Engineering the performance of wool knitwear for softness and appearance retention

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What's behind the title?

- Judicious raw material selection
- Suitable processing sequence and conditions
- Application of quality and process control measures

What is the result of getting it right?

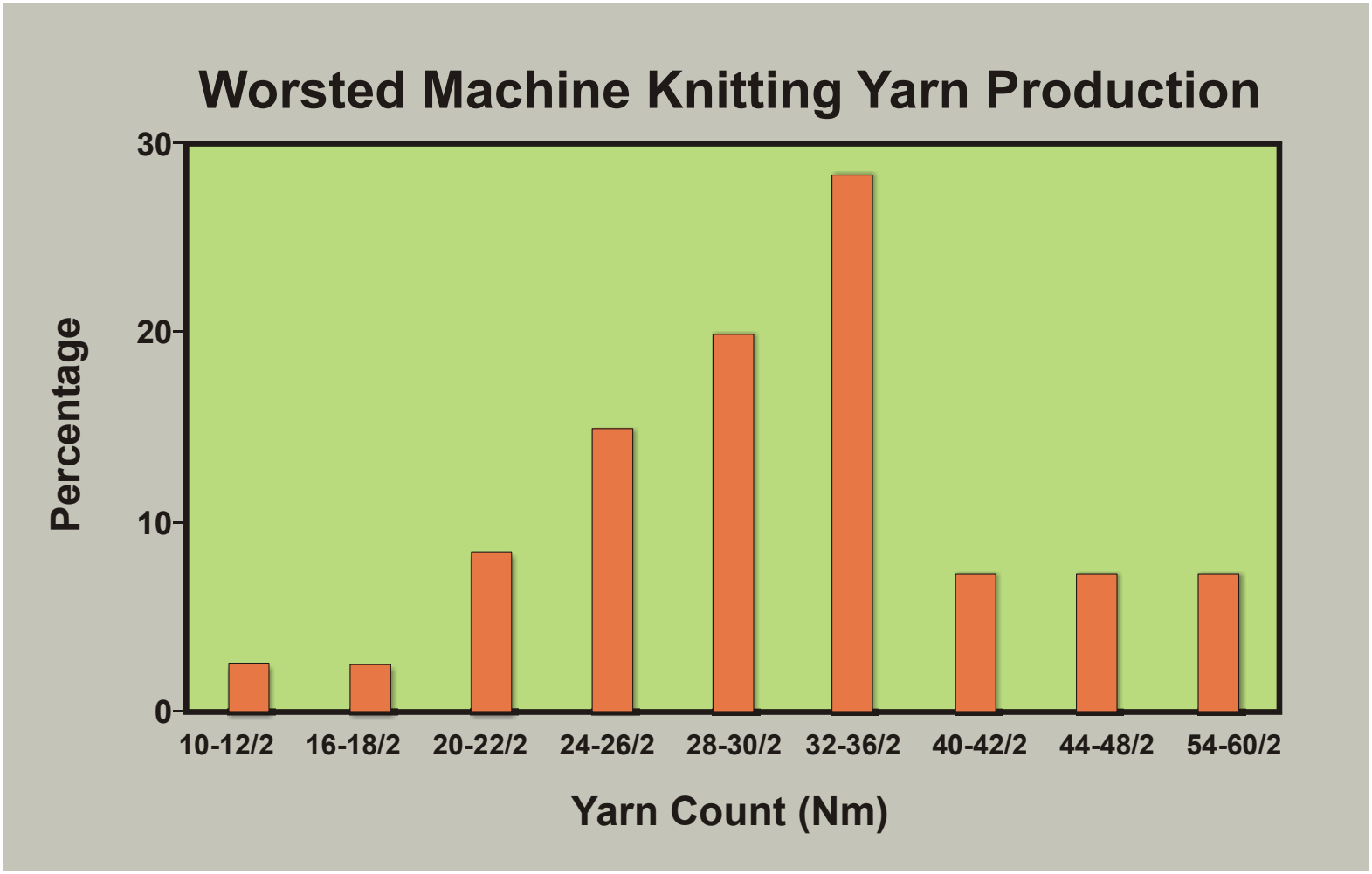
- Superior hand feel and comfort – at point of sale and during wear
- Good appearance retention – at point of sale and after wear/laundering
- Meeting customer performance expectation – during wear and after laundering

Raw material selection

- Fibre diameter and wool quality
- Traditionally quoted as a ‘quality number’ given to each lot at sale by an experienced woolclasser
- Based on the finest worsted yarn quality capable of being spun from a particular lot of greasy wool
- Now measured objectively in microns

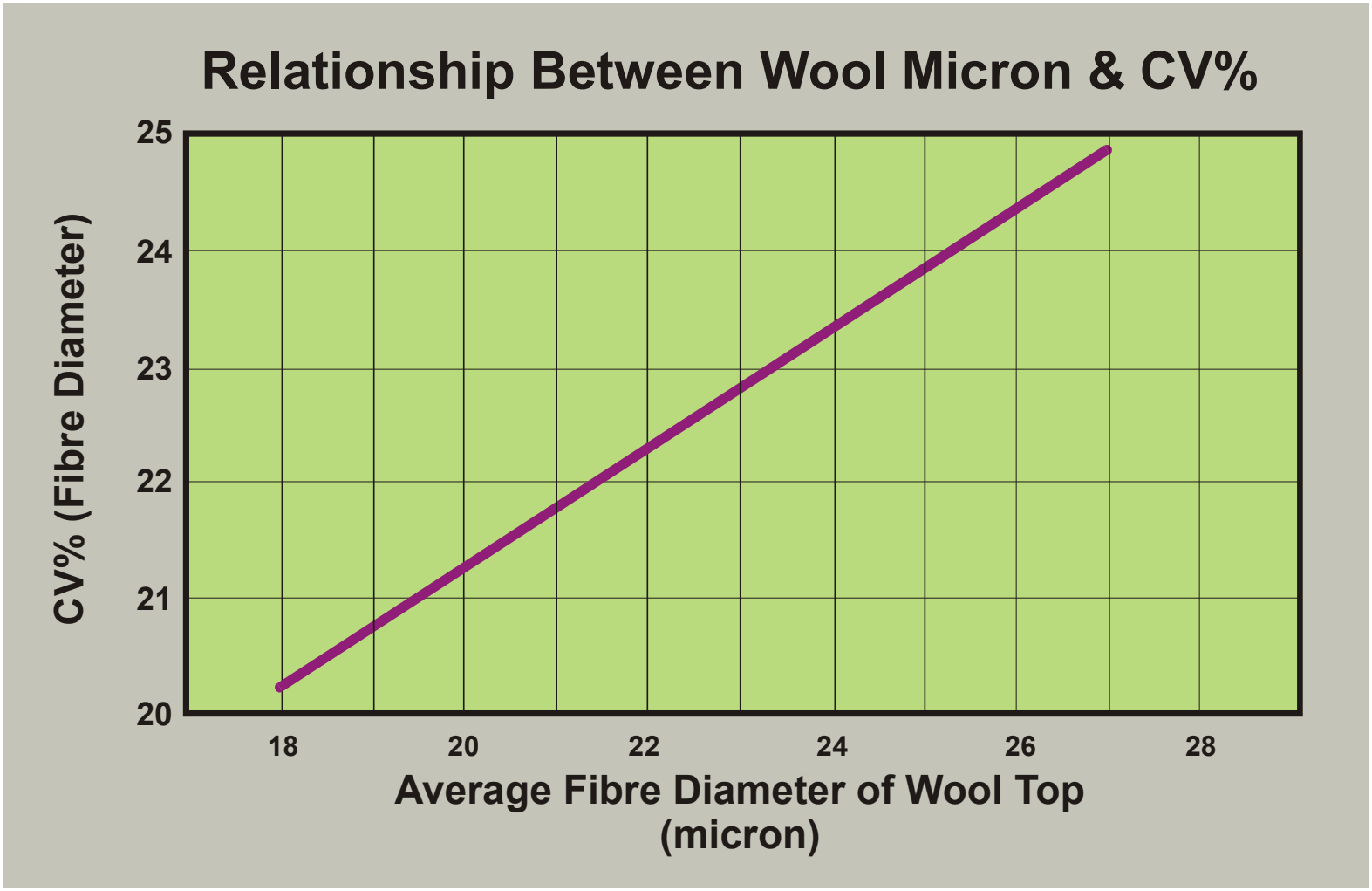
Wool quality versus micron

Quality value	Average micron
Super 140s	~16.5 micron
Super 120s	~17.5 micron
Super 100s	~18.5 micron
80s	~ 19.5 micron
70s	~ 20.5 micron
64s	~ 21.5 micron


Worsted Machine Knitting Yarn Production
Percentage
30
20
10
0
10-12/2
16-18/2
20-22/2
24-26/2
28-30/2
32-36/2
40-42/2
44-48/2
54-60/2
Yarn Count (Nm)

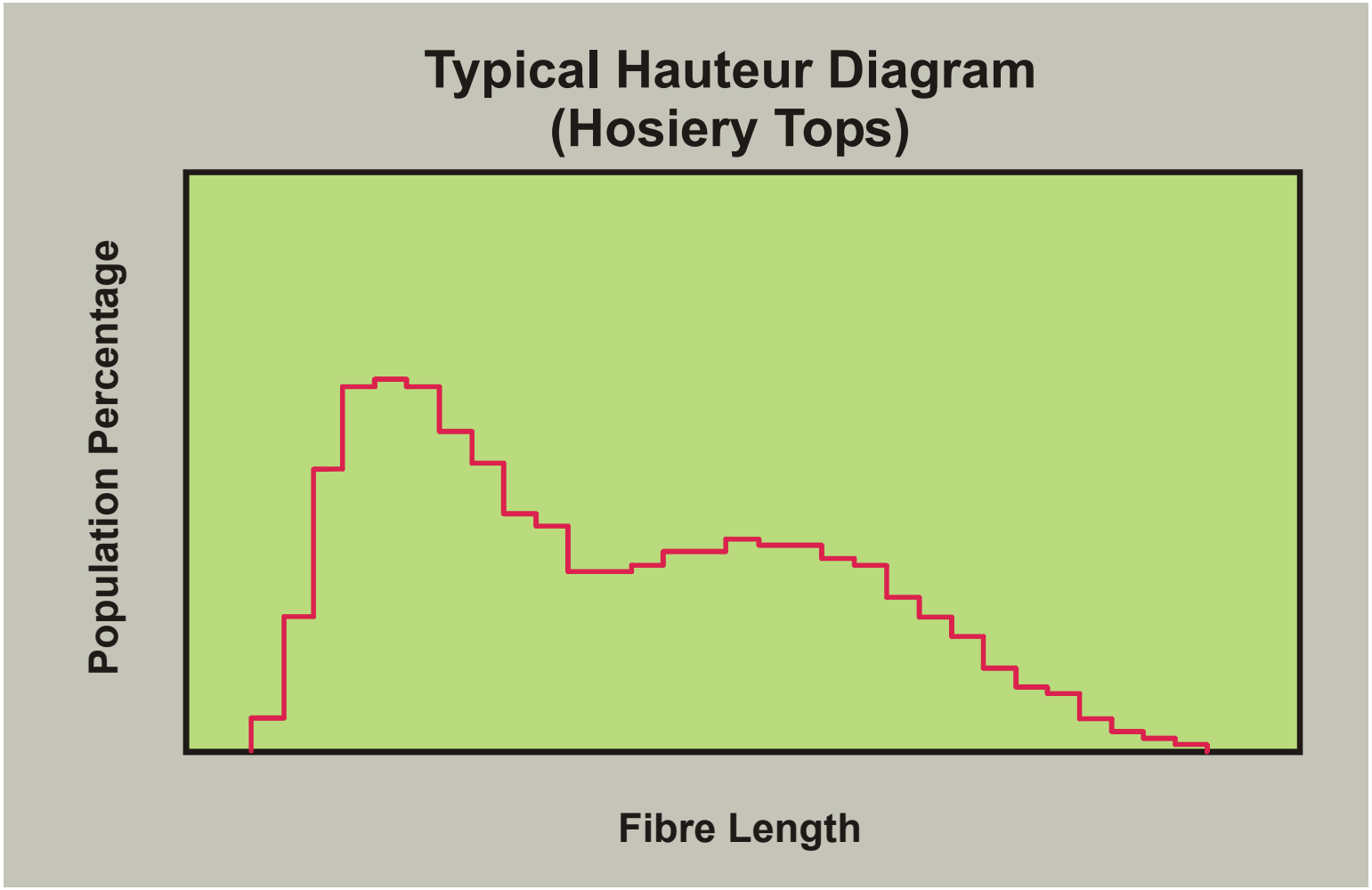
Common micron/two-fold knitting yarn counts

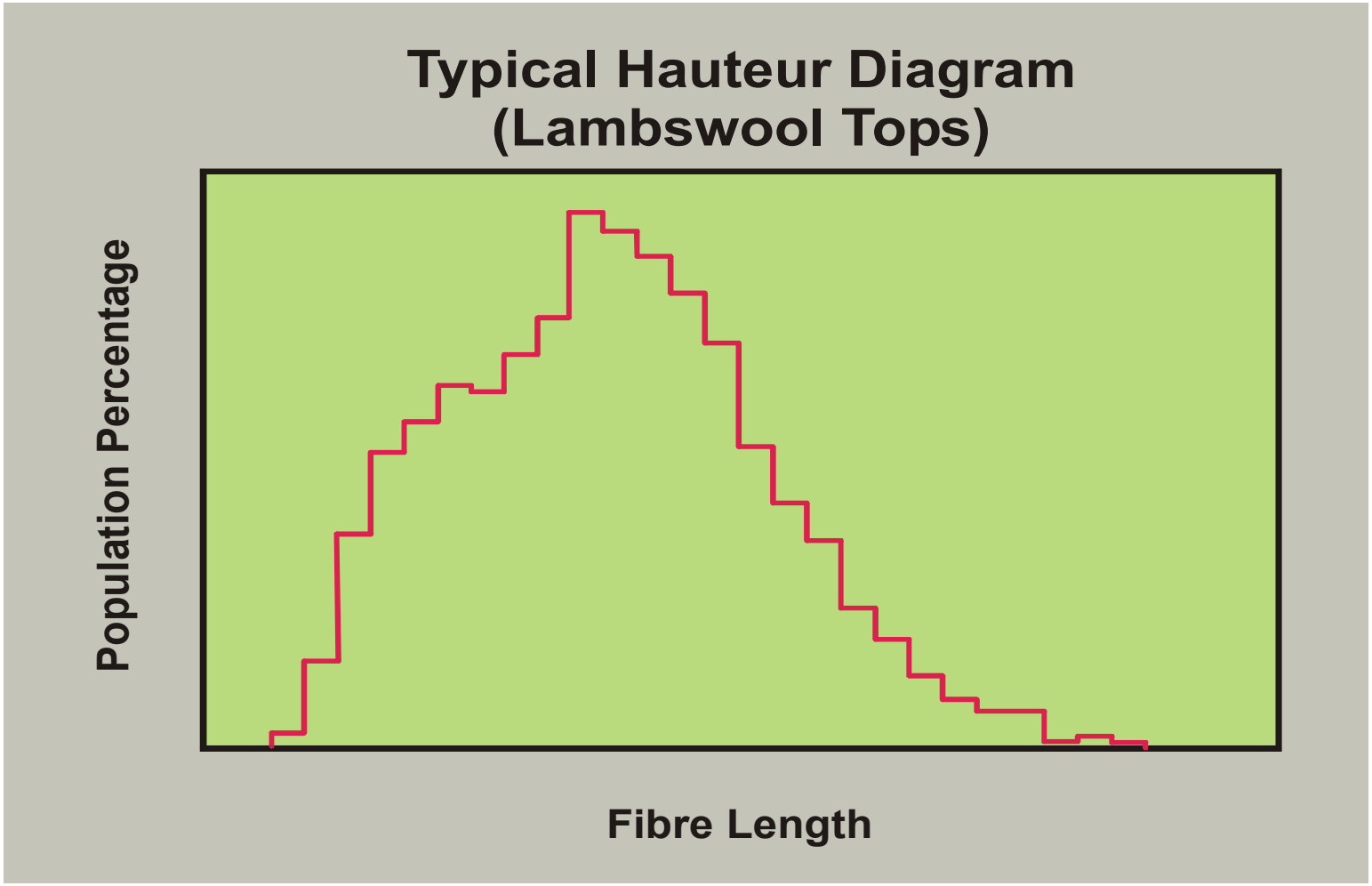
Yarn count (Nm)	Wool diameter (micron)
2/30s	<21.5
2/40s	<20.5
2/48s	<19.5
2/60	<18.5
2/72	<17.5


Relationship Between Wool Micron & CV%
CV% (Fibre Diameter)
25
24
23
22
21
20
18
20
22
24
26
28
Average Fibre Diameter of Wool Top
(micron)

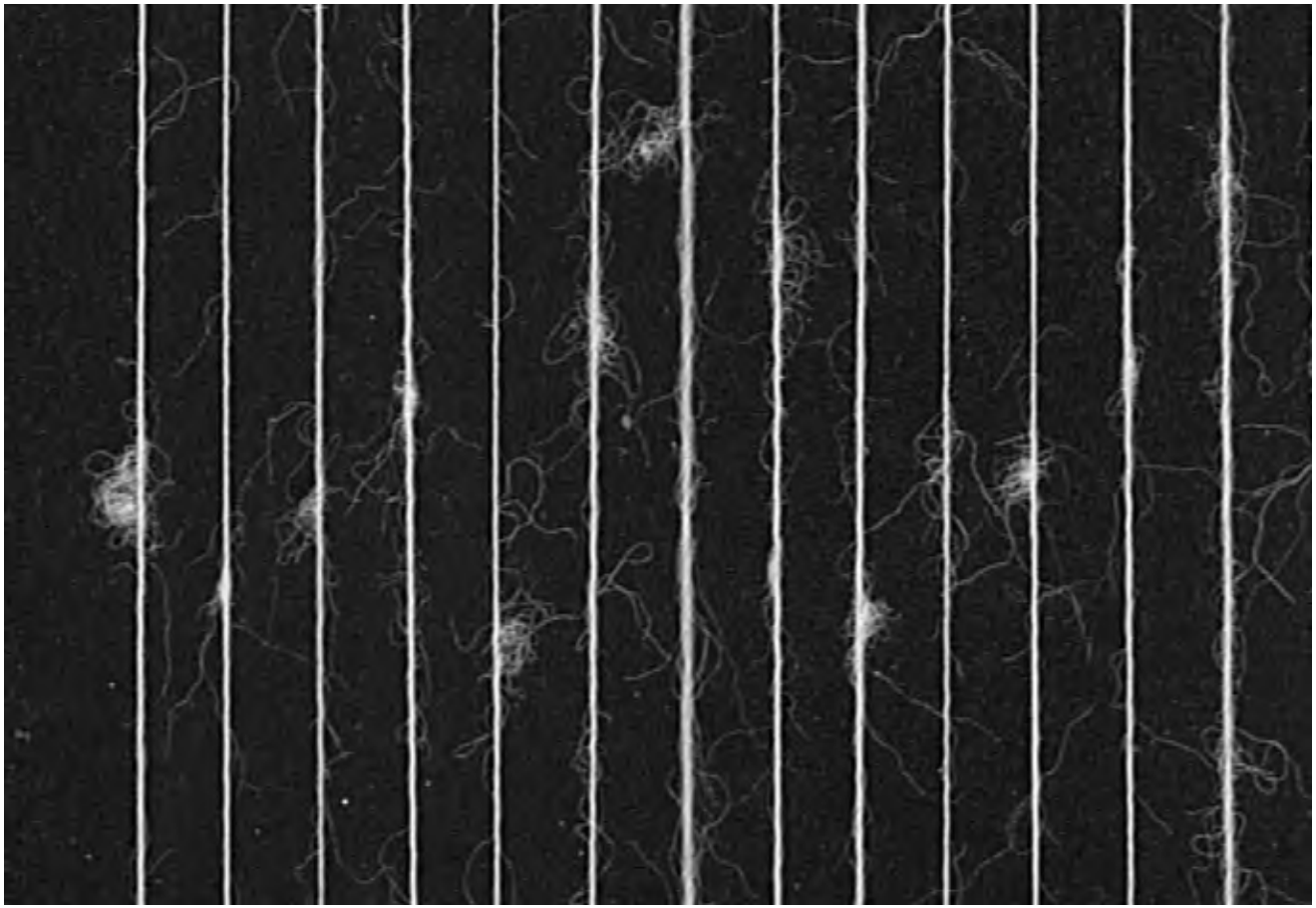
Typical hosiery top profile

- Mean Fibre Length (Hauteur) 60-65mm
- Coefficient of Variation (Hauteur) 48%
- Coefficient of Variation of Diameter 22%
- Curvature 90°

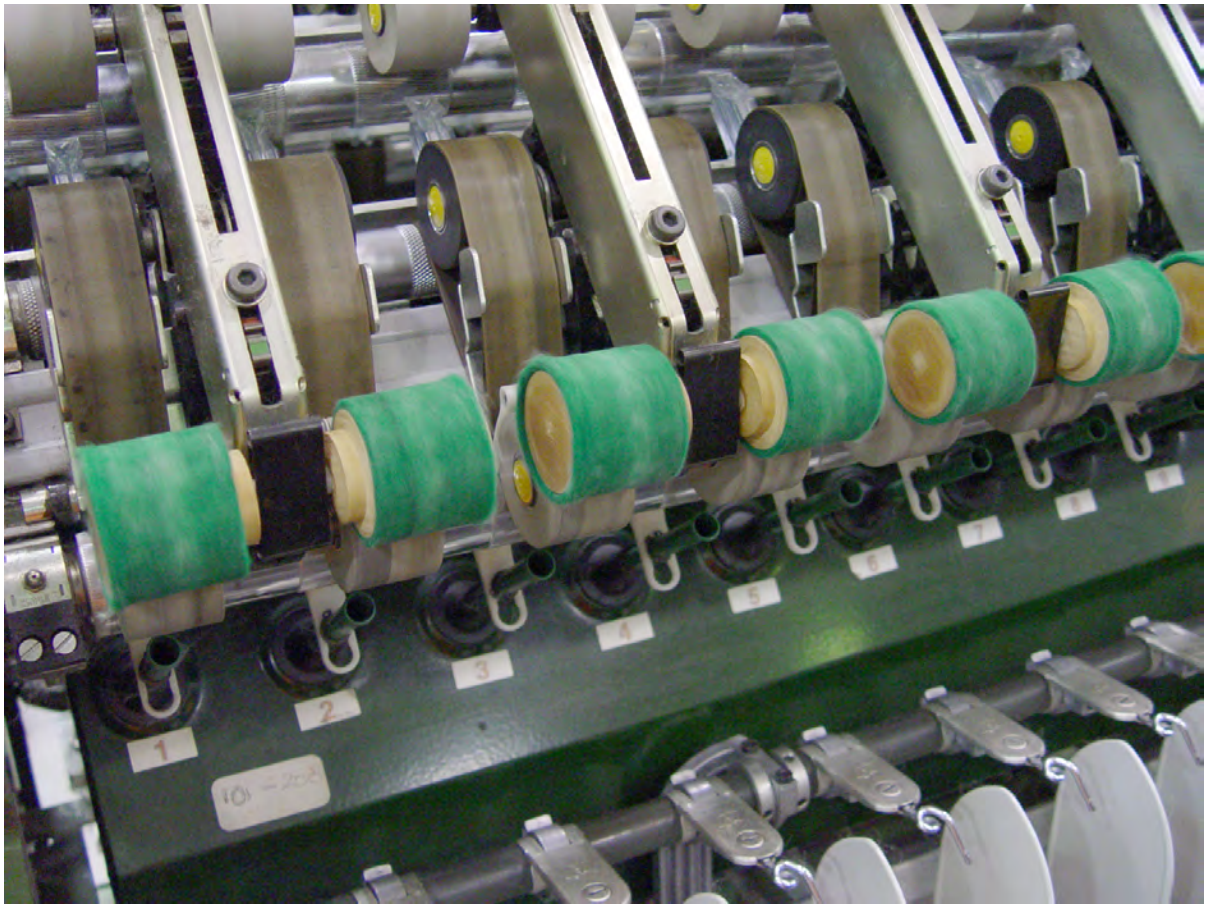

Typical Hauteur Diagram
(Hosiery Tops)
Population Percentage
Fibre Length


Typical Hauteur Diagram
(Lambswool Tops)
Population Percentage
Fibre Length

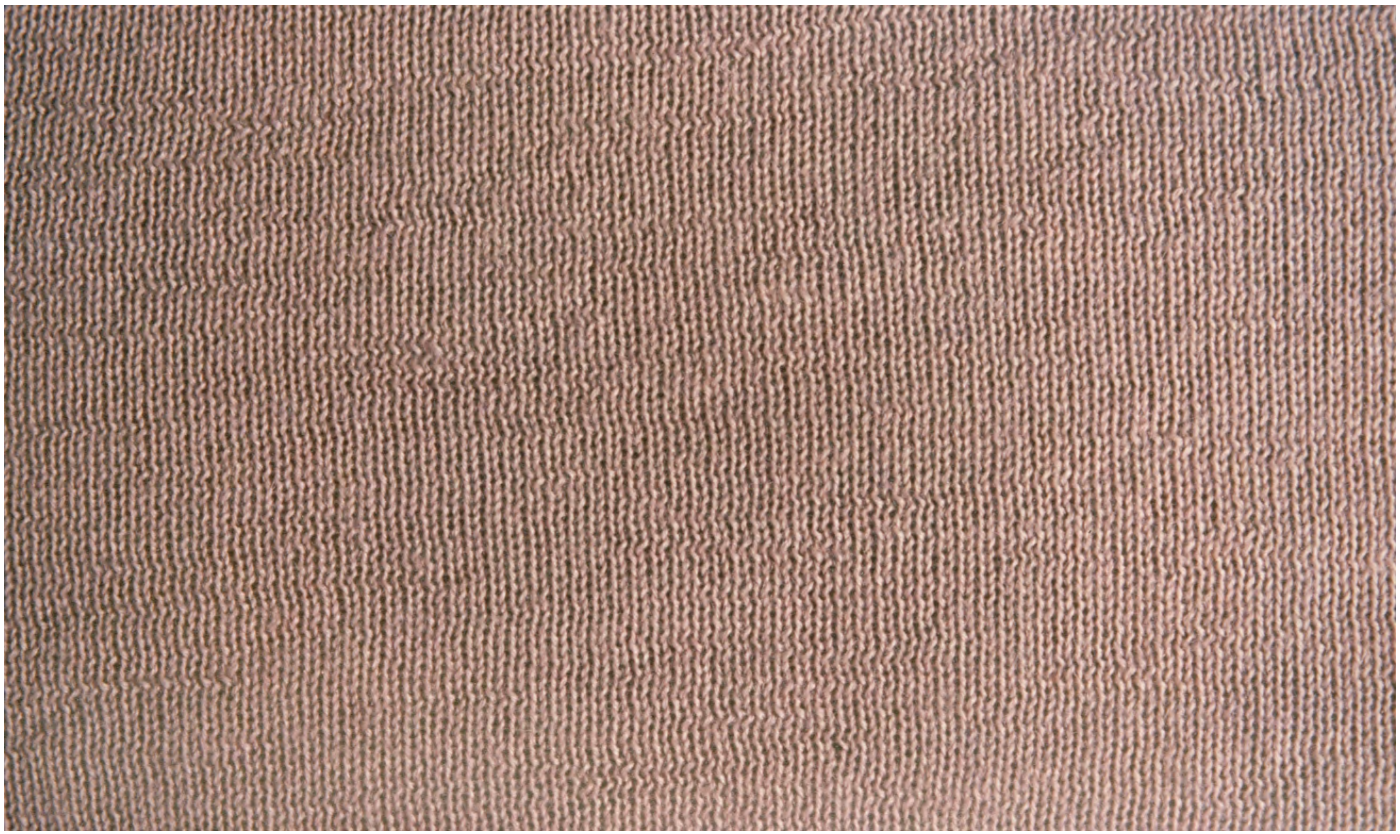
Neps



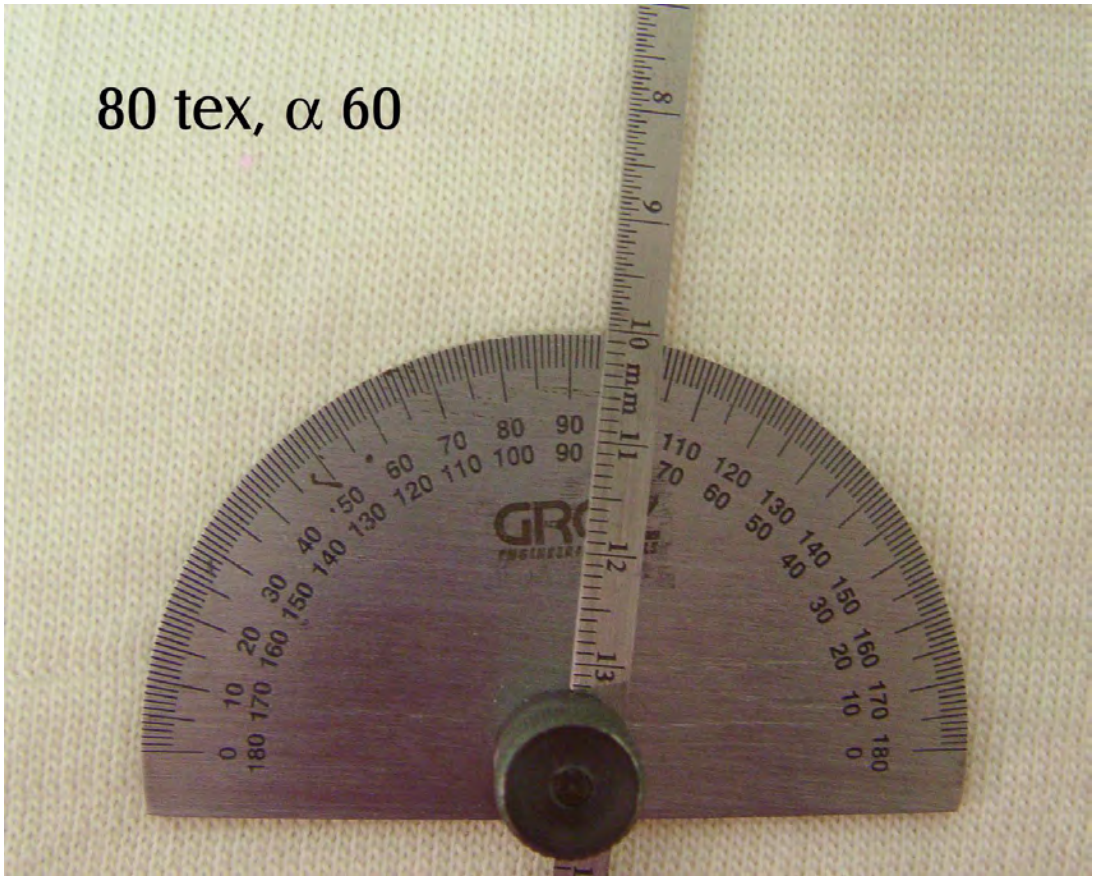
Worsted spinning



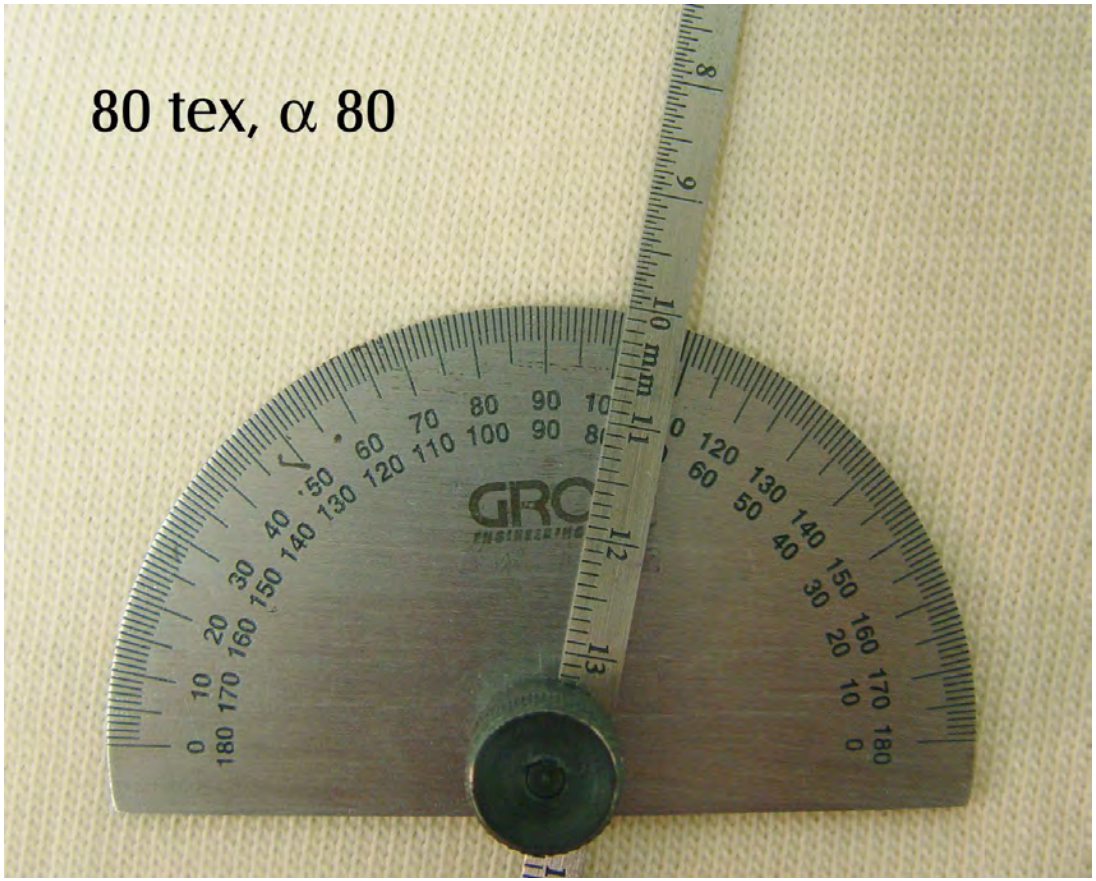
Effect of yarn setting on fabric appearance - cockling



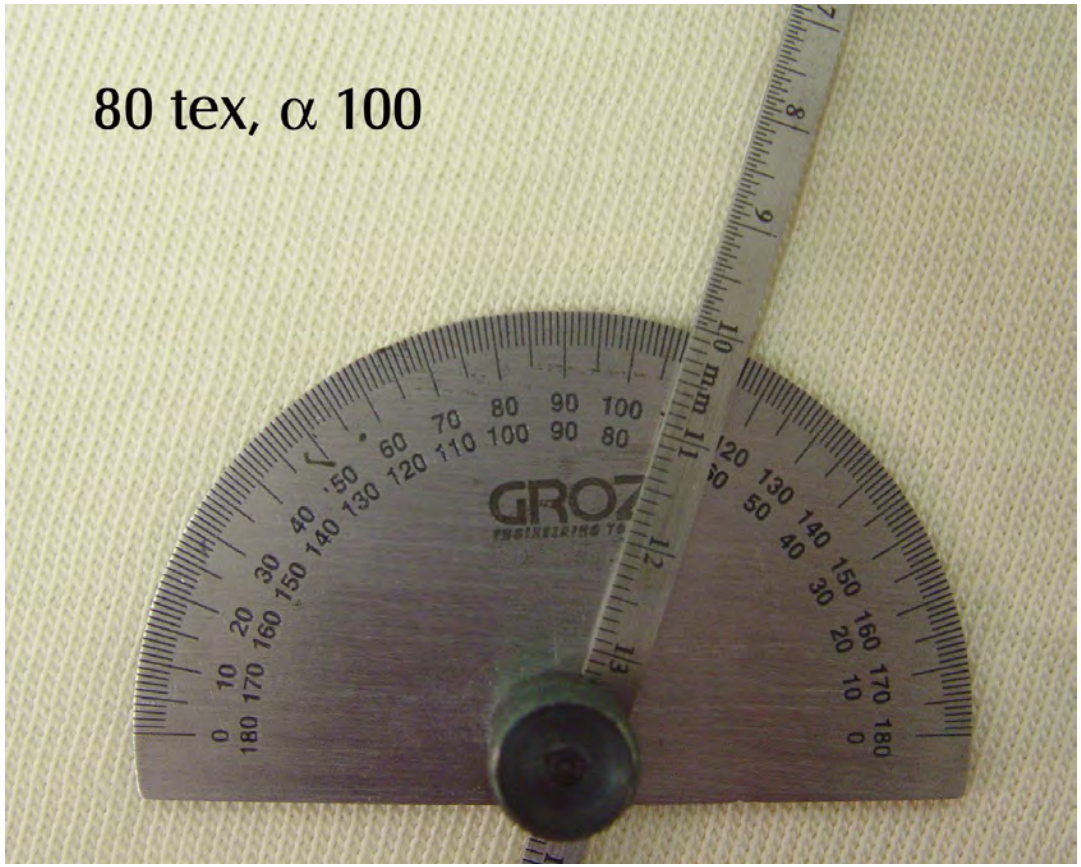
Spirality
80 Tex, Alpha 60, 5° Spirality



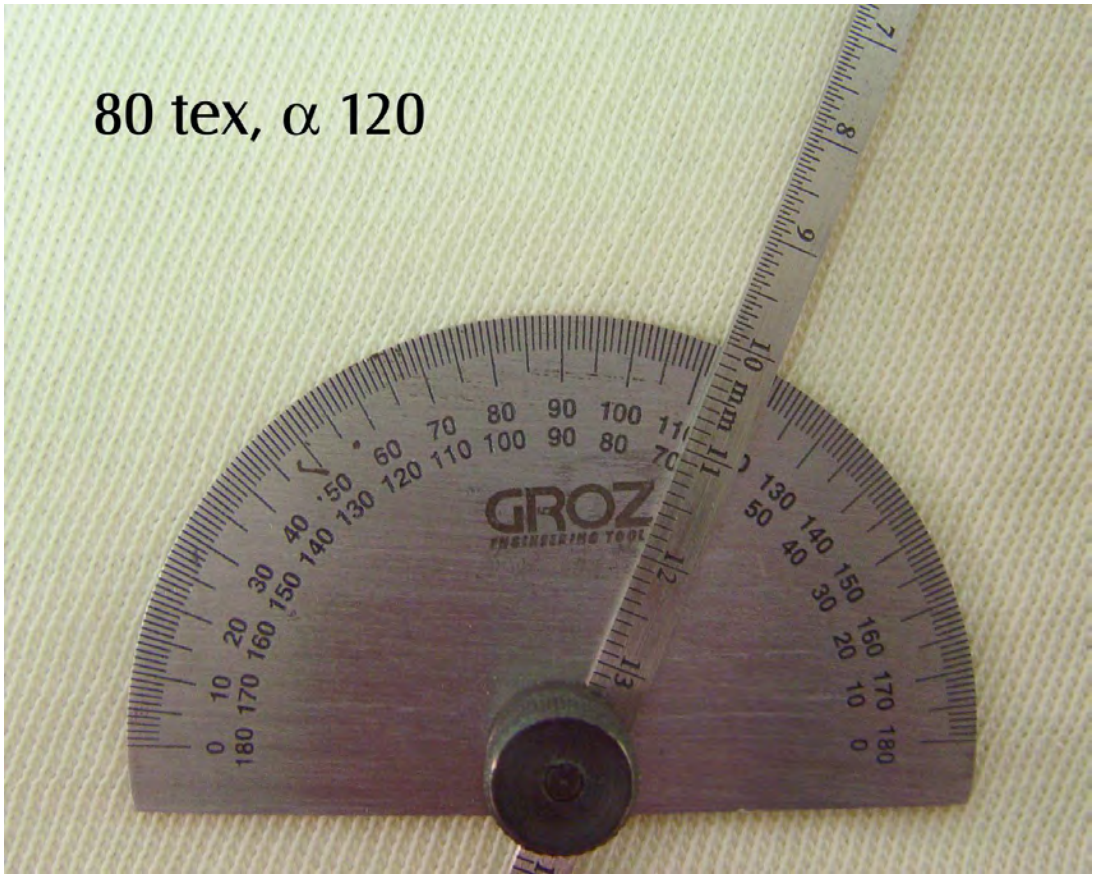
Spirality
80 Tex, Alpha 80, 10° Spirality



Spirality
80 Tex, Alpha 100 17° Spirality



Spirality
80 Tex, Alpha 120, 22° Spirality

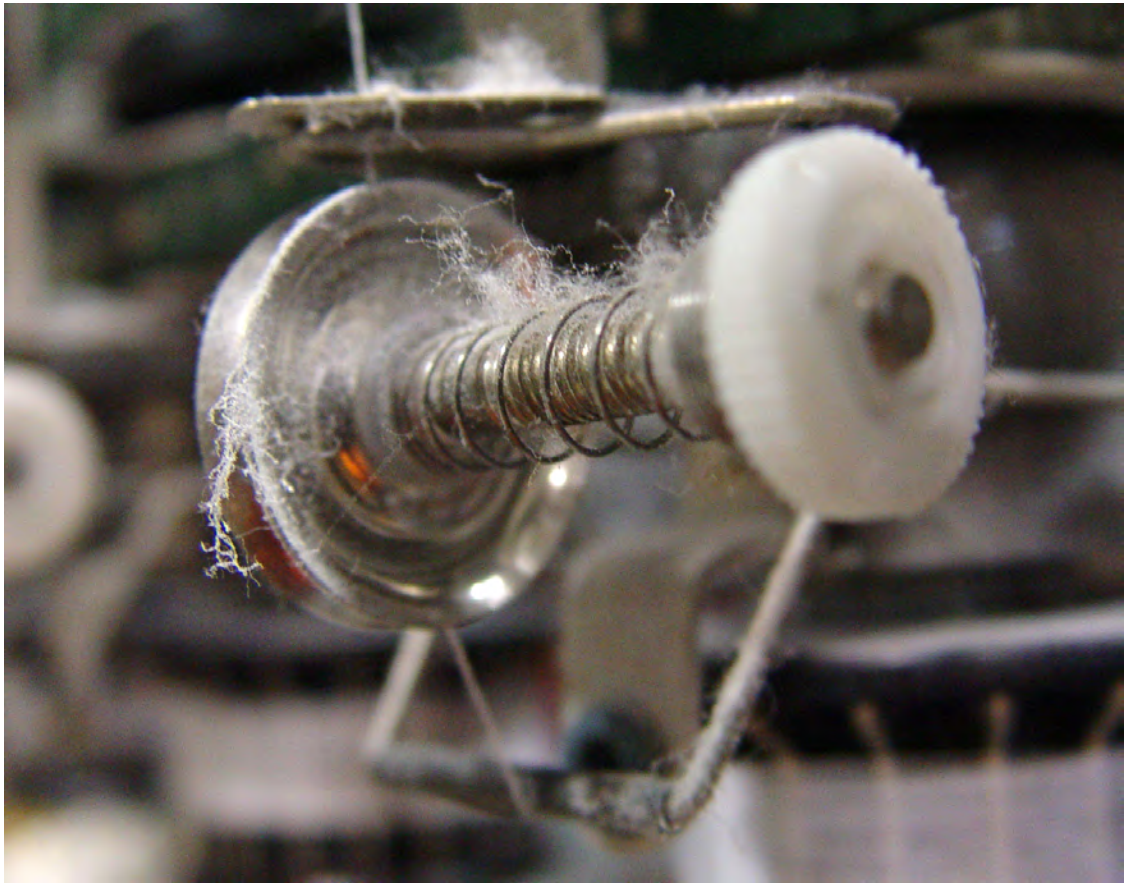


Typical yarn steaming sequence

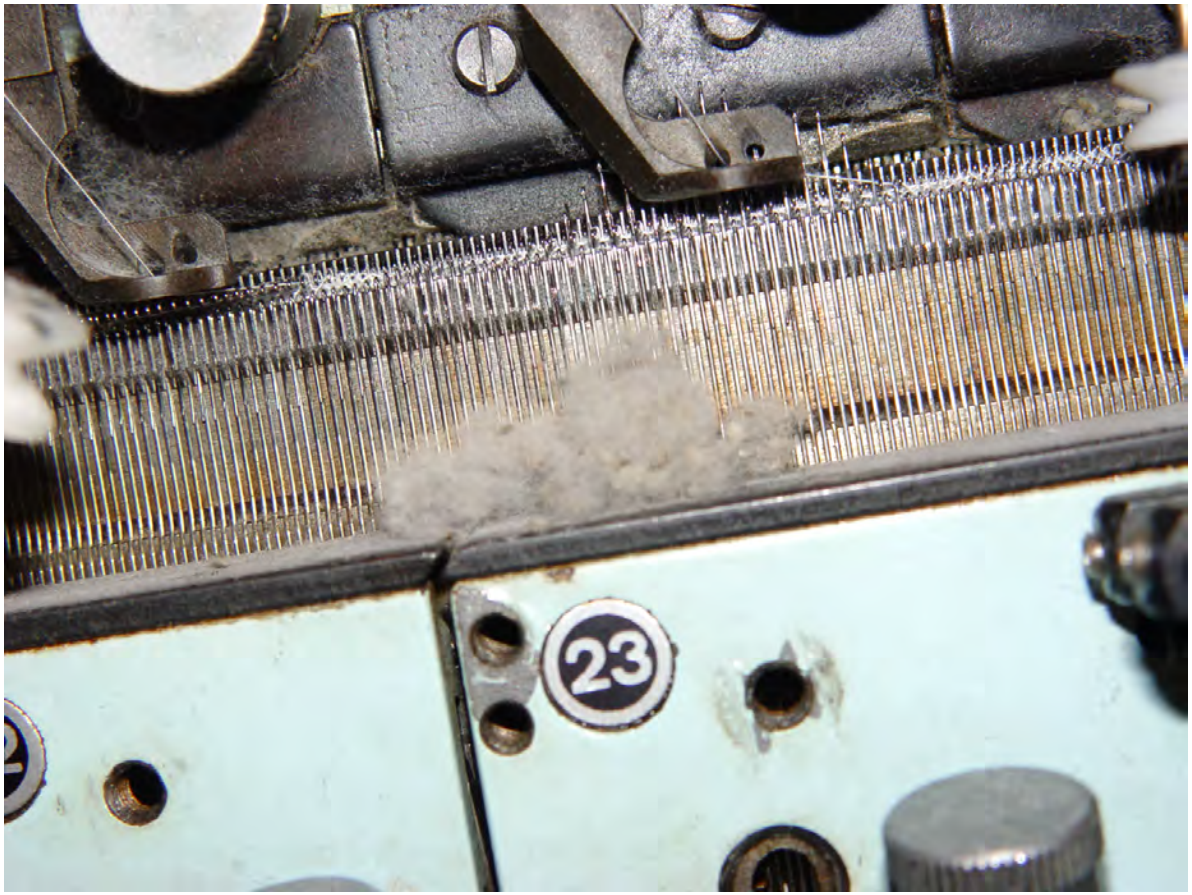
Sequence	Operation	Time (min)	Vacuum (Hg/bar)
1	Vacuum		25”/0.12
2	Steam	3	15”/0.48
3	Vacuum	3-5	25”/0.12
4	Steam	10	15”/0.48
5	Vacuum	5-10	25”/0.12

Autoclave
for killing or setting twist in yarn

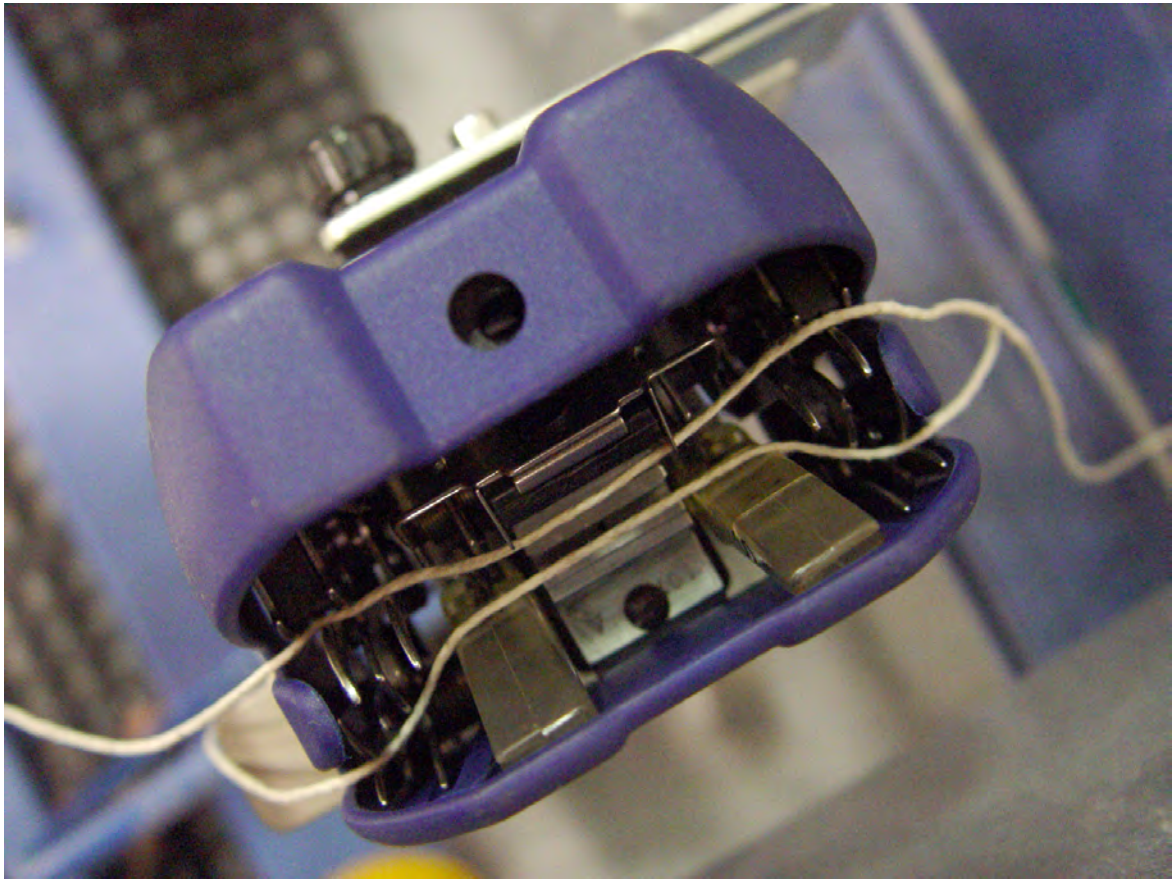
Loose fibre (fly) contamination on yarn guide/cymbal tension



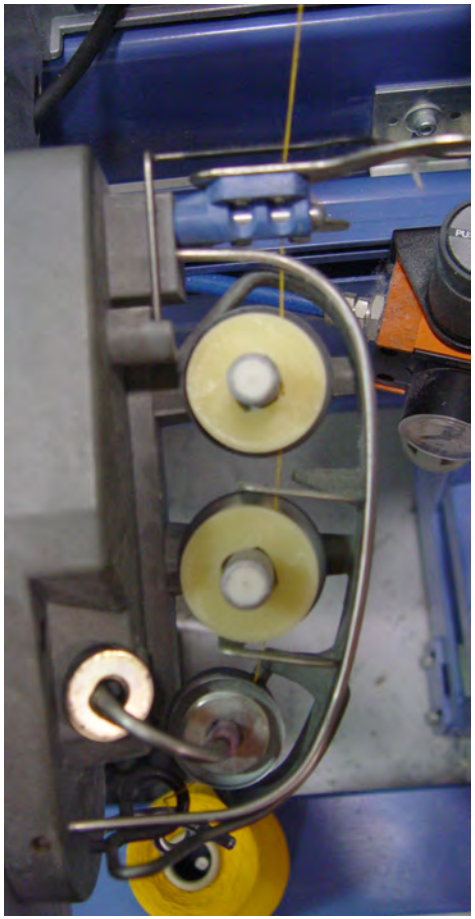
Loose fibre (fly) contamination on knitting machine head



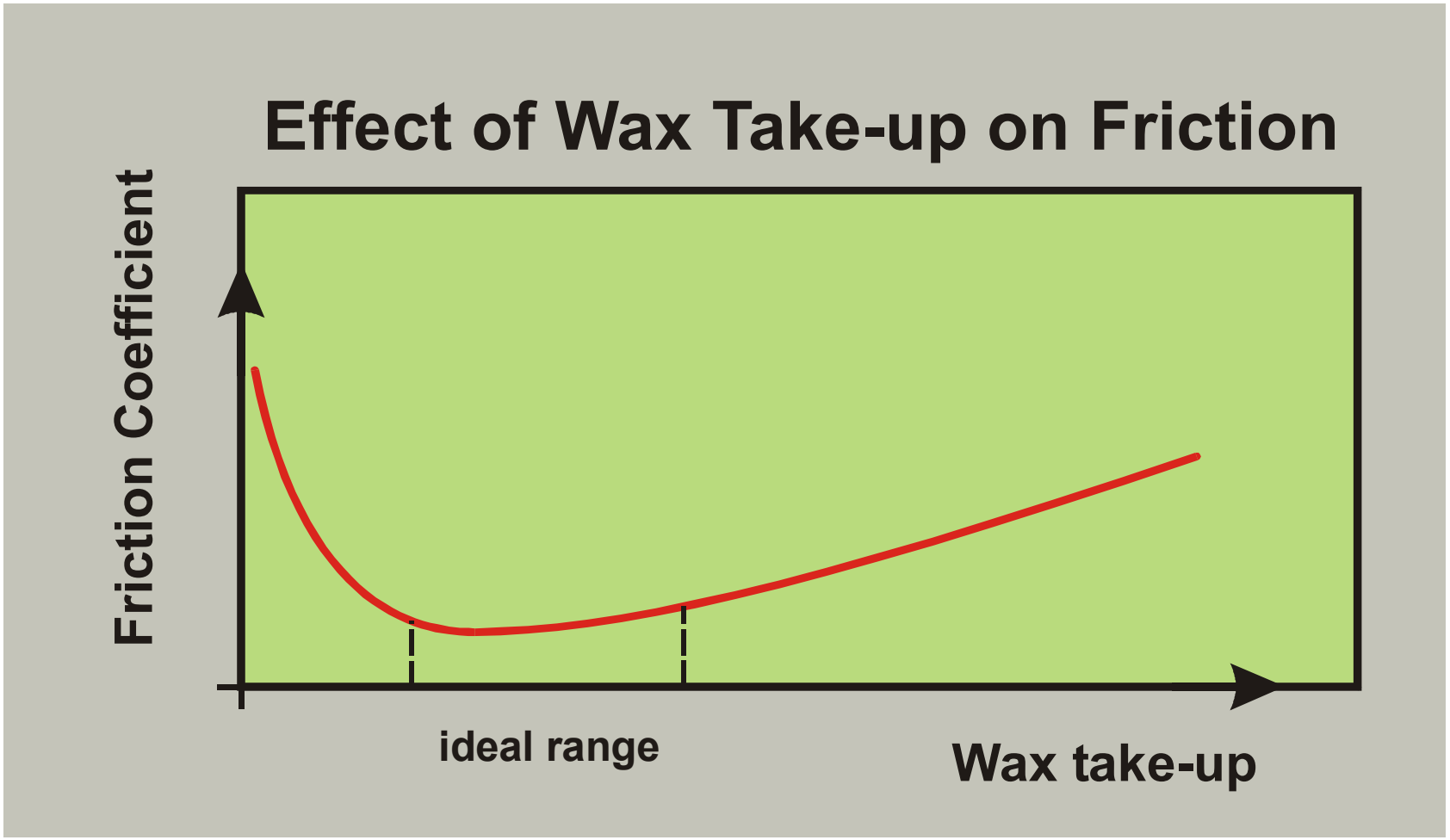
Clearing and jointing yarn knotter



Yarn waxing
gravity application

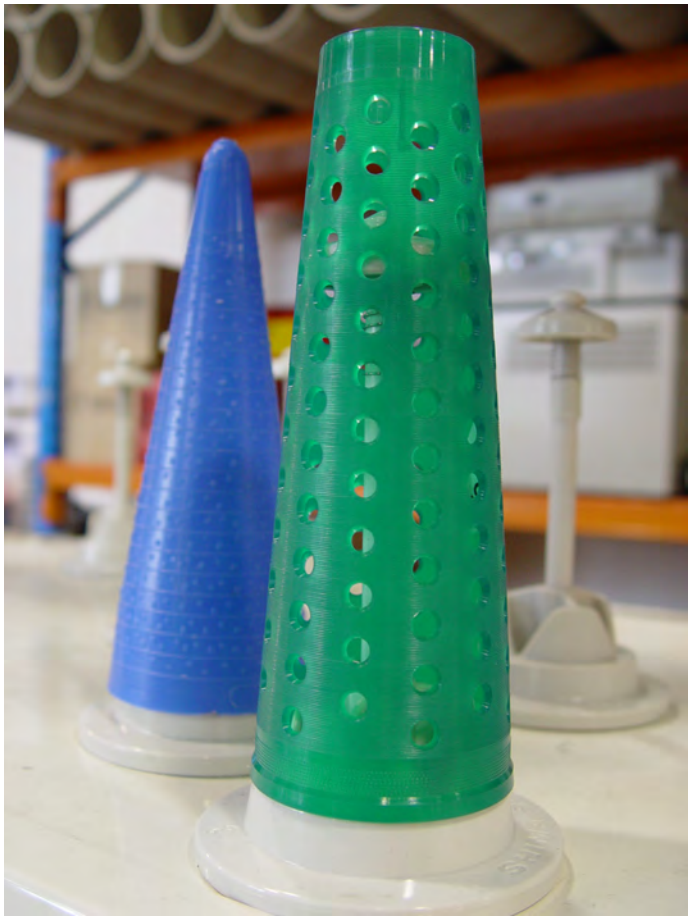


Yarn waxing
preloaded wax application


Effect of Wax Take-up on Friction
Friction Coefficient
ideal range
Wax take-up

Measuring yarn-to-metal friction

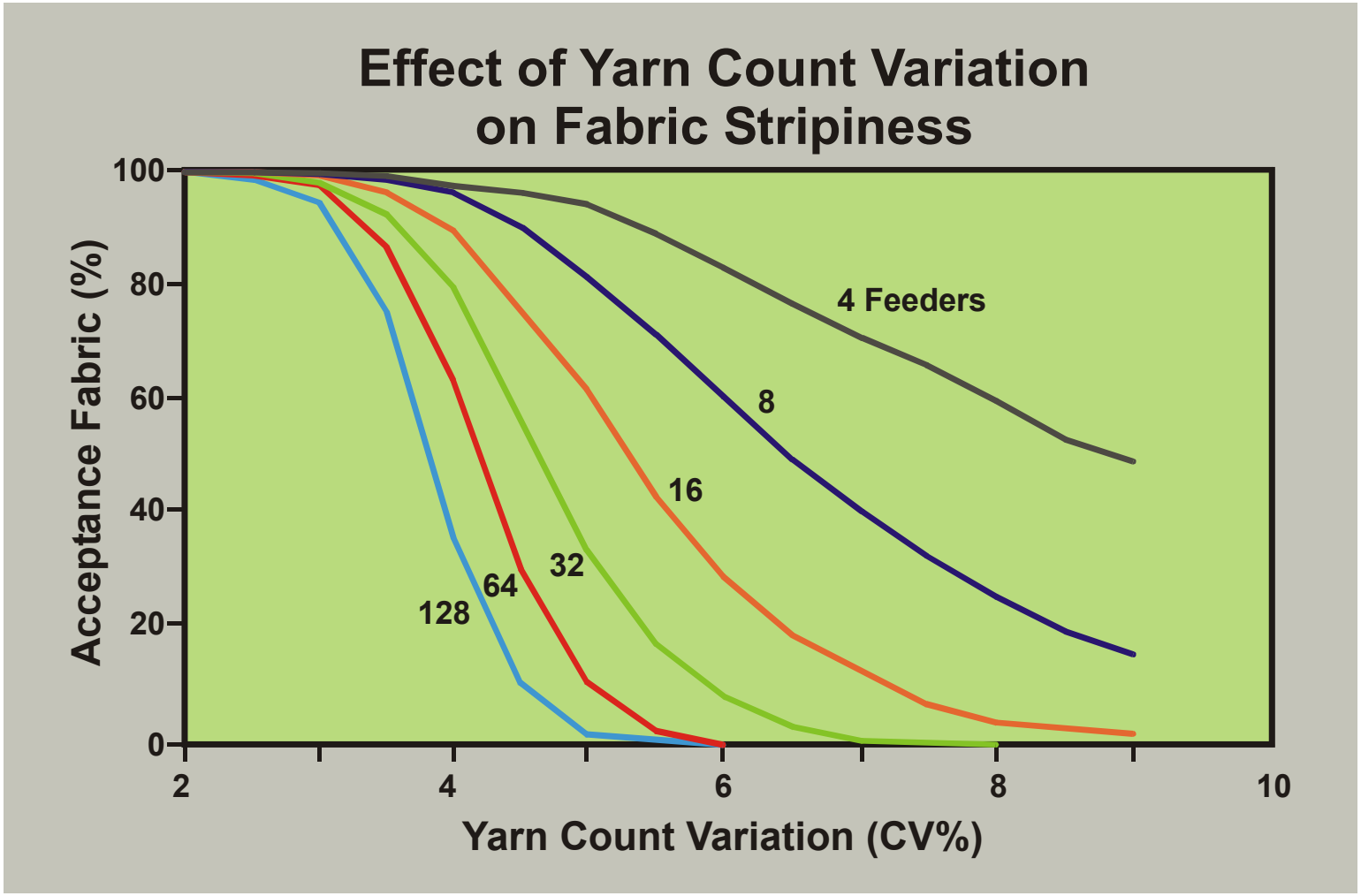
Common hosiery yarn packages Front 5°57’ Behind 9°15’



Well wound knitting package
Left: OK, Right: Mis-shapen

IWTO yarn count tolerances

- <15 Nm: +/- 0.5 Nm
- 15 Nm – 29.99 Nm: +/- 0.75Nm
- 30 Nm – 69.99 Nm: +/- 2.5%
- >70 Nm: +/- 3%


Effect of Yarn Count Variation
on Fabric Stripiness
Acceptance Fabric (%)
100
80
60
40
20
0
2
4
6
8
10
Yarn Count Variation (CV%)
4 Feeders
8
16
32
64
128

Controlling knit density

- Knit density is the single most important fabric property for controlling pilling, loop distortion, fabric dimensional stability and fabric handle (softness).
- Knit density is controlled by loop length (stitch length).

If loop length is too long, fabric becomes slack and may suffer from:

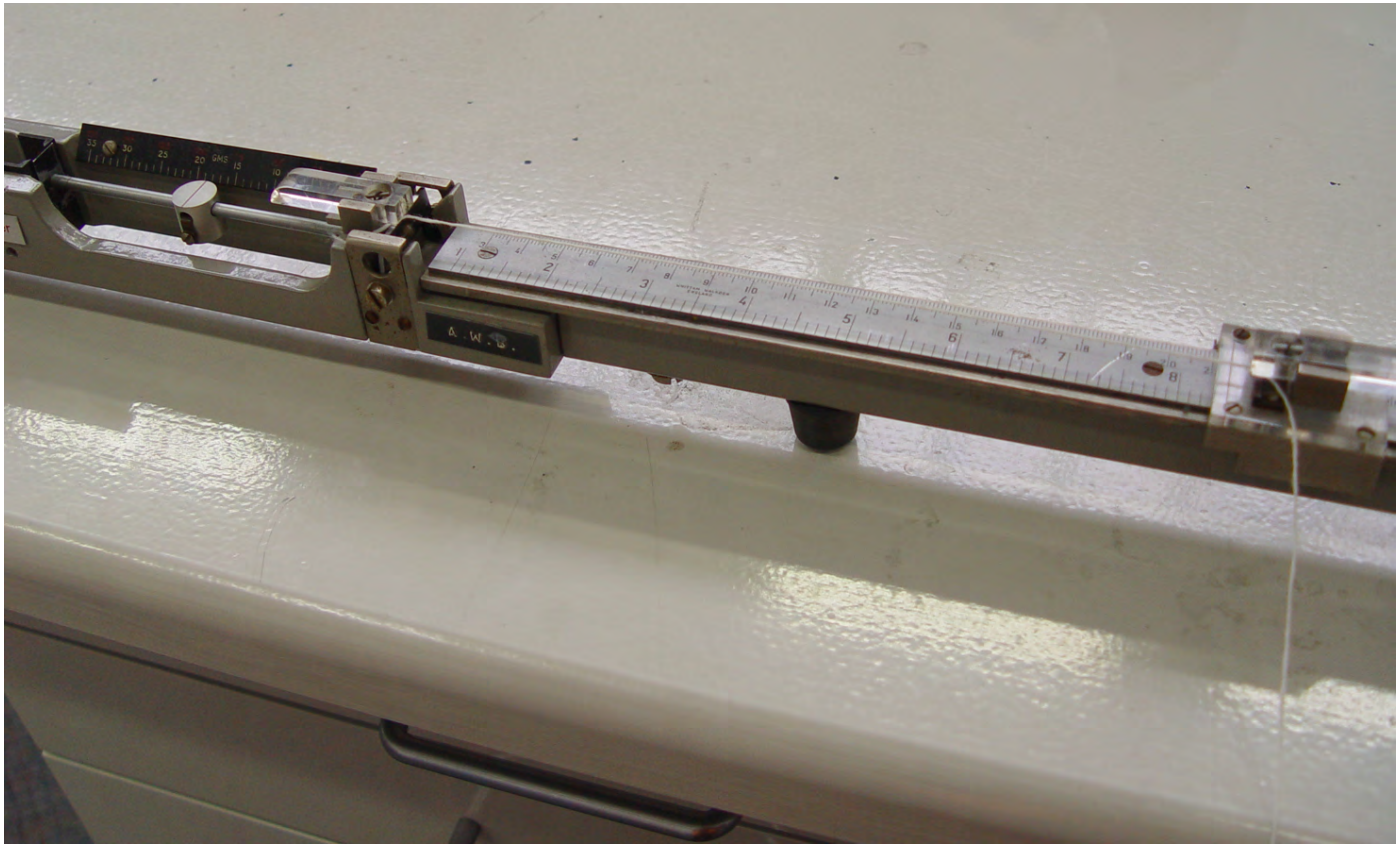
- bagging
- snagging
- low bursting strength
- loop distortion and cockling
- pilling and facing-up
- poor dimensional stability to wear and laundering
- generally poor wash and wear performance.

If loop length is too short, fabric becomes stiff and may suffer from:

- low elasticity
- harsh handle
- heavy weight
- generally poor aesthetic properties.

Hatra course length measuring board

Shirley Crimp Tester

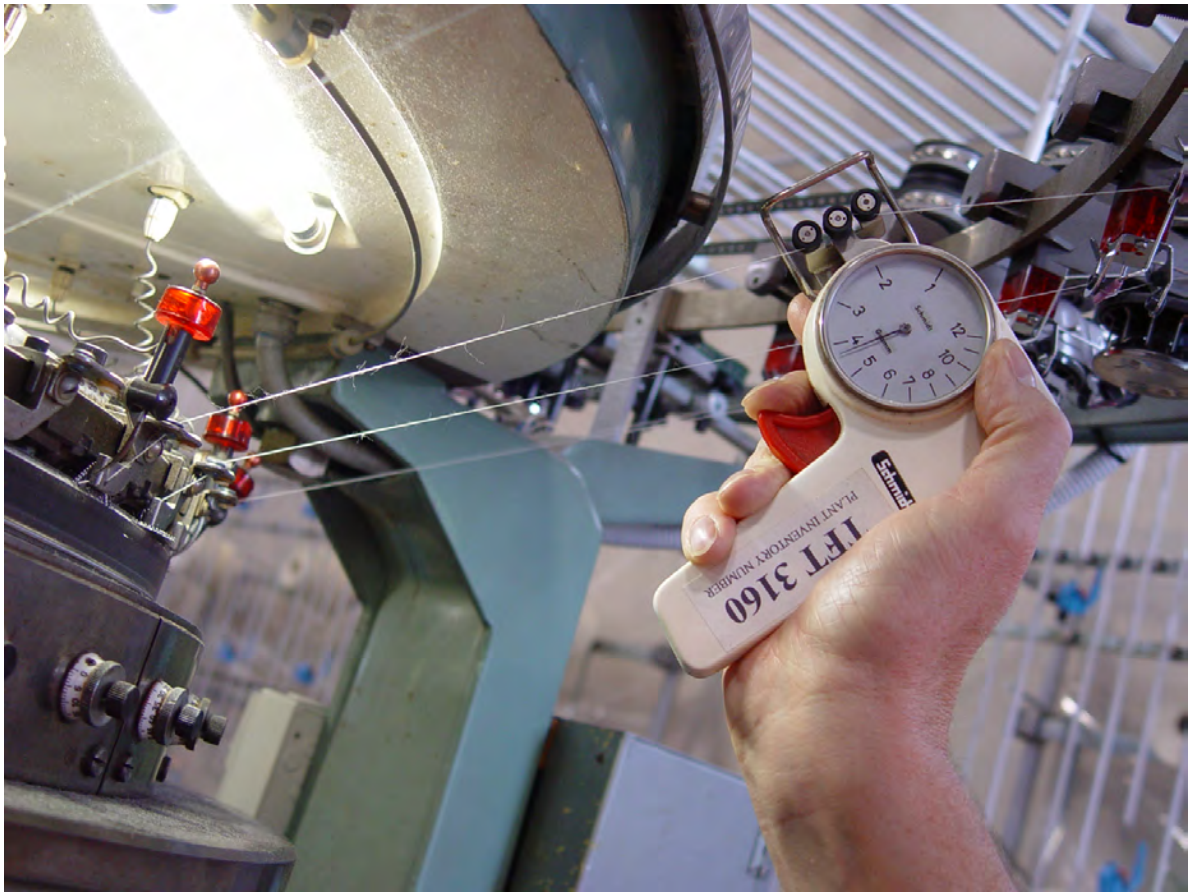


Enables course length to be measured accurately in knitted fabrics

Wisco Course Length Meter

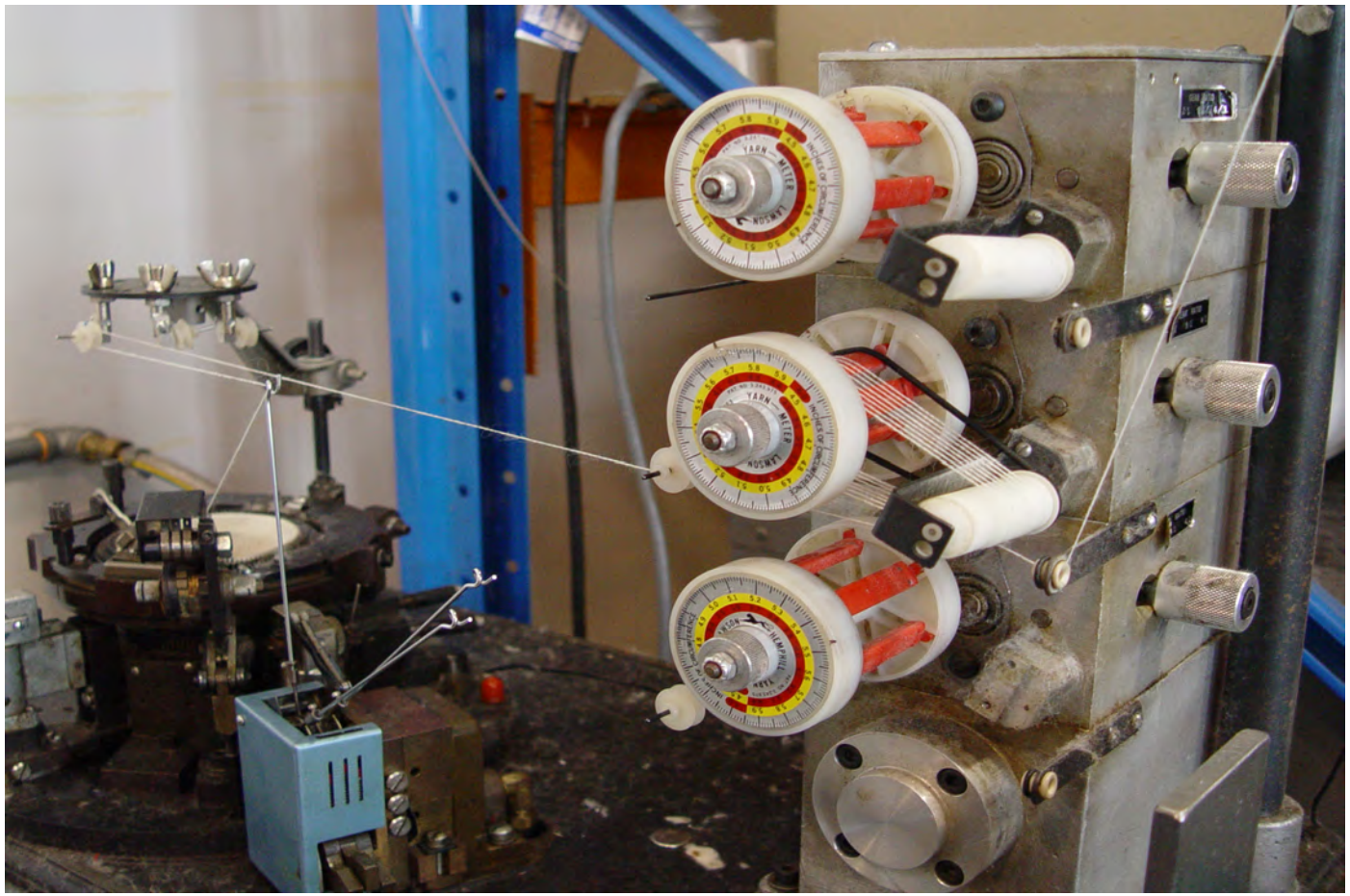
Enables measurement and control of loop length/cover factor

Yarn Tension Meter



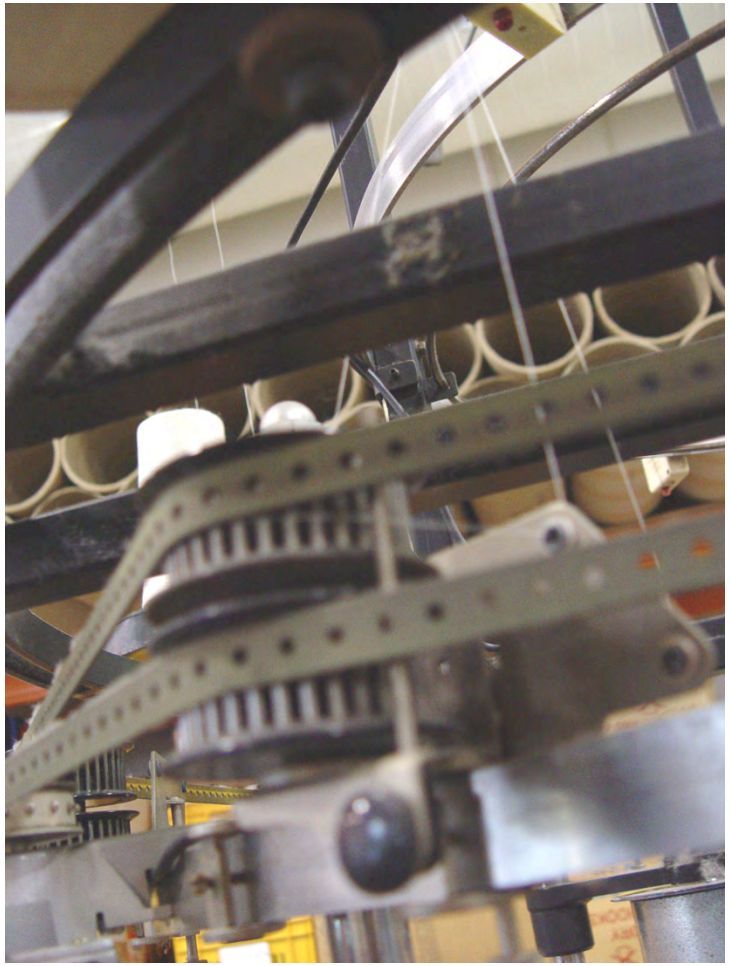
Measures yarn input tension – assists in control of fabric barre

Positive yarn feed – capstan roller

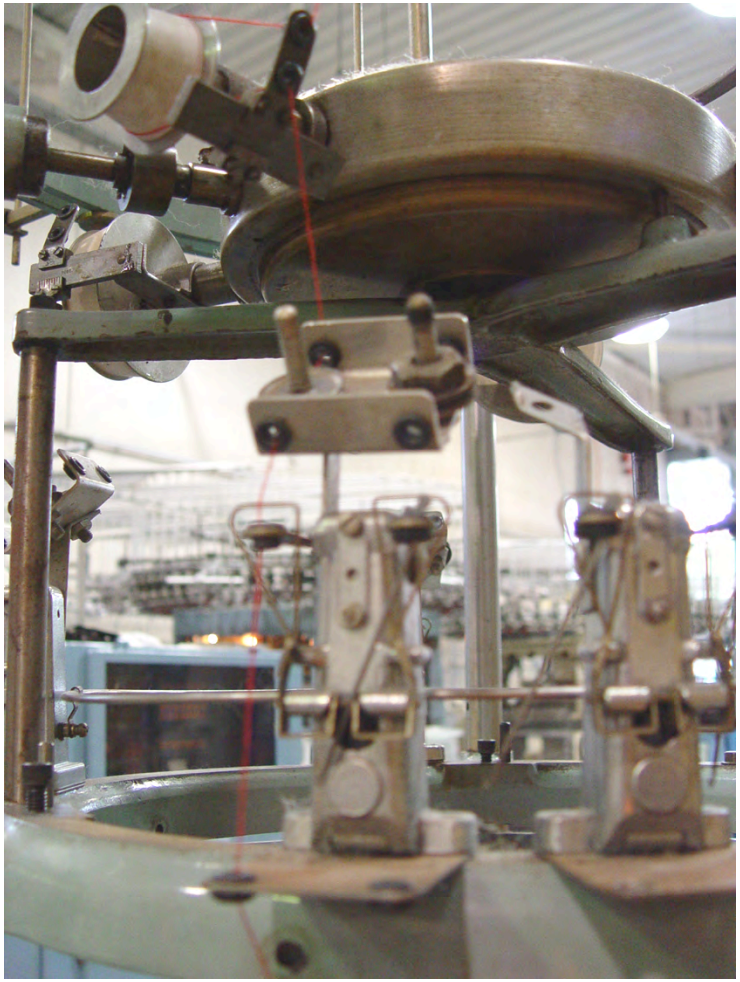


Assisted yarn feed – slip rollers

Positive yarn feed – Triplite tape



Positive yarn feed – conical wheel

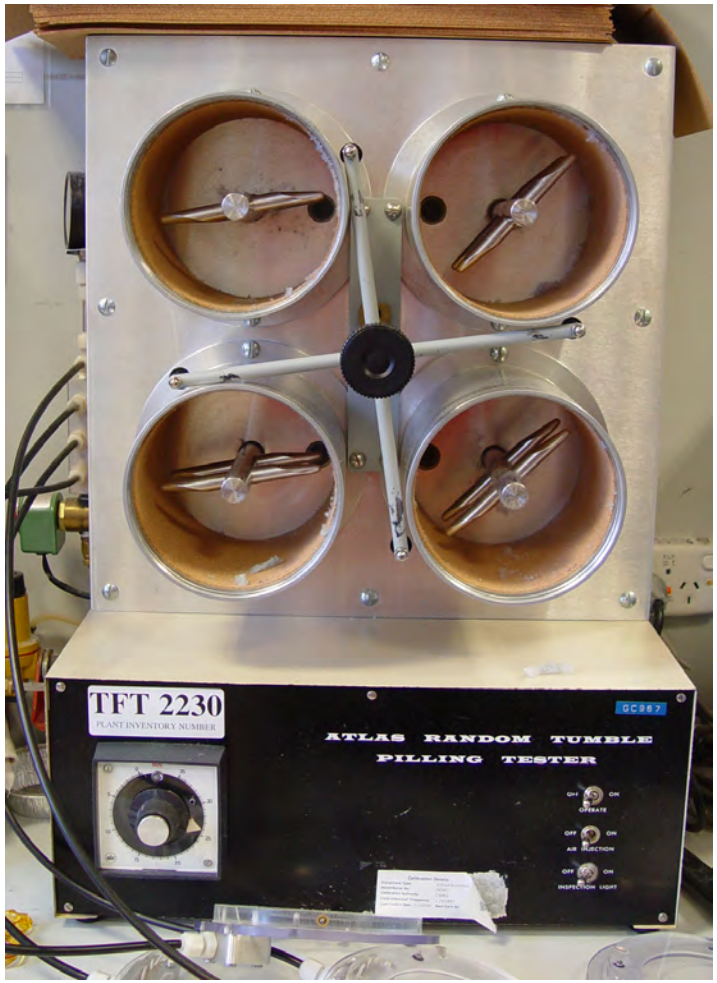


Test equipment for measuring fabric properties

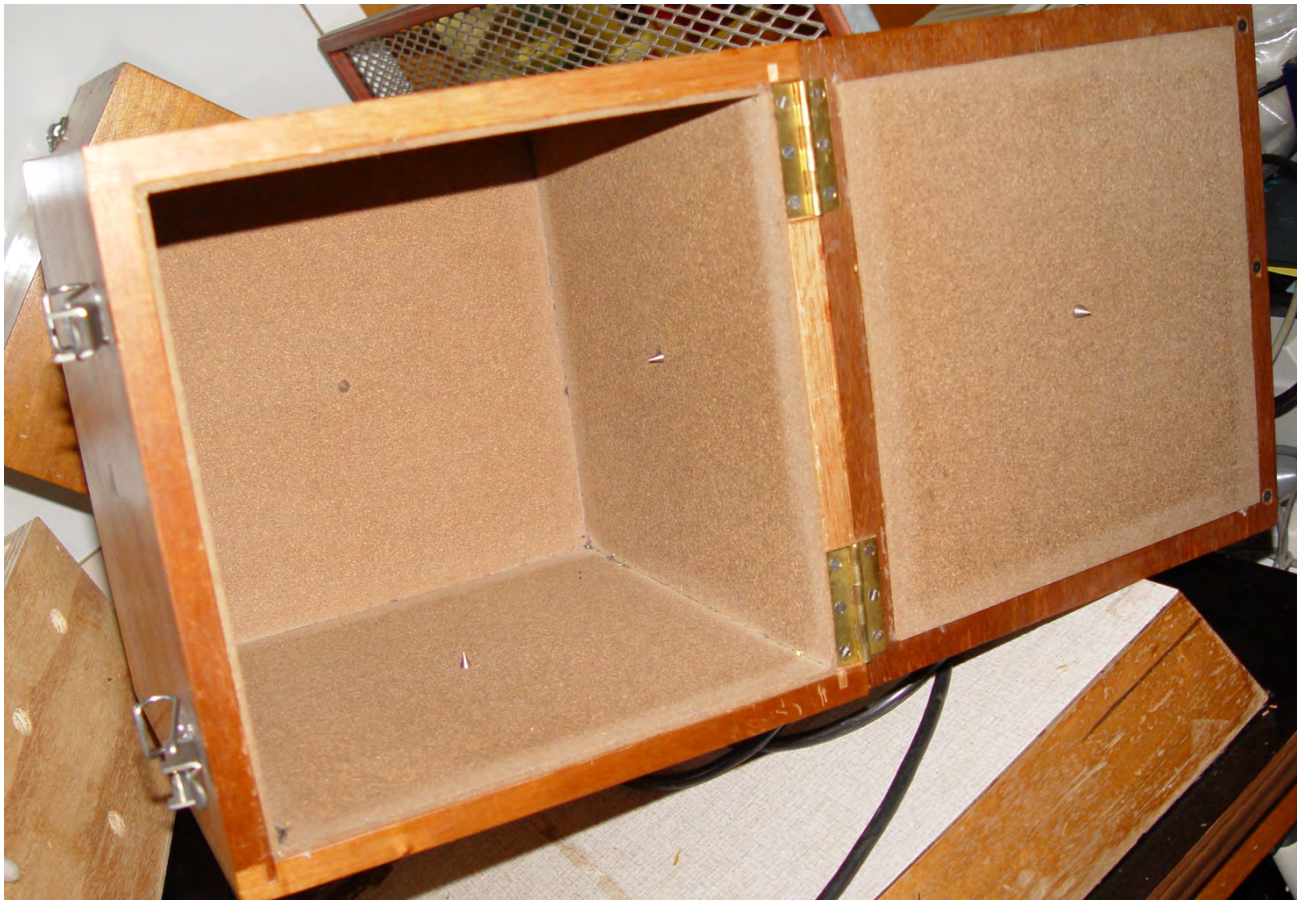
- Bursting
- Pilling

Burst strength
hydraulic diaphragm method

Atlas random tumble pill tester



Key tests – pilling
ICI Pill Box



Common fabric complaints: harsh/dry handle

- Wool micron too coarse
- Yarn twist level too high
- Knitting density too high
- Inappropriate finishing
- Insufficient softener application

Common fabric complaints: cockling/loop distortion

- Too coarse a micron or high percentage of coarse fibres
- Yarn setting (steaming/package dyeing) resulting in increased flexural rigidity
- Incorrect twist balance
- Large twist variations
- Large difference in knit density (fabric width) between rib border and body fabric of garment

Common fabric complaints: spirality

- Singles yarn or incorrect twist balance in plied yarns
- Feeder drop in high feeder density circular knitting machines

Common fabric complaints: facing-up

- Excessive short fibre content in yarn (more fibre ends)
- Soft twist yarn
- Low fabric density
- Wet finishing procedure (scouring/piece dyeing) too severe
- Excessive tumble drying
- Over application of fabric softener
- Borderline shrink-resist treatment level