Management of Quality in Finishing Part 1: Basic Principles

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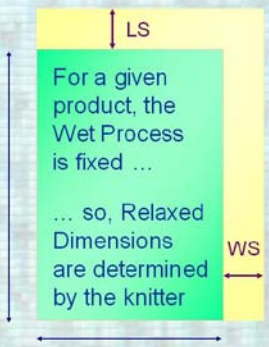
The Finisher's Dilemma



Delivered Dimensions (Weight & Width) are fixed by the Customer

Therefore SHRINKAGE is pre-determined

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The Finisher Needs Knowledge

He must discover:

For every fabric quality …

- what are the Reference Dimensions?

For every customer specification …

- is it attainable with the available equipment?

For every wet process route …

- how does it affect the Reference Dimensions?

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Check Customer Specification

Example:

Interlock: 38 Ne, 3.38 mm, 1500 needles

- Finished weight 165 gsm
- Finished width 60 cm
- Maximum shrinkage 12 %

STARFISH predicts

- Length shrinkage 16 %
- Width shrinkage 13 %

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Know Your Fabrics

Communication is vital

- Ensure grey fabric properly specified
- Ensure conformity to specification
- Agree attainable finishing targets
- Keep informed about grey fabric changes

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Know Your Process

Changing the Conditions
of
Wet Processing
can
Change the Reference Dimensions

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Wet Process Monitoring

Correct Finishing Targets

Finishing Control targets ...
are Courses and Width (only)

If we can QUANTIFY ...
the effect of the wet process

Then we can CALCULATE ...
the correct Finishing Targets

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Effect of Wet Processing

Can be determined by

- STARFISH
- CALIBRATION

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STARFISH vs Measured Values

If *average* measured values do not correspond to STARFISH predictions, then ...

- Grey fabric quality
- Relaxation procedure
- Wet process effect

are not as specified

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Nevertheless There Should Be

A constant offset
... averaged over a period

Provided that
... basic conditions are constant

Therefore
... the process can be calibrated

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Every Wet Process Route

Should be calibrated
... to check the level of agreement with STARFISH predictions

... to monitor process weight losses

... to be able to deal with fabrics not included in STARFISH

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Basic Calibration Principle

- Monitor Reference Dimensions
- Set up Control Charts
- Create a UDP for STARFISH

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Basic Calibration Method

Sample a series of grey rolls
- Confirm knitting specification
- Normal dyeing and finishing

Sample the same rolls
- Reference Relaxation procedure
- Measure Courses, Wales, Weight

Repeat at regular intervals

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Accurate Calibration Allows

- Easier dialogue with customer
- Better relationship with knitter
- Accurate finishing targets
- Better (simplified) process control
- Reduced cost of quality control

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Accurate Finishing Targets

For an average shrinkage of 5%

If Reference Courses are C

- Control Target Courses are 0.95 * C

If Reference Wales are W

- Control Target Wales are 0.95 * W
- Width = Needles / Wales

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Better (Simplified) Process Control

It is not sensible to attempt to control weight and shrinkages independently

All of the random manufacturing variances are reflected in variation of weight and shrinkage

Random variation in the final product is minimised by tight control of *only* Courses and Width

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Reduced Cost of Quality Control

If the process is properly calibrated ...

it is not necessary to make routine tests for weight and shrinkage, because ...

If Courses and Width are held constant at the target level, then Weight and Shrinkage must be correct

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Reduced Cost of Quality Control

Example:

Computer print-outs of routine QC data were obtained from a large US manufacturer.

One quality is produced in a range of sizes.

A process calibration was deduced from the QC data for one of the sizes

For the other sizes, QC data were simulated using only the measured values for Courses and Width

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QC Data Simulation: Averages

	Len Shr. %		Wid Shr. %		Weight gsm	
Size	Meas	Calc	Meas	Calc	Meas	Calc
16	3.5	3.9	5.1	3.9	144	144
17	4.4	4.4	4.6	3.9	144	143
18	2.2	1.1	8.5	9.5	144	142
19	3.0	3.5	6.8	6.6	142	141
20*	3.0	2.5	6.9	7.4	142	141
21	5.1	4.5	5.8	5.9	141	140

* Measured Courses and Width data from 20 inch size used for calibration

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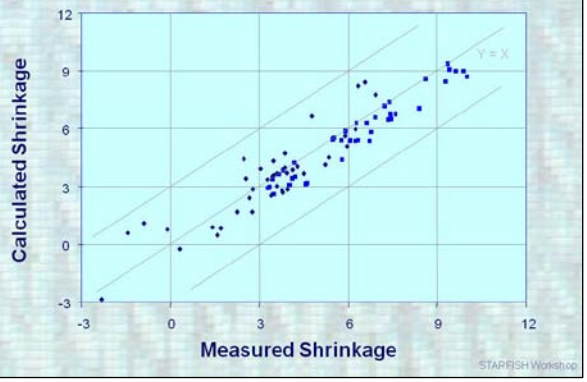
Simulated Shrinkage Data: Individuals



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Fabrics Outside STARFISH

Calibration also allows calculation of:

- Finishing Factors
- Calibration Ratios

Which can be used for some fabrics
that are outside the scope
of the STARFISH predictions

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Finishing Factors

For a given fabric quality, the ratio
Grey Reference / Finished Reference
will be more or less constant
for both
Courses and Wales

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Finishing Factors: Method

Sample a series of grey rolls

- Reference Relaxation procedure
- Measure Courses and Wales
- Normal dyeing and finishing

Sample the same rolls

- Reference Relaxation procedure
- Measure Courses and Wales

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Finishing Factors: Calculation

	Grey	Finished
Reference Courses	Cg	Cf
Reference Wales	Wg	Wf

$$FFc = Cf / Cg$$

$$FFw = Wf / Wg$$

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Using Finishing Factors

Example:
Single piqué, 1/20 Ne, 3.00 mm

	Grey	Finished	FF
Reference CPI	80.2	71.9	0.896
Reference WPI	26.3	26.3	0.998

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New Single Piqué Quality

Measured	CPI = 78.2
Grey Reference	WPI = 25.5
Calculated	78.2 * 0.896 = 70.1
Finished Reference	25.5 * 0.998 = 25.4
Finishing Targets	70.1 * 0.95 = 66.6
(5% shrinkage)	25.4 * 0.95 = 24.1

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Limitations of Finishing Factors

Finishing Factors can be applied

- Only to closely similar fabrics
- Because of proportioning errors

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Calibration Ratios

For a given fabric quality, the ratio

STARFISH Prediction / Finished Reference

will be more or less constant

for both

Courses and Wales

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Calibration Ratios: Calculation

	Finished	STARFISH
Reference Courses	Cf	Cs
Reference Wales	Wf	Ws

$$CRc = Cf / Cs$$

$$CRw = Wf / Ws$$

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Using Calibration Ratios

Example:
Three-thread fleece from Plain Single Jersey

	Measured (3TF)	STARFISH (PSJ*)	CR
Reference C/cm	14.9	14.3	1.04
Reference W/cm	10.0	10.4	0.96

*NB: PSJ prediction is made using sum of 3TF ground and tie Yarn Tex and mean of 3TF ground and tie Stitch Length

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New Fleece Fabric Quality

Predictions for Finishing Targets (PSJ*)

Courses /cm = 15.0

Tubular width = 72 cm

Actual Finishing Targets (3TF)

C /cm = 15 * 1.04 = 15.6

Width = 72 / 0.96 = 75.0

*NB 1: PSJ prediction is made using sum of 3TF ground and tie Yarn Tex and mean of 3TF ground and tie Stitch Length

*NB 2: A weight correction will be required (see text)

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Versatility of Calibration Ratios

Calibration Ratios can be applied

- Across a wide range of qualities
- Across certain fabric types
- Across processing routes

Because proportioning errors are small

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Process Weight Loss

Cotton fabrics lose weight
during scouring and bleaching

Cotton fabrics gain weight
during dyeing and finishing

The net result is
Process Weight Loss

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Process Weight Loss

If good Calibration records are kept ...

Process Weight Loss can be calculated
from the average weight per loop
in grey and finished fabrics

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Average Weight per Loop

$$\text{Fab Wt} = C * W * \text{tex} * \text{loop length} * F$$

number of loops | weight per loop | scaling factor

Grey fabric

$$\text{Loop Wt (g)} = \text{tex} * \text{loop length}$$

Finished fabric

$$\text{Loop Wt (f)} = \text{Fab Wt} / (C * W * F)$$

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Net Weight Change Percent

$$100 \cdot \frac{(\text{Loop Wt (g)} - \text{Loop Wt (f)})}{\text{Loop Wt (g)}}$$

Requires good data for accurate results

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Process Weight Loss: Example

Interlock: Ne 38, SL 3.38 mm – Continuous bleach
Grey Fabric: Ne 37.65, 3.382 mm, Loop Wt = 0.530

Bleached	C /3cm	W /3cm	Wt gsm	Loop Wt	Loss %	Run Mean
1	37.3	35.9	150	0.504	5.03	5.03
2	38.3	34.3	143	0.490	7.56	6.29
3	38.2	36.4	159	0.514	3.07	5.22
4	37.2	36.8	155	0.511	3.68	4.84
5	38.1	36.0	158	0.517	2.60	4.39
6	39.0	36.2	156	0.498	6.09	4.67
7	37.7	38.5	162	0.504	5.07	4.73
8	39.3	38.2	173	0.518	2.38	4.44
9	37.8	37.0	157	0.505	4.87	4.48
10	33.4	38.2	146	0.513	3.21	4.36
11	38.7	38.9	167	0.498	6.11	4.52
12	40.3	36.9	165	0.499	5.96	4.64
13	38.4	38.5	170	0.516	2.71	4.49
14	40.2	34.6	159	0.515	3.00	4.38

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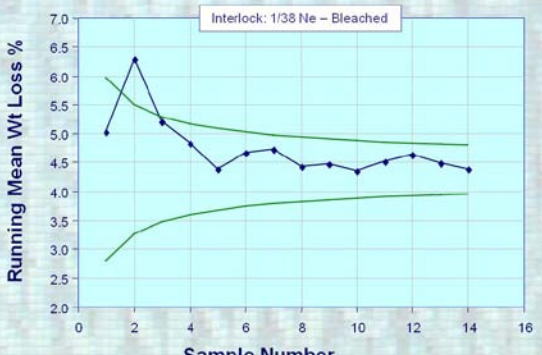
Weight Loss: Running Mean



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Weight Loss: Running Mean
1x1 Rib: 1/30 Ne – Jet dyed
Running Mean Wt Loss %
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
14
16
Sample Number
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