

**STARFISH Technology  
Introduction and Overview**

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**Manufacturers of Cotton Knits**

Are faced with

- Intensified global competition
- Demands for better quality and reliability

One of the key demands is

- Ever lower levels of potential shrinkage

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**Achieving Low Shrinkage Levels**

Is not the main problem

Low shrinkage has to be combined with

- A specific fabric width
- A specific area weight
- Consistency between deliveries

Finding the right combination of materials, machine settings, and processing conditions is not always a simple matter

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### An Important Consequence

Of lowered maximum shrinkage levels

Is a drastic reduction in the possible margin for errors

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### Margin For Error

The diagram illustrates the relationship between fabric dimensions and shrinkage. It shows a vertical bar representing fabric dimensions, divided into three sections: 'after dyeing' (top), 'customer allowance' (middle), and 'plant capability' (bottom). A 'margin' is indicated by two yellow arrows pointing upwards from the 'plant capability' section. To the left, 'longer length' is associated with 'higher shrinkage' and 'lower weight', while 'shorter length' is associated with 'lower shrinkage' and 'higher weight'. A central box states 'weight and length shrinkage controlled by adjusting the length', and a bottom box notes 'width is fixed'. A callout box on the right states 'Allowed weight and length shrinkage must lie within this region'.

longer length  
> higher shrinkage  
> lower weight

shorter length  
> lower shrinkage  
> higher weight

width is fixed

weight and length shrinkage controlled by adjusting the length

Allowed weight and length shrinkage must lie within this region

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### Traditional Methods

Of Product Development & Quality Control are no longer adequate

- \* They are too slow
- \* They are too unreliable
- \* They are too costly

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### Modern Quality Management

“Right First Time and Every Time”

Products have to be engineered

- for specific performance requirements

Performance has to be guaranteed by

- strict specification of materials
- continuous control of processes

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### Shrinkage - Definition

Shrinkage Sample

Original Dimensions  $L_o, X_o$

Relaxed Dimensions  $L_r, X_r$

$LS = 100 \cdot (L_o - L_r) / L_o$

$WS = 100 \cdot (X_o - X_r) / X_o$

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### Shrinkage Measurement

Is not very useful for process control

Large quantities of fabric can be processed during the time it takes to measure shrinkage

We need an on-line measurement

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### Fabric Dimensions

Are a reflection of stitch density

- \* Length is inversely proportional to the density of Courses ( CPI, C/cm )
- \* Width is inversely proportional to the density of Wales ( WPI, W/cm )

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### It Follows That

Shrinkage can be calculated

From differences in the densities of Courses and Wales in the Original and Relaxed fabrics

$$LS = 100 \cdot (Cr - Co) / Cr$$

$$WS = 100 \cdot (Wr - Wo) / Wr$$

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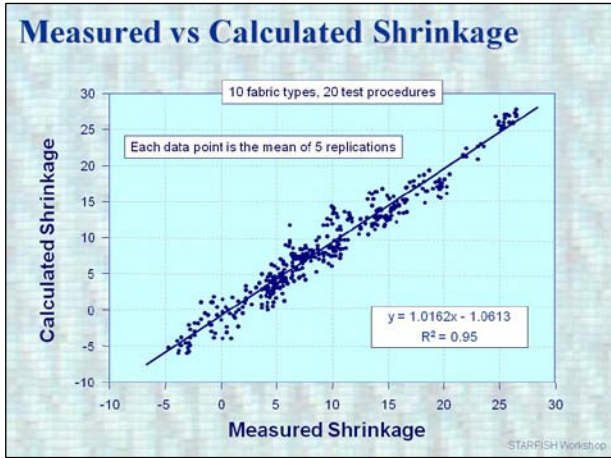
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### For a Fixed Fabric Width

In the as-delivered fabric

There is a fixed number of Wales per cm depending on the knitting machine that was used to make the fabric

$$\text{Wales / cm} = \text{Needles / Width}$$

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### Fabric Area Weight

Can also be calculated ...

The number of loops per unit area multiplied by the weight of each loop

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

↓
↓  
 number of loops                      weight per loop

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### For a Fixed Area Weight

and a given fabric construction

If the fabric width is fixed then the fabric length is also fixed

Therefore the number of Courses per cm is also fixed

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### Control of Fabric Dimensions

by the dyer and finisher

- Can be achieved by controlling the density of Courses and Wales
- Wale density is easily controlled through the fabric width
- Control of Course density requires electronic sensors & feedback control at the final finishing machine

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### The First Requirement



Is that the Relaxed Dimensions must be appropriate for the target Weight & Width and Shrinkages

Relaxed Dimensions can be predicted

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### Relaxed Fabric Dimensions

Are determined by

- Knitting variables
  - average loop length
  - yarn specification
  - size of knitting machine
- Wet processing type
  - preparation / dyeing machinery
  - loading / speed / tension
  - depth of shade

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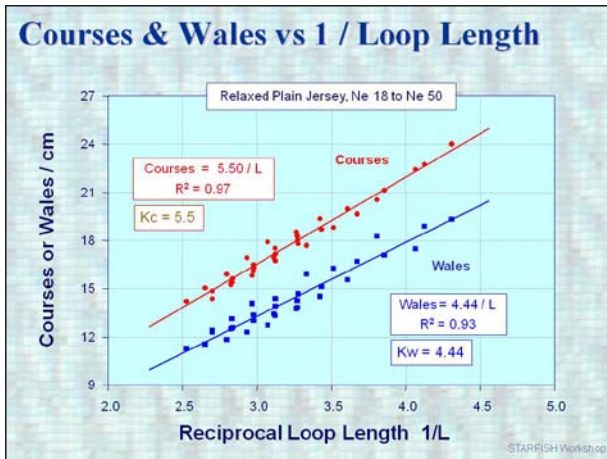
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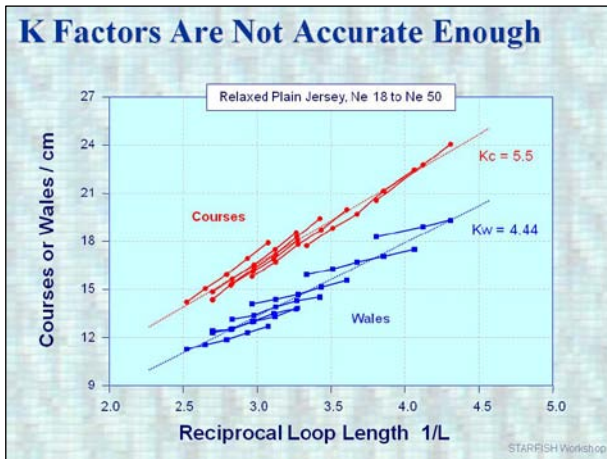
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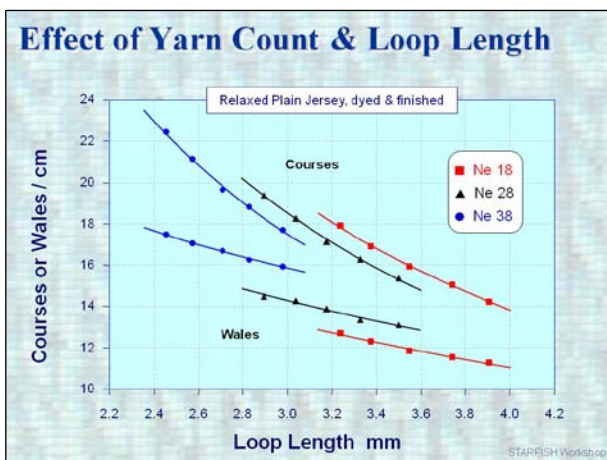
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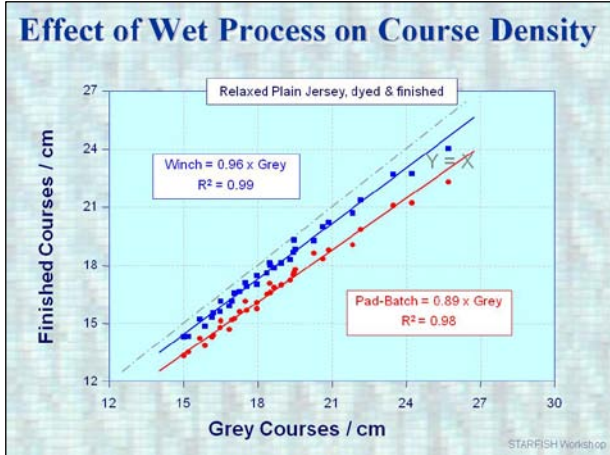
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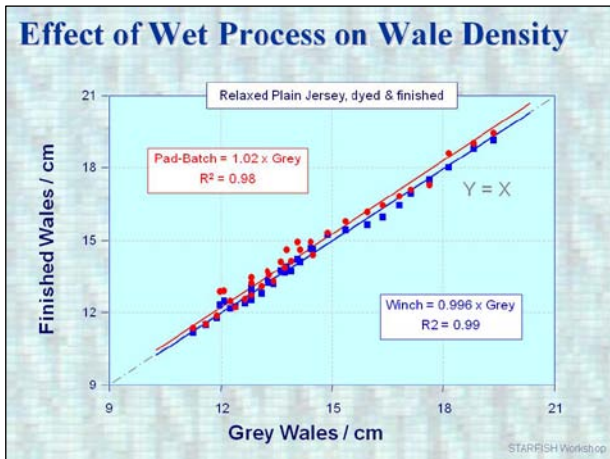
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**The Finisher Can Deliver**

Either  
The target Weight and Width

Or  
The target Length and Width Shrinkages

He can not control all four simultaneously

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**Practical Process Control**

The Finisher should concentrate  
on controlling only two parameters

Width and Course Density

Ideally, the final finishing machine  
should be equipped with electronic sensors  
to monitor and adjust the Course Density

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**The Knitter Must Ensure**

The basic fabric construction is properly  
specified and manufactured so that ...

When the target Courses and Width  
are actually delivered by the Finisher ...

Then the Weight and Shrinkages  
will also be correct

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### Low Shrinkage By Design

Requires

- \* Correctly engineered fabric
  - yarn quality and knitting conditions
- \* Appropriate finishing targets
  - course density and width
- \* Automatic control of machinery
  - sensors for course density

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### Correctly Engineered Fabric

Is an indispensable requirement

The basic Fabric Dimensions are

- \* Subject to strict mathematical rules ...  
that govern the relationships between  
weight, width, and shrinkage
- \* Predetermined by the knitter ...  
and modified by the wet process

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### The Manufacturer Must be Able

- \* To check for himself  
that the fabric is correctly engineered
- \* To calculate  
the proper finishing targets

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### STARFISH Simulation Program

Enables the manufacturer to make

- \* Generalised predictions of weight, width and shrinkage assuming average conditions
- \* Individual calibrations for particular conditions existing in a given dyeing and finishing plant

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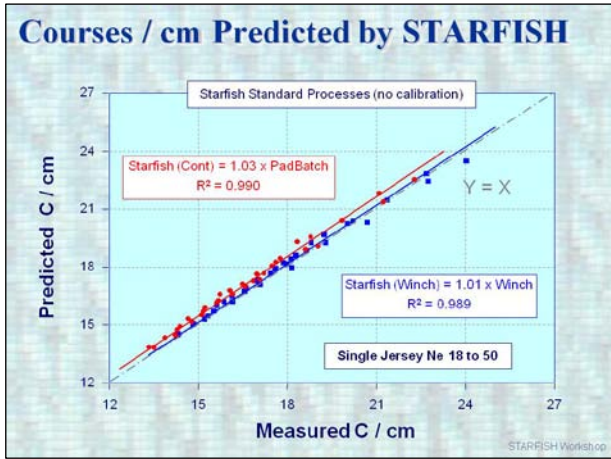
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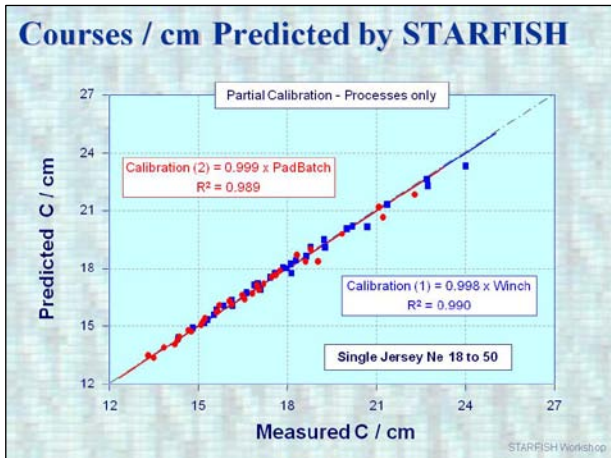
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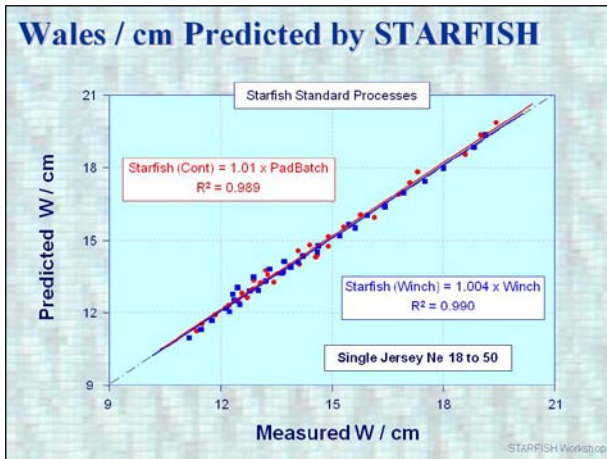
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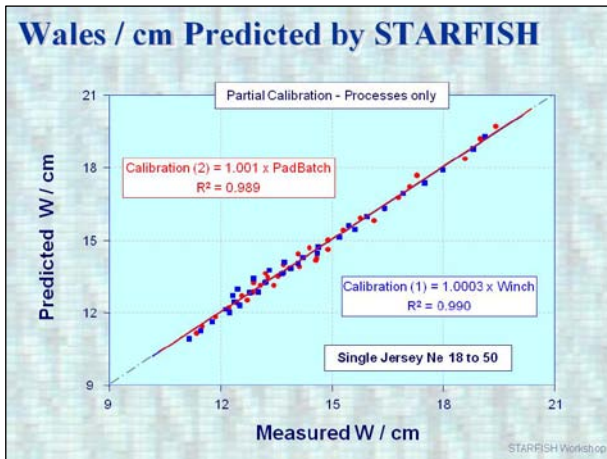
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### Computer Program is a Good Start

But we also need

- \* Good quality assurance procedures ...  
targeted on key control variables
- \* Latest finishing technology ...  
and corresponding know-how

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### Targeted Quality Assurance

STARFISH predictions are averages

Variation must be contained by systematic control of ...

- raw materials
- key production parameters

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### Finishing Technology

STARFISH sets the Targets  
but the FINISHER  
has to achieve them

He needs the latest equipment and know-how

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### The Total STARFISH System

Fabric Engineering by Computer

Targeted Quality Assurance

Application Know-how



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