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Results of Random Sampling of Two Interlock and Rib Qualities at Meridian

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Contents

1. Introduction

This report contains a more detailed analysis of the results of a series of random samplings which were taken from routine production at Meridian during the second half of 1981 and early 1982. An outline summary was given to Meridian shortly after testing was completed and this was said to be sufficient for their purposes. However, we are interested in several further points which are not easy to evaluate from the simple summary.

The study had the following objectives:

1. To discover the extent of the normal random variation in production variables such as yarn count, stitch length and as-delivered dimensions within two basic fabric qualities.
2. To evaluate the consequences of these for the variability of the reference state.
3. To check whether the current STARFISH models are correctly predicting the reference state and the as-delivered dimensions for the chosen qualities.
4. To obtain some insight into the degree of precision which it is reasonable to expect from STARFISH predictions.

At the outset, it was decided that the experimental approach would be one of random sampling of yarn, grey fabric, and finished cloth in the chosen qualities rather than attempting to follow individual grey pieces through the mill. There were two reasons for this choice, as follows.

1 Following individual pieces would require a prohibitive investment in time and organisation.

2 We wanted to see the "real" picture from the point of view of both producer and customer where a given quality with a single specification may indeed be produced from different yarns (different suppliers) and through different finishing routes (white *vs.* coloured, winch *vs.* jet).

Notwithstanding this limitation in experimental design, we hoped to gain some insight into the systematic influences (if any) of yarn supplier and finishing route so this information was collected and noted in the computer records for each sample.

A data storage and retrieval programme, including simple editing, tabulation, statistics and plotting routines ("MILLVAR") was written to handle the results from this project as well as those from the parallel study carried out at Klynton Davis / Martins / Westertex. The data editing, tabulation, statistics, and plotting sections of this programme were later rebuilt into a free-standing general data handling programme which goes under the name "TABPLOT" and which was used for the majority of the analysis reported here.

Samples were collected at roughly three-weekly intervals over a period of six months and resulted in:

18 lots	of Ne 38 yarns	(5 - 10 part-cones)
18 lots	of Ne 30 yarns	(5 - 10 part-cones)
29 samples	of greige interlock	(3 - 5 metres)
42 samples	of greige 1 x 1 rib	(3 - 5 metres)
20 samples	of finished interlock	(3 - 5 metres)
24 samples	of finished 1 x 1 rib	(3 - 5 metres)

Details of the sampling schedule are given in *Figures 1, 2, and 3*.

The basic interlock was a 20-gauge quality made from nominal Ne38 with a stitch length of 3.38 mm.

The basic 1x1 rib was a 14-gauge quality made from nominal Ne30 with a stitch length of 2.85 mm.

These qualities are right in the middle of the current STARFISH range of applicability.

2. Yarns

2.1 Qualities sampled

Figure 1 shows that Meridian had (at least) 6 yarn suppliers at that time, although the major supplier was Caleb Wright, part of Courtaulds. Mars, Kent, and Swan Lane are also Courtaulds mills. Volos is a Greek mill, and Atzenbach is German.

As it turned out, we did not obtain yarn samples from Atzenbach or Swan Lane.

Within the two yarn counts are also two basic qualities typified by the Caleb Wright LW and KCW qualities. LW is supposed to be a superior yarn - for leisurewear - whilst KCW is the standard underwear quality. The Volos quality is supposed to be equivalent to LW; Mars, Kent and Swan Lane are KCW types. All the yarns are combed, ring spun, waxed, with a nominal twist factor of 3.5 / 3.6.

2.2 Results

Test data for the Ne38 yarns are given in *Figure 4* and those for the Ne30 yarns are in *Figure 5*. Each individual datum is the mean for a given yarn lot of 5 to 10 part-cones.

The means and standard deviations over all 18 lots are given under the tabulated results.

The grand means for both yarn counts are within half a unit of nominal with CV of 1.6 - 1.8%. The CV of strength is also low and the average frictional coefficient is correct for knitting yarns. These are obviously yarns of pretty good quality.

Figure 6 shows the variation in yarn count in graphical form; most deliveries lie within ± 2.5% of the nominal yarn count. There is perhaps a suspicion that the Volos yarns are systematically heavier than the LW / KCW types but more data would be needed to confirm this.

Application of Grubb's test for outliers in the data is negative for all test parameters and both yarn counts.

Application of Filliben's test for a normal distribution of the data yields negative results for only the turns/inch and the frictional coefficient in the Ne30 data. These two negative results are probably due to bunching of the data and, considering the normal aspect of the rest, would probably disappear with a greater number of samples.

In all probability the data are normally distributed with no outliers - an important conclusion when considering those STARFISH models which make such an assumption about production variables.

2.3 Differences Between Suppliers

The data have also been analysed separately for each individual yarn supplier.

No statistically significant differences were found between the two Ne38 qualities, nor between the two Ne30 qualities from Courtaulds. However, the Volos Ne30 yarn was found to be significantly different in count, twist, and friction from the corresponding Courtaulds product. The actual differences were + 0.9Ne, + 1.5 turns/inch, and + 0.022 in frictional coefficient. Since there were only 5 Volos samples it is difficult to say whether these differences are typical and have any practical (as opposed to statistical) significance.

3. Greige Fabrics

3.1 Qualities Sampled

Figure 2 shows that all six yarn suppliers were represented in the greige fabrics, together with Velca, another Greek company. As with the yarn samples, Courtaulds is the major supplier.

Within the two basic fabric types there are also two qualities. For the 20-gauge interlock, FW 1033 is the leisurewear and FW 1007 is the underwear quality. Both are made with the same nominal yarn count and stitch length (Ne38 at 3.38 mm). For the 1x1 rib, FQ 1018 is the leisurewear and FQ 1007 the underwear. Both are made with nominal Ne30 at 2.85mm.

In the analysis which follows, very little effort has been made to separate the greige fabrics according to yarn suppliers but the leisurewear and underwear qualities are treated separately, usually in the order given above. The number of samples obtained was as follows.

Quality:	FW 1033	FW 1007	FQ 1018	FQ 1007
No. Samples:	18	11	23	19

3.2 Results

Figures 7 to 10 show the test results on the un-relaxed fabrics. *Figures 11 to 14* are the corresponding data for relaxed samples. Overall means and standard deviations are also given for each parameter.

Figures 15 and 16 show the simple quality control charts for yarn count and stitch length respectively, taken from the greige fabric samples. Both charts suggest that production is under good control but the 1x1 rib fabric was actually being produced at a stitch length of about 2.82 rather than the nominal 2.85 mm.

Figures 17 to 20 give the results of shrinkage measurements. Shrinkage after five cycles is consistently greater than that after one, but only by a small amount, one percentage point or less, on average. *Figures 21 and 22* show this difference graphically.

3.3 Differences Between Qualities

When the means and standard deviations of the appropriate parameters (mainly the reference dimensions) are tested for statistically significant differences, the following conclusions emerge (U = un-relaxed, R = relaxed).

FW 1033 *vs*. FW 1007 (Interlock)

No significant differences in:

Stitch length (U or R)

Courses (R)

Wales (R)

Significant differences in:

Yarn count (U or R), by 3% and 1.9% respectively

Weight (R), by 2.6%

FQ 1018 *vs.* FQ 1007 (1 x 1 Rib)

No significant differences in:

Yarn count (R)

Stitch length (U)

Significant differences in:

Yarn Count (U), by 1.9%

Stitch length (U), by 0.5%

Courses (R), by 1.7%

Wales (R), by 1.3%

Weight (R), by 3.0%

Three remarks can be made concerning those differences which were found to be statistically significant.

- In most cases, the significance was caused by low standard deviation rather than by a high mean difference. No difference was actually greater than 3%.
- This means that the differences are probably of no practical significance.
- When considering the FQ 1018 quality more carefully, it seems to be the Volos yarns which are causing the differences to appear and this can probably be traced to the yarn count difference which was noted earlier. When the comparison is restricted to the two basic yarn qualities from Courtaulds (LW *vs*. KCW) no significant differences are found.

Thus, we have a suggestion that yarn deliveries from different suppliers can be the source of a (relatively minor) difference between fabrics of the same nominal quality.

3.4 Yarn Changes During Relaxation

Inspection of the average yarn count and stitch length data before and after relaxation yields the following estimates of yarn shrinkage.

Changes in Count and Stitch Length During Relaxation

Quality	Yarn Type	Yarn Count, Ne			Stitch Length, mm		
		U	R	% Diff.	U	R	%Diff
FW 1033	LW	38.83	39.59	+ 1.92	3.382	3.322	- 1.74
FW 1007	KCW (2)	37.65	38.82	+ 3.01	3.382	3.321	- 1.80
FQ 1018	LW	30.41	31.22	+ 2.59	2.810	2.760	- 1.78
FQ 1018	Volos	29.67	30.41	+ 2.43	2.802	2.751	- 1.78
FQ 1007	KCW (1)	30.74	31.09	+ 1.13	2.816	2.756	- 2.13
FQ 1007	KCW (2)	30.36	30.88	+ 1.68	2.818	2.773	- 1.63

KCW (1) is exclusively from Caleb Wright

KCW (2) is from all other suppliers of this quality (including non - Courtaulds equivalents).

Averaging over all qualities and fabrics the mean change in yarn Tex turns out to be about -2.13%, and in stitch length about -1.81%. This means that the yarn lost in weight per unit length even though there was some contraction in length. If the Tex is adjusted according to the average shrinkage it should be almost 4% heavier than that actually found. Thus, there was a weight loss of about this amount in the greige fabrics caused only by the relaxation procedure.

3.5 Internal Consistency of the Data

One problem in assessing variability in a set of data is to know how much variation is contributed by the sampling and testing procedure. This is especially so with knitted fabrics which are notoriously un-reproducible. One way of checking out the consistency of the test data for knits is to make independent calculations for several parameters, for example:

Width calculated from the wales /cm and the number of needles.

Weight calculated from Tex, stitch length, courses and wales.

Weight (U) calculated from weight (R) and shrinkages.

Weight (R) calculated from weight (U) and shrinkages.

Shrinkages calculated from changes in courses and wales.

Stitch density calculated from weight, Tex, and stitch length.

Figures 23 to 26 show the results of some of these calculations for the un-relaxed fabrics. Inspection of these tables will show that our test procedures are remarkably consistent for measurements on un-relaxed fabrics. In no case is there a difference between measured or calculated properties which is statistically significant and, with one exception, the absolute differences are always within ± 2%. The one exception is weight calculated from relaxed weight and shrinkages where there was a (not significant) difference of 2.5%.

Similar conclusions apply to calculated shrinkages, which appear in a later table (Appendix) but for the relaxed weight (Appendix) and relaxed stitch density (Appendix) there are one or two differences which are just significant at the 95% confidence level.

For convenience, a summary of the differences between all measured and calculated properties is given below. In this table, the mean difference is expressed as a percentage of the mean measured value (except for shrinkage which already has percentage units). A negative value indicates that the calculated result is less than that measured.

Mean Percent Difference Between Measured and Calculated

	FW 1033	FW 1007	FQ 1018	FQ 1007	Mean
Width (U)	0.4	1.1	-0.4	2.0	0.8
Weight 1 (U)	1.1	1.7	0.1	-0.9	0.5
Weight 2 (U)	-1.0	-1.7	-2.5	-0.9	-1.5
Stitches (U)	1.1	-1.7	1.0	-0.1	0.1
Length Shrinkage	-1.5	-2.2	-0.1	-0.5	-1.1
Width Shrinkage	1.7	1.3	0.02	1.1	1.0
Weight 1 (R)	2.5*	1.4	2.1*	1.5	1.9
Weight 2 (R)	0.8	1.5	2.3	0.7	1.3
Stitches (R)	-2.5	-1.3	-2.1*	-1.5	-1.9

* significant at 95% level

Two conclusions follow from this analysis.

1. Our testing is remarkably consistent, especially on un-relaxed fabrics and, perhaps more surprisingly, on shrinkages. If there is a problem it is likely to be in either the relaxed weight or in one of the four parameters that go into the weight calculations. In view of the good shrinkage correspondence and the pretty good agreement of weight 2 (R), the latter alternative is the most likely. Of the four parameters, Tex seems to be the most suspect with a possible contribution from the wales. This does not mean that the Tex measurement may be "wrong" - only that the Tex as measured may not be the same Tex which exists in the cloth (e.g. due to tensioning during measurement?).
2. Presumably, we can not expect STARFISH models to do much better than the % "errors" shown here.

3.6 K3 Model Predictions of the Mean Reference Dimensions

Predictions of greige reference dimensions were made using the HP85 "K3MOD" programme (June 1983) which uses the original equations established during the K3 project (1983 version) and the results are presented in *Figure 27*. Inputs were the mean measured values of yarn count and stitch length. The correspondence between measured and predicted values should be seen in the light of the variation in the measured values and so a summary of these variations is given

below, in terms of the CV%, except for shrinkages where standard deviation is given since these data are already represented in percentage form.

Almost all of the measured data conform to a normal distribution. Outliers are relatively few and are found mainly in FW 1033.

Variation in Measured Properties, CV%

	FW 1033	FW 1007	FQ 1018	FQ 1007	Mean
Yarn Tex (U)	1.72	2.00	2.18	1.11	1.75
Yarn Tex (R)	2.11	1.41	2.18	1.35	1.76
Stitch Length (U)	0.62	0.71	0.80	0.72	0.71
Stitch Length (R)	0.79	1.13	0.68	1.30	0.98
Courses /3cm (R)	1.75	1.71	1.76	2.03	1.81
Wales /3cm (R)	2.17	2.27	1.34	2.16	1.99
Weight (R)	2.11	1.52	3.17	1.57	2.09
Length Shrinkage	1.84	2.07	3.02	2.87	2.45
Width Shrinkage	1.86	2.61	3.16	3.06	2.67

Inspecting these normal variations, we may perhaps erect the following provisional criteria for our model predictions.

Excellent:	% "error" within	± 1%
Good:	% "error" within	± 2%
Mediocre:	% "error" within	± 3%
Poor:	% "error" within	± 5%
Unacceptable:	% "error" outside	± 5%

Turning back to *Figure 27* we may now assess the predictions roughly as follows.

Yarn Tex:	good to excellent for rib; mediocre to poor for interlock.
Stitch length:	excellent in all cases.
Courses /3cm:	good to excellent.
Wales /3cm:	mediocre to good.
Weight:	uniformly poor.
Calculated weight:	good to excellent.

3.7 Comparison of Different Predictive Models

Using the "TABPLOT" data editing routines, it is a relatively simple matter to make a series of transformations of columns of data according to a (series of) user-defined equation(s) entered into the programme at the stipulated line number(s). If the user-defined equations are those of the STARFISH type models, then one may easily compare the results given by different models in a relatively short time. This approach was applied to several parameters using several different models and has resulted in 24 separate tables of data which are given in the Appendix but will not be discussed in detail. What follows is an outline summary which deals mainly with the average predictive power of the various models.

For the relaxed Tex and stitch length, four comparisons were made as follows:

1. Adjust un-relaxed value by the grand average change measured as a result of relaxation, i.e. -2.1% in Tex, and -1.8% in stitch length.
2. The original K3MODEL equations (1983).
3. The HP85 "WVAR" equations - these are a rough average of the interlock and rib data.
4. The "IRJs" equations which are a rough average of interlock, rib, and single jersey (singles) data.

Using the same criteria for assessing the predictions as in section 3.6, the following performances were found.

	FW 1033	**FW 1007**	**FQ 1018**	**FQ 1007**	**Mean**
Tex (1)	E	E	E	E	E
Tex (2)	G	M / P	E	E	G
Tex (3)	E	G	M	G	G
Tex (4)	E	E	G	E	E
Stitch Length (1)	E	E	E	E	E
Stitch Length (2)	E	E	E	E	E
Stitch Length (3)	E	E	E	E	E
Stitch Length (4)	E	E	E	E	E

In every case equation (1) was superior to all others and this was to be expected since it simply reflects the measured values. Next best was equation (4), the crude combination of interlock, rib, and jersey models. The WVAR model was marginally superior to K3 MODEL in Tex; this was due to an improvement of a poor interlock prediction at the expense of some worsening of the rib situation.

Stitch length prediction was uniformly excellent for all models, though the same relative performance could be seen as for Tex.

For relaxed courses and wales, two models were examined.

1. The original K3MODEL equations using both steps 1 and 2, i.e. starting inputs were individual Tex and stitch length values as measured in the greige un-relaxed fabrics.
2. Step 2 only of the K3MODEL equations; i.e. starting inputs were individual Tex and stitch length values as measured in the relaxed fabrics.

The results were as follows.

	FW 1033	**FW 1007**	**FQ 1018**	**FQ 1007**	**Mean**
Courses (1)	G	G	E	E	E
Courses (2)	E	E	E	E	E
Wales (1)	M	G	G / M	G	G
Wales (2)	G / M	G	G	E	G

In general, courses are better predicted than wales and equation (2) is better than equation (1). This latter effect is presumably due to the sometimes mediocre to poor performance of the Tex equation in Step 1 of K3MODEL.

For the length and width shrinkages, three models were evaluated. Each equation was based upon the changes in courses and wales, the differences being the source of the course / wale estimates.

1. Measured courses and wales.
2. Courses and wales predicted by K3MODEL, steps 1 and 2.
3. Courses and wales predicted by K3MODEL, step 2 only.

The predictive power of these was as follows.

	FW 1033	**FW 1007**	**FQ 1018**	**FQ 1007**	**Mean**
Length (1)	G	M	E	E	G
Length (2)	E	G	G	E	E
Length (3)	E	M	G	E	E
Width (1)	G	G	G	E	G
Width (2)	E	E	E	E	E
Width (3)	E	E	E	E	E

These good to excellent predictions of shrinkage came as quite a surprise considering the variability of shrinkage data. However, it has to be borne in mind that these comparisons are between means of samples of 11 to 23 individuals. Any one individual would not be predicted

to such a close accuracy (see Appendix). Standard deviations of the individual errors tend to be anywhere between 0.5 and 5 with the majority in the 2 to 3% range. Thus, we cannot expect to be within much better than ± 2 percentage points for individual predictions.

For the relaxed weight, six models were considered:

1. K3MODEL *Tex/L* equation - steps 1 and 2.
2. K3MODEL *S* equation - steps 1 and 2.
3. K3MODEL *Tex/L* equation - step 2 only.
4. K3MODEL *S* equation - step 2 only.
5. Corrected measured un-relaxed weight adjusted according to the measured shrinkages (the correction is to allow for the 4% weight loss caused by the relaxation procedure).
6. Product of measured Tex, stitch length, courses and wales.

The results were as follows.

	FW 1033	**FW 1007**	**FQ 1018**	**FQ 1007**	**Mean**
Weight (1)	P	P	P	P	P
Weight (2)	M	M	E	E	G
Weight (3)	U	U	P	M / P	U
Weight (4)	G	E	E	G	E
Weight (5)	E	G	M	E	G
Weight (6)	M	G	M	G	G

There are four striking features in this set of results:

a) The *S* equation is always better than the *Tex/L* equation, and sometimes much better.

b) Although the *S* equation is better when Step 1 is omitted, the *Tex/L* equation is not; in fact for this model Step 2 only is worse.

c) For the first time we are seeing Unacceptable predictions, i.e. the mean predicted value is more than 5% away from that measured.

d) Even the models which depend upon weight calculated from measured parameters contain some mediocrity. The shrinkage-based calculation (5) is better than the *Tex.L.C.W* model (6).

We may conclude that the relaxed weight is a difficult parameter to predict, and this conclusion will be supported in the next section which examines the finished fabrics.

For the relaxed stitch density, three models were considered:

1. Calculation from relaxed weight, Tex, and stitch length.
2. K3MODEL equations - Steps 1 and 2
3. K3MODEL equation - Step 2 only

Results were as follows.

	FW 1033	**FW 1007**	**FQ 1018**	**FQ 1007**	**Mean**
Stitches (1)	M	G	M	G	G
Stitches (2)	G	G	M / P	G	G
Stitches (3)	G	G	M	E	G

On balance, the Step 2 only model is better than Steps 1 and 2, and both are about as good as direct calculation from measured properties.

To summarise this section, the K3MODEL equations do a pretty good job of predicting the mean reference state of a group of samples of nominally the same quality.

The stitch length predictions are outstandingly accurate. Prediction of average courses, and of shrinkages are also extremely good. Minor problems may exist with wales and Tex, but there is a potentially serious problem with the weight.

4. Finished Fabrics

4.1 Qualities Sampled

Figure 3 shows that, of the four basic greige qualities, only three were actually sampled in the finished state; quality FQ 1018 was not represented. There were four main finishing routes and the final breakdown of qualities was the following:

FW 1033 Jet dyed:	4 samples
FW 1007, Continuous bleach:	14 samples
FQ 1007 Jet dyed:	14 samples
FQ 1007 Winch dyed:	10 samples

Thus, the interlock leisurewear quality is severely under-represented and it is doubtful whether four samples can provide meaningful average data, let alone information on variability.

4.2 Results

Figures 28 to 31 show the basic test data before relaxation (U), *Figures 32 to 35* after relaxation (R), and *Figures 36 to 39* give the measured shrinkages.

Variation coefficients taken from the above tables are collected below. For Tex and stitch length they are significantly greater than those measured in the greige. Average CV of Tex (U + R) was 1.75% in the greige and 2.35% finished. The corresponding values for stitch length were 0.85% and 1.32%.

Variation Coefficients in the Finished Fabrics

	FW 1033 JD	**FW 1007 CB**	**FQ 1007 JD**	**FQ 1007 WD**	**Mean**
UN-RELAXED					
Yarn Count, Ne	1.6	2.5	2.9	2.7	2.4
Stitch Length, mm	1.6	1.4	0.8	1.3	1.3
Courses /3cm	3.9	4.4 º*	2.8	2.6	3.4
Wales /3cm	2.4	3.9	2.6	3.4 º	3.1
Weight	3.6	4.6 º	5.7	5.2	4.8
RELAXED					
Yarn Count, Ne	2.0	2.4	2.5	2.4 *	2.3
Stitch Length, mm	1.1	1.7	1.0	1.5	1.3
Courses /3cm	4.3	1.8	2.6	1.5	2.6
Wales /3cm	1.6	3.5	1.3	2.3	2.2
Weight	2.3	2.2	4.8	4.0	3.3
SHRINKAGE					
Length (1)	0.4	3.2 º	1.0	2.0	1.7
Width (1)	1.6	2.5 º	2.0	2.5	2.2
Length (5)	0.7	3.2 º*	1.2	2.1	2.2
Width (5)	0.4	2.3 º*	1.6	2.2	1.6

º contains outliers * data not normally distributed

Variation coefficients for relaxed courses, wales, and weight were also generally greater in finished fabrics than those found in the greige. Average CV for relaxed courses was 1.8% in the greige and 2.6% in the finished. The corresponding values for relaxed wales were 2.0% and 2.2%, and for relaxed weight 2.1% and 3.3%.

Thus, one might feel tempted to relax the assessment criteria for model predictions, since the model can hardly be expected to predict to within better than one standard deviation. This temptation will be resisted however, in the interests of uniformity and rigour. For convenience, the assessment criteria are repeated below.

Symbol	Predictive Power	Required Precision
E	Excellent	Within ± 1%
G	Good	Within ± 2%
M	Mediocre	Within ± 3%
P	Poor	Within ± 5%
U	Unacceptable	Outside ± 5%

In the un-relaxed fabrics, the average variation coefficients for courses, wales, and weight were, respectively, 3.4%, 3.1%, and 4.8%. Standard deviations for shrinkages were, on the whole, significantly lower than the CV's of courses and wales. This is a most interesting observation and suggests (at first sight) that there is some relationship between the reference courses and wales and the courses and wales as delivered. The effect was most pronounced in the length direction but existed also in the width. However, brief attempts to obtain support for such a hypothesis by graphical means were inconclusive, there being too much scatter and not enough range in the data.

Filliben / Grubb tests for normality and outliers showed a few outliers, mainly in the un-relaxed figures but the majority of the data were normally distributed. Outliers were not removed since they were few and did not affect the outcome of later comparisons to any significant extent.

Figures 40 and 41 show the plots of length and width shrinkages respectively, comparing the 1-cycle results with those after 5 cycles. The scatter in the data is such that it may not be very meaningful to talk about an average difference between the results of the two methods. However, these averages are given below.

	Difference Between 1 & 5 Cycles	
	Length	**Width**
FW 1033 JD	2.5	0.8
FW 1007 CB	5.0	0.3
FQ 1007 JD	1.6	0.5
FQ 1007 WD	1.4	-0.4

The average discrepancy is smaller for width than length and smaller for rib than interlock. The outstanding feature is the large discrepancy (5%) for the continuous-bleached samples. This may be a fairly important observation. The CB samples have not been separately identified on *Figure 40* but, in fact, in every case they lie above the JD set. Following this line of thought; if the data are grouped according to finishing route, then the scatter becomes much less - as though the discrepancy between the 1 and 5-cycle test results were determined by the combination of fabric type and finishing route.

4.3 Comparison Between Qualities

According to the STARFISH philosophy, for a given fabric quality the finishing route determines the relaxed dimensions so we should see significant differences between the two interlock qualities (JD *vs.* CB) and the two ribs (JD *vs.* WD). The measured differences are shown below.

Differences in Relaxed Dimensions Between Finishing Routes

	Interlock (CB - JD)		Rib (WD - JD)	
	δ%	t	δ%	t
Tex (U)	-4.0	3.1 **	2.4	1.9
Tex (R)	-0.8	0.6	3.2	3.0 **
Stitch Length (U)	0.5	0.6	-0.1	0.2
Stitch Length (R)	0.9	0.9	0.1	0.1
Courses (R)	-3.4	2.2 *	0.4	0.4
Wales (R)	-0.7	0.3	-0.9	1.0
Weight (R)	-0.5	0.4	-5.4	2.8 **

t = Student's t * = significant at 95% ** = significant at 99%

The interlock comparison is complicated by the fact that the JD set contained only 4 samples and there may have been a difference in the starting Tex. According to K3MODEL for the same fabric quality, CB should have about 3.2% less courses but 3.5% more wales. The weight should be about 2.5% less. The measured discrepancy for courses is close to that expected but weight and wales do not agree too well. Only the course difference was statistically significant.

The rib comparison is complicated by the fact that there was a significant difference in the yarn Tex; WD was about 1 Tex unit heavier. This would tend to increase the courses by an insignificant amount but reduce the wales by slightly more. The weight would be increased almost in direct proportion, i.e. by 2.5 to 3%. According to K3MODEL, for an identical initial construction, WD should have almost identical courses but about 1.8% more wales. The weight should be about 2% less. In the measured discrepancies, only the weight difference was statistically significant and its amount is exactly that expected being the sum of the yarn Tex effect and the predicted finish effect. The insignificant difference in courses was as predicted but the negative (though insignificant) difference in wales can only be accounted for by assuming that the finish effect was balanced by the yarn Tex effect. This hypothesis is tenable, but thin.

On the whole, it has to be said that the differences between nominally identical qualities caused by the differences in finishing route are not great. The differences in courses were successfully predicted, but those in wales were not predicted at all; those in weight were reasonably predicted.

4.4 Yarn Changes During Relaxation

In the greige fabrics, significant changes in yarn Tex and stitch length were found as a result of the relaxation procedure. One would expect much smaller, if any, changes in the finished fabrics and this proved to be the case.

The average change in Tex was +0.24% and that in stitch length -0.68%. For stitch length there were no obvious differences between finishing routes. For tex there was a suggestion of a finish effect. Thus, the average change for the two jet dyed qualities was +1.3% whereas the continuous bleached yarns suffered a loss in Tex of -1.6%. There was no change for winch dyed materials. Although none of these changes was statistically significant, they conform to intuitive expectations. It was not possible to relate the weight gain in jet dyed fabrics to the depth of shade, although a rough general trend in this direction was apparent.

4.5 Internal Consistency of the Test Data

As with the greige fabric results, it was thought useful to compare measured properties with independent (or semi-independent) estimations obtained by calculations from other measured properties, in order to assess the general reliability of the data, and the best that can be expected of STARFISH models. Internal comparisons for the un-relaxed fabrics are given in *Figures 42 to 45* and those for relaxed fabrics are in *Figures 46 to 49*.

A summary of the differences between measured and calculated properties is given below, where the mean difference is expressed as a percentage of the mean measured value except for shrinkage which already has percentage units. Statistically significant differences are marked in the usual way. A negative value indicates that the calculated value is less than that measured.

In the un-relaxed fabrics all measured and calculated parameters are in good agreement with the exception of Weight (2). This is the weight calculated from the measured relaxed weight, adjusted for the measured shrinkages. Although most of the Weight (2) differences are not statistically significant, they are consistent.

Since the measured shrinkages correspond well to those calculated from changes in courses and wales, there can only be two explanations for this pattern in the un-relaxed data.

Either there has been some weight loss during relaxation (little or none was found in the Tex and stitch length changes) or there is some kind of measuring error in the relaxed weight.

Looking at the relaxed properties, we see that the Weight (2) differences are almost an exact reflection of those found in the un-relaxed data but, in addition, discrepancies have now appeared in Weight (1), Stitches, and the product *Tex . Stitch Length*.

This pattern of data confirms that the source of the error must be in the measured relaxed weight which has been underestimated by about 4.2%. The fact that the error in Weight (1), Tex.L and Stitches average only 3.6% means that there may be additional error in the data which amounts to about 0.5%. It is not possible to say whether this lesser error is contributed by only one parameter or several.

Mean Percent Difference Between Measured and Calculated Values

	FW 1033 JD	FW 1007 CB	FQ 1007 JD	FQ 1007 WD	Mean
UN-RELAXED					
Width	-2.0	-0.6	0.3	-0.1	-0.6
Weight (1)	1.5	0.5	-2.5	-0.3	-0.2
Weight (2)	-5.0	-5.1 **	-2.6	-3.7	-4.1
Stitches	-1.5	-0.2	0.2	0.3	-0.3
Tex.L	-1.5	-0.4	0.3	0.3	-0.3
RELAXED					
Weight (1)	5.2	3.1 *	2.4	4.2 *	3.7
Weight (2)	5.3	5.3 **	2.7	3.8	4.3
Stitches	-4.8	-3.0 *	-2.3	-4.0 **	-3.6
Tex.L	-4.9	-3.0 **	-2.3	-4.0	-3.6
SHRINKAGE					
Length	-0.2	-0.6	-0.4	0.1	-0.3
Width	-2.1	0.6	-0.1	0.7	-0.2

It should be noted that, although the word "error" has been used throughout the above discussion, this should not necessarily be taken to mean a mistake by testing lab staff. The fault, if any, is more likely to reside in the test procedures themselves - for example an inevitable slight stretching of the fabric when patterns are being cut for weighing which would be more noticeable on relaxed fabrics.

To summarise: our testing is again remarkably consistent for all parameters except relaxed weight where an apparent discrepancy of 3.5 to 4% exists. This discrepancy should be investigated.

Finally, in this section, it should be mentioned that the standard deviations of the individual differences between measured and calculated data range from as low as 1% (of the measured value) up to as much as 5%, with the average deviations between 2% and 3%. These numbers lend further support to the chosen range of evaluation criteria given in *Sections 2.4 and 3.1*, i.e. from Excellent at ±1% to unacceptable at >5% discrepancy.

4.6 Model Predictions for Mean Relaxed Dimensions

Predictions of relaxed finished dimensions were made using the HP85 "K3MOD" programme (June 1983) for the JDH, CBT, and WD2 models. Results are shown in *Figure 50*. Inputs were the mean measured values of Tex and stitch length taken from the greige fabrics.

As with the greige fabrics, these predictions have to be seen in the light of the variations in the measured data which, for finished fabrics, were given in *Section 4.2* and range from ±1% for stitch length to ±5% for weight. A summary of the predictive power of the K3MODEL equations is given below. All predicted properties are relaxed.

	FW 1033 JDH	**FW 1007 CBT**	**FQ 1007 JDH**	**FQ 1007 WD2**	**Mean**
Tex	E	G / M	G	E	G
Stitch Length	G	E	G	G	G
Courses	M	G	G	G	G
Wales	E	M	P	E	G
Weight	G	E	U	E / G	M

This is a rather mixed bag of results; no one model can be unreservedly accepted as there is some mediocrity in every column. The worst model seems to be the jet dyed rib and the best seems to be winch dyed rib. Considering that it is one of our "minor" finishing routes, CBT has performed adequately. Once again stitch length emerges as the most predictable property and Tex and courses are adequate but wales and weight leave something to be desired. However, if the Rib JDH model is taken out then the rest is tolerable since the greatest percentage error was only 2.1%. All predictions were within ± 2 standard deviations and most were within ± 1.

4.7 K3MODEL Transformations on Individual samples

For the individual finished fabrics, only the equations of the Reference State (Step 2) are relevant. *Figures 51 to 54* give the results of applying the appropriate K3MODEL equations (working under TABPLOT) and a summary of their predictive power is given below.

Predictive Power of K3MODEL Equations

	FW 1033 JDH	**FW 1007 CBT**	**FQ 1007 JDH**	**FQ 1007 WD2**	**Mean**
Courses	E	G	E	G	E
Wales	E	E	P	E	G
Stitches	E	G	P	G	G
Weight	M	M	P	M	M

Again, the Rib JDH model is shown to be inadequate and weight prediction is generally a problem. The weight predictions were not systematically improved by using the *'S'* equation instead of *Tex/L*. However, remember that the rib fabrics showed quite high variation coefficients for the measured weight data.

4.8 As-delivered Dimensions: HP85 Models

The HP85 "VARMIL" and WVAR" models were used to attempt to match (rather than predict) the average as-delivered dimensions. Two versions of each model were used.

In the basic VARMIL models, the inputs are Tex and Stitch length as knitted, and the finished courses and wales as delivered. The reference Tex, stitch length, courses, wales and weight are calculated from equations which are similar to, but not identical with the K3 Model equations. The difference is that crude combinations have been made of several of the finishing routes, e.g. JD and JDH, by simply averaging the corresponding coefficients. Shrinkages are calculated from the differences between relaxed courses and wales and those given as inputs. Finished weight is calculated from the relaxed weight and the shrinkages.

In this exercise, two variants of this basic model were used.

1. VARMIL-C: in which the only difference is that the finished weight is calculated from the finished relaxed Tex and stitch length, and the given finished courses and wales.
2. VARMIL-98: in which the only difference from the basic model is that the reference Tex and stitch length are estimated as 98% of the given as-knitted parameters instead of via the Step 1 equations.

In the basic WVAR model, the inputs are Tex and Stitch length as knitted, and the finished weight and width as delivered. The reference Tex, Stitch length, courses, wales and weight are calculated from the same, crudely combined equations as VARMIL. Finished wales are calculated from the given finished width and the given number of needles and hence the width shrinkage from the difference between relaxed and finished wales. Length shrinkage is then calculated from the given finished weight and the width shrinkage, and hence the finished courses from the relaxed courses and the length shrinkage.

In this exercise, two variants were used:

3. WVAR: the basic model
4. WVAR-98: in which the reference Tex and stitch length are 98% of those given for the as-knitted values.

The original purpose of the VARMIL & WVAR series was to allow:

a) Variation, according to given levels of CV%, of the input variables so that the corresponding variation in outputs could be seen,

b) Comparison of the outputs with a given customer specification.

However, in this evaluation these facilities have been suppressed by setting all variation of inputs to negligible levels (CV% = 0.1). This was mainly in the interests of saving time. The next section will look at variation and correspondence with specifications. Furthermore, when running these models, the inputs used for the finishing targets were not always exactly those measured on the finished samples. In each case the finishing inputs were arbitrarily adjusted (by as little as possible and not by more than ±5% from the measured values) in order to try to improve the correspondence of the predicted shrinkages with those actually measured. Tex and stitch length inputs were not adjusted.

The detailed results are given in *Figure 55* and a summary appears in the table below, where the percentage discrepancy between the average input / predicted values and those measured is shown.

In assessing these discrepancies, it should be remembered that those which refer to Tex and stitch length are a direct reflection of the adequacy of the particular Step 1 equation, whereas those referring to other parameters reflect not only the predictive power of the whole model (for a given quality and finishing route) but also the degree of success with which any deficiencies in the model (or in the measured data) could be shared out.

For this reason, the Excellent to Unacceptable classification for predictive power can not really be applied to individual parameters - only the overall fit can be assessed.

Looking down the four data columns of this table, it is clear that, once again, the FQ1007 JD/JDH quality is the most problematical. In order to get within ± 2 percentage points of the measured shrinkages, it has proved necessary to introduce relatively large discrepancies in the input parameters. The small discrepancies in courses for this quality are only due to the fact that they could not be made greater since even greater discrepancies in either weight or shrinkage would have resulted.

The other three qualities have been matched pretty well by all models although the occasional mediocre set of predictions is to be seen. Especially good is the FW1007 CB/CBT model which, since this results from a combination of "minor" routes, is very encouraging.

The minor route WD/WB combination is also pretty good, especially in the "98" versions of the models. This leads to the expectation that this model can be made into a Good to Excellent one by cleaning up the Step 1 equations (and the inclusion of WD2).

In the case of FW1033 JD/JDH only the VARMIL-C model is giving problems, the rest being Good to Excellent, so hopefully this finishing route will also be made perfectly adequate by the forthcoming "cleaning up" of our model equations.

Matching As-delivered Dimensions Using the VARMIL and WVAR Models

% Difference from Measured values

	FW 1033 JD/JDH	FW 1007 CB/CBT	FQ 1007 JD/JDH	FQ 1007 WD/WB	I / O
Ne (1)	-1.3	-1.5	0.3	1.3	O
Ne (2)	0.0	-2.5	3.0	-0.3	O
Ne (3)	-1.8	-1.5	0.7	1.3	O
Ne (4)	0.0	-2.5	3.0	-0.3	O
Stitch Len. (1)	1.5	0.3	1.1	-0.7	O
Stitch Len. (2)	0.9	0.0	0.4	0.4	O
Stitch Len. (3)	1.8	0.0	1.8	-0.7	O
Stitch Len. (4)	0.9	0.0	0.4	0.4	O
Courses (1)	-0.8	-0.8	-0.4	-0.4	I
Courses (2)	-3.3	-0.8	-0.4	-1.2	I
Courses (3)	-1.8	-0.5	-0.8	-0.6	O
Courses (4)	-0.8	-1.0	0.2	-1.6	O
Wales (1)	-0.8	0.8	-3.1	1.0	I
Wales (2)	-1.8	0.8	-3.1	-0.3	I
Wales (3)	-1.8	1.4	-3.1	0.7	I
Wales (4)	-1.8	1.4	-2.0	0.0	I
Weight (1)	3.6	0.0	-2.3	-2.4	O
Weight (2)	0.6	0.6	-5.7	-1.2	O
Weight (3)	0.6	-0.2	-4.0	-3.0	I
Weight (4)	-0.6	-0.2	-4.6	-1.8	I
% LS (1)	-1.3	-1.5	-2.0	-1.2	O
% LS (2)	-0.7	-1.3	-1.0	-1.5	O
% LS (3)	-0.5	-1.7	-1.2	-1.1	O
% LS (4)	-0.9	-1.0	-1.7	-1.1	O
% WS (1)	-3.2	0.7	-0.9	-1.2	O
% WS (2)	-1.7	0.5	-1.2	-0.6	O
% WS (3)	-2.2	0.1	-2.0	-0.9	O
% WS (4)	-1.6	-0.1	-2.0	-1.1	O

I/O identifies the parameter as an Input or an Output for a given model.

A negative result means predicted less than measured.

4.9 Comparison with Customer Specifications

In this section, the properties of the fabrics as delivered are compared with those laid down in the customer specifications.

Furthermore, both the measured values and the specified values are treated as inputs for the VARMIL model in order to:

a) check whether the specified properties are actually being delivered;

b) check whether the specified tolerances are reasonable;

c) check whether the specification is a reasonable (self consistent) one.

The VARMIL model was chosen for this section because it is a finisher's model. Apart from the grey Tex and stitch length, its inputs are the as-delivered courses and wales which are the parameters used by the finisher to set his targets and control his production.

Two runs were made for each quality. In the first run, the inputs were the mean measured grey Tex and stitch length, and the mean measured courses and wales. Variation coefficients for these four parameters were set at those actually measured.

In the second run, the inputs were the specified nominal Tex and stitch length and the specified courses and wales. Variation coefficients for these were arrived at by dividing the allowed tolerances by two. This means that about 95% of deliveries should fall within the specified tolerances.

The results will be discussed under the three headings mentioned above.

a) Are the specified properties actually being delivered?

Weight

In all four qualities, the average finished weight is actually pretty close to that specified, but the variation is such that up to 40% of samples are out of tolerance.

	Specified	Average Measured	% Out Of Tolerance
FW 1033 JD	165	165	0
FW 1007 CB	165	158	29
FQ 1007 JD	173	176	36
FQ 1007 WD	173	168	40

Courses

The interlock fabrics have been delivered on average to within ± 1 course /3cm and the ribs to within ± 2 courses. In spite of this, between 50 and 75% of samples were out of tolerance due to variation between deliveries.

	Specified	Average Measured	% Out Of Tolerance
FW 1033 JD	39	39.8	75
FW 1007 CB	39	38.1	50
FQ 1007 JD	48	50.1	71
FQ 1007 WD	48	49.6	50

Wales

Apart from the jet dyed interlock, average wales were within ± 1 wale /3cm but between 36 and 60% were out of tolerance. The offending interlock is either deliberately finished under width (to meet the weight and shrinkage specification?) or is still being finished according to a previous specification which asked for 38 wales /3cm.

	Specified	Average Measured	% Out Of Tolerance
FW 1033 JD	36.5	39.0	100
FW 1007 CB	36.5	36.9	57
FQ 1007 JD	30	29.3	36
FQ 1007 WD	30	29.1	40

Length Shrinkage

In the case of shrinkages, it is the maximum permitted value which is specified rather than a target mean. The rib fabrics have reasonable length shrinkages and are generally within tolerances. The interlock fabrics are more problematical.

	Specified (max)	Measured		% Out Of Tolerance
		Mean	Max	
FW 1033 JD	15	15.8	16.3	50
FW 1007 CB	15	16.9	25.6	78
FQ 1007 JD	12	9.4	11.2	0
FQ 1007 WD	12	10.3	14.9	10

Width Shrinkage

In the width direction, it is the interlock fabrics which are under better control, partly due to the under-width finishing of the jet dyed fabrics. The rib fabrics are practically all way out of tolerance.

	Specified (max)	Measured Mean	Measured Max	% Out Of Tolerance
FW 1033 JD	15	12.6	13.2	0
FW 1007 CB	15	14.1	17.4	28
FQ 1007 JD	12	15.1	17.9	100
FQ 1007 WD	12	14.3	19.9	90

Thus, in general, the finisher is doing a reasonably good job of delivering the specified weight, courses and wales on the average, but the random variation in these properties is taking him out of tolerance for a large proportion of deliveries. The level of shrinkages delivered has to be seen as the consequence of meeting the specified courses and wales. This will be more closely examined in section (c).

b) Are the specified tolerances reasonable?

The purpose of tolerances is presumably to allow for unavoidable random variations in manufacturing and to encourage suppliers to reduce these variations to the minimum (economic) level. Thus, it is reasonable to expect that the tolerances should be set at such a level that only the most competent of manufacturers can actually achieve them consistently. Since Meridian is acknowledged as one of the more competent manufacturers, the actual level of variation achieved by them should be a good guide to what is reasonable. If we expect 95% of deliveries to be within specification, then the tolerances should be set at ± two standard deviations (assuming a normal distribution) or, in percentage terms, at two times the normal coefficient of variation.

One fact which has to be recognised in setting tolerances is that the variation in outputs is a direct consequence of the combined variation in inputs, i.e. the variation in weight and shrinkages will depend upon the variation which is allowed for yarn count and stitch length together with that which is achieved in finished courses and wales. In this section we will merely compare the specified tolerances with the variation coefficients actually measured.

Specified Tolerances Compared with Measured variations

	Interlock		Rib	
	% Tolerance	**2 x CV%**	**% Tolerance**	**2 x CV%**
As Knitted				
Ne	2.5	3.2	2.5	3.2
L	2.5	1.25	2.5	1.44
Finished				
Courses	2.5	8.3	2.0	5.4
Wales	2.8	5.3	3.3	6.0
Weight	5.0	8.2	5.0	10.9

Only in the case of the knitted stitch length were the specified tolerances actually being met. The yarn count variation was close to tolerance and perhaps could have been met by restricting the production to yarns from a single supplier. However, this is a risky thing to do in practice.

There was apparently no way that the specified tolerances for finished courses and wales could have been met and the consequence was that the weight tolerance could not be met either.

Either Meridian is a less competent manufacturer than we suppose, or the specified tolerances for finished courses, wales, and weight are unreasonable. Note that this conclusion depends upon the assumption that 95% of deliveries should be within specification. However, even if this assumed value is lowered to 75% (bringing the required variation down to ± 1.15 standard deviations) the specified tolerances would still be too narrow. A reduction to about 50% of deliveries within specification would be required to bring the measured variations into line with the tolerances.

c) Are the specifications self-consistent?

In this context, "self-consistent" means that, if the specified yarn and stitch length are knitted within tolerances, and the average course and wales are delivered within tolerances, then the resulting weight is as specified and within tolerance, and the shrinkages do not go above the maximum permitted values for more than 5% of deliveries.

The self-consistency of the specifications has been checked using the VARMIL model. This model has earlier been shown to be reasonably accurate for the interlock and the Rib WD qualities, but less satisfactory for the jet dyed rib. In this section, no attempt is made to "force" a fit by small adjustments to the inputs. Therefore, all errors from all sources are concentrated in the outputs (weight and shrinkages). The inputs are the specified yarn count and stitch lengths, and the specified courses and wales, together with variation coefficients for these which are set at half the allowed percentage tolerances.

A second independent way to check the self-consistency of the specification is through measured data. If we assume that the yarn count and stitch length were near enough to the specified values so that their influence upon the relaxed courses and wales was very small, then we can adjust the average measured weight and shrinkages to what they would have been if the specified average courses and wales had actually been delivered. This approach is alright for

the interlock fabrics but, with the ribs, the knitted stitch length was significantly less than that specified (2.82 instead of 2.85). In theory such a difference would affect the weight and the width shrinkage only marginally but might add a percentage point or so onto the length shrinkage when finishing to constant courses and wales.

It should be noted that only one specification is issued for the two interlock qualities and only one for the two ribs. The differences caused by the finishing routes are therefore of some interest.

Self-consistency of the Specifications

	FW 1033 JD	FW 1007 CB	FQ 1007 JD	FQ 1007 WD
Weight				
Specified	165	165	173	173
VARMIL *	161	154	177	167
Measured **	151	160	173	168
Length Shrinkage				
Specified (max)	15	15	12	12
VARMIL *	15.8	12.7	10.0	10.7
Measured **	17.4	14.8	13.2	13.2
Width Shrinkage				
Specified (max)	15	15	12	12
VARMIL *	13.9	16.4	7.5	10.7
Measured **	18.2	15.1	13.0	11.8

* finished to specified courses and wales (mean of 100)

** mean, adjusted to specified courses and/or wales

According to these results, not one of the specifications is really satisfactory. For the interlock fabrics, the weight specification is only a little too high (5 to 10 grammes) but the shrinkage targets can never be met consistently. In most cases the *average* predicted shrinkage is about the same as, or greater than the *maximum* specified.

For the rib fabrics, the weight specification is quite close to reality but the permitted maximum shrinkages are still rather close to the averages predicted by VARMIL and the adjusted measured results.

When it is remembered that a difference of one course and one wale per 3cm makes a difference of about 2 to 3½ percentage points on the shrinkages, and about 8 to 10 grammes per square metre on the weight, then it is clear that any specification needs to be drawn up very accurately if the finisher is to be given a fair chance of meeting it consistently and in all respects.

Incidentally, the relatively poor performance of the Rib JD model is again shown up here by the big difference in the two predictions for width shrinkages.

5. Summary and Conclusions

1. The yarns sampled in this exercise were generally of good quality and were, on average, within half a unit of their nominal Ne values.

2. The variation coefficient of yarn count was 1.6 to 1.8%. This means that about 95% of deliveries would be within ± 3.2 to 3.6% of the mean values. This compares reasonably with the specified tolerances of ± 2.5% and it is doubtful whether a smaller range of variation could be achieved in practice.

3. There was a suggestion that the yarn from one supplier was different in yarn count from the others and that this may have caused small differences in the relaxed dimensions of the corresponding greige and finished fabrics. This was only a suspicion which could not be proved due to the nature of the data.

4. Stitch length in the greige fabrics was under remarkably good control with variation coefficients in the region of 0.6 to 0.75%. This means that about 95% of deliveries would be within ± 1.2 to 1.5% of the mean values. For the interlock fabrics, this meant that all deliveries were well within the specified tolerances of ± 2.5% from nominal. However, the rib fabrics were actually being knitted, on average, about 1% below the nominal value so that occasional fabrics were on the borderline of the specification. Presumably this systematically low stitch length was produced deliberately.

5. During the relaxation of the greige fabrics there was a shrinkage of about 2% in stitch length and a loss in yarn Tex of about 2% also. This indicates an overall weight loss of about 4%.

   Relaxation of the finished fabrics produced much smaller changes in stitch length and Tex, -0.65% and +0.24% respectively, indicating an overall weight loss of 0.4%.

   The changes in the greige fabrics were statistically significant and showed no apparent trends as between the different qualities.

   The changes in the finished fabrics were statistically not significant from zero but seemed systematic and showed different tendencies for the different finishing routes.

6. The internal consistency of the test data was assessed and found to be remarkably good for all test parameters except the relaxed weight. In the greige fabrics this was possibly in "error" by about 2%, and in the finished fabrics it was almost certainly in "error" by about 3.6%. Errors from all other sources are probably less than 0.5% in total.

7. Almost all of the test data conformed to a normal distribution with relatively few outliers. Variation coefficients, within qualities, were mostly in the range of 1.5% to 3.5% and, since we should not expect the STARFISH models to make predictions with a better accuracy than ± 1 standard deviation, the following classification scheme was set up for evaluating the accuracy of the various models.

Symbol	Predictive Power	Required Precision
E	Excellent	Within ± 1%
G	Good	Within ± 2%
M	Mediocre	Within ± 3%
P	Poor	Within ± 5%
U	Unacceptable	Outside ± 5%

Variation coefficients for the data from finished fabrics were invariably significantly higher than those for the greige and so this scheme represents a reasonably severe assessment criterion.

8. Using this assessment criterion, it was found that the K3 model equations produced Good to Excellent predictions for relaxed stitch length and Good to Mediocre predictions for relaxed Tex, courses, wales and shrinkage. There were sometimes poor predictions for relaxed weight, however, and one particular model was shown to be suspect, namely that for jet dyed 1x1 rib. The poor weight predictions may be related to the apparent measuring error mentioned in Conclusion 6.
9. When the weight is calculated from the measured Tex, stitch length, courses and wales, it is almost invariably heavier than that measured by the cut and weigh technique by an average of roughly 4%. This point deserves a thorough investigation.
10. A comparison of the actual properties of the finished fabrics with the customer specifications showed that the specifications were probably unreasonable. Although the finisher was (with one exception) delivering the specified weight, courses and wales, the shrinkages were often much too high. Furthermore, the inevitable random variations of manufacturing were such that more than 50% of fabrics were out of tolerance on one or more parameters. The parameter under closest control was the weight. Specified tolerances on courses and wales are apparently completely unrealistic. The rib specification is a much better one than the interlock. For the interlock there is literally no chance that the maximum shrinkage requirements can be met over a series of deliveries, whereas for the rib they can probably be met for a proportion of deliveries.
11. Good evidence was found that the performance of our predictive models is likely to be significantly improved as a result of the "cleaning up" exercise which is shortly to be undertaken, in which the Step 1 equations will be made representative of several combinations of fabric and finishing route, and rather fewer combinations of finishing route will be made for the Step 2 equations. The performance of the "minor" route models was especially encouraging.
12. The difference in length shrinkages measured after one and five cycles may be dependent upon the finishing route. The continuous bleach process seems to give an outstandingly high difference.

6 Appendix

Comparison of different predictive models for the greige fabrics; tables and results. These tables are held only in the Master Copy.

Figure 1

YARN SAMPLING SCHEDULE

LOT	1		2		3		4		5		6		7		8	
DATE	15/7		30/7		26/8		18/9		14/10		2/11		3/12		13/1	
COUNT NE	30	38	30	38	30	38	30	38	30	38	30	38	30	38	30	38
Atzenbach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Volos	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0
Mars KCW	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
Kent KCW	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0
Swanlane KCW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calebwright LW	1	2	1	4	1	1	0	1	0	1	2	1	1	1	0	1
Calebwright KCW	0	0	1	0	2	0	1	0	1	0	0	0	1	0	1	0
TOTAL	2	2	3	4	4	2	2	2	1	2	3	2	2	2	1	2

Figure 2

GREIGE FABRIC SAMPLING SCHEDULE

LOT	1		2		3		4		5		6		7		8	
DATE	15/7		30/7		26/8		18/9		14/10		2/11		3/12		13/1	
FABRIC	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I
Atzenbach	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Volos	2	0	1	0	1	0	3	0	3	0	4	0	0	0	0	0
Marks KCW	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
Kent KCW	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
Swanlane KCW	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calebwright LW	1	3	1	7	1	2	2	1	0	1	3	1	1	1	0	2
Calebwright KCW	0	0	1	0	1	1	2	1	2	1	2	0	1	0	1	0
Velca	0	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0
TOTAL	5	5	3	8	3	3	7	2	7	2	12	2	2	2	3	5

Figure 3

FINISHED FABRIC SAMPLING SCHEDULE

LOT	1	2	3	4	5	6	7	8
DATE	15/7	30/7	26/8	18/9	14/10	2/11	3/12	13/1
FW 1033 JD	0	0	0	2	1	1	0	0
FW 1007 CB	0	4	2	2	2	1	1	2
FQ 1007 JD	0	4	1	3	1	1	2	2
FQ 1007 WD	0	3	1	1	1	2	1	1
TOTAL	0	11	4	8	5	5	4	5

Figure 4

Ne38 YARNS SAMPLED FROM CONES

Sample	Yarn Ne	Twist Factor	Turns /inch	SES g	Ext'n %	Frict Coeff
LW Quality (Caleb Wright)						
1	38.2	3.77	23.3	197.5	6.2	0.11
2	37.4	3.65	22.4	198.7	6.3	0.12
3	38.7	3.89	24.2	217.3	6.1	0.18
4	38.8	3.69	23	212.1	6.1	0.15
5	38.3	3.69	22.9	221.7	6.2	0.11
6	39.1	3.64	22.7	208.5	6.1	0.13
7	38.8	3.75	23.4	202.1	5.6	0.11
8	39.7	3.69	23.2	190.8	6.1	0.1
9	38.4	3.79	23.7	189.4	5.7	0.09
10	38.3	3.68	22.8	203.3	5.7	0.12
11	39.3	3.62	22.7	200.1	5.4	0.15
12	38.5	3.67	22.8	216.9	6.5	0.12
KCW Quality (Kent/Mars)						
1	38.1	3.8	24.5	215.8	6.5	0.14
2	37.9	3.55	21.9	219.3	6.6	0.18
3	38.8	3.67	22.9	209.8	5.5	0.12
4	37.7	3.65	22.4	219.5	6.1	0.11
5	39.2	3.61	22.6	188.3	5.2	0.09
6	37.6	3.79	23.2	236.7	6.6	0.1

*** COLUMN STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	18	38.4889	0.6230	1.62
2.Twist	Factor	18	3.7000	0.0832	2.25
3.Turns	/inch	18	23.0333	0.6352	2.76
4. SES	g	18	208.2111	12.9780	6.23
5.Ext'n	%	18	6.0278	0.4212	6.99
6.Frict	Coeff	18	0.1239	0.0268	21.65

Figure 5

Ne30 YARNS SAMPLED FROM CONES

Sample	Yarn Ne	Twist Factor	Turns /inch	SES g	Ext'n %	Frict Coeff
LW Quality (Caleb Wright)						
1	30.4	3.59	19.8	281	6.4	0.11
2	30.6	3.62	20	272.6	6.6	0.1
3	30.2	3.58	19.7	286.8	6.7	0.11
4	31.1	3.47	19.4	284.6	6.7	0.13
5	30.7	3.5	19.4	260.3	6.1	0.09
6	30.8	3.5	19.4	272.4	6.1	0.09
LW Equivalent (Volos)						
7	30.8	3.4	18.9	254.4	5.3	0.1
8	30.2	3.75	21.6	272.3	6.1	0.12
9	29.4	3.4	21.1	287.2	6.1	0.12
10	29.7	3.88	21.1	281.3	6.1	0.13
11	30.5	3.77	20.8	252.7	5.5	0.13
12	29.3	3.79	20.5	260.9	5.3	0.13
KCW Quality (Caleb Wright)						
1	30.9	3.5	19.5	279.5	6.6	0.12
2	30.7	3.51	19.4	287.5	6.3	0.13
3	30.4	3.51	19.4	279.8	6.4	0.09
4	31.3	3.44	19.2	264.5	6	0.1
5	30.6	3.62	20	257.8	5.2	0.09
6	30.5	3.57	19.7	274.7	6.3	0.1

*** COLUMN STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	18	30.4500	0.5361	1.76
2.Twist	Factor	18	3.5778	0.1389	3.88
3.Turns	/inch	18	19.9389	0.7640	3.83
4. SES	g	18	272.7944	11.7083	4.29
5.Ext'n	%	18	6.1000	0.4814	7.89
6.Frict	Coeff	18	0.1106	0.0159	14.38

Figure 6

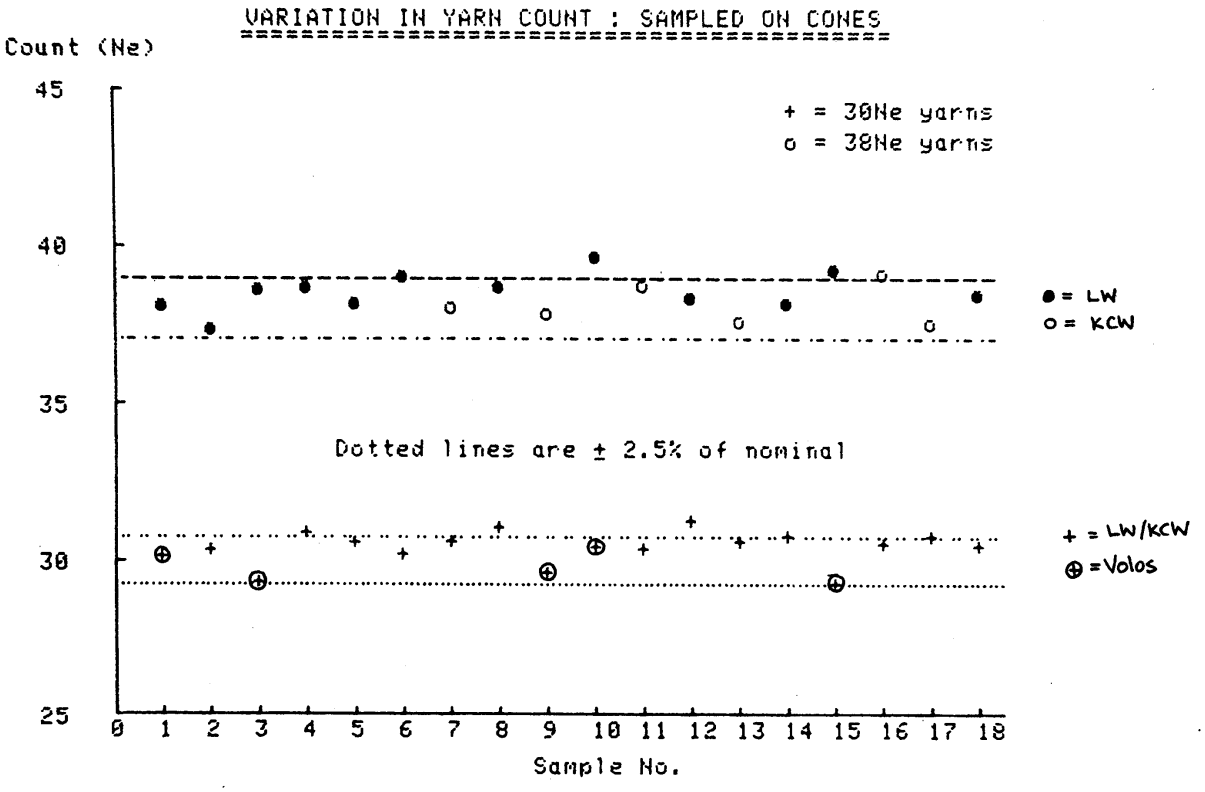
VARIATION IN YARN COUNT : SAMPLED ON CONES
Count (Ne)
45
40
35
30
25
+ = 30Ne yarns
o = 38Ne yarns
● = LW
o = KCW
Dotted lines are ± 2.5% of nominal
+ = LW/KCW
⊕ = Volos
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Sample No.

Figure 7

GREIGE INTERLOCK FABRICS : QUALITY FW 1033

Properties Measured Before Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	38.4	3.4	39.7	35.4	159.2	1260	54.2
2	37.9	3.39	39.9	35.1	159.9	940	40
3	38.8	3.37	44.4	35.6	171.8	1572	66
4	39.3	3.39	39.8	34.4	157.6	940	38.5
5	38.5	3.41	40.6	34.4	163.3	1008	43.1
6	38.9	3.35	41.1	38.5	172	1320	57.3
7	38.9	3.37	40.4	36.2	165.6	1632	66.8
8	39.3	3.39	41	34.2	160.4	1428	61.2
9	38.9	3.37	40.6	34.9	162.2	1044	44.5
10	38.6	3.38	39.8	36.6	165.6	1200	49.8
11	39.3	3.37	41.8	33.4	160.1	1500	63
12	39	3.4	41.7	35.2	166.2	1632	68.7
13	40.3	3.4	46.1	30.9	156.5	940	43.8
14	39	3.4	39.2	35.4	158.1	936	39.5
15	38.7	3.41	41.9	34	163.3	936	41.5
16	38.8	3.34	42.2	35.9	166.9	1572	68.6
17	39.6	3.38	42.7	34.2	163.8	1632	72.2
18	37.2	3.35	41.9	34.3	163.7	936	40

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. Yarn	Ne	18	38.8556	0.6582	1.69
2. St. Len	mm	18	3.3817	0.0209	0.62
3. Crses	/3cm	18	41.3778	1.7454	4.22
4. Wales	/3cm	18	34.9222	1.5445	4.42
5. Weight	gsm	18	163.1222	4.4307	2.72
6. Needls		18	1246.0000	290.1951	23.29
7. Width	cm	18	53.2611	12.2036	22.91

Figure 8

GREIGE INTERLOCK FABRICS : QUALITY FW 1007

Properties Measured Before Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	37.9	3.4	40	36.8	173.9	1236	49.8
2	38.6	3.38	41.1	34.6	169.6	1380	60
3	37.7	3.38	40.2	36.2	173.3	1236	49.8
4	37.5	3.42	38.7	34.9	161.2	1260	52.6
5	38.6	3.37	46.7	34.1	163.7	1236	55.5
6	38.3	3.38	40.2	35.9	170	1200	50
7	37.2	3.42	41.3	33.8	167.5	1380	62
8	38.2	3.36	43.1	37.3	180.4	1380	56.5
9	36.4	3.34	40.1	35.6	170.4	1236	49.8
10	36.9	3.37	43.8	33.7	168.3	1128	47.1
11	36.8	3.38	43.8	33.7	170.5	1440	63.4

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. Yarn	Ne	11	37.6455	0.7528	2.00
2. St. Len	mm	11	3.3818	0.0240	0.71
3. Crses	/3cm	11	41.7273	2.3504	5.63
4. Wales	/3cm	11	35.1455	1.2926	3.68
5. Weight	gsm	11	169.8909	5.1085	3.01
6. Needls		11	1282.9091	96.5168	7.52
7. Width	cm	11	54.2273	5.6105	10.35

Figure 9

GREIGE 1×1 RIB FABRICS : QUALITY FQ 1018

Properties Measured Before Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	30.3	2.8	49.7	27.1	166.8	1056	59
2	30.1	2.8	52.6	26.6	157.9	1320	78.7
3	29.2	2.86	47.9	26.3	160.8	736	40
4	31	2.81	51	26.1	165.8	1320	72.3
5	29.2	2.81	46.3	26.7	155.8	848	47.6
6	29.4	2.82	52.4	25.1	160.4	1056	55.3
7	30.3	2.8	52	25	161.5	1320	77.9
8	30.7	2.82	51	25.9	153.8	1320	74.9
9	30.9	2.81	48	26.9	158.6	1056	56.8
10	30.3	2.84	47.3	26.3	153.2	1056	58.1
11	30.5	2.79	48.6	27.1	156.6	924	49.3
12	30.5	2.79	52.6	24	159.2	1320	78.3
13	28.9	2.77	49.6	25.6	164.5	876	50
14	29.5	2.84	48.8	26	167.1	840	47.2
15	29.3	2.78	49.1	26.3	166.5	736	40.6
16	29.7	2.81	48.1	26.8	163.2	966	53.5
17	30.5	2.79	50.3	28.5	158.3	792	41.5
18	30.1	2.81	47.8	28.7	170.5	1056	55.9
19	29.2	2.8	46.8	27.5	167.1	848	46.3
20	29.1	2.77	48.4	28.1	172	736	39.1
21	29.5	2.78	50.7	28	180.9	1056	57.6
22	30.7	2.82	50.5	26.9	174.1	1320	72.5
23	30.4	2.83	52.2	26.7	168.9	1320	74.2

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. Yarn	Ne	23	29.9696	0.6519	2.18
2. St. Len	mm	23	2.8065	0.0227	0.81
3. Crses	/3cm	23	49.6391	1.9430	3.91
4. Wales	/3cm	23	26.6174	1.1224	4.22
5. Weight	gsm	23	163.6304	6.8960	4.21
6. Needls		23	1038.1739	218.3166	21.03
7. Width	cm	23	57.6783	13.4657	23.35

Figure 10

GREIGE 1×1 RIB FABRICS : QUALITY FQ 1007

Properties Measured Before Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	30.2	2.84	48	29.2	166.8	840	44.3
2	30.8	2.84	48.4	28.2	162.8	840	45
3	30.9	2.8	50	28.3	163.9	1140	61.8
4	30.9	2.84	50.2	25.1	156.6	1320	73.9
5	30.4	2.81	48.6	28.3	161.6	876	46.4
6	30.3	2.81	51.5	25.3	162.1	1320	76.3
7	31	2.83	49.1	27.8	163.5	1140	63.5
8	30.4	2.79	49.7	27.2	166	1056	58.3
9	31.4	2.83	48	26.7	158.6	966	54.4
10	30.7	2.79	48.1	27.2	159	792	42.7
11	30.1	2.83	47.4	28.1	164.1	792	41.4
12	30.2	2.83	48.8	28.2	169.2	1140	63.5
13	30.6	2.84	50.3	26.3	173.3	1320	77.5
14	30.6	2.8	48.1	27.9	173.6	876	49.1
15	30.3	2.78	47.3	27.8	168	792	42.2
16	30.4	2.81	53.3	27	168.8	1320	73
17	30.2	2.82	45.8	29.9	164.4	840	42.6
18	30.2	2.85	47	29.1	147.7	736	39.8
19	30.6	2.83	47.9	29.4	160.9	840	42.4

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. Yarn	Ne	19	30.5368	0.3451	1.13
2. St. Len	mm	19	2.8195	0.0204	0.72
3. Crses	/3cm	19	48.8158	1.7289	3.54
4. Wales	/3cm	19	27.7368	1.2872	4.64
5. Weight	gsm	19	163.7316	6.0123	3.67
6. Needls		19	997.1579	211.4997	21.21
7. Width	cm	19	54.6368	13.3490	24.43

Figure 11

GREIGE INTERLOCK FABRICS : QUALITY FW 1033

Properties Measured after Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm
1	38.2	3.36	48.5	45.1	239.2
2	38.3	3.36	48.6	44.6	244.4
3	40.6	3.28	49.1	46.4	246.1
4	40.6	3.34	49.2	45.4	235.7
5	38.9	3.36	49.5	43.7	240.9
6	40.5	3.3	49.8	47.2	246.3
7	39.9	3.33	49.3	46.4	237.9
8	40.7	3.33	48.5	44.8	227.4
9	39.9	3.31	49.6	45.2	238.4
10	39.7	3.31	48.9	46.2	239.7
11	39.4	3.32	48.5	46.4	238.8
12	39.9	3.34	48.2	46.3	241
13	40.1	3.32	48.1	46.1	244
14	39.2	3.33	48.5	45.6	236.7
15	40	3.35	50.3	43.8	234.9
16	39.6	3.29	51.6	46	250
17	38.1	3.31	49.3	44.7	240.3
18	39.4	3.28	49.8	44.4	239.6

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. Yarn	Ne	18	39.6111	0.8167	2.06
2. St. Len	mm	18	3.3233	0.0259	0.78
3. Crses	/3cm	18	49.1833	0.8604	1.75
4. Wales	/3cm	18	45.4611	0.9877	2.17
5. Weight	gsm	18	240.0722	5.0731	2.11

Figure 12

GREIGE INTERLOCK FABRICS QUALITY FW 1007

Properties Measured after Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm
1	37.9	3.31	48.7	45.9	249.8
2	38.6	3.38	50.3	45.7	241.3
3	38.5	3.33	49	44.6	240.8
4	38.5	3.34	49.2	45	244.7
5	39.1	3.31	49	46.3	253.7
6	39.8	3.33	49.3	45.3	244.6
7	39.2	3.36	49.8	44.1	243.6
8	39.5	3.3	51.2	45.5	248.1
9	38.4	3.29	50.3	44.4	246.8
10	38.8	3.34	50	42	246.4
11	38.8	3.24	48.3	43.6	247.6

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. Yarn	Ne	11	38.8273	0.5405	1.39
2. St. Len	mm	11	3.3209	0.0375	1.13
3. Crses	/3cm	11	49.5545	0.8478	1.71
4. Wales	/3cm	11	44.8545	1.0192	2.27
5. Weight	gsm	11	246.1273	3.7398	1.52

Figure 13

GREIGE 1x1 RIB FABRICS : QUALITY FQ 1018

Properties Measured after Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm
1	31.2	2.78	59.1	35.2	236
2	32.3	2.74	59.1	35.6	230
3	29.8	2.79	56.5	34.7	232
4	31.3	2.77	58	34.4	217.4
5	29.8	2.76	58.1	35.1	239.2
6	31.3	2.77	58.3	34.1	230
7	30.6	2.74	60.2	34.8	236.9
8	31.2	2.77	56.9	35.2	221.9
9	31.5	2.76	56.4	35.7	227.5
10	31	2.76	56.6	35.7	234.6
11	31.2	2.74	57.5	35.4	235.3
12	31	2.74	58.4	34.1	224.6
13	29.8	2.74	59.2	35.7	246.2
14	30.6	2.78	57.6	34.7	239.6
15	30.7	2.72	59.4	35.3	243.5
16	30.3	2.77	58.6	35.2	239.6
17	30.6	2.73	58.3	34.9	234.7
18	30.5	2.77	57.5	34.8	236.9
19	29.9	2.76	58.2	34.9	243.9
20	30	2.73	59.6	34.7	243.5
21	29.8	2.73	59.2	34.9	244.5
22	31	2.77	58	34.7	232.2
23	31.3	2.77	58	35.4	237.2

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. Yarn Ne	23	30.7261	0.6703	2.18
2. St. Len mm	23	2.7561	0.0195	0.71
3. Crses /3cm	23	58.2043	1.0245	1.76
4. Wales /3cm	23	35.0087	0.4680	1.34
5. Weight gsm	23	235.0957	7.4625	3.17

Figure 14

GREIGE 1x1 RIB FABRICS : QUALITY FQ 1007

Properties Measured after Relaxation

Sample	Yarn Ne	St. Len mm	Crses /3cm	Wales /3cm	Weight gsm
1	30.9	2.84	56.7	34.7	228.9
2	30.7	2.82	57.3	34.9	232
3	31.1	2.72	57.8	35.4	230
4	31.3	2.78	56.9	34.3	226.1
5	31.1	2.77	55.9	35.8	232.4
6	31.1	2.77	57.5	35.2	224.1
7	31.3	2.78	57.2	35.8	224.8
8	30.7	2.74	57.7	34.1	224.6
9	31.7	2.79	57.2	35.2	223.7
10	31.3	2.75	58.5	34.5	229.7
11	31.1	2.79	58	33.8	231.4
12	30.5	2.79	57	33.3	224.4
13	30.3	2.79	57.6	34.6	234.4
14	30.7	2.76	58.3	33.6	227
15	30.8	2.74	58.2	33.4	225.9
16	30.9	2.74	59.4	35	235.5
17	31.8	2.71	54.8	34.6	228.6
18	30.9	2.78	55	34	228.2
19	30.2	2.7	56	34.4	226.3

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. Yarn Ne	19	30.9684	0.4177	1.35
2. St. Len mm	19	2.7663	0.0359	1.30
3. Crses /3cm	19	57.2105	1.1633	2.03
4. Wales /3cm	19	34.5579	0.7448	2.16
5. Weight gsm	19	228.3158	3.5801	1.57

Figure 15

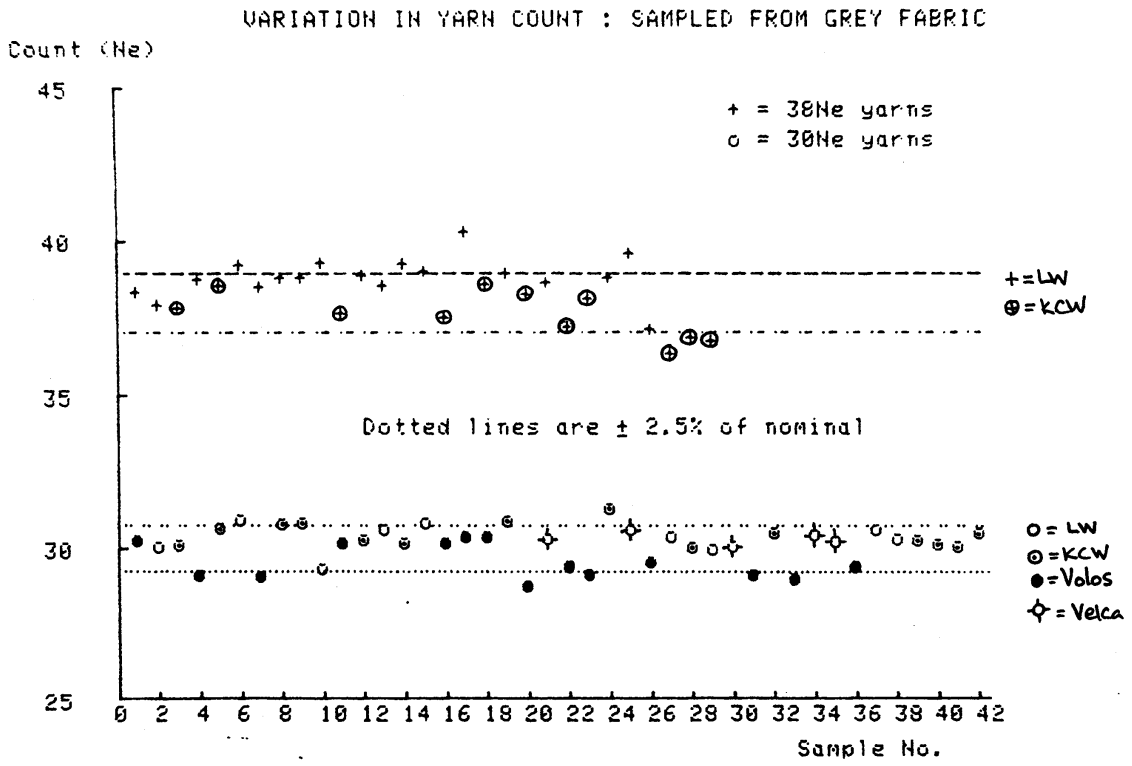

Figure 16

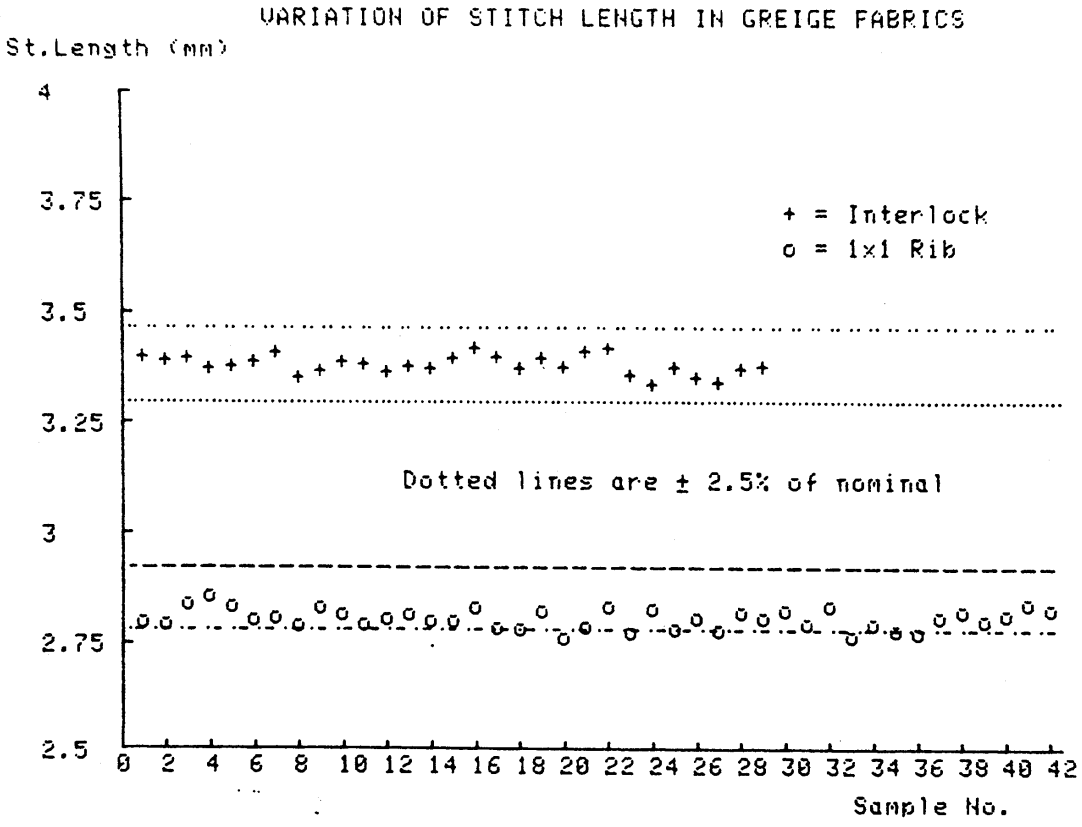

Figure 17

GREIGE INTERLOCK FABRICS

QUALITY FW 1033

Shrinkages after 1 & 5 Cycles

Sample	Length (1)	Width (1)	Length (5)	Width (5)
1	18.7	20.9	19.6	21.4
2	18	21.3	18.9	23.3
3	13.5	21.5	14.2	22.2
4	16.1	21.7	17.3	23.4
5	15.3	20.2	16.8	22
6	14.5	19	16.3	19.1
7	13.8	23.4	15.2	24.4
8	16.8	21.2	18.1	22
9	17.8	20.4	18.9	21.8
10	16.6	21.4	18	22.2
11	19.3	21.1	18.9	21.1
12	16.5	21.8	15.8	20.4
13	16.6	23.6	18.8	24.1
14	19.6	21.2	20.2	22.1
15	14.9	21.7	16.8	22.5
16	16.3	22.1	18.4	20.9
17	10.6	25	13.8	16.3
18	12.4	20	16.1	21.6

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. Length (1)	18	16.0167	2.3142	14.45
2. Width (1)	18	21.5278	1.3919	6.47
3. Length (5)	18	17.3389	1.8376	10.60
4. Width (5)	18	21.7111	1.8582	8.56

Figure 18

GREIGE INTERLOCK FABRICS

QUALITY FW 1007

Shrinkages after 1 & 5 Cycles

Sample	Length (1)	Width (1)	Length (5)	Width (5)
1	15.9	20	16.7	20.4
2	17.2	21.1	18	22
3	18.7	17.2	19.9	18.3
4	20.5	20.9	20.8	19
5	17.7	22.5	19.8	23.6
6	17.9	19	18.5	19
7	14.6	21.4	17	22.3
8	14.6	18.3	16.4	17.6
9	18.2	17.1	17.1	17.9
10	17.8	17.8	20.2	18.3
11	10.9	23.6	13.9	25.4

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. Length (1)	11	16.7273	2.6016	15.55
2. Width (1)	11	19.9000	2.1923	11.02
3. Length (5)	11	18.0273	2.0650	11.45
4. Width (5)	11	20.3455	2.6117	12.84

Figure 19

GREIGE 1x1 RIB FABRICS

QUALITY FQ 1007

Shrinkages after 1 & 5 Cycles

Sample	Length (1)	Width (1)	Length (5)	Width (5)
1	9.7	20.5	10.1	20.8
2	10.7	22.7	12.2	22.1
3	12.3	20.2	13.4	21.7
4	11.9	23.8	11.9	24.4
5	14.4	16.4	15.8	19.4
6	9.3	22.5	10	25.6
7	14	21.4	14.7	21.3
8	12.8	18.3	13.7	19.2
9	15.5	19.9	16.4	20.4
10	15.9	18.3	16.8	19.6
11	16.5	16	18.3	16.5
12	13.3	14.6	15.3	15.1
13	11.4	20.5	12.5	21.6
14	14.8	16.3	16.7	17.5
15	17	16.5	18.9	16.2
16	9.5	20.8	11	21.8
17	16.8	14.5	18.9	15.4
18	15.3	18.3	17.4	20.8
19	13.7	13.2	16	15.1

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. Length (1)	19	13.4105	2.5015	18.65
2. Width (1)	19	18.6684	3.0429	16.30
3. Length (5)	19	14.7368	2.8735	19.50
4. Width (5)	19	19.7105	3.0608	15.53

Figure 20

GREIGE 1x1 RIB FABRICS

QUALITY FQ 1018

Shrinkages after 1 & 5 Cycles

Sample	Length (1)	Width (1)	Length (5)	Width (5)
1	13.2	21.7	13.5	23.1
2	9.9	26.4	10.1	27.9
3	15.1	21.7	15.5	21.2
4	11.1	23.3	12.1	25.2
5	16.9	23.3	19	24.4
6	12	22.1	12.1	22.8
7	12	24.6	11.4	25.8
8	10.6	22.9	11.9	25.8
9	16.8	18.5	18.5	21
10	17.7	19.5	19	21.9
11	14.7	17.5	15.8	19.9
12	10.8	25.2	11.7	28.6
13	15.2	26	15.3	26.5
14	15.3	23.9	15.8	26.7
15	16.5	22.8	16.9	23.5
16	17.7	22.1	18.2	23.4
17	14.3	17.4	16	19.6
18	16.5	17	18.1	17.6
19	18.4	18.9	20	20.3
20	16.9	17.3	18.5	17.9
21	15.1	17.9	15.7	19.2
22	12.6	19.5	13.8	20
23	9.5	22.1	11	23.4

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. Length (1)	23	14.2957	2.7460	19.21
2. Width (1)	23	21.3739	2.9516	13.81
3. Length (5)	23	15.2130	3.0227	19.87
4. Width (5)	23	22.8565	3.1584	13.82

Figure 21

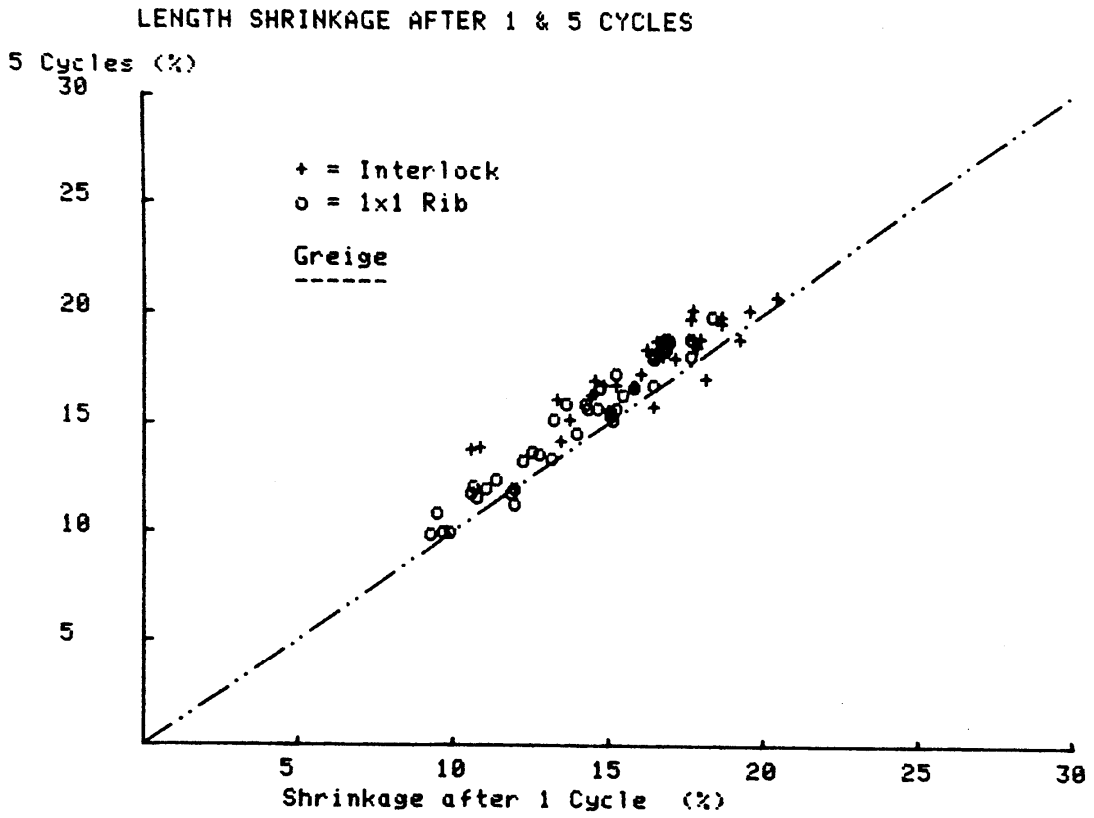

Figure 22

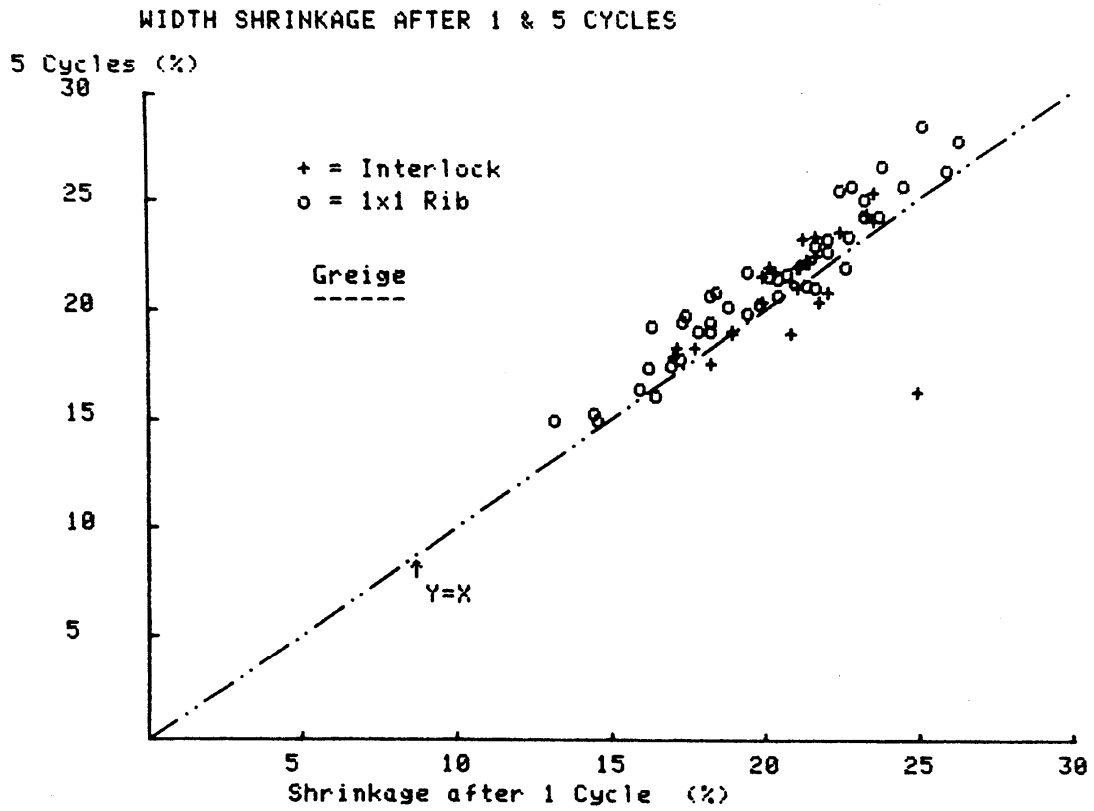

Figure 23

GREIGE INTERLOCK FABRICS

Quality FW 1033

Measured vs Calculated Width, Weight, & Stitch Density

Sample	Width Meas.	Width (1)	Weight Meas.	Weight (2)	Weight (3)	Stches C*W	Stches (4)
1	54.2	53.4	159	163	157	156	152
2	40	40.2	160	164	158	156	151
3	66	66.2	172	180	171	176	167
4	38.5	41	158	155	155	152	155
5	43.1	44	163	162	163	155	156
6	57.3	51.4	172	179	173	176	169
7	66.8	67.6	166	166	159	162	162
8	61.2	62.6	160	159	151	156	157
9	44.5	44.9	162	161	157	157	159
10	49.8	49.2	166	167	159	162	160
11	63	67.4	160	157	159	155	158
12	68.7	69.5	166	168	168	163	161
13	43.8	45.6	157	158	156	158	157
14	39.5	39.7	158	159	153	154	154
15	41.5	41.3	163	165	158	158	157
16	68.6	65.7	167	171	168	168	164
17	72.2	71.6	164	164	180	162	162
18	40	40.9	164	170	164	160	154

(1) Calculated from Needles & Wales
(2) Calculated from Tex, St.Length, Courses, & Wales
(3) Calculated from Relaxed Weight (corrected) & Shrinkages
(4) Calculated from Weight, Tex, & St.Length

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	18	53.2611	12.2036	22.91
2.Width (1)	18	53.4556	12.0030	22.45
3.Weight Meas.	18	163.1667	4.4491	2.73
4.Weight (2)	18	164.8889	6.9103	4.19
5.Weight (3)	18	161.6111	7.6554	4.74
6.Stches C*W	18	160.3333	6.9027	4.31
7.Stches (4)	18	158.6111	4.9126	3.10

Figure 24

GREIGE INTERLOCK FABRICS

Quality FW 1007

Measured vs Calculated Width, Weight, & Stitch Density

Sample	Width Meas.	Width (1)	Weight Meas.	Weight (2)	Weight (3)	Stches C*W	Stches (4)
1	49.8	50.4	174	173	172	164	164
2	60	59.8	170	163	161	158	164
3	49.8	51.2	173	171	164	162	164
4	52.6	54.2	161	162	163	150	150
5	55.5	54.4	164	182	162	177	159
6	50	50.1	170	167	168	160	163
7	62	61.2	168	168	163	155	154
8	56.5	55.5	180	186	178	179	174
9	49.8	52.1	170	172	175	159	157
10	47.1	50.2	168	177	167	164	156
11	63.4	64.1	171	178	165	164	157

1) Calculated from Needles & Wales
2) Calculated from Tex, St.Length, Courses, & Wales
3) Calculated from Relaxed Weight (corrected) & Shrinkages
4) Calculated from Weight, Tex, & St.Length

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	11	54.2273	5.6105	10.35
2.Width (1)	11	54.8364	4.8611	8.86
3.Weight Meas.	11	169.9091	5.0091	2.95
4.Weight (2)	11	172.6364	7.5931	4.40
5.Weight (3)	11	167.0909	5.6295	3.37
6.Stches C*W	11	162.9091	8.5960	5.28
7.Stches (4)	11	160.1818	6.5087	4.06

Figure 25

GREIGE 1x1 RIB FABRICS

Quality FQ 1018

Measured vs Calculated Width, Weight, & Stitch Density

Sample	Width Meas.	Width (1)	Weight Meas.	Weight (2)	Weight (3)	Stches C*W	Stches (4)
1	59	58.5	167	163	163	150	153
2	78.7	74.4	158	171	155	155	144
3	40	42	161	162	161	140	139
4	72.3	75.9	166	158	149	148	155
5	47.6	47.6	156	156	152	137	137
6	55.3	63.1	160	166	162	146	142
7	77.9	79.2	162	158	162	144	148
8	74.9	76.4	154	159	151	147	142
9	56.8	58.9	159	154	152	143	148
10	58.1	60.2	153	153	154	138	138
11	49.3	51.1	157	158	165	146	145
12	78.3	82.5	159	152	147	140	147
13	50	51.3	165	160	159	141	145
14	47.2	48.5	167	160	154	141	147
15	40.6	42	167	161	161	143	149
16	53.5	54.1	163	160	156	143	146
17	41.5	41.7	158	172	165	159	147
18	55.9	55.2	171	168	166	152	155
19	46.3	46.3	167	162	162	143	148
20	39.1	39.3	172	170	169	151	153
21	57.6	56.6	181	176	173	158	163
22	72.5	73.6	174	164	167	151	160
23	74.2	74.2	169	170	168	155	154

(1) Calculated from Needles & Wales
(2) Calculated from Tex, St.Length, Courses, & Wales
(3) Calculated from Relaxed Weight (corrected) & Shrinkages
(4) Calculated from Weight, Tex, & St.Length

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Width	Meas.	23	57.6783	13.4657	23.35
2.Width	(1)	23	58.8087	13.6190	23.16
3.Weight	Meas.	23	163.7391	6.9165	4.22
4.Weight	(2)	23	162.3043	6.4345	3.96
5.Weight	(3)	23	159.6957	7.0158	4.39
6.Stches	C*W	23	146.5652	6.3305	4.32
7.Stches	(4)	23	148.0435	6.6365	4.48

Figure 26

GREIGE 1×1 RIB FABRICS

Quality FQ 1007

Measured vs Calculated Width, Weight, & Stitch Density

Sample	Width Meas.	Width (1)	Weight Meas.	Weight (2)	Weight (3)	Stches C*W	Stches (4)
1	44.3	43.2	167	173	169	156	150
2	45	44.7	163	165	165	152	149
3	61.8	60.4	164	168	162	157	153
4	73.9	78.9	157	152	157	140	144
5	46.4	46.4	162	167	164	153	148
6	76.3	78.3	162	159	156	145	148
7	63.5	61.5	164	164	157	152	152
8	58.3	58.2	166	163	163	150	153
9	54.4	54.3	159	152	155	142	149
10	42.7	43.7	159	156	160	145	148
11	41.4	42.3	164	164	164	148	148
12	63.5	60.6	169	169	168	153	153
13	77.5	75.3	173	161	167	147	158
14	49.1	47.1	174	161	162	149	161
15	42.2	42.7	168	158	160	146	155
16	73	73.3	169	175	170	160	155
17	42.6	42.1	164	168	163	152	149
18	39.8	37.9	148	169	155	152	133
19	42.4	42.9	161	171	168	156	147

(1) Calculated from Needles & Wales
(2) Calculated from Tex, St.Length, Courses, & Wales
(3) Calculated from Relaxed Weight (corrected) & Shrinkages
(4) Calculated from Weight, Tex, & St.Length

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	19	54.6368	13.3490	24.43
2.Width (1)	19	54.4105	13.7339	25.24
3.Weight Meas.	19	163.8421	5.9279	3.62
4.Weight (2)	19	163.9474	6.5615	4.00
5.Weight (3)	19	162.3684	4.8214	2.97
6.Stches C*W	19	150.2632	5.2582	3.50
7.Stches (4)	19	150.1579	5.8620	3.90

Figure 27

GREIGE FABRICS – K3 MODEL PREDICTIONS

Mean Values after Relaxation

	FW1033 LW	FW1007 KCW(2)	FQ1007 KCW(1)	FQ1007 KCW(2)	FQ1018 LW	FQ1018 Volos
Yarn Tex						
Measured	14.9	15.2	19	19.1	18.9	19.4
K3 Model	15.2	15.7	18.9	19.1	19.1	19.6
% Diff	2	3.3	-0.5	0	1.1	1
Stitch Length mm						
Measured	3.32	3.32	2.76	2.77	2.76	2.75
K3 Model	3.31	3.31	2.77	2.78	2.77	2.76
% Diff.	-0.3	-0.3	0.36	0.4	0.4	0.4
Courses/3cm						
Measured	49.2	49.6	57.2	57.2	57.8	58.4
K3 Model	49.8	49.8	57.3	57.3	57.6	57.9
% Diff.	1.2	0.4	0.2	0.2	-0.4	-0.9
Wales/3cm						
Measured	45.5	44.9	35.1	34.1	35	35
K3 Model	44.4	44.1	34.2	34.2	34.2	34.5
% Diff.	-2.4	-1.8	-2.6	0.3	-2.3	-1.4
Weight gsm						
Measured	240	246	228	229	230	239
K3 Model	229	235	218	221	222	229
% Diff.	-4.6	-4.5	-4.4	-3.5	-3.5	-4.2
Stitches/sq.cm						
Measured	249	247	223	217	225	227
K3 Model	245	244	220	219	220	222
% Diff.	-1.6	-1.2	-1.3	0.9	-1.8	-2.2
Calculated Weight						
Measured	246	250	234	229	235	242
K3 Model	247	254	228	231	232	240
% Diff.	0.4	1.6	-2.6	1.3	-0.9	-0.8

Calculated weight is from Tex, Stitch length, courses, and wales.

Figure 28

FINISHED INTERLOCK FABRICS

Quality FW 1033 : Jet Dyed

Properties Measured Before Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	40.7	3.24	41.6	39.9	168	1296	51.8
2	39.4	3.35	39.3	38.3	171	1428	55.6
3	40.7	3.31	40.3	38.1	160	1488	60.5
4	40.6	3.36	37.9	39.7	159	1380	51.9

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	4	40.3500	0.6351	1.57
2.St.Len	mm	4	3.3150	0.0545	1.64
3.Crses	/3cm	4	39.7750	1.5650	3.93
4.Wales	/3cm	4	39.0000	0.9309	2.39
5.Weight	gsm	4	164.5000	5.9161	3.60
6.Needls		4	1398.0000	81.0925	5.80
7.Width	cm	4	54.9500	4.1008	7.46

Figure 29

FINISHED INTERLOCK FABRICS

Quality FW 1007 : Continuous Bleach

Properties Measured Before Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	39.5	3.37	37.3	35.9	150	1128	46.6
2	40.1	3.3	38.3	34.3	158	1260	57
3	37.9	3.3	38.2	36.4	164	1120	45.1
4	36.6	3.43	37.2	36.8	155	1608	65.5
5	38.4	3.36	38.1	36	157	1236	51.6
6	39	3.29	39	36.2	159	1116	45.8
7	39.4	3.36	37.7	38.5	158	1368	55.7
8	38.2	3.35	39.3	38.2	163	1368	55.2
9	39.2	3.35	37.8	37	154	1368	55.9
10	38.3	3.33	33.4	38.2	141	1368	54.8
11	39.6	3.34	38.7	38.9	158	1380	54.3
12	39.3	3.32	40.3	36.9	165	1380	55.8
13	38.1	3.33	38.4	38.5	171	984	39.8
14	38.1	3.23	40.2	34.6	164	1368	56.3

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	14	38.6929	0.9144	2.36
2.St.Len	mm	14	3.3329	0.0461	1.38
3.Crses	/3cm	14	38.1357	1.6588	4.35
4.Wales	/3cm	14	36.8857	1.4443	3.92
5.Weight	gsm	14	158.3571	7.3023	4.61
6.Needls		14	1289.4286	159.4730	12.37
7.Width	cm	14	52.8143	6.4889	12.29

Figure 30

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Jet Dyed

Properties Measured Before Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	31.2	2.76	50.6	30.2	182	876	42.6
2	30	2.78	50.4	29.5	185	966	49.3
3	29.9	2.74	46.5	30.5	180	966	47.9
4	29.5	2.76	51.3	29.3	184	966	49
5	31.4	2.78	50.8	28.5	166	792	41.2
6	31	2.79	49.5	28.3	161	966	50.7
7	29.7	2.76	50	29.6	182	848	43.6
8	29.7	2.75	50.8	28	173	848	45.1
9	30.9	2.78	49.9	28.9	176	848	43.8
10	30.4	2.76	50.5	30.1	186	1056	52.5
11	29.4	2.73	52.6	29.6	186	736	38.2
12	29.6	2.72	50.4	29.4	176	1320	66.9
13	32.2	2.8	48.5	28.5	162	736	37.8
14	31.4	2.78	50.3	29.4	157	792	40.4

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	14	30.4500	0.8899	2.92
2.St.Len	mm	14	2.7636	0.0231	0.83
3.Crses	/3cm	14	50.1500	1.3921	2.78
4.Wales	/3cm	14	29.2714	0.7467	2.55
5.Weight	gsm	14	175.4286	10.0744	5.74
6.Needls		14	908.2857	152.6703	16.81
7.Width	cm	14	46.3571	7.4849	16.15

Figure 31

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Winch Dyed

Properties Measured Before Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Needls	Width cm
1	32.3	2.82	49.3	30.3	175	840	40.4
2	31.1	2.73	49	28.9	156	966	50.8
3	32	2.82	50.1	28.4	166	840	44.4
4	31.9	2.76	49.9	28.5	162	966	50.4
5	32	2.74	50.1	29.3	165	924	47.8
6	30.9	2.72	50.9	26.9	160	792	41.4
7	31.1	2.74	46.5	29.2	162	924	47
8	30.1	2.78	49.4	30.1	176	840	43.1
9	30.3	2.78	49.1	29.2	177	840	43.6
10	30.1	2.74	51.2	29.9	182	840	44.5

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	10	31.1800	0.8377	2.69
2.St.Len	mm	10	2.7630	0.0359	1.30
3.Crses	/3cm	10	49.5500	1.2981	2.62
4.Wales	/3cm	10	29.0700	0.9922	3.41
5.Weight	gsm	10	168.1000	8.7108	5.18
6.Needls		10	877.2000	61.7608	7.04
7.Width	cm	10	45.3400	3.5557	7.84

Figure 32

FINISHED INTERLOCK FABRICS

Quality FW 1033 : Jet Dyed

Properties Measured After Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Colour	% Dye
1	40.3	3.23	49.2	43.4	216	3	0.37
2	38.8	3.3	47.4	43.1	216	2	5.5
3	40.3	3.27	47.6	43.2	210	3	0.37
4	39.1	3.31	44.4	44.6	206	4	1.3

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	4	39.6250	0.7890	1.99
2.St.Len	mm	4	3.2775	0.0359	1.10
3.Crses	/3cm	4	47.1500	2.0025	4.25
4.Wales	/3cm	4	43.5750	0.6946	1.59
5.Weight	gsm	4	212.0000	4.8990	2.31
6.Colour		4	3.0000	0.8165	27.22
7. %	Dye	4	1.8850	2.4496	129.95

Figure 33

FINISHED INTERLOCK FABRICS

Quality FW 1007 : Continuous Bleach

Properties Measured After Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Colour	% Dye
1	40	3.32	45.1	44.1	206	0	0
2	39.5	3.31	45.6	44.7	215	0	0
3	39.4	3.25	44.1	46.2	218	0	0
4	38.3	3.34	45.4	44.1	218	0	0
5	38.6	3.35	45.1	41.6	207	0	0
6	38.6	3.28	46.2	41.8	208	0	0
7	39.8	3.33	46	42.5	206	0	0
8	38.4	3.32	45.3	45.6	215	0	0
9	40	3.34	45.2	42.6	210	0	0
10	40.3	3.39	44.2	44.4	212	0	0
11	41.3	3.34	46.5	42.6	203	0	0
12	39.8	3.32	47.2	42	210	0	0
13	38.6	3.18	45.8	42.3	212	0	0
14	37.9	3.21	45.8	41.7	212	0	0

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	14	39.3214	0.9513	2.42
2.St.Len	mm	14	3.3057	0.0572	1.73
3.Crses	/3cm	14	45.5357	0.8280	1.82
4.Wales	/3cm	14	43.3000	1.5232	3.52
5.Weight	gsm	14	210.8571	4.5886	2.18
6.Colour		14	0.0000	0.0000	0.00
7. %	Dye	14	0.0000	0.0000	0.00

Figure 34

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Jet Dyed

Properties Measured After Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Colour	% Dye
1	30.9	2.77	55.8	34.7	219	7	5.6
2	29.6	2.77	55.9	33.9	230	8	8.9
3	29.9	2.75	55.4	34.9	232	8	8.9
4	30	2.76	56.5	34.2	233	8	8.9
5	31.5	2.76	54.7	34.5	210	9	0.1
6	30.3	2.78	54.8	33.7	206	12	1.2
7	29.4	2.74	55.5	34.5	222	13	6.5
8	29.9	2.73	55	34.1	213	14	3.4
9	30.6	2.76	53.2	34.1	212	13	6.5
10	30	2.72	56.8	34.7	228	17	6.5
11	29	2.7	57.6	34.4	236	18	5.4
12	29.4	2.72	53.3	34.4	236	7	5.6
13	31.3	2.81	52.8	35.4	209	19	0.1
14	30.8	2.75	54	34.9	220	21	0.9

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	14	30.1857	0.7472	2.48
2.St.Len	mm	14	2.7514	0.0282	1.03
3.Crses	/3cm	14	55.0929	1.4166	2.57
4.Wales	/3cm	14	34.4571	0.4484	1.30
5.Weight	gsm	14	221.8571	10.6544	4.80
6.Colour		14	12.4286	4.8153	38.74
7. %	Dye	14	4.8929	3.2217	65.84

Figure 35

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Winch Dyed

Properties Measured After Relaxation

Sample	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	Colour	% Dye
1	31.7	2.82	54.2	34.7	217	6	0.01
2	31.2	2.79	56.6	33.7	209	6	0.01
3	31.5	2.8	54.8	33.3	207	6	0.01
4	31.6	2.74	54.1	34	208	11	0.08
5	31.8	2.72	55.8	35.2	193	0	0
6	31.6	2.72	55.7	33.4	206	15	0.04
7	31.9	2.72	54.8	34.8	206	0	0
8	30	2.76	55.7	34.3	219	16	0.01
9	30	2.77	56	33.3	221	9	0.1
10	30.4	2.69	55.3	35.3	218	0	0

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1.Yarn	Ne	10	31.1700	0.7469	2.40
2.St.Len	mm	10	2.7530	0.0419	1.52
3.Crses	/3cm	10	55.3000	0.8097	1.46
4.Wales	/3cm	10	34.2000	0.7732	2.26
5.Weight	gsm	10	210.4000	8.4879	4.03
6.Colour		10	6.9000	5.9151	85.73
7. %	Dye	10	0.0260	0.0360	138.32

Figure 36

FINISHED INTERLOCK FABRICS

Quality FW 1033 : Jet Dyed

Shrinkages After 1 & 5 Cycles

Sample	% LS (1)	% WS (1)	% LS (5)	% WS (5)
1	13.6	11.4	14.8	13.2
2	13.4	9.7	16.3	12.2
3	12.8	13.1	15.6	12.4
4	13.5	12.9	16.3	12.5

*** COLUMNS STATISTICS ***

	N	Mean	SD	CV%
1. % LS (1)	4	13.3250	0.3594	2.70
2. % WS (1)	4	11.7750	1.5777	13.40
3. % LS (5)	4	15.7500	0.7141	4.53
4. % WS (5)	4	12.5750	0.4349	3.46

Figure 37

FINISHED INTERLOCK FABRICS

Quality FW 1007 : Continuous Bleach

Shrinkages After 1 & 5 Cycles

Sample	% LS (1)	% WS (1)	% LS (5)	% WS (5)
1	12.8	15.8	16.4	16.2
2	11.3	14.6	14.9	14.9
3	8.3	17	13.2	17.3
4	13.9	16.1	19.2	15.5
5	11.5	14.8	15.1	14.7
6	9.9	15	16.1	13.3
7	12.7	12.4	18.4	13.6
8	7.9	16.2	12.8	16.6
9	14.5	12.2	19.1	12.9
10	20.3	14.7	25.6	14.1
11	14.1	7.3	17.7	7.9
12	11.3	12.1	15.4	13.3
13	9.4	11.5	17.7	13
14	9.1	13.3	15.1	14

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. % LS	(1)	14	11.9286	3.2288	27.07
2. % WS	(1)	14	13.7857	2.5477	18.48
3. % LS	(5)	14	16.9071	3.2042	18.95
4. % WS	(5)	14	14.0929	2.2615	16.05

Figure 38

FINISHED 1x1 RIB FABRICS

Quality FQ 1007 : Jet Dyed

Shrinkages After 1 & 5 Cycles

Sample	% LS (1)	% WS (1)	% LS (5)	% WS (5)
1	7.5	12.6	8.4	12.7
2	8.3	12.3	8.8	13.4
3	9.3	15.8	10.7	15.3
4	7.8	14.1	8.3	14.2
5	7.6	17.3	7.8	15.7
6	8.6	12	11	15.4
7	8.5	12.9	10.5	13.9
8	6.2	17.1	7.9	17.9
9	7.8	14.5	9	14.4
10	9.2	12.8	11.2	13.2
11	7.1	17.7	8.2	17.4
12	6.9	14.3	9.2	15.9
13	6.1	13.8	9.8	14.8
14	7.9	17.2	10.1	16.7

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. % LS	(1)	14	7.7714	0.9793	12.60
2. % WS	(1)	14	14.6000	2.0479	14.03
3. % LS	(5)	14	9.3500	1.1876	12.70
4. % WS	(5)	14	15.0643	1.5663	10.40

Figure 39

FINISHED 1x1 RIB FABRICS

Quality FQ 1007 : Winch Dyed

Shrinkages After 1 & 5 Cycles

Sample	% LS (1)	% WS (1)	% LS (5)	% WS (5)
1	8.3	11.1	9.2	11.7
2	10	13.8	11.1	14
3	7.2	14.2	7.8	15.2
4	7.8	17.8	8.1	15
5	7.1	14.7	9.6	13
6	9	20	10	19.9
7	12.6	14.5	14.9	13.1
8	9.3	13.2	11.3	14.1
9	10	14.8	11.7	13.3
10	5.3	12.7	8.9	13.7

*** COLUMNS STATISTICS ***

		N	Mean	SD	CV%
1. % LS	(1)	10	8.6600	2.0101	23.21
2. % WS	(1)	10	14.6800	2.5389	17.30
3. % LS	(5)	10	10.2600	2.0972	20.44
4. % WS	(5)	10	14.3000	2.2121	15.47

Figure 40

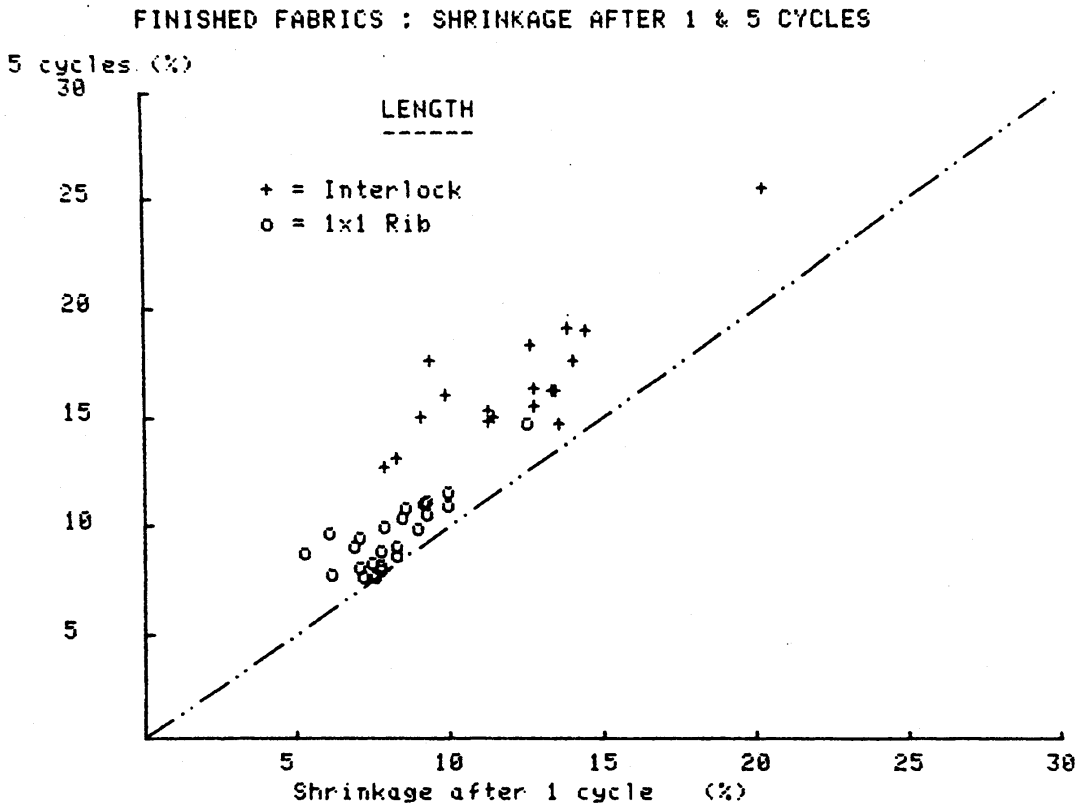

Figure 41

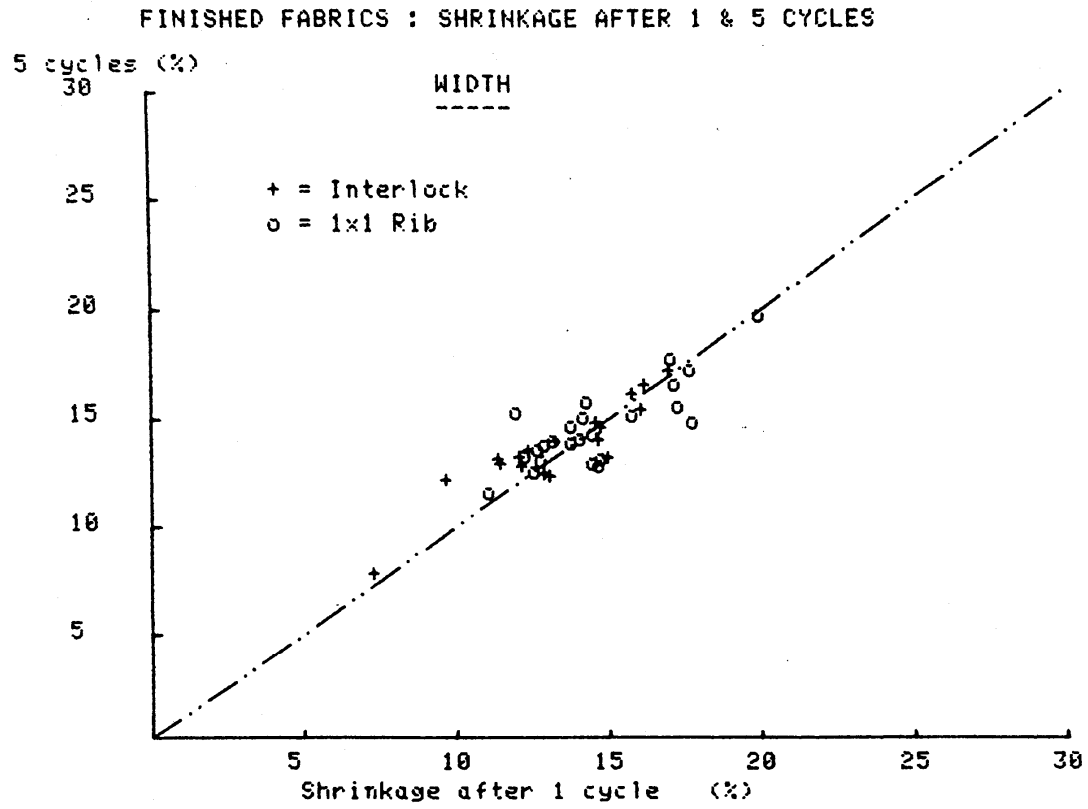

Figure 42

FINISHED INTERLOCK FABRICS

Quality FW 1033 : Jet Dyed

Internal Test-measurement Checks - Before Relaxation

Sample	Width Meas.	Width Calc.	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)
1	51.8	48.7	168	173	160	184	179	47	45.5
2	55.6	55.9	171	168	159	167	170	50.2	51.1
3	60.5	58.6	160	164	155	171	167	48	46.9
4	51.9	52.1	159	163	151	167	163	48.9	47.6

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Relaxed Weight & Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	4	54.9500	4.1008	7.46
2.Width Calc.	4	53.8250	4.3339	8.05
3.Weight Meas.	4	164.5000	5.9161	3.60
4.Weight (1)	4	167.0000	4.5461	2.72
5.Weight (2)	4	156.2500	4.1130	2.63
6.Stches C*W	4	172.2500	8.0571	4.68
7.Stches (3)	4	169.7500	6.8007	4.01
8.Tex.1 Meas.	4	48.5250	1.3598	2.80
9.Tex.1 (4)	4	47.7750	2.3824	4.99

Figure 43

FINISHED INTERLOCK FABRICS

Quality FW 1007 : Continuous Bleach

Internal Test-measurement Checks - Before Relaxation

Sample	Width Meas.	Width Calc.	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)
1	46.6	47.1	150	150	144	149	149	50.4	50.4
2	57	55.1	158	142	156	146	163	48.6	54.1
3	45.1	46.2	164	159	156	154	159	51.4	53.1
4	65.5	65.5	155	168	149	152	140	55.3	51
5	51.6	51.5	157	157	150	152	152	51.7	51.5
6	45.8	46.2	159	156	151	157	160	49.8	50.7
7	55.7	53.3	158	162	145	161	157	50.4	49
8	55.2	53.7	163	173	156	167	157	51.8	48.9
9	55.9	55.5	154	157	148	155	153	50.5	49.5
10	54.8	53.7	141	146	135	142	137	51.3	49.7
11	54.3	53.2	158	167	154	167	159	49.8	47.2
12	55.8	56.1	165	165	154	165	165	49.9	49.9
13	39.8	38.3	171	170	152	164	166	51.6	52
14	56.3	59.3	164	155	155	155	164	50.1	53.1

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Relaxed Weight & Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	14	52.8143	6.4889	12.29
2.Width Calc.	14	52.4786	6.5583	12.50
3.Weight Meas.	14	158.3571	7.3023	4.61
4.Weight (1)	14	159.0714	9.1101	5.73
5.Weight (2)	14	150.3571	5.9434	3.95
6.Stches C*W	14	156.1429	7.8236	5.01
7.Stches (3)	14	155.7857	8.8594	5.69
8.Tex.1 Meas.	14	50.9000	1.5620	3.07
9.Tex.1 (4)	14	50.7214	1.9023	3.75

Figure 44

FINISHED 1x1 RIB FABRICS

Quality FQ 1007 : Jet Dyed

Internal Test-measurement Checks - Before Relaxation

Sample	Width Meas.	Width Calc.	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)
1	42.6	43.5	182	177	175	170	174	52.2	53.6
2	49.3	49.1	185	181	182	165	169	54.7	56
3	47.9	47.5	180	171	175	158	166	54.1	57.1
4	49	49.5	184	185	183	167	167	55.3	55.1
5	41.2	41.7	166	168	163	161	159	52.3	51.6
6	50.7	51.2	161	165	155	156	151	53.1	51.7
7	43.6	43	182	180	171	164	166	54,9	55.3
8	45.1	45.4	173	173	161	158	158	54.7	54.7
9	43.8	44	176	170	165	160	166	53.1	54.9
10	52.5	52.6	186	181	176	169	173	53.6	55.1
11	38.2	37.3	186	190	179	173	170	54.8	53.8
12	66.9	67.3	176	179	180	165	162	54.3	53.4
13	37.8	38.7	162	158	161	154	158	51.4	52.7
14	40.4	40.4	157	172	165	164	150	52.3	47.8

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Relaxed Weight & Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	14	46.3571	7.4849	16.15
2.Width Calc.	14	46.5143	7.5607	16.25
3.Weight Meas.	14	175.4286	10.0744	5.74
4.Weight (1)	14	175.0000	8.4762	4.84
5.Weight (2)	14	170.7857	9.0229	5.28
6.Stches C*W	14	163.1429	5.5727	3.42
7.Stches (3)	14	163.5000	7.4705	4.57
8.Tex.1 Meas.	14	53.6286	1.2356	2.30
9.Tex.1 (4)	14	53.7714	2.3210	4.32

Figure 45

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Winch Dyed

Internal Test-measurement Checks - Before Relaxation

Sample	Width Meas.	Width Calc.	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)
1	40.4	41.6	175	171	174	166	170	51.6	52.7
2	50.8	50.1	156	163	160	157	150	51.8	49.6
3	44.4	44.4	166	165	162	158	159	52	52.5
4	50.4	50.8	162	161	162	158	159	51.1	51.3
5	47.8	47.3	165	165	152	163	163	50.6	50.6
6	41.4	44.2	160	158	149	152	154	52	52.6
7	47	47.5	162	157	152	151	156	52	53.7
8	43.1	41.9	176	180	167	165	161	54.5	53.3
9	43.6	43.2	177	173	169	159	163	54.2	55.6
10	44.5	42.1	182	183	171	170	169	53.8	53.5

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Relaxed Weight & Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Width Meas.	10	45.3400	3.5557	7.84
2.Width Calc.	10	45.3100	3.4001	7.50
3.Weight Meas.	10	168.1000	8.7108	5.18
4.Weight (1)	10	167.6000	8.9094	5.32
5.Weight (2)	10	161.8000	8.6384	5.34
6.Stches C*W	10	159.9000	6.0818	3.80
7.Stches (3)	10	160.4000	6.2574	3.90
8.Tex.1 Meas.	10	52.3600	1.3335	2.55
9.Tex.1 (4)	10	52.5400	1.7057	3.25

Figure 46

FINISHED INTERLOCK FABRICS

Quality FW 1033 : Jet Dyed

Internal Test-Measurement Checks - After Relaxation

Sample	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)	% LS Meas.	% LS (5)	% WS Meas.	% WS (5)
1	216	225	227	237	228	47.3	45.5	14.8	15.4	13.2	8.1
2	216	228	233	227	215	50.2	47.6	16.3	17.1	12.2	11.1
3	210	219	216	228	219	47.9	46	15.6	15.3	12.4	11.8
4	206	220	217	220	206	50	46.8	16.3	14.6	12.5	11

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Weight BW and Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales
(5) Calculated from changes in Courses or Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Weight Meas.	4	212.0000	4.8990	2.31
2.Weight (1)	4	223.0000	4.2426	1.90
3.Weight (2)	4	223.2500	8.1803	3.66
4.Stches C*W	4	228.0000	6.9761	3.06
5.Stches (3)	4	217.0000	9.1287	4.21
6.Tex.1 Meas.	4	48.8500	1.4663	3.00
7.Tex.1 (4)	4	46.4750	0.9215	1.98
8.% LS Meas.	4	15.7500	0.7141	4.53
9.% LS (5)	4	15.6000	1.0614	6.80
10.% WS Meas.	4	12.5750	0.4349	3.46
11.% WS (5)	4	10.5000	1.6391	15.61

Figure 47

FINISHED INTERLOCK FABRICS

Quality FW 1007 : Continuous Bleach

Internal Test-Measurement Checks - After Relaxation

Sample	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)	% LS Meas.	% LS (5)	% WS Meas.	% WS (5)
1	206	217	214	221	210	49	46.6	16.4	17.3	16.2	18.6
2	215	224	218	226	217	49.5	47.5	14.9	16	14.9	23.3
3	218	221	228	226	224	48.7	48.1	13.2	13.4	17.3	21.2
4	218	229	227	222	212	51.5	49	19.2	18.1	15.5	16.6
5	207	214	217	208	202	51.3	49.6	15.1	15.5	14.7	13.5
6	208	215	219	215	207	50.2	48.5	16.1	15.6	13.3	13.4
7	206	215	224	217	208	49.4	47.4	18.4	18	13.6	9.4
8	215	234	224	230	211	51.1	46.8	12.8	13.2	16.6	16.2
9	210	211	219	214	213	49.3	49.1	19.1	16.4	12.9	13.1
10	212	217	221	218	213	49.7	48.6	25.6	24.4	14.1	14
11	203	210	208	220	213	47.8	46.1	17.7	16.8	7.9	8.7
12	210	217	225	220	213	49.3	47.7	15.4	14.6	13.3	12.1
13	212	209	239	215	210	48.7	49.2	17.7	16.2	13	9
14	212	212	225	212	212	50	50	15.1	12.2	14	17

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Weight BW and Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales
(5) Calculated from changes in Courses or Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Weight Meas.	14	210.8571	4.5886	2.18
2.Weight (1)	14	217.5000	7.2616	3.34
3.Weight (2)	14	222.0000	7.3170	3.30
4.Stches C*W	14	218.8571	5.9853	2.73
5.Stches (3)	14	212.3571	5.2125	2.45
6.Tex.1 Meas.	14	49.6786	1.0613	2.14
7.Tex.1 (4)	14	48.1571	1.1830	2.46
8.% LS Meas.	14	16.9071	3.2042	18.95
9.% LS (5)	14	16.2643	2.9343	18.04
10.% WS Meas.	14	14.0929	2.2615	16.05
11.% WS (5)	14	14.7214	4.4035	29.91

Figure 48

FINISHED 1x1 RIB FABRICS

Quality FQ 1007 : Jet Dyed

Internal Test-Measurement Checks - After Relaxation

Sample	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)	% LS Meas.	% LS (5)	% WS Meas.	% WS (5)
1	219	228	228	215	207	52.9	50.9	8.4	9.3	12.7	13
2	230	233	234	211	208	55.3	54.6	8.8	9.8	13.4	13
3	232	233	238	215	214	54.3	54	10.7	16.1	15.3	12.6
4	233	233	234	215	214	54.3	54.3	8.3	9.2	14.2	14.3
5	210	217	214	210	203	51.7	50.1	7.8	7.1	15.7	17.4
6	206	222	214	205	198	54.2	50.2	11	9.7	15.4	16
7	222	234	236	213	202	55	52.2	10.5	9.9	13.9	14.2
8	213	225	229	208	198	53.9	51.1	7.9	7.6	17.9	17.9
9	212	215	226	202	199	53.3	52.6	9	6.2	14.4	15.2
10	228	235	241	219	213	53.5	52.1	11.2	11.1	13.2	13.3
11	236	242	245	220	215	55	53.6	8.2	8.7	17.4	14
12	236	223	230	204	216	54.6	57.9	9.2	5.4	15.9	14.5
13	209	220	211	208	197	53	50.3	9.8	8.1	14.8	19.5
14	220	221	210	209	209	52.7	52.5	10.1	6.9	16.7	15.8

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Weight BW and Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales
(5) Calculated from changes in Courses or Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Weight Meas.	14	221.8571	10.6544	4.80
2.Weight (1)	14	227.2143	7.9438	3.50
3.Weight (2)	14	227.8571	11.4614	5.03
4.Stches C*W	14	211.0000	5.4491	2.58
5.Stches (3)	14	206.0714	8.0715	3.92
6.Tex.1 Meas.	14	53.8357	1.0315	1.92
7.Tex.1 (4)	14	52.6000	2.1626	4.11
8.% LS Meas.	14	9.3500	1.1876	12.70
9.% LS (5)	14	8.9357	2.6093	29.20
10.% WS Meas.	14	15.0643	1.5663	10.40
11.% WS (5)	14	15.0500	2.0587	13.68

Figure 49

FINISHED 1x1 RIB FABRICS

Quality FQ 1007 : Winch Dyed

Internal Test-Measurement Checks - After Relaxation

Sample	Weight Meas.	Weight (1)	Weight (2)	Stches C*W	Stches (3)	Tex.1 Meas.	Tex.1 (4)	% LS Meas.	% LS (5)	% WS Meas.	% WS (5)
1	217	220	218	209	207	52.5	51.9	9.2	9	11.7	12.7
2	209	224	204	212	198	52.8	49.3	11.1	13.4	14	14.2
3	207	213	212	203	197	52.5	51	7.8	8.6	15.2	14.7
4	208	209	207	204	203	51.2	50.9	8.1	7.8	15	16.2
5	193	220	210	218	191	50.5	44.2	9.6	10.2	13	16.8
6	206	210	222	207	203	50.8	49.8	10	8.6	19.9	19.5
7	206	213	219	212	205	50.4	48.6	14.9	15.1	13.1	16.1
8	219	231	231	212	202	54.3	51.6	11.3	11.3	14.1	12.2
9	221	226	231	207	203	54.5	53.3	11.7	12.3	13.3	12.3
10	218	227	231	217	209	52.3	50.3	8.9	7.4	13.7	15.3

(1) Calculated from Tex, St.Length, Courses, & Wales
(2) Calculated from Weight BW and Shrinkages
(3) Calculated from Weight, Tex, & St.Length
(4) Calculated from Weight, Courses, & Wales
(5) Calculated from changes in Courses or Wales

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Weight Meas.	10	210.4000	8.4879	4.03
2.Weight (1)	10	219.3000	7.7179	3.52
3.Weight (2)	10	218.5000	10.2116	4.67
4.Stches C*W	10	210.1000	5.0431	2.40
5.Stches (3)	10	201.8000	5.2451	2.60
6.Tex.1 Meas.	10	52.1800	1.4658	2.81
7.Tex.1 (4)	10	50.0900	2.4723	4.94
8.% LS Meas.	10	10.2600	2.0972	20.44
9.% LS (5)	10	10.3700	2.5764	24.84
10.% WS Meas.	10	14.3000	2.2121	15.47
11.% WS (5)	10	15.0000	2.2944	15.30

Figure 50

FINISHED FABRICS

K3 Model Predictions of Mean Relaxed Dimensions

	FW1033 JDH	FW1007 CBT	FQ1007 JDH	FQ1007 WD2
Yarn Tex				
Measured	14.9	15	19.6	18.9
K3 Model	15	15.3	19.3	18.8
% Diff.	-0.7	-2	1.5	-0.5
St.Length mm				
Measured	3.28	3.31	2.75	2.75
K3 Model	3.34	3.32	2.79	2.78
% Diff.	1.8	0.3	1.5	1.1
Courses/3cm				
Measured	47.2	45.5	55.1	55.3
K3 Model	46.2	44.7	54	54
% Diff.	-2.1	-1.8	-1.6	-1.3
Wales/3cm				
Measured	43.6	43.3	34.5	34.2
K3 Model	43.2	44.2	33	34.2
% Diff.	-0.9	2.1	-4.3	0
Weight gsm				
Measured	212	211	222	210
K3 Model	216	209	208	212
% Diff.	1.9	-0.9	-6.3	1
Calculated Weight *				
Measured	223	217	228	218
K3 Model	222	223	213	215
% Diff.	-0.4	2.3	-6.6	-1.4

* Calculated from Tex, St.Length, Courses, & Wales

A negative difference means Predicted was less than Measured
Model inputs were mean greige Count & Stitch Length

Figure 51

FINISHED INTERLOCK FABRICS

Quality FW 1033 : Jet Dyed

STARFISH Predictions for the Reference State

Sample	Crses Meas.	Crses (1)	Wales Meas.	Wales (1)	Stches C*W	Stches (1)	Weight Meas.	Weight (2)	Weight (3)	Weight (4)
1	49.2	47.9	43.4	44	237	234	216	218	225	221
2	47.4	46.9	43.1	43.2	227	225	216	220	228	226
3	47.6	47.2	43.2	43.8	228	229	210	216	219	220
4	44.4	46.7	44.6	43.3	220	224	206	218	220	224

(1) Calculated from K3 Model Equations
(2) Calculated from K3 Model (Tex/1) Equation
(3) Calculated from Meas. Tex, St.Length, Courses, & Wales
(4) Calculated from K3 Model (S) Equation, Tex & St.Length

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Crses Meas.	4	47.1500	2.0025	4.25
2.Crses (1)	4	47.1750	0.5252	1.11
3.Wales Meas.	4	43.5750	0.6946	1.59
4.Wales (1)	4	43.5750	0.3862	0.89
5.Stches C*W	4	228.0000	6.9761	3.06
6.Stches (1)	4	228.0000	4.5461	1.99
7.Weight Meas.	4	212.0000	4.8990	2.31
8.Weight (2)	4	218.0000	1.6330	0.75
9.Weight (3)	4	223.0000	4.2426	1.90
10.Weight (4)	4	222.7500	2.7538	1.24

Figure 52

FINISHED INTERLOCK FABRICS

Quality FW 1007 : Continuous Bleach

STARFISH Predictions for the Reference State

Sample	Crses Meas.	Crses (1)	Wales Meas.	Wales (1)	Stches C*W	Stches (1)	Weight Meas.	Weight (2)	Weight (3)	Weight (4)
1	45.1	44.4	44.1	43.7	221	216	206	201	217	211
2	45.6	44.6	44.7	43.5	226	216	215	204	224	214
3	44.1	45.6	46.2	43.8	226	222	218	208	221	216
4	45.4	44.4	44.1	42.9	222	212	218	209	229	218
5	45.1	44.2	41.6	43	208	211	207	206	214	216
6	46.2	45.3	41.8	43.3	215	218	208	211	215	219
7	46	44.3	42.5	43.6	217	214	206	201	215	212
8	45.3	44.7	45.6	43.1	230	214	215	209	234	218
9	45.2	44.1	42.6	43.6	214	214	210	199	211	211
10	44.2	43.3	44.4	43.5	218	209	212	195	217	208
11	46.5	43.9	42.6	44.1	220	215	203	193	210	206
12	47.2	44.4	42	43.6	220	215	210	202	217	212
13	45.8	47	42.3	43.9	215	229	212	218	209	222
14	45.8	46.6	41.7	43.4	212	224	212	220	212	224

(1) Calculated from K3 Model Equations
(2) Calculated from K3 Model (Tex/l) Equation
(3) Calculated from Meas. Tex, St.Length, Courses, & Wales
(4) Calculated from K3 Model (S) Equation, Tex & St.Length

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Crses Meas.	14	45.5357	0.8280	1.82
2.Crses (1)	14	44.7714	1.0246	2.29
3.Wales Meas.	14	43.3000	1.5232	3.52
4.Wales (1)	14	43.5000	0.3397	0.78
5.Stches C*W	14	218.8571	5.9853	2.73
6.Stches (1)	14	216.3571	5.3724	2.48
7.Weight Meas.	14	210.8571	4.5886	2.18
8.Weight (2)	14	205.4286	7.8025	3.80
9.Weight (3)	14	217.5000	7.2616	3.34
10.Weight (4)	14	214.7857	5.1617	2.40

Figure 53

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Jet Dyed

STARFISH Predictions for the Reference State

Sample	Crses Meas.	Crses (1)	Wales Meas.	Wales (1)	Stches C*W	Stches (1)	Weight Meas.	Weight (2)	Weight (3)	Weight (4)
1	55.8	54.4	34.7	33	215	200	219	207	228	211
2	55.9	54.7	33.9	33	211	200	230	217	233	221
3	55.4	55.1	34.9	33.2	215	203	232	217	233	220
4	56.5	54.8	34.2	33.1	215	201	233	215	233	219
5	54.7	54.6	34.5	33.1	210	201	210	204	217	208
6	54.8	54.3	33.7	32.9	205	198	206	211	222	215
7	55.5	55.4	34.5	33.2	213	204	222	221	234	225
8	55	55.5	34.1	33.4	208	206	213	218	225	222
9	53.2	54.7	34.1	33.1	202	201	212	210	215	214
10	56.8	55.8	34.7	33.5	219	207	228	218	235	222
11	57.6	56.4	34.4	33.6	220	211	236	228	242	232
12	53.3	55.9	34.4	33.4	204	207	236	223	223	227
13	52.8	53.5	35.4	32.7	208	194	209	201	220	206
14	54	54.9	34.9	33.2	209	203	220	210	221	214

(1) Calculated from K3 Model Equations
(2) Calculated from K3 Model (Tex/l) Equation
(3) Calculated from Meas. Tex, St.Length, Courses, & Wales
(4) Calculated from K3 Model (S) Equation, Tex & St.Length

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Crses Meas.	14	55.0929	1.4166	2.57
2.Crses (1)	14	55.0000	0.7504	1.36
3.Wales Meas.	14	34.4571	0.4484	1.30
4.Wales (1)	14	33.1714	0.2431	0.73
5.Stches C*W	14	211.0000	5.4491	2.58
6.Stches (1)	14	202.5714	4.2916	2.12
7.Weight Meas.	14	221.8571	10.6544	4.80
8.Weight (2)	14	214.2857	7.5185	3.51
9.Weight (3)	14	227.2143	7.9438	3.50
10.Weight (4)	14	218.2857	7.3634	3.37

Figure 54

FINISHED 1×1 RIB FABRICS

Quality FQ 1007 : Winch Dyed

STARFISH Predictions for the Reference State

Sample	Crses Meas.	Crses (1)	Wales Meas.	Wales (1)	Stches C*W	Stches (1)	Weight Meas.	Weight (2)	Weight (3)	Weight (4)
1	54.2	52.9	34.7	33.8	209	198	217	206	220	208
2	56.6	53.6	33.7	34	212	202	209	212	224	214
3	54.8	53.3	33.3	34	203	201	207	209	213	211
4	54.1	54.7	34	34.5	204	209	208	213	209	214
5	55.8	55.1	35.2	34.6	218	211	193	213	220	214
6	55.7	55.1	33.4	34.6	207	212	206	215	210	215
7	54.8	55.1	34.8	34.6	212	211	206	213	213	213
8	55.7	54.5	34.3	34.2	212	207	219	223	231	225
9	56	54.3	33.3	34.1	207	205	221	222	226	224
10	55.3	56.1	35.3	34.8	217	216	218	226	227	226

(1) Calculated from K3 Model Equations
(2) Calculated from K3 Model (Tex/1) Equation
(3) Calculated from Meas. Tex, St.Length, Courses, & Wales
(4) Calculated from K3 Model (S) Equation, Tex & St.Length

*** COLUMN STATISTICS ***

	N	Mean	SD	CV%
1.Crses Meas.	10	55.3000	0.8097	1.46
2.Crses (1)	10	54.4700	0.9730	1.79
3.Wales Meas.	10	34.2000	0.7732	2.26
4.Wales (1)	10	34.3200	0.3393	0.99
5.Stches C*W	10	210.1000	5.0431	2.40
6.Stches (1)	10	207.2000	5.6529	2.73
7.Weight Meas.	10	210.4000	8.4879	4.03
8.Weight (2)	10	215.2000	6.4256	2.99
9.Weight (3)	10	219.3000	7.7179	3.52
10.Weight (4)	10	216.4000	6.2752	2.90

Figure 55

FINISHED FABRICS

Matching of As-delivered Dimensions

Comparison of VARMIL & WVAR Models

	Yarn Ne	St.Len mm	Crses /3cm	Wales /3cm	Weight gsm	% Shr. Length	% Shr. Width
FW 1033 JD/JDH							
Measured	39.6	3.28	39.8	39	165	15.8	12.6
1	39.1	3.33	39.5	38.7	171	14.5	9.4
2	39.6	3.31	38.5	38.3	166	15.1	11.1
3	38.9	3.34	39.1	38.3	166	15.3	10.4
4	39.6	3.31	39.5	38.3	164	14.9	11
FW 1007 CB/CBT							
Measured	39.3	3.31	38.1	36.9	158	16.9	14.1
1	38.7	3.32	37.8	37.2	158	15.4	14.8
2	38.3	3.31	37.8	37.2	159	15.6	14.6
3	38.7	3.31	37.9	37.4	155	15.2	14.2
4	38.3	3.31	37.7	37.4	155	15.9	14
FQ 1007 JD/JDH							
Measured	30.2	2.75	50.1	29.3	175	9.3	15.1
1	30.3	2.78	49.8	28.4	171	7.3	13.2
2	31.1	2.76	49.8	28.4	165	8.3	13.9
3	30.4	2.8	49.3	28.4	168	8.1	13.1
4	31.1	2.76	50.2	28.7	167	7.6	13.1
FQ 1007 WD/WB							
Measured	31.2	2.75	49.6	29.1	168	10.3	14.3
1	31.6	2.67	50	29.6	164	10.6	14.3
2	31.1	2.76	49	29	166	8.8	13.7
3	31.6	2.73	49.3	29.3	163	9.2	13.4
4	31.1	2.76	48.8	29.1	165	9.2	13.2

Model No. 1 = VARMIL-C
2 = VARMIL-98
3 = WVAR
4 = WVAR-98