Management of Quality in Knitting

Part 2: Specification & Control

Management of Quality in Knitting

- Identify key control parameters
- Establish appropriate specifications
- Identify potential sources of variation
- Establish reliable monitoring procedures

Variations in grey fabric
cannot be eliminated during finishing

Key Control Areas

For Each Fabric Quality

- Yarn Quality
  type, count, twist
- Average Stitch Length

these determine the Reference Dimensions

Yarn Quality

- Fibre Quality
- Yarn Type
- Count & Count Variation
- Twist & Twist Variation
- Irregularity & Imperfections
- Strength & Strength Uniformity
- Friction

Yarn Specification

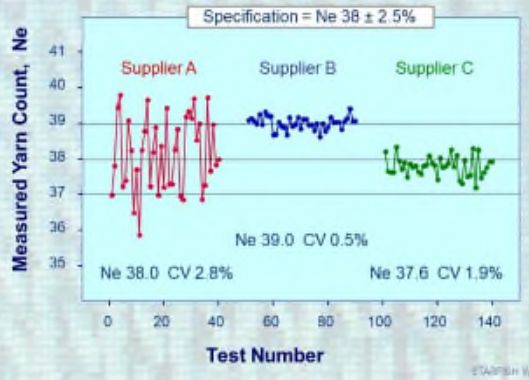
- Yarn properties are inter-dependent
- Low variation is often more important than high mean values
- High quality usually means high price
- Consider the end product

Control of Yarn Quality

Difficult for the knitter

- Depends on reliability of ALL suppliers
- Good relationships essential
- Quality checks must be installed

Yarns from Different Spinners



Effect of Yarn Count Variation

Fabric: Interlock 20g 30d 1884n
Knit Spec: Ne 1/38, SL 3.4 mm
Process: Winch-jet: Mid Tension, White
Finish Spec: 14.5 c/cm, 68 cm tub (200 gsm)

Variation due to Yarn Count only

Weight, gsm	195 to 207
Length Shr.%	-4.4 to -5.5
Width Shr.%	-4.4 to -6.0

No allowance for variation in SL or Processing

Yarn Count Variation

If fabrics finished to the same weight and width

Range in Length Shrinkage increases to between -1.6% and -8.5%

Variation in Ne between deliveries of ± 3% is not unusual

For Ne 38, range is Ne 39.14 to Ne 36.86

Actual range was Ne 39.2 to Ne 36.9

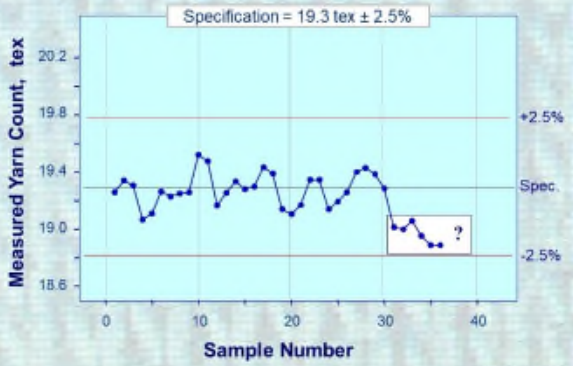
Monitoring Yarn Quality

- Obtain test data from ALL suppliers
- Identify and check EACH delivery for count, twist & friction before knitting
  NB moisture content
- COMPARE with agreed Specification
- Establish PROCEDURES for out of tolerance deliveries

Monitoring Yarn Quality

- Use charts to monitor suppliers
- Establish NORMAL variation for each supplier over time
- Establish appropriate tolerances
- Establish guide-lines for action
- Communicate results to suppliers

Monitoring Yarn Count



Control of Yarn Quality

New Suppliers

should get more stringent checking

until their reliability is proved

Control of Yarn Quality

Finally

- Pay attention to yarn storage
  e.g. temperature and relative humidity
- Check for damaged cones or boxes
- NEVER MIX LOTS

Good Yarn Makes Good Fabric

- Lowest price is seldom the lowest cost
- Dependability of supply is valuable
- Consistency is important
- Limit the number of suppliers

Knitting Specification

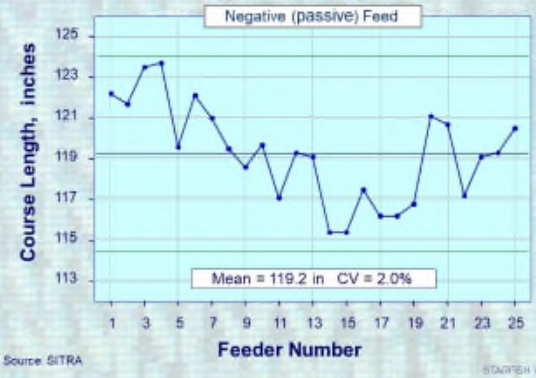
For each quality on each knitting machine the key production control parameters are

- Course Length (SL * Needles)
  - determines reference dimensions
- Courses per Roll (revs * feeders)
  - determines roll length & weight

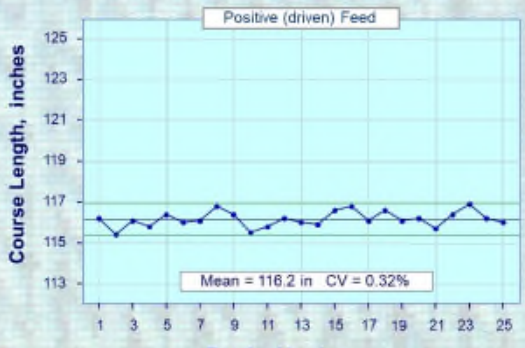
Control of Course Length

- Positive (driven) Feed
- Instrumentation
- Control Procedures

Variation Between Feeders



Variation Between Feeders

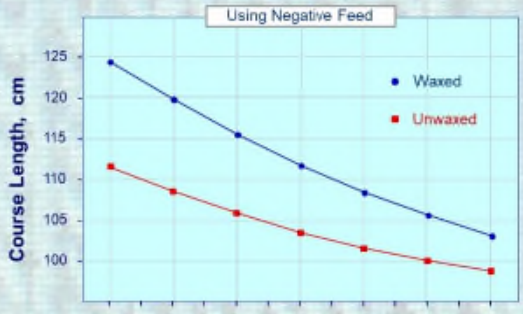


Control of Course Length

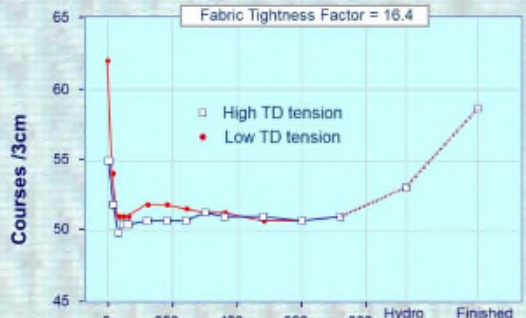
Yarn input tension and take-down tension

- Can influence knitting efficiency and fabric appearance therefore proper control is important
- But they do not affect stitch length provided positive feed is used

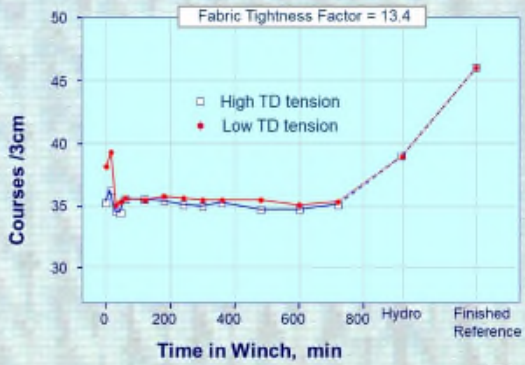
Effect of Yarn Input Tension



Effect of Take-down Tension



Effect of Take-down Tension



Control of Course Length

Positive Feed alone is not enough

Accurate setting of positive feed drives is needed

Drive wheel markings not accurate enough

Modern systems should be more accurate

Control of Course Length

Positive Feed alone is not enough

- Accurate setting of positive feed drives
  – drive wheel markings are not accurate enough

- Regular Maintenance
  – wax and fly contamination

- Independent Checks
  – using appropriate instrumentation

Course Length Instruments: Examples

Direct length per revolution measurement

- Wesco (Memminger-IRO)
- Unilength (Meiners-del)
- Schmidt LMC

Course Length Instruments: Examples

Indirect and integral systems

- SDL yarn length & speed meter
- Decotex (Memminger-Iro)
- Intus (Mayer & Cie)
- Knit Master (Barco)

Course Length Instruments

- Check Results by measuring stitch length of yarns taken from fabric
- Calibrate Instruments on a regular basis
- Establish Accuracy and Variability using Control Charts

Course Length Instruments: Variation

Course Length & Needles

- Number of needles can vary between different makes and models
- Stitch Length depends on Course Length
  SL = Course Length / Needles
- Needles must also be specified when Course Length is the Control Parameter
- Fabric Width depends on No. of Needles
  Width = Needles / Wales

Variation in Cylinder Needles

SJ 30" Diam, 20 Gg	Needles	% Diff
Theoretical	1884	
Falmac "B" Series	1848	-1.9
Monarch VXC-73S	1860	-1.3
Pai Lung FS3A/T	1872	-0.6
Vanguard 1SJ4	1920	+1.9

Course Length & Stitch Length

- Use Course Length to set-up and control production on individual machines

CL may be different, depends on needles

- Use Stitch Length to specify quality and compare production across all machines

Stitch Length should be the same on all

Monitoring Stitch Length

Stitch Length Variation

Fabric: 1 x 1 Rib 14g 20d 876n
Knit spec: Ne 1/30, SL 2.82 mm
Process: Winch-jet: Mid tension, Medium
Finish spec: 17.6 c/cm, 41 cm tub, 200 gsm

Variation due to Stitch Length only

Weight, gsm	194 to 206
Length Shr%	-0.8 to -8.1
Width Shr%	-5.1 to -9.6

No allowance for variation in Ne or Processing

Control of Course Length

Prevention better than Cure

Check average CL before production and record the results

- establish variation between feeders
- establish variation between machines
- determine minimum number of feeders to be checked

Control of Course Length

Making Measurements

- Regular checks throughout production to ensure the quality is maintained
- Record results so that average values and the variation can be monitored
- Calculate Standard Deviation of means for each machine, quality & yarn lot

Control of Course Length

Frequency of Checking

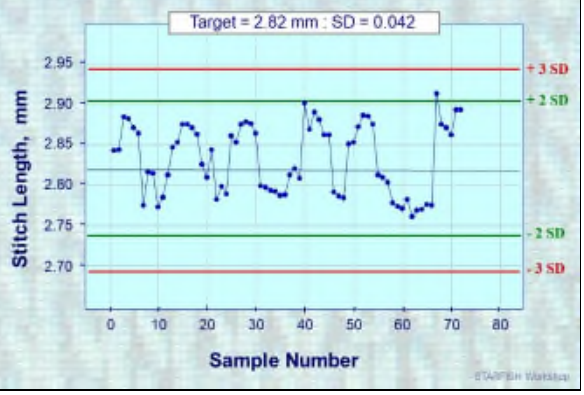
- Initially may need to be intensive until true variation established
- Reduction only with clear proof
- Increase frequency after maintenance, new parts, new yarn lot
- Effective monitoring will quickly detect deterioration or drift

Control of Course Length

Tolerances and Control Limits

- Must be Realistic and Achievable
- Optimum levels take time to establish
  - Normal Tolerance is ± 2 SD
    95 in 100 within Normal Tolerance
  - Action Tolerance is ± 3 SD
    1 in 300 outside Action Tolerance

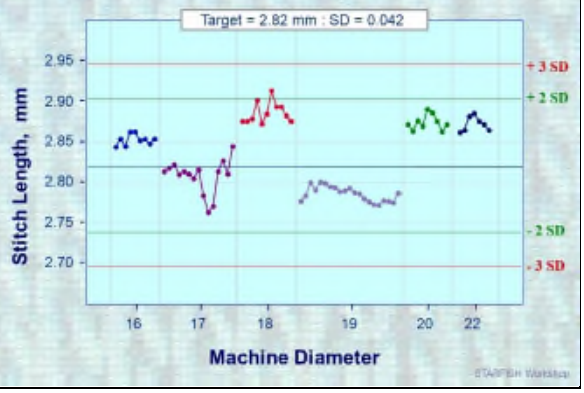
Monitoring Stitch Length



Control of Course Length

- Practical Control Tolerances (± 3 SD)
  - reflect current capabilities
  - closer tolerances do not improve control
- If Practical Tolerances are too high
  - first identify and reduce variation
  - then calculate new tolerances

Monitoring Stitch Length



Stitch Length Sorted by Machine

Diam	SL mm	SD	CV%
16	2.850	0.007	0.25
17	2.806	0.021	0.76 ?
18	2.884	0.013	0.45
19	2.785	0.010	0.35
20	2.873	0.011	0.39
22	2.785	0.009	0.31
all data	**2.832**	**0.042**	**1.49**

Control of Course Length

- Maintain a Consistent Standard
- Check on-line instrumentation regularly
  - internal lab measurements of SL
  - external calibration
  - monitor using Control Charts
- QC independent from production

Control of Roll Weight and Length

- Consistent roll Weight
  - planning, monitoring & control
  - storage & handling
  - easy composition of dyelots
- Consistent roll Length
  - improves lay planning
  - reduces cutting waste
  - reduces costs

Both can be accurately controlled based on Yarn Count & Course Length

Roll Weight and Yarn Tex Count

Roll Weight (kg) =

$$\text{tex} * \text{CL(cm)} * \text{feeders} * \text{revs} * 10^{-8}$$

therefore

$$\text{tex} = \frac{\text{roll weight (kg)} * 10^{8}}{\text{CL(cm)} * \text{feeders} * \text{revs}}$$

$$\text{tex} = \frac{590.54}{\text{Ne}} \qquad \text{Ne} = \frac{590.54}{\text{tex}}$$

Roll Length

Roll Length = Total Courses / Course Density

Total Courses = Feeders * No. of Revs

- Knitting Control Parameter = Revs
- Use *finished* Course Density to calculate total courses to knit
- Don't forget construction effects e.g. Two-thread fleece

Quality Checks on Grey Fabric

Grey (machine state) dimensions are

- Unstable
- Unreliable

They are influenced by

- Take-down tensions
- Stretcher board settings

which do not affect Reference Dimensions

Quality Checks on Grey Fabric

- Grey area weight
  is NOT a reliable check of fabric quality
- Roll Weight
  can be useful, but only if
  - Course length is accurately controlled
  - Exact no of courses is known