing trial on a batch of navy fabric where they varied the finishing route (drying and calendering) and tried to determine whether this had any effect on fabric width creep-back. Very slight differences were observed but nothing of any significance to explain the high levels of creep-back which had been observed on the garments.

A sample of this batch was obtained and submitted to the TRD lab for analysis. The results obtained are given below.

	C/3cm	W/3cm	Width	Tex	SL
Before Wash	36.8	39.7	19 in	-	-
After Wash*	41.5	46.9	15.8	15.5	0.137 in

* 5 cycles

If again it is assumed that 2% yarn shrinkage occurs during dyeing and finishing, this would put the knitted stitch length as 0.140 inches and the yarn as 15.2 tex. When these are fed into the computer and an estimate of the reference state obtained for a winch dyed operation, the following is obtained:

C/3cm	W/3cm	Width
42.9	43.2	17.2 inch

From this it will be clear that STARFISH is predicting a reference width of 17.2 inches whereas the actual reference width of the Springfield winch dyed fabric is 15.8 inches.

If finishing targets are then calculated based on a reference width of 17.2 inches instead of 15.8 inches then excessive levels of width shrinkage will be built into the fabric which will almost inevitably result in width creep-back.

Since an anomaly such as this has never occurred before with STARFISH predictions, it was felt that further investigation was required and an agreement was made with Springfield to investigate their winch dye route.

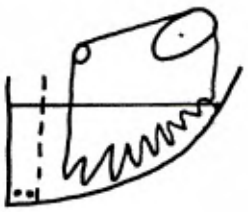
3. TRIALS AT SPRINGFIELD

The route through which the GB Textiles interlock fabric was processed at Springfield was:-

winch dye (including prescour)
hydroextract
Pegg dry
calender

Two types of winch are used at Springfield. The Horrocks winch, commonly known as the deep draught winch, which is characterised by its relatively short front to back dimension and segment shaped cross-section.

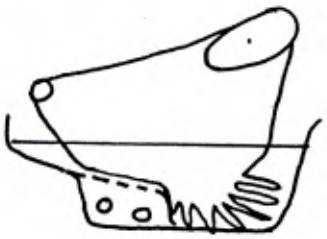
Diagram: HORROCKS



This is a very common winch in dyehouses processing cotton fabrics and is the type of winch on which the original central project fabrics were processed.

The other type of winch used at Springfield is the Leemetal shallow draught winch, which has a longer front to back dimension and has a completely different cross-section.

Diagram: LEEMETAL



Whether these two types of winch have a different effect on fabric structure is therefore of considerable interest and arrangements were made with Springfield to process some IIC interlock fabric on both types of machine and to try to determine whether any differences were apparent.

Ideally it would have been preferable to have been able to process a complete dye load of IIC fabric through each route but this would have been far too expensive. In the event, single pieces of IIC fabric which had been exhaustively tested in the greige state, were incorporated into normal production dyelots.

During discussion with Springfield it was agreed that as well as the machinery variable, it would be very interesting to also investigate the difference between depth of shade. Four pieces of IIC interlock fabric were therefore processed through the following sequences together with bulk production under fully commercial conditions.

1) Pale shade (I9) Horrocks deep draught
2) Dark shade (I6) Horrocks deep draught
3) Pale shade (I8) Leemetal shallow draught
4) Dark shade (I10) Leemetal shallow draught

The references in brackets are the IIC identifiers for the particular pieces of interlock fabric.

Both of the pale shades were dyed with direct dyestuffs whilst the two dark shades were dyed with Procion HE reactive dyes. Prior to dyeing, all four dyelots were given a scour/bleach.

The processing cards for the four dye lots are given in the Appendix.

After dyeing, the IIC fabrics were hydroextracted and dried on the Pegg machine.

Finishing targets of 38/39 courses/3cm and 39 wales/3cm were given to Springfield based on a STARFISH prediction for a winch dye (medium) route with residual shrinkage levels of:

Length 15%
Width 10%

This, if achieved, would result in a finished width of 57cms.

All four fabrics were brought off the Pegg dryer at 60cms and after one days's standing, had relaxed to 58/59 cms. They were finally calendered to a width of 59 cms. After a period of several weeks the widths were remeasured and found to be:

I6 57.4cms
I8 57.9cms
I9 57.7cms
I10 56.7cms

The only variant which had crept back to a width which was below the target finished width was I10 which is the variant dyed to a deep shade in the Leemetal winch. However, this was only marginally below the target.

The fabric was returned to Manchester and three separate 3-metre samples were removed from different parts of each piece. These were submitted to the lab for full tests.

Full finished test results are given in Table 2. The corresponding full greige test results are given in Table 1.

Since the main purpose of this exercise is to determine whether the particular type of winch machine has an effect on fabric structure this can be assessed by studying the reference courses and wales of the greige state and dyed state fabrics.

Since three replicates were taken for each processing variant, the averages were calculated for the dyed and finished fabrics.

Pc. Ref.	VARIANT	Ref.C/3cm	Ref. W/3cm
I6	Horrocks deep	44.7	43.1
I8	Leemetal pale	44.1	43.2
I9	Horrocks pale	45.2	42.6
I10	Leemetal deep	44.8	44.9

A cursory inspection of these reveals that with both types of winch the deeper dyed fabrics are permanently slightly narrower (more reference wales) than the paler shades.

However, since there is always some variability between individual pieces a better comparison is possible if allowance is made for this variation and Table 3 compares the reference courses and wales predicted by STARFISH using the actual values of Tex and stitch length measured in the greige fabric with those measured in the dyed and finished fabrics.

It will be apparent that there are in fact nine fabrics given in Table 3. The first five pieces which were in fact from the same lot of greige fabric which were purchased from Meridian were bleached and finished as part of another exercise at a different finisher, namely, Martins of Leicester. They have been included for two reasons:

- they are from the same batch of greige fabric,
- although they are bleached, the operation was carried out in a Horrocks deep draught winch.

The STARFISH predictions for these first five pieces was obtained using the winch dye (white) option, but Table 4 shows that these are in fact very similar to those obtained by the winch (medium) option.

If the variance columns in Table 3 are considered, the only clear picture which emerges is that the winch dye (white) option is consistently under-estimating the reference courses. If target courses are then calculated using the reference courses then higher than expected length shrinkage values are likely to be obtained.

With the Springfield dyed fabrics no clear picture emerges which enables any conclusions to be drawn regarding the effect of the two types of winch.

During one of the visits to GB Textiles however, a number of dyed samples were collected from stock which had been produced on different diameters of knitting machine. The four shades which were collected were all available from three sizes of knitting machine and the twelve samples were evaluated in the TRD lab. The test results are given in Table 5.

An examination of the stitch lengths and Tex data indicates that the knitting was under control and that the knitted stitch length was around 0.140 inches. If the reference courses and wales are plotted (Figure 1) it is apparent that considerable differences exist between dyed shades. The spread is from 41-45 courses/3cm and 43-46 wales/3cm. The STARFISH prediction of the reference state for this quality is 42.9 courses/3cm and 43.2 wales/3cm.

The prediction is therefore giving a reasonable estimate of the average courses/3cm, but is tending to be on the low side when estimating the reference wales/3cm. In the extreme instance it is out by almost 3 wales/3cm, which in percentage terms, is almost 7%.

For the original sizing operation for the American customer, GB Textiles specified finished widths which they calculated from the STARFISH prediction with a residual width shrinkage level of14%. Under certain circumstances, therefore, it is quite feasible that due to the variability which is very apparent between shades this 14% width shrinkage could conceivably have been 21%.

At this level of residual width shrinkage it is almost inevitable that creep-back would occur. The question arises therefore as to why there are differences between shades. Long discussions with the technical manager at Springfield have raised the following points:

1. the fabric is always given a pretreatment prior to dyeing and this is invariably with caustic soda and peroxide,

2. the darker shades are always given a longer fixation time (reactives) than the paler shades,

3. in order to ensure very good washfastness, they always give two boiling backscour treatments to the dark shades. This in itself can mean an additional two hours in the winch for the dark shades when compared with the lighter shades.

4. CONCLUSIONS

This small trial on only four pieces of fabric has not enabled significant differences to be found between the two different types of winch.

The STARFISH prediction using the winch dye (medium) option tends to be over-estimating the reference width of Springfield dyed interlock.

Due to the variability which has been observed between different dyed shades and also the fact that the relatively high 14% width shrinkage which was being built into the finishing targets by GB Textiles, width creep-back under some circumstances could be expected.

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TESTS REQUIRED			I1	95%CL	I2	95%CL	I 3	95%CL	I 4	95%CL	I 5	95%CL	I 6	95%CL	I 8	95%CL	I 9	95%CL
FABRIC WEIGHT	BW	✓	162·8	4.2	1658	3.6	160·9	4·6	164·3	4·8	161·2	4·3	164·3	4·0	163·6	3·3	156·7	2·5
G.S.M.	AW	✓	241·8	3·0	245·2	5·5	239·6	6·2	239·4	7·2	235·2	5·4	239·9	3·7	241·3	4·2	235·9	5·8
C/3 CM	BW	✓	37.1	0.4	36·6	0·4	36·4	0·5	37·0	0·6	36·4	0·4	37·4	0·8	37·0	0·5	36·3	0·6
	AW	✓	48·5	0·5	48·4	0·4	47·6	0·6	50·4	0·6	47·7	0·4	47·6	0·6	49·6	0·5	47·2	0·5
W/3 CM	BW	✓	36·4	0·4	35·5	0·4	36·8	0·5	37·2	0·5	37·4	0·4	37·1	0·7	36·8	0·9	36·4	0·7
	AW	✓	43·6	0·6	43·0	0·6	43·2	0·6	42·0	0·6	43·5	0·8	43·5	0·5	39·7	0·7	42·8	0·7
STITCH LENGTH	BW	✓	3·48	0·01	3·44	0·01	3·43	0·02	3·48	0·01	3·48	0·01	3·49	0·004	3·49	0·01	3·447	0·02
MM	AW	✓	3·47	0·01	3·42	0·01	3·43	0·01	3·46	0·01	3·46	0·01	3·38	0·01	3·47	0·01	3·42	0·01
BURST STRENGTH	BW																	
Kn/m2	AW																	
DISTENSION	BW																	
mm	AW																	
SPIRALITY ANGLES	BW																	
	AW																	
NO OF NEEDLES IN TUBE	BW	✓	1486		1489		1487		1485		1469		1485		1487		1488	
THICKNESS	BW																	
	AW																	
YARN COUNT	BW	✓	159		16·1		15·8		15·8		15·5		16·0		15·7		15·6	
TEX	AW	✓	15.2		15·6		15·4		15·0		14·8		15·4		14·9		15·1	
S.E.S. g	BW	✓	190·4	11.2	195·4	11·2	192·6	11·1	186·8	10·3	178·7	7·7	188·6	9·7	181·6	9·2	177·9	10·4
	AW	✓	175.7	9.3	186·6	11·1	188·0	11·1	184·5	9·0	177·9	10·3	186·0	8·4	191·3	11·1	175·2	8·6
% EXT	BW	✓	7.1	0·6	7·2	0·2	7·1	0·3	6·8	0·4	6·4	0·3	6·3	0·2	6·3	0·2	6·3	0·3
	AW	✓	7·0	0·4	7·1	0·3	7·4	0·3	7·8	0·4	7·2	0·4	7·1	0·5	7·0	0·3	6·6	0·2

TESTS REQUIRED			I 10	95%CL		95%CL		95%CL		95%CL		95%CL		95%CL		95%CL		95%CL
FABRIC WEIGHT	BW	✓	167·6	3·1														
G.S.M.	AW	✓	241.2	2·7														
C/3 CM	BW	✓	38·3	0·6														
	AW	✓	50·0	0·5														
W/3 CM	BW	✓	36·2	0·3														
	AW	✓	42·5	0·4														
STITCH LENGTH	BW	✓	339	0·005														
MM	AW	✓	3·37	0·01														
BURST STRENGTH	BW																	
Kn/m2	AW																	
DISTENSION	BW																	
mm	AW																	
SPIRALITY ANGLES	BW																	
	AW																	
NO OF NEEDLES IN TUBE	BW	✓	1487															
THICKNESS	BW																	
	AW																	
YARN COUNT	BW	✓	16·1															
TEX	AW	✓	15·0															
S.E.S. g	BW	✓	202·2	11·7														
	AW	✓	175·7	8·3														
% EXT	BW	✓	6·6	0·3														
	AW	✓	7·3	0·4														

COMMENTS:

FABRIC DETAILS: STOCK FABRIC PURCHASED FROM MERIDIAN QUAL - FW 1007. INTERLOCK 20 GAUGE 24" DIAM. (GREIGE)

GREIGE FABRIC TEST RESULTS

TABLE 1.

INTERNATIONAL INSTITUTE FOR COTTON. KNITTING REF. LAB. REF. 1123 SUBMITTED BY. DL DATE. 7th FEB

SPRINGFIELD TRIAL FINISHED SAMPLES

TESTS REQUIRED			I6/A	95%CL	I6/B	95%CL	I6/C	95%CL	I8/A	95%CL	I8/B	95%CL	I8/C	95%CL	I9/A	95%CL	I9/B	95% CL
FABRIC WEIGHT	BV	✓	162.6	8.0	160.4	2.5	160.9	2.0	149.6	2.3	149.0	2.6	156.4	1.9	153.1	1.1	157.5	0.8
G.S.M.	AV	✓	208.8	3.4	212.4	2.4	212.6	3.1	200.8	2.4	200.9	1.0	208.6	2.3	210.0	2.9	204.5	1.6
/3 CM	BV	✓	37.1	0.4	37.1	0.2	37.5	0.4	35.1	0.2	34.3	0.4	34.2	0.3	36.3	0.4	36.1	0.2
	AV	✓	44.9	0.2	44.6	0.4	44.6	0.4	44.1	0.2	44.1	0.2	44.0	0	45.3	0.4	45.3	0.4
1/3 CM	BV	✓	38.7	0.5	38.2	0.5	37.3	0.4	37.5	0.4	38.1	0.2	38.6	0.3	37.9	0.2	38.2	0.3
	AV	✓	43.1	0.2	43.2	0.3	43.1	0.2	43.0	0	43.3	0.4	43.4	0.4	42.5	0.4	42.9	0.4
STITCH LENGTH	BV	✓	3.445	0.01	3.445	0.01	3.418	0.01	3.411	0.01	3.394	0.01	3.452	0.01	3.444	0.02	3.394	0.01
MM	AV	✓	3.415	0.003	3.385	0.01	3.360	0.01	3.397	0.01	3.396	0.01	3.404	0.01	3.370	0.01	3.400	0.01
FIRST STRENGTH	BV	✓	706.1	20.8	698.0	22.4	696.2	19.3	669.5	24.0	634.6	30.0	687.0	20.5	666.7	20.9	643.4	25.2
Kn/m²	AV	✓	674.1	18.0	669.2	38.3	675.3	32.4	685.7	18.7	691.3	30.6	694.1	27.0	730.5	19.0	712.1	42.9
DISTENSION	BV	✓	15.7	0.4	16.4	0.7	15.9	0.4	15.9	0.8	15.4	0.7	16.2	1.1	15.5	0.4	16.0	0.9
MM	AV	✓	20.7	0.5	20.8	0.6	21.4	0.6	20.6	0.2	20.6	0.4	21.1	0.9	20.8	0.7	20.9	0.4
SPIRALITY ANGLES	BV	✓	-1.0	0.5	-2.1	0.7	-1.4	0.7	-0.9	0.8	0.1	0.7	1.5	0.6	-0.7	1.2	1.2	0.8
	AV	✓	-1.4	0.8	-1.7	0.8	-0.04	1.0	-1.7	0.6	0.1	1.0	1.7	0.7	1.8	0.7	0.1	0.8
WIDTH	BV	✓	57.6	0.9	57.9	0.9	58.0	0.4	58.5	1.3	58.2	0.8	57.1	0.3	57.6	0.6	57.6	1.6
THICKNESS	BV	✓	745.9	12.4	757.9	7.1	751.8	6.0	694.9	15.6	685.9	17.0	706.7	13.5	718.3	18.8	752.0	15.3
	AV	✓	1217.9	9.8	1228.7	12.7	1215.3	14.2	1200	9.2	1187.6	11.0	1181.7	9.8	1184.7	10.0	1202.4	13.1
YARN COUNT	BV	✓	15.5		15.7		15.7		15.2		15.3		15.1		15.1		15.5	
TEX	AV	✓	15.5		15.9		15.4		15.3		15.4		15.2		15.4		15.2	
L.E.S. Q	BV	✓	194.9	4.2	196.2	5.9	197.5	6.1	224.0	6.5	214.0	5.6	206.8	12.3	203.9	8.5	199.7	5.8
	AV	✓	215.6	7.8	212.6	11.5	219.1	9.0	228.2	14.8	237.8	13.0	229.2	11.1	236.1	9.6	239.5	10.0
% EXT	BV	✓	6.2	0.1	6.7	0.2	6.3	0.2	6.2	0.1	6.1	0.2	6.0	0.2	6.2	0.2	6.6	0.1
	AV	✓	6.6	0.3	6.7	0.3	6.9	0.3	6.8	0.4	6.8	0.3	7.0	0.3	6.6	0.1	6.7	0.2

COMMENTS:

FABRIC DETAILS:

SPRINGFIELD TRIAL

FINISHED TEST RESULTS

TESTS REQUIRED			I9/C	95%CL	I10/A	95%CL	I10/B	95%CL	I10/C	95%CL		95%CL		95%CL		95%CL		95% CL
FABRIC WEIGHT	BV		157.9	1.8	155.2	1.7	158.3	0.4	155.4	2.6								
G.S.M.	AV		204.6	2.7	212.2	1.9	210.5	2.4	210.4	5.2								
/3 CM	BV		35.7	0.4	35.9	0.2	35.5	0.4	35.6	0.4								
	AV		45.1	0.5	45.0	0	44.6	0.4	44.7	0.5								
1/3 CM	BV		38.6	0.4	39.2	0.5	38.7	0.4	38.7	0.4								
	AV		42.5	0.4	44.7	0.4	45.0	0.3	45.0	0.3								
STITCH LENGTH	BV		3.346	0.01	3.344	0.01	3.375	0.01	3.374	0.01								
MM	AV		3.371	0.01	3.383	0.003	3.334	0.003	3.331	0.001								
FIRST STRENGTH	BV		663.9	24.3	712.7	26.1	633.3	24.3	642.4	18.3								
Kn/m²	AV		723.0	5.1	697.6	24.6	690.5	15.9	673.9	26.2								
DISTENSION	BV		17.4	1.1	17.2	1.0	15.7	1.0	15.7	0.5								
MM	AV		20.5	0.4	20.7	0.9	21.1	0.6	20.2	0.2								
SPIRALITY ANGLES	BV		-1.6	0.5	-0.1	0.7	-0.7	0.7	0.7	0.6								
	AV		0.9	0.8	-0.1	1.3	0.4	0.9	1.5	0.9								
WIDTH	BV		57.8	0.5	54.3	0.6	56.9	0.6	56.8	0.6								
THICKNESS	BV		707.2	9.3	706.9	3.6	715.7	5.0	719.2	9.2								
	AV		1171.6	10.3	1196.8	9.3	1203.2	7.2	1196.7	11.9								
YARN COUNT	BV		15.3		15.5		15.2		15.3									
TEX	AV		15.4		15.5		15.5		15.4									
L.E.S. Q	BV		199.2	8.9	194.8	6.0	196.1	4.1	180.7	6.6								
	AV		259.1	14.9	206.6	7.4	195.1	11.4	202.5	9.6								
% EXT	BV		6.2	0.2	6.3	0.2	6.6	0.1	6.4	0.2								
	AV		6.4	0.3	6.2	0.2	5.9	0.4	6.3	0.3								

COMMENTS:

FABRIC DETAILS:

SPRINGFIELD TRIAL

FINISHED TEST RESULTS

SPRINGFIELD TRIAL

REF 1123

% SHRINKAGE FINISHED SAMPLES

			I6/A	95%CL	I6/B	95%CL	I6/C	95%CL		95%CL	I8/A	95%CL	I8/B	95%CL	I8/C	95%CL
WASH + TUMBLE DRY	LENGTH	✓	15.1	0.9	15.1	0.8	14.2	0.9			17.6	0.9	18.2	0.9	17.9	0.3
	WIDTH	✓	10.0	0.8	10.3	1.1	10.1	0.9			11.0	0.8	10.4	1.3	10.6	0.8
1 WASH + 4 RINSES + TUMBLE DRY	LENGTH	✓	16.4	0.5	16.7	1.0	17.5	1.3			21.9	2.2	22.0	0.9	21.9	0.5
	WIDTH	✓	10.3	0.6	11.1	1.9	11.5	1.8			11.2	1.0	10.4	0.8	10.9	1.2
WASH + TUMBLE LINE DRY	LENGTH		43.6	0.6	44.0	0.5	43.6	0.6			42.9	0.4	42.5	0.4	42.1	0.4
	WIDTH		44.1	0.6	44.1	0.4	44.0	0.6			43.7	0.5	43.8	0.8	44.5	0.5
1 WASH + 4 RINSES + LINE DRY	LENGTH															
	WIDTH															

SIZE TESTED		NO. REPS TUMBLE	50		NO. REPS LINE	50	
	50CM						
	25CM		25	✓5		25	

SPRINGFIELD

% SHRINKAGE

			I9/A	95%CL	I9/B	95%CL	I9/C	95%CL	%	95%CL	I10/A	95%CL	I10/B	95%CL	I10/C	95%CL	
WASH + TUMBLE DRY	LENGTH		17.4	1.0	16.5	0.8	16.5	0.9	16.9		16.8	0.8	14.9	1.7	15.4	1.1	15.5
	WIDTH		9.3	1.3	9.2	0.8	10.0	1.4	9.5		11.0	0.9	12.0	0.9	12.3	1.6	11.8
1 WASH + 4 RINSES + TUMBLE DRY	LENGTH		20.4	0.8	19.6	0.4	20.2	0.5			20.0	0.6	20.3	0.7	19.9	0.8	
	WIDTH		8.2	1.5	9.2	1.4	9.0	1.7			11.0	0.9	11.7	0.8	12.1	1.2	
WASH + TUMBLE LINE DRY	LENGTH		43.5	0.4	43.4	0.4	43.1	0.5			43.4	0.6	42.2	0.3	42.8	0.6	
	WIDTH		43.3	0.8	43.5	0.5	43.6	0.4			45.6	0.6	45.6	0.6	45.9	0.6	
1 WASH + 4 RINSES + LINE DRY	LENGTH																
	WIDTH																

SIZE TESTED		NO. REPS TUMBLE	50		NO. REPS LINE	50	
	50CM						
	25CM ✓		25	5		25	

FINISHED FABRIC TEST RESULTS TABLE 2

STARFISH PREDICTIONS----------20 GAUGE INTERLOCK
PREDICTED AGAINST PRACTICALLY MEASURED

REFERENCE STATE DIMENSIONS

	TEX	ST. LEN.	PRED. C/3	PRED. W/3	MEAS. C/3	MEAS. W/3	VARIANCE C/3	VARIANCE W/3
1	15.9	0.348	44.1	43.1	45.5	44	-1.4	-0.9
2	16.1	0.344	44.8	43.2	46.1	43.3	-1.3	-0.1
3	15.8	0.343	44.9	43.5	45.6	42.9	-0.7	+0.6
4	15.8	0.348	44	43.2	45.7	42.8	-1.7	+0.4
5	15.5	0.342	44.9	43.8	46.7	42.3	-1.8	+1.5
6	16	0.34	45.7	43.5	44.7	43.1	+1.0	+0.4
7	15.7	0.349	44.2	43.2	44.1	43.2	+0.1	NIL
8	15.6	0.347	44.4	43.4	45.2	42.6	-0.8	+0.8
9	16.1	0.339	45.9	43.5	44.8	44.9	+1.1	-1.5

ITEM 1---MARTINS BLEACHED HORROCKS WINCH
ITEM 2--- " " " "
ITEM 3--- " " " "
ITEM 4--- " " " "
ITEM 5--- " " " "
ITEM 6---SPRINGFIELD DEEP DYED HORROCKS WINCH
ITEM 7---SPRINGFIELD PALE DYED LEEMETAL WINCH
ITEM 8---SPRINGFIELD PALE DYED HORROCKS WINCH
ITEM 9---SPRINGFIELD DEEP DYED LEEMETAL WINCH

— INDICATES UNDERPREDICTING BY .....

+ INDICATES OVERPREDICTING BY .....

Table 3

IIC -STARFISH 84- MODEL PREDICTIONS

Interlock - singles, combed ring yarns
20g 24in 1488 needles
Winch dye (white)
Targets are Finished Length & Width Shrinkages 28-FEB-85 14:08

As knitted				Average finished dimensions				Shrinkage (5 W&T)		
Yarn Tex	StLen cm	C.Len cm	Tness Fctr	courses 3cm	wales 3cm	weight g/sm	width cm(T)	Length %	Width %	
15.9	0.3480	517.8	11.5	44.1	43.1	214	51.8	0.0	0.0	*
16.1	0.3440	511.9	11.7	44.8	43.2	219	51.7	0.0	0.0	*
15.8	0.3430	510.4	11.6	44.9	43.5	216	51.3	0.0	0.0	*
15.8	0.3480	517.8	11.4	44.0	43.2	213	51.7	0.0	0.0	*
15.5	0.3420	508.9	11.5	44.9	43.8	213	51.0	0.0	0.0	*

NB : Shrinkage convention is + for growth, - for contraction
: Qualities marked with * have unreasonable finishing targets
: Estimates are given in good faith but without liability
: Yarn counts are given as Resultant for folded yarns
: Tightness Factor is Root(Tex)/St.Len in cm

IIC -STARFISH 84- MODEL PREDICTIONS

Interlock - singles, combed ring yarns
20g 24in 1488 needles
Winch dye (medium)
Targets are Finished Length & Width Shrinkages 28-FEB-85 14:10

As knitted				Average finished dimensions				Shrinkage (5 W&T)		
Yarn Tex	StLen cm	C.Len cm	Tness Fctr	courses 3cm	wales 3cm	weight g/sm	width cm(T)	Length %	Width %	
15.9	0.3480	517.8	11.5	44.4	43.1	215	51.8	0.0	0.0	*
16.1	0.3440	511.9	11.7	45.1	43.1	221	51.7	0.0	0.0	*
15.8	0.3430	510.4	11.6	45.1	43.5	217	51.4	0.0	0.0	*
15.8	0.3480	517.8	11.4	44.4	43.1	214	51.7	0.0	0.0	*
15.5	0.3420	508.9	11.5	45.1	43.8	214	51.0	0.0	0.0	*

NB : Shrinkage convention is + for growth, - for contraction
: Qualities marked with * have unreasonable finishing targets
: Estimates are given in good faith but without liability
: Yarn counts are given as Resultant for folded yarns
: Tightness Factor is Root(Tex)/St.Len in cm

Table 4.

TESTS REQUIRED			← LIGHT BLUE → 1A	95%CL	1B	95%CL	1C	95%CL	← PINK → 2A	95%CL	2B	95%CL	2C	95%CL		95%CL		95% CL
FABRIC WEIGHT	BW	✓	171.4	5.1	164.9	5.7	159.8	1.9	155.9	4.8	154.0	4.8	160.9	4.1				
G.S.M.	AW	✓	220.3	3.6	215.7	6.7	213.0	5.1	217.4	6.0	215.9	6.0	218.7	5.1				
C/3 CM	BW	✓	37.1	0.5	36.8	0.5	36.9	0.2	35.5	0.5	37.8	0.7	36.7	0.4				
W/S/Swash	AW	✓	434/451	0.6/0.2	413/442	0.4/0.5	427/445	0.6/0.5	412/433	0.7/0.8	426/447	0.5/0.5	423/438	0.5/0.6				
W/3 CM	BW	✓	40.7	0.6	40.1	0.9	41.2	0.9	40.4	1.0	38.3	0.8	38.8	0.8				
W/S/Swash	AW	✓	458/461	0.6/0.7	447/452	0.8/0.6	439/456	0.8/0.6	465/457	0.8/0.8	443/446	0.5/0.8	453/463	0.5/0.7				
STITCH LENGTH	BW	✓	3.507	0.01	3.514	0.02	3.539	0.02	3.510	0.01	3.532	0.01	3.559	0.01				
MM	AW	✓	3.452	0.01	3.497	0.02	3.484	0.02	3.465	0.01	3.494	0.01	3.469	0.01				
BURST STRENGTH	BW																	
Kn/m2	AW																	
DISTENSION	BW																	
mm	AW																	
SPIRALITY ANGLES	BW																	
	AW																	
WIDTH	BW	✓	46.2	0.4	49.5	1.5	51.6	1.6	49.3	1.2	50.1	0.8	52.6	0.9				
THICKNESS	BW																	
No. Needles.	BW		1260		1305		1379		1319		1260		1380					
YARN COUNT	BW	✓	14.8		14.6		14.7		14.7		14.9		14.7					
TEX	AW	✓	15.0		14.6		14.6		15.0		14.6		14.9					
S.E.S. g	BW	✓	202.6	10.9	197.2	9.6	192.1	10.1	201.3	10.4	195.5	10.5	204.1	9.3				
	AW	✓	228.7	10.8	234.5	11.3	222.5	11.8	218.7	13.0	203.9	11.8	229.6	13.4				
% EXT	BW	✓	6.7	0.2	6.3	0.3	6.5	0.2	6.8	0.2	6.9	0.3	6.9	0.2				
	AW	✓	7.0	0.2	7.2	0.2	6.8	0.3	6.3	0.2	6.6	0.2	7.0	0.3				

COMMENTS:

Shrinkage. Measure after 1 W+T and after 5 cycles. for shrinkage + C/W.
Also measure no. of needles

FABRIC DETAILS: 20G INTERLOCK FABRICS FROM G.B. TEXTILES.
A = 19" } M/C DIAM.
B = 20"
C = 21"
FINISHED. (SPRINGFIELD)

INTERNATIONAL INSTITUTE FOR COTTON. KNITTING REF. GB TEX LAB. REF. SUBMITTED BY. JTE DATE. 22-5-84

TESTS REQUIRED			← RED → 3A	95%CL	3B	95%CL	3C	95%CL	← WHITE → 4A	95%CL	4B	95%CL	4C	95%CL		95%CL		95% CL
FABRIC WEIGHT	BW	✓	171.0	3.2	171.9	3.1	173.6	1.5	169.3	3.4	165.1	3.9	171.7	2.3				
G.S.M.	AW	✓	226.3	4.1	225.8	2.9	227.8	6.8	214.7	3.6	217.6	3.2	221.5	4.5				
C/3 CM	BW	✓	37.4	0.5	36.6	0.5	36.3	0.5	36.8	0.7	37.9	0.5	37.9	0.4				
W/S/Swash	AW	✓	449/416	0.4/0.6	446/420	0.6/0.7	449/408	0.6/1.1	404/422	0.6/0.7	419/420	0.4/0.8	420/428	0.3/0.6				
W/3 CM	BW	✓	38.3	0.7	39.6	0.8	39.3	0.5	39.5	0.8	39.0	0.5	38.8	0.6				
W/S/Swash	AW	✓	441/423	0.4/0.6	449/448	0.6/0.5	447/436	0.7/0.6	426/439	0.7/0.9	450/442	0.7/0.7	454/442	0.7/0.6				
STITCH LENGTH	BW	✓	3.531	0.01	3.534	0.01	3.550	0.005	3.516	0.01	3.534	0.01	3.531	0.01				
MM	AW	✓	3.547	0.01	3.543	0.01	3.533	0.02	3.505	0.01	3.547	0.01	3.537	0.01				
BURST STRENGTH	BW																	
Kn/m2	AW																	
DISTENSION	BW																	
mm	AW																	
SPIRALITY ANGLES	BW																	
	AW																	
WIDTH	BW	✓	46.1	1.9	47.7	1.9	50.3	1.5	46.7	2.3	49.2	2.5	52.0	1.3				
THICKNESS	BW																	
NO. needles	BW		1220		1265		1335		1210		1265		1340					
YARN COUNT	BW	✓	15.4		14.8		15.0		14.7		14.9		15.1					
TEX	AW	✓	15.1		15.0		15.0		14.6		14.8		14.7					
S.E.S. g	BW	✓	184.6	8.4	177.0	6.8	169.2	8.0	165.8	8.1	168.5	7.0	183.0	9.8				
	AW	✓	189.6	7.9	213.4	8.7	202.6	8.5	220.5	8.7	205.4	8.3	220.3	9.6				
% EXT	BW	✓	6.9	0.2	6.4	0.2	5.9	0.2	6.3	0.3	6.4	0.2	6.8	0.3				
	AW	✓	4.4	0.3	4.9	0.3	4.6	0.3	5.3	0.3	5.1	0.2	5.1	0.4				

COMMENTS:

Shrinkage:- Measure after 1 W+T and after 5 cycles.

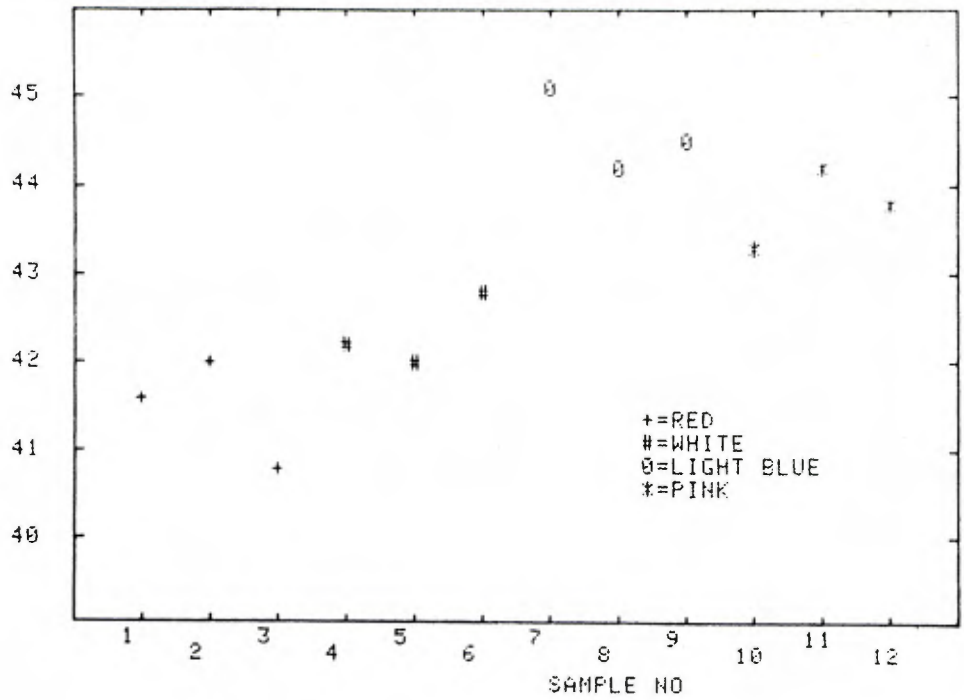
FABRIC DETAILS: 20G INTERLOCK FABRICS FROM G.B. TEXTILES
A = 19" } M/C DIAM.
B = 20"
C = 21"
FINISHED (SPRINGFIELD)

G.B. STOCK FABRICS

Table 5

G.B.INTL.FINISHED AT SPRINGFIELDS

C/3cms A.W.



G.B.INTL.FINISHED AT SPRINGFIELDS

W/3cms A.W.

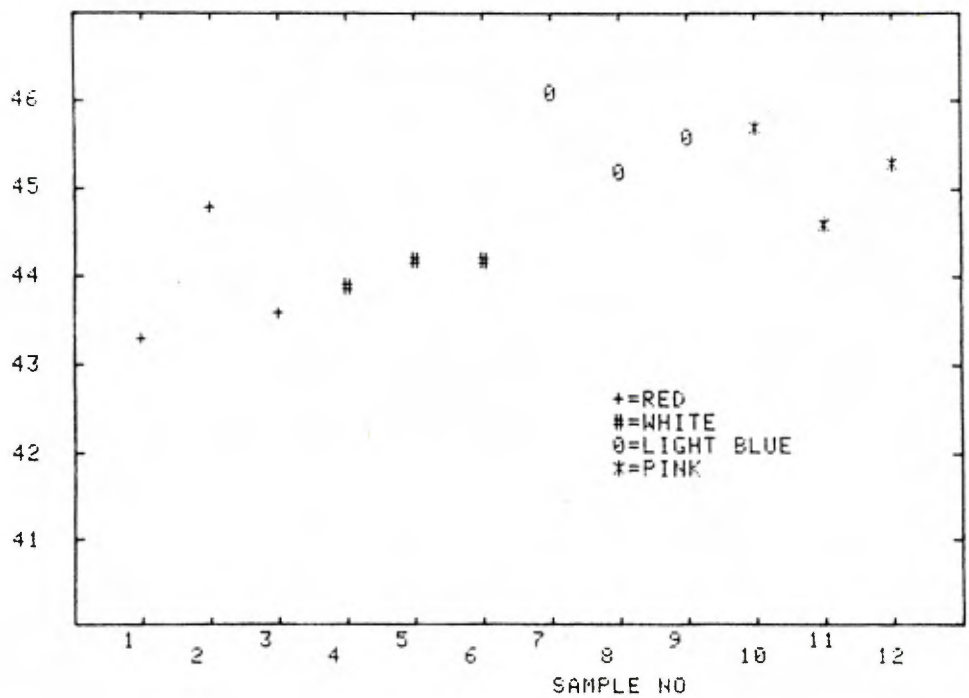
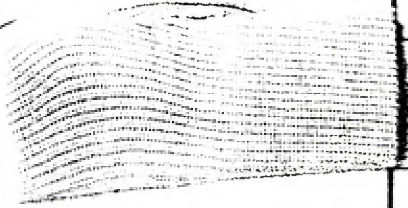


Fig. 1.

Customer	Shade	Total Wt	Rib etc. Wt	Code No
Dylewant	Cream	1165.11		

Machine No	Fibre/Section	Time on	Time off	Passed by	Date
Operator	ABCS COMBED COTTON / 45449	1	18.15	Steve	21.9.8

CHEMICALS		INSTRUCTIONS
Crosscare 11	3000	
Product WB171	2000	
Peroxide	8700	
Caustic	1100	
Sulphite	1100	Direct Dye,
Hot Wash 50°C		Start Cold

Added Chem.	INSTRUCTIONS
Crosoft NL	3900
Mystox	650
20' @ 40°C	

DYES		SERVES
Sulphenyl Brown AGL	26.5	
Sulphenyl Yellow FFL %	3.0	
Sulphenyl Blue AGFL %	0.85	
Rucoreveler EN	4000	
Calgon	4000	

ADDITIONAL DYES

PIECE No I 8
PALE SHADE DIRECT DYE
LEEMETAL WINCH

Customer	Shade	Total Wt	Rib etc. Wt	Code No
[illegible]	[illegible]	1116.9		NJSIAIC

Machine No	Fibre/Section	Time on	Time off	Passed by	Date
31	1/3U COMB COTTON / SILLS	14.9 / 161.4	17.25	Steve	18.12.8
Operator					

CHEMICALS		INSTRUCTIONS
~~Viscavine~~	4000	
Peroxide	12,000	
Caustic	4000	
Sulphite	4000	Procion HE method
Acetic 50°C	1000	85°C
		Run 90' in Soda

Added Chem.	INSTRUCTIONS
Calgon	400
Product WB171	40
Boil 30'	
Calgon	400
Product WB171	40
Boil 3'	
~~Sandofix~~	3
20' at 40°C	
Crosoft NL	480
20'	

DYES		SERVES
Procion Scarlet HE3G	5300	
" Red HE3B	2700	
Salt	360 kg	
Soda Ash	80 kg	

ADDITIONAL DYES

50

PIECE No I 10
DEEP SHADE REACTIVE
LEEMETAL WINCH

Table 6

Customer	Shade	Total Wt	Rib etc. Wt	Code No
GEMINI	Yellow C7611 –	125·40	–	4091VC

Machine No	Fibre/Section	Time on	Time off	Passed by	Date
34	80% COTTON	15·0			
Operator	5424 / 20% NYLON	14·0·4	P10·40AM	Sdews	11.10.

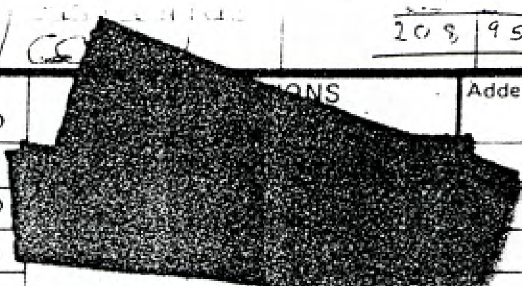
CHEMICALS		INSTRUCTIONS	Added Chem.	INSTRUCTIONS
SANCOWAD CO	625	CHECK PILE DIRECTION		SLOW COOL
" VLE	625			
RUN 10' @ 25°C - ADD -		DO NOT USE ANTIFOAM		
VISCAVIN E	2500			
PEROXIDE	8700			
CAUSTIC	2500	DIRECT DYE		
	2500			
SULPHITE		START COLD		CROSOFT HL 3
				20' @ 48C
2x15' COLD RINSES			½ CATE 10GM	

DYES		SERVES					ADDITIONAL DYES
Solophenyl Yellow A2GL	62	74.4	69.4	3	–		
" " ARL	24.5	22.9	27.4	1.5	2.5		
SANCOWAD CO	625						
" VLE	625						
RUCOLAVULEN	2500						
CALGON	2500						
SALT		5K.					

PIECE N° I9
PALE SHADE DIRECT DYE
HORROCKS WINCH

Customer	Shade	Total Wt	Rib etc. Wt	Code No
Edwards	Dk Logan[illegible]	[illegible]		[illegible]

Machine No	Fibre/Section	Time on	Time off	Passed by	Date
36					
Operator	1878 / C[illegible]	208 95	P6.30	BC	24.10.84.



CHEMICALS			INSTRUCTIONS	Added Chem.	INSTRUCTIONS	
CROSCOUR 11	548	6000		150	PRODUCT WB171	5000
PRODUCT WB171		4000		376	CALGON	5000
PEROXIDE	645.6	17000			BOIL 30' x 2.	
CAUSTIC	45.1	2200				
					MOTESAL FC-PN	6000
SULPHITE	67.1	2200		378	20' @ 40°C	
ACETIC (50%)		1000	PROCION H-E METHOD,			
	71.4		85°C	376	CROSOFT HL	6000
					RESINFIX C	500

DYES		SERVES			ADDITIONAL DYES
Procion Red H-E3B	978	+74	1065.7	3642.7	20' @ 40°C
" Blue H-EGN	13.147	+999	27437.8		
SALT	450Kgs	2385.0		1978	50
SODA ASH	100Kgs	1280.0			

PIECE N° I6
DEEP SHADE REACTIVE
HORROCKS WINCH

Table 6.