WOOLLEN CARDING

&

SPINNING

Niall Finn, Ray Wood

Woollen Inputs

- Broken Top
- Stretch Broken Top
- Carbonised Wool
- Carbonised Noils
- Low VM scoured wools
- Synthetics
- Exotic fibres
- Recycled Fibres

Broken Top

- High Quality but short wools,
- Usually lamb's (often slipe)
- Carded and combed by top-maker with noil setting of 25 to 30mm then broken by roller draft and bailed for delivery
- Expensive but good length and free of VM and most contamination
- Specifications cover: micron, Hauteur, CV_H

Stretch Broken Top

- Worsted tops stretch-broken to required length
- Very expensive but good length and free of VM and most contamination, low short fibre content, guarantee zero long fibre content
- tops may have been dyed before breaking

Carbonised Wool

- Range of input qualities:
  - high VM Fleece wools
  - Noils
  - Bellies
  - Pieces
  - Second cuts
  - Dags

The Carbonising Process
(a black art)

- Inputs *subjectively* chosen to meet specs
- Blending
- Scouring
- acidification (Conc. Sulphuric)
- Baking: cellulosic material “carbonised”
- Crushing, dusting
- neutralising
- bleaching
- drying
- testing: count VM
- baling

NB: often only micron is guaranteed, most carbo types sold by sample, “guarantee” is that lot is like sample

Woollen Inputs

- Synthetics
  - Nylon
  - Acrylic
  - Polypropylene

    Enhance production efficiency & product performance
- Exotics
  - Cashmere
  - Angora
  - Mohair
  - Alpaca

Fibre Specification For Carding Wools

- Fibre micron, “fibre length” (of staples)
  - Currently no good measure of carding wool properties available to predict their processing and product performance in the way that the TEAM formula or TOPSPEC can.
  - Open & Broken Top specified like Worsted Tops

Length After Carding (LAC)

- Developed by CSIRO and others, now being pushed by AWTA for IWTO approval
- LAC: samples carded on “standard” card , 3 passages of back draft gill then Almeter.
- Most processors suspicious of its merits.
- Carding Wools highly variable: good sampling techniques are essential

Fibre Specification For Carding Wools

- Sirolan Tensor can provide measure of fibre bundle strength.
  - May correlate with performance in carding
  - May be measure of damage caused in carbonising or dyeing
  - Research is on-going

Loose Stock Dyeing

- Conducted in large Vats
  - damages fibre
  - sets fibre in an entangled state:
  - causes fibre breakage in carding
  - provides colour blends that are only obtainable in this way
- Addition of auxiliaries
  - Anti-Setting Agents (ASA's)
  - Sirolan LTD: allows lower temperatures to be used:

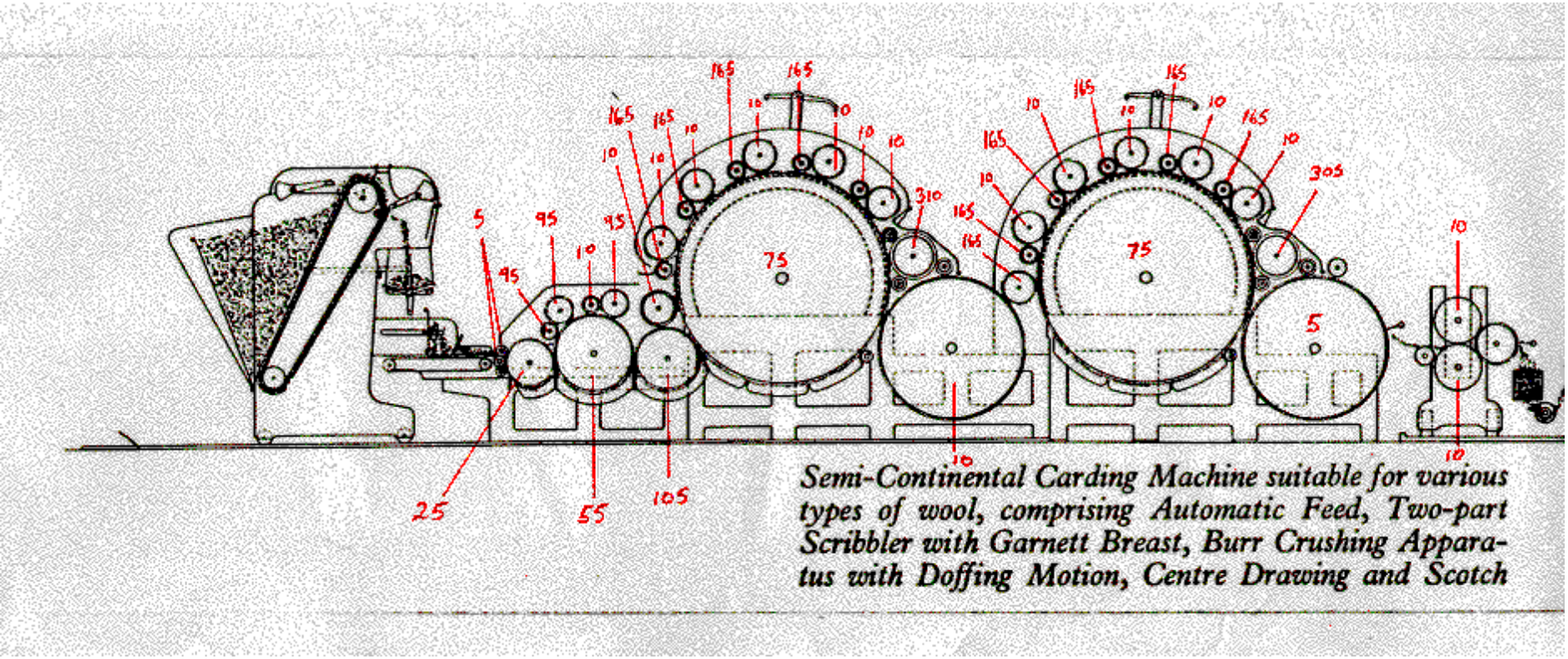
BLENDING

- Provides large scale uniformity of Product:
  - **Colour:** many different colours may be used in woollen blends
  - **Fibre:** **many** different *types* may be used
  - **Lubrication:** up to 10% oil is used on Woollens
    - High short fibre content common, oil and adhesion aids keep fibre on the card: improves yield

The Purpose of Carding

- Opening & Individualisation of Fibres
- Intimate Blending of Fibres
- Parallelisation of Fibres
- Formation of a uniform web
- Division into “Slubbings” for Spinning

The Woollen Carding Machine

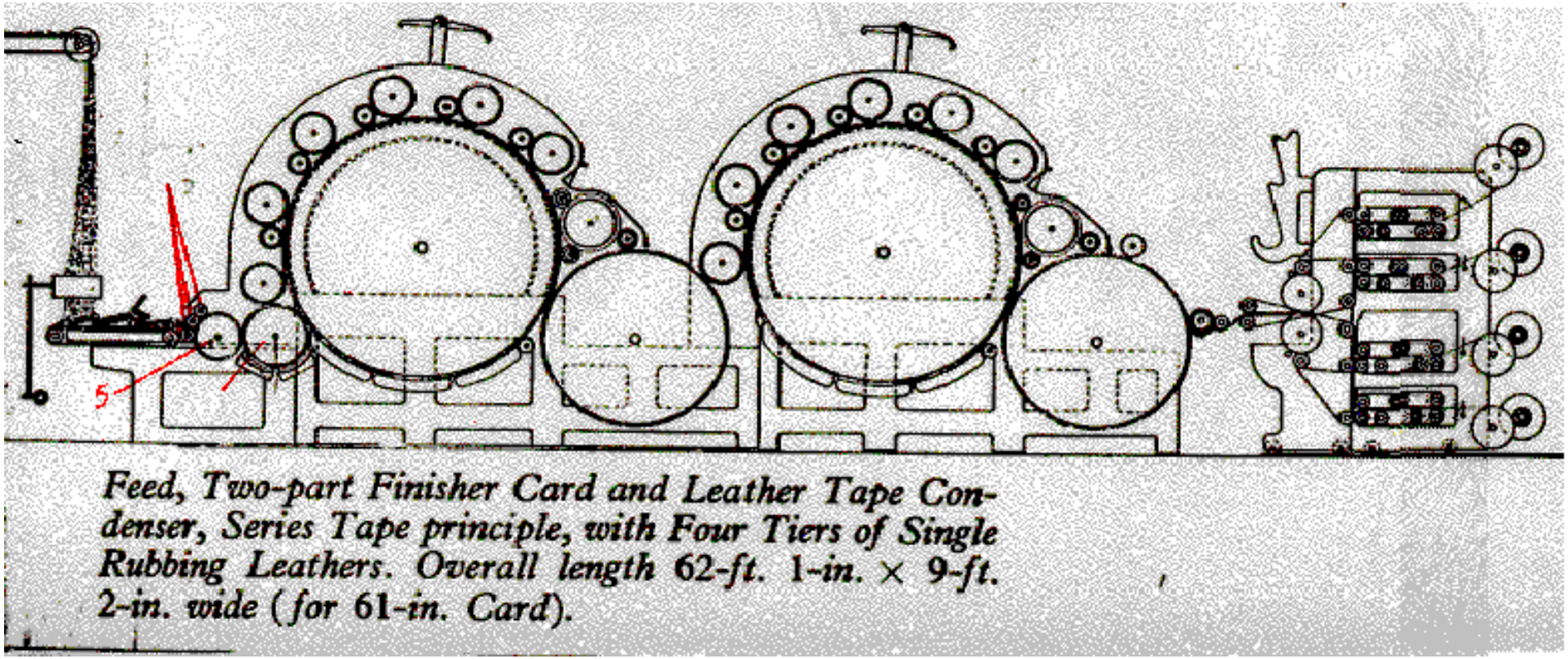


Semi-Continental Carding Machine suitable for various types of wool, comprising Automatic Feed, Two-part Scribbler with Garnett Breast, Burr Crushing Apparatus with Doffing Motion, Centre Drawing and Scotch

The Scribbler Section

Woollen cards use flexible “fillet” wire to get higher point density than worsted cards

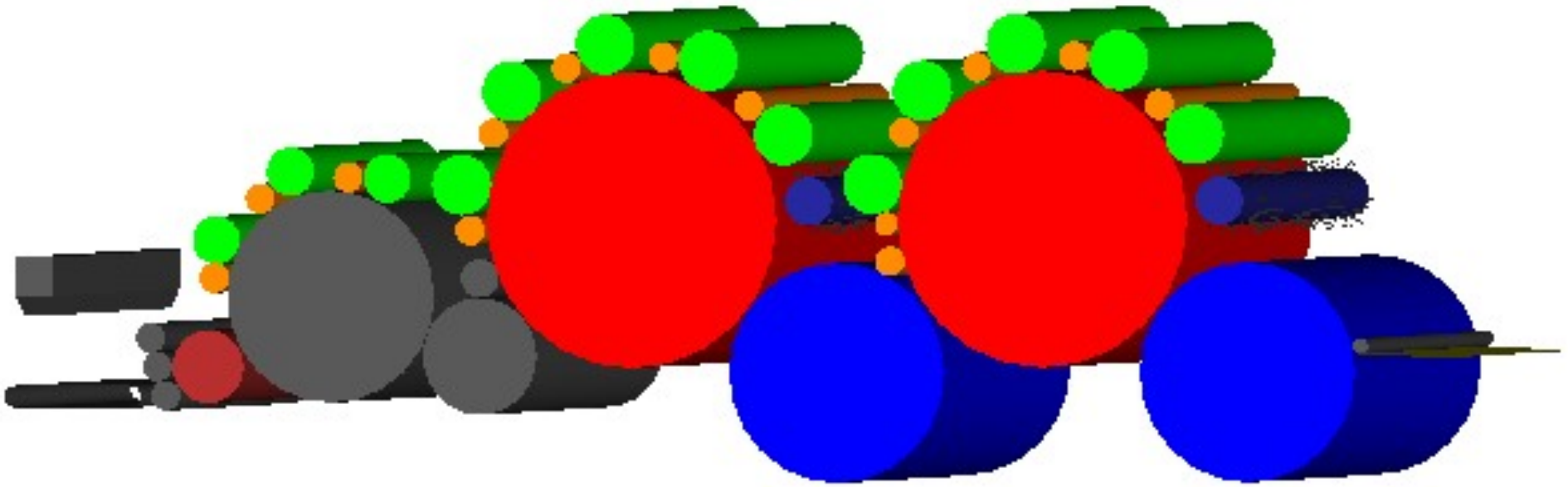
The Woollen Carding Machine



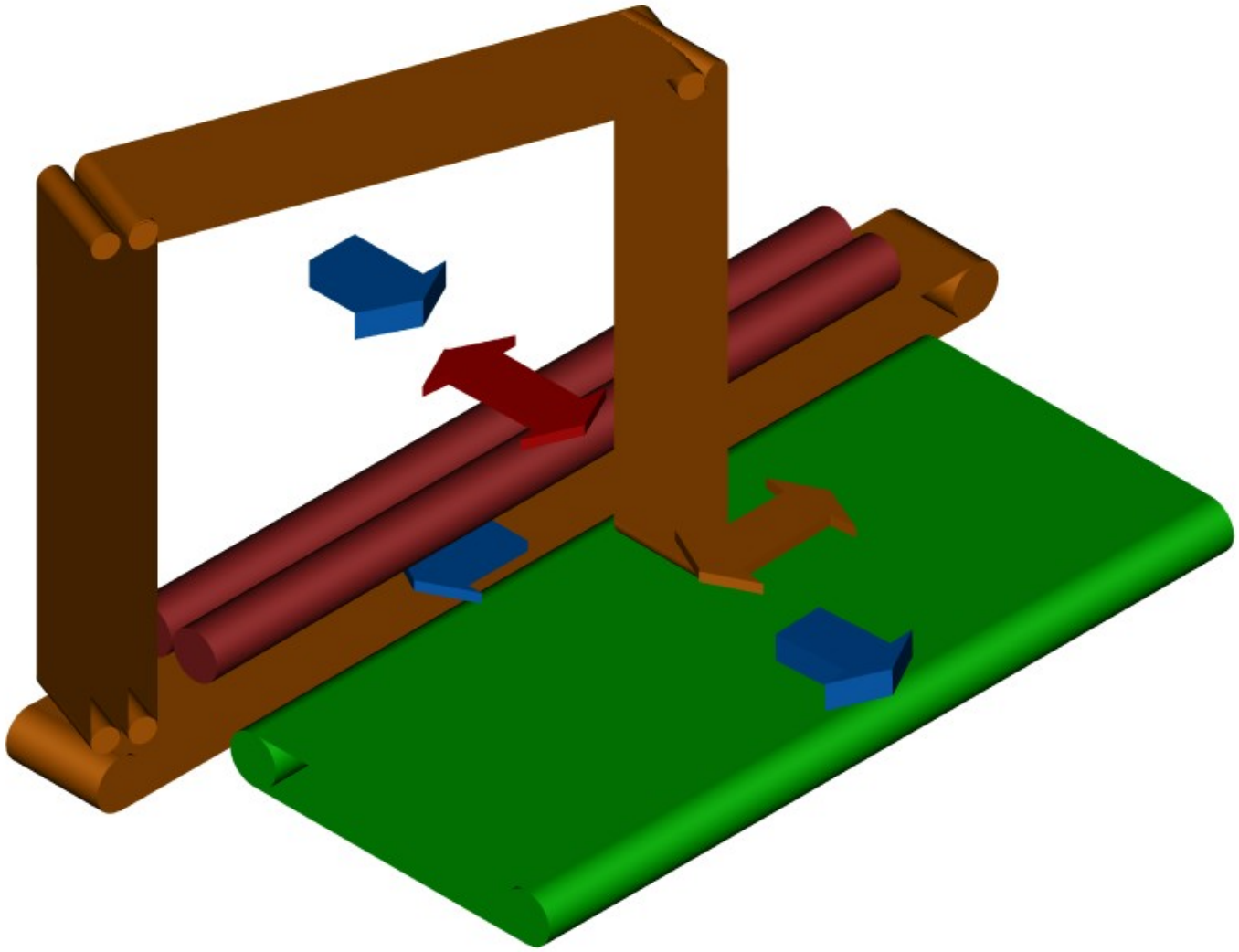
Feed, Two-part Finisher Card and Leather Tape Condenser, Series Tape principle, with Four Tiers of Single Rubbing Leathers. Overall length 62-ft. 1-in. × 9-ft. 2-in. wide (for 61-in. Card).

The Finisher Section

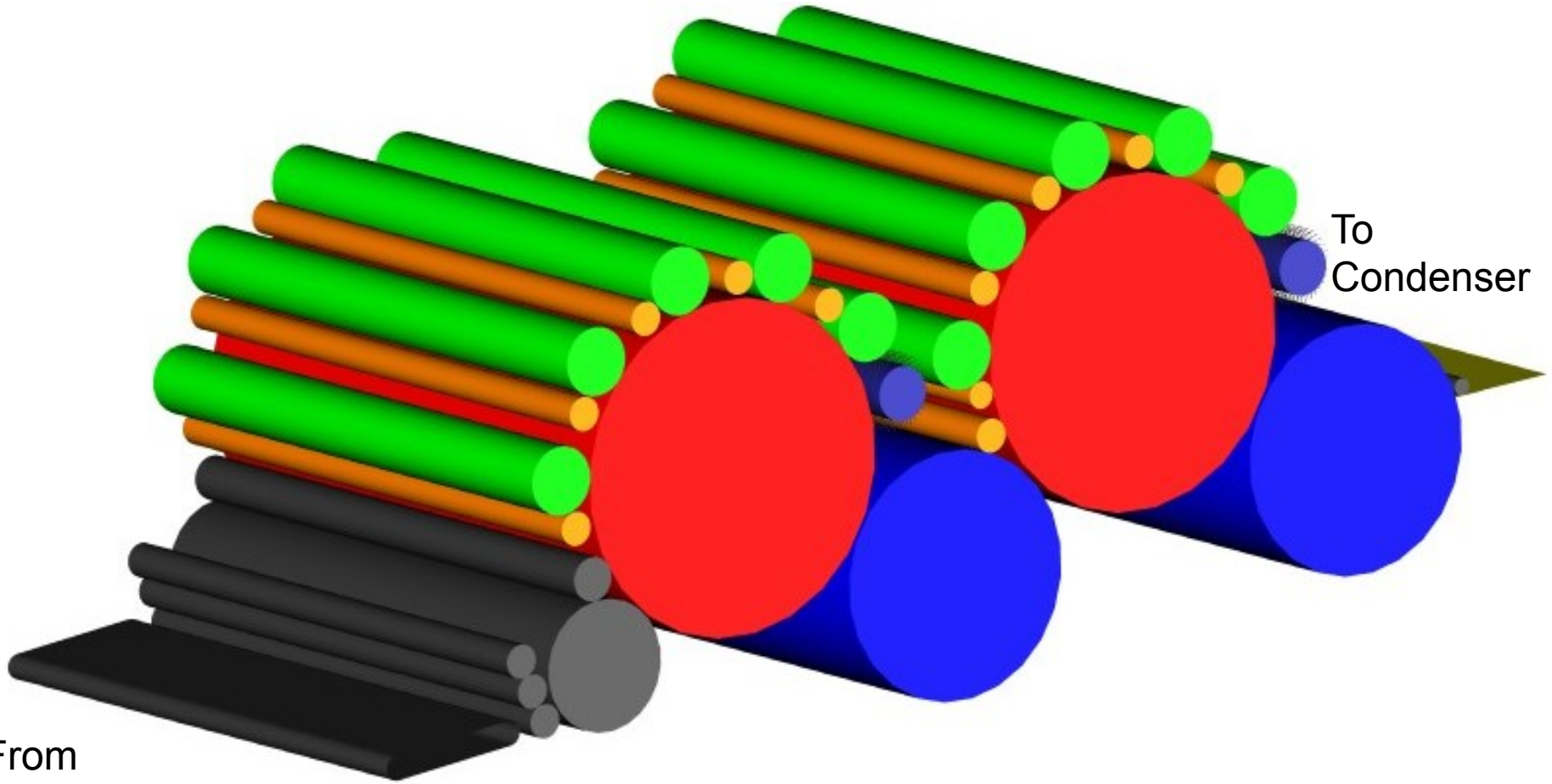
Woolen Card – Fore Part



Woollen Card Intermediate



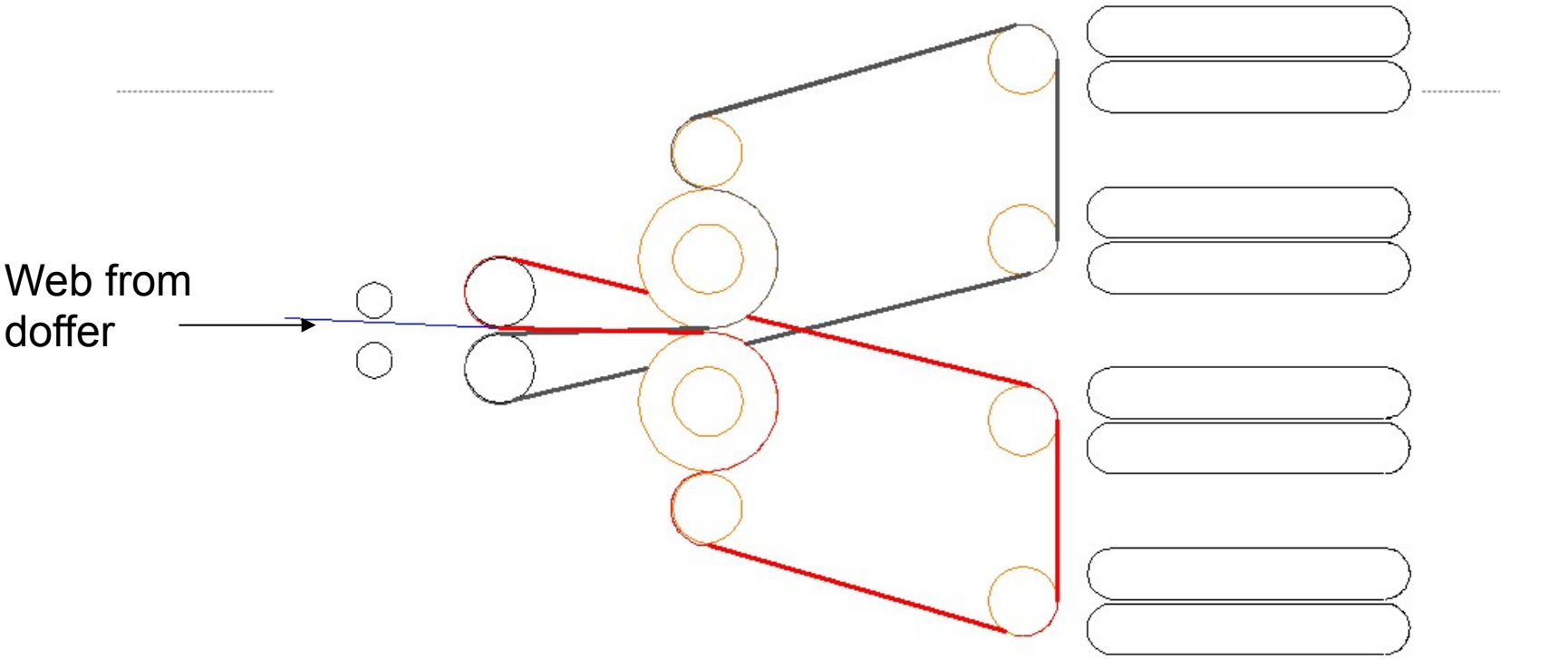
Woollen Card Finisher Section



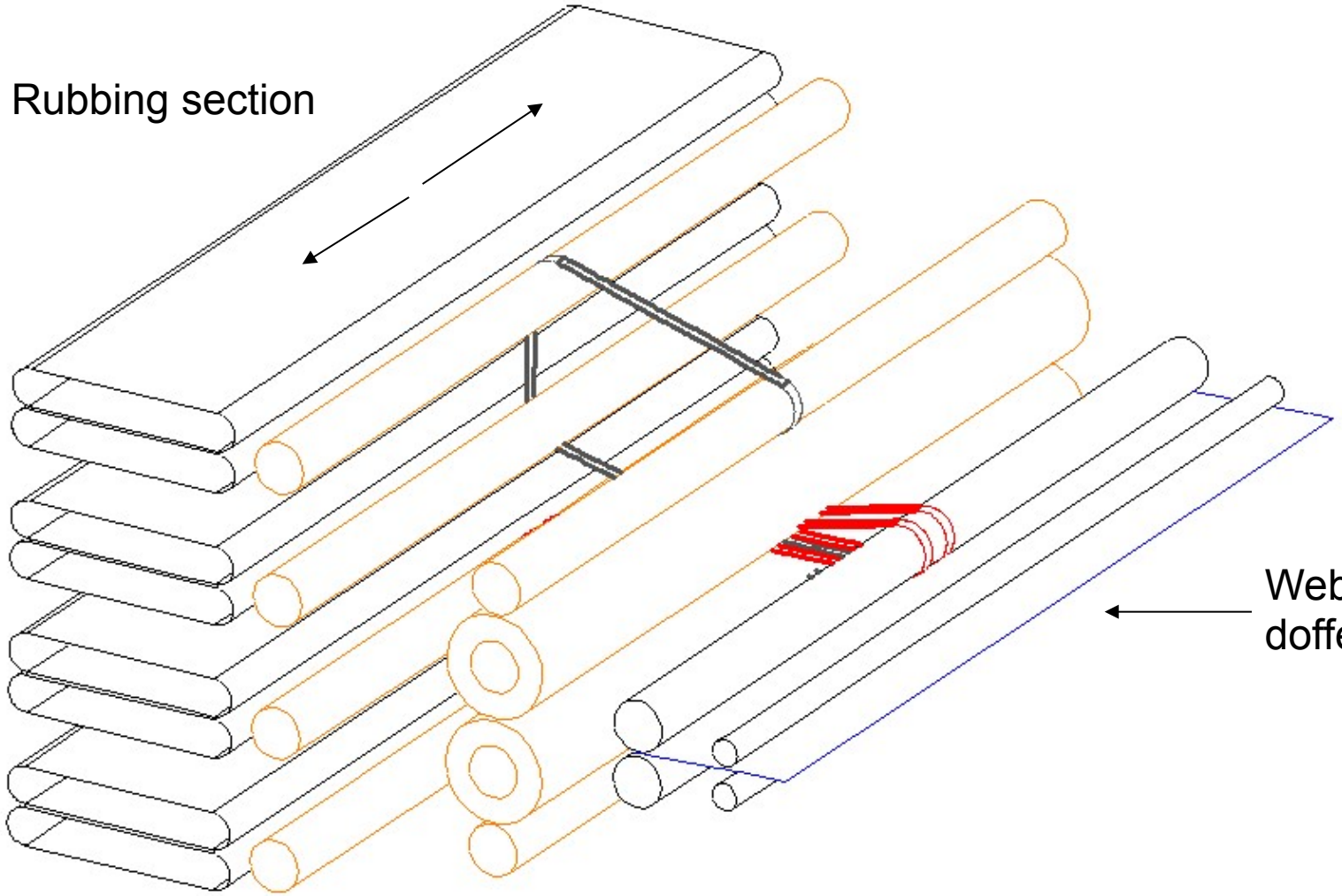
Woollen Card Condenser

Octir Woollen Card

Woollen Card Condenser

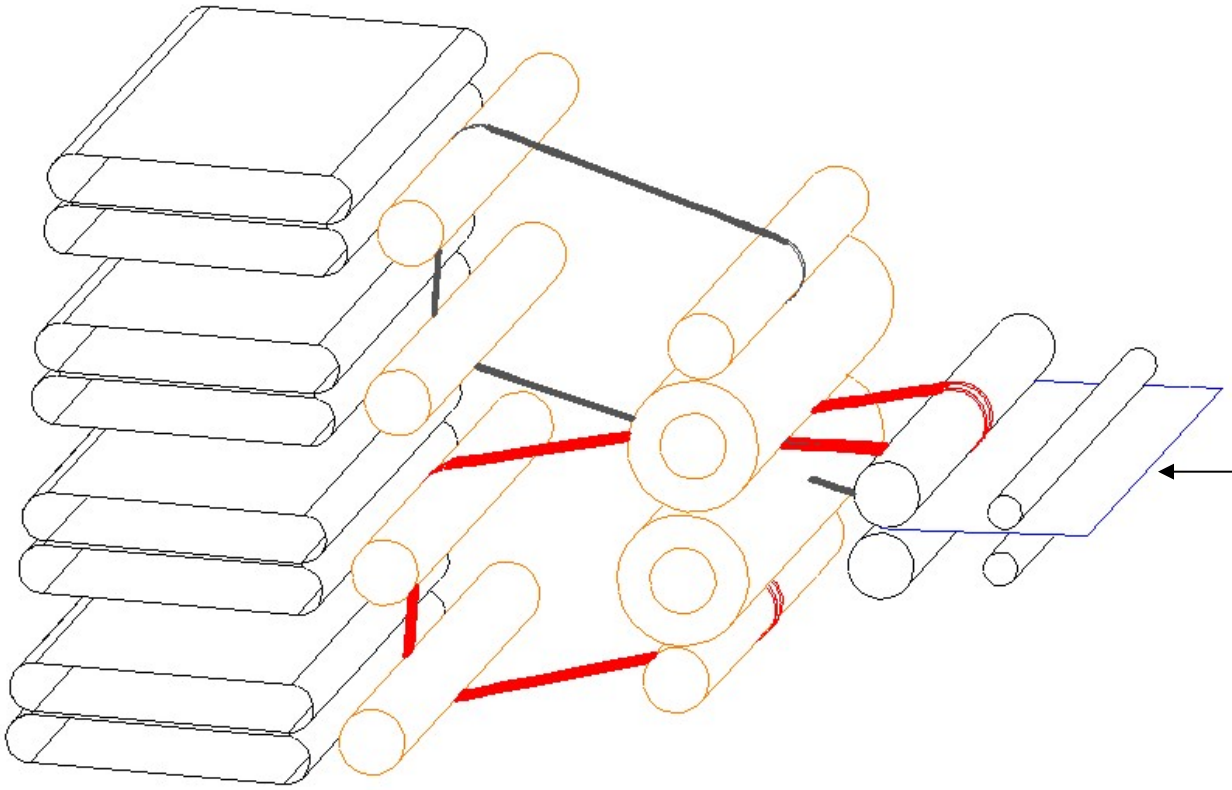


Woollen Card Condenser



Woollen Card Condenser

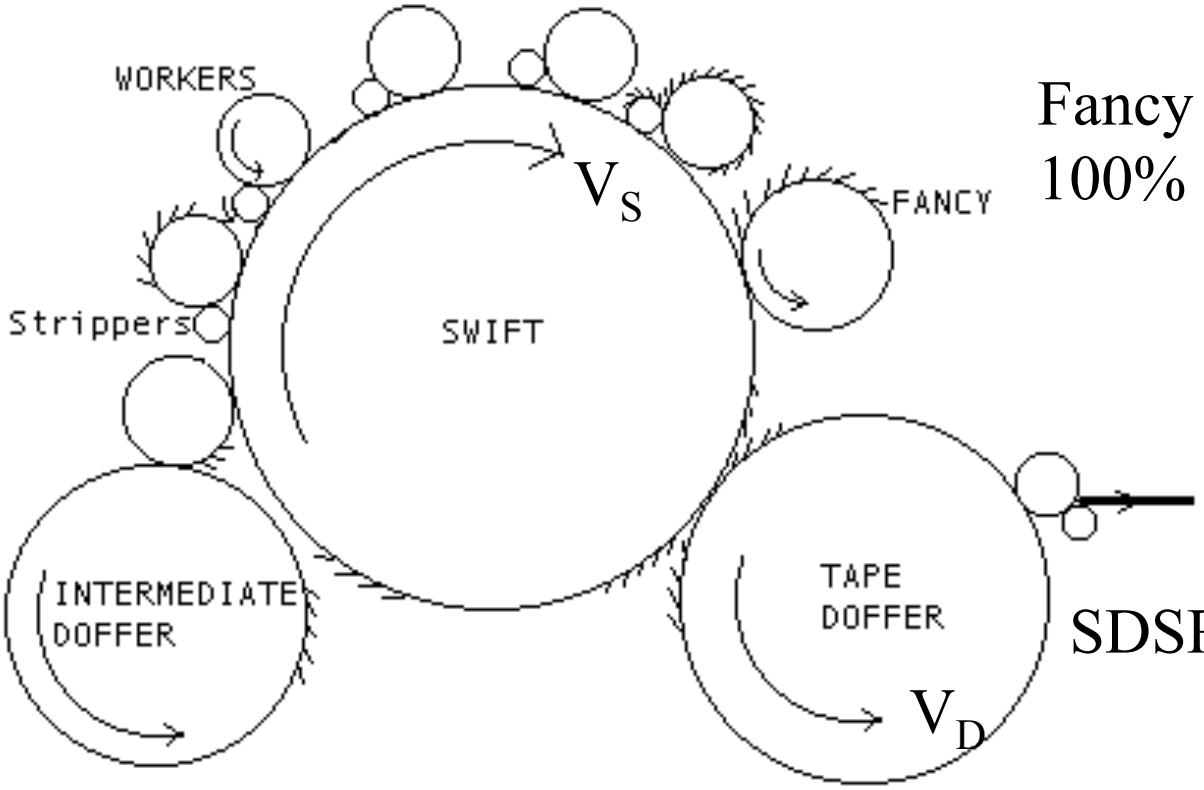
Rubbing section



To Slubbing Creel

Web from doffer

The Woollen Carding Machine



Fancy Lead =
$100\% * (V_F - V_S)/V_S$

$SDSR = V_S / V_D$

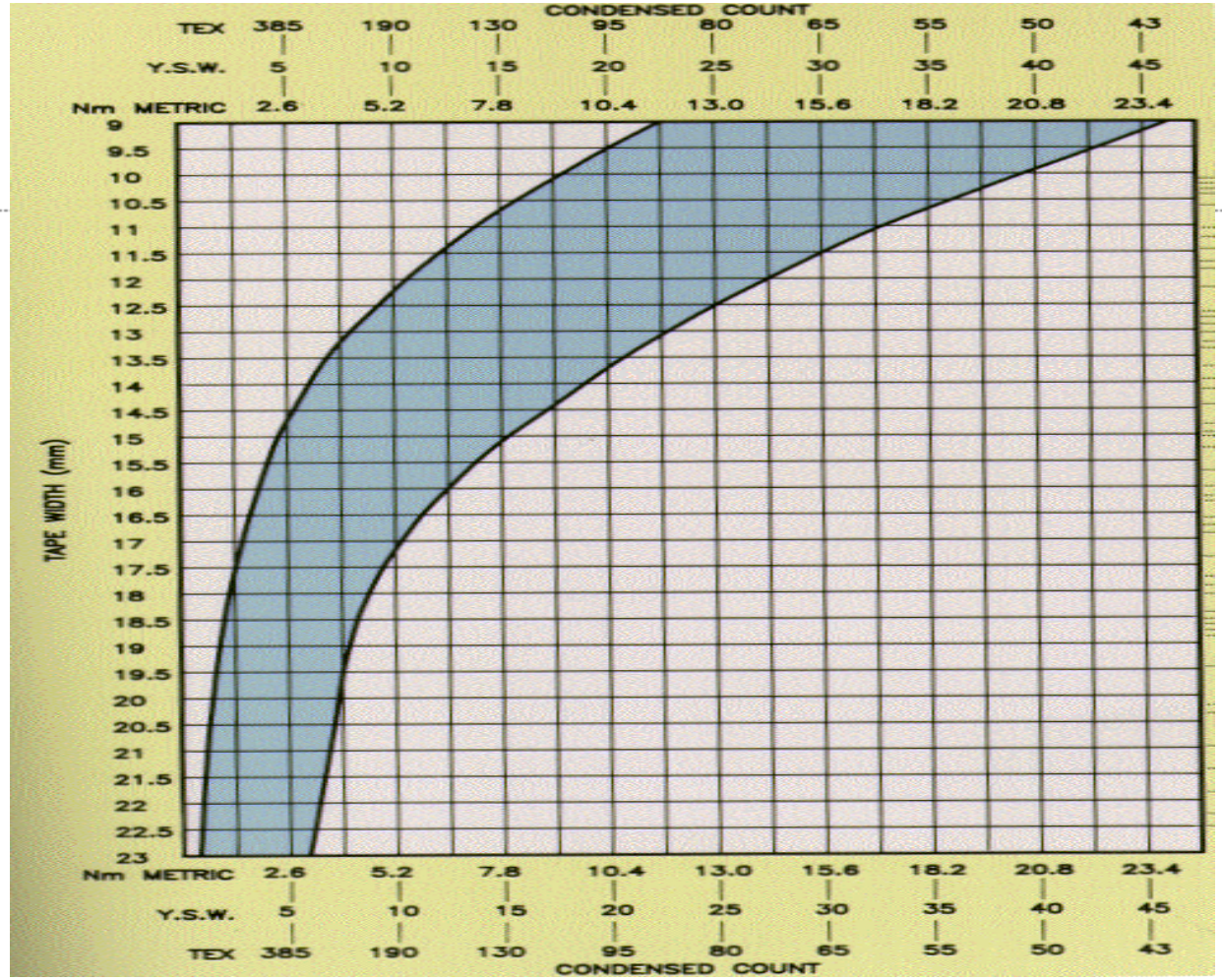
The Swift-to-Doffer-Speed-Ratio and the Fancy Lead determine Transfer Efficiency and hence the degree of fibre recycling.

Woollen Carding

Important Parameters:

- Fibre micron
  - The more fibres in the yarn the more even it is
  - card wire limits micron range
  - yarn count dictated by micron >90fibres
  - tape width also limits range of counts available

Condenser Tape Width v. Yarn Count



Courtesy Tatham UK

Woollen Carding

Important Parameters:

- Fibre Length & Strength
  - The Longer the fibres the better
  - Stronger fibres maintain Length → better yarns
  - Small Quantity of Synthetic fibre can improve performance dramatically

Woollen Carding

- Generally, the lower the fibre loading the better the web evenness → better yarn
- The weaker or shorter the fibres:
  - the lower the loading must be
  - the lower the maximum production rate

Woollen Carding

Important Parameters:

- Card Clothing and configuration limits the range of fibre inputs
- Roughly, fibre number is kept constant on the card: finer fibres = lower kgs loading = lower speed
- Coarser counts: faster delivery possible
- Industrially, Swifts are not run faster than 450m/min.
- Delivery ranges from 15m/min (fine counts) to 50m/min (carpets)

Woollen Character

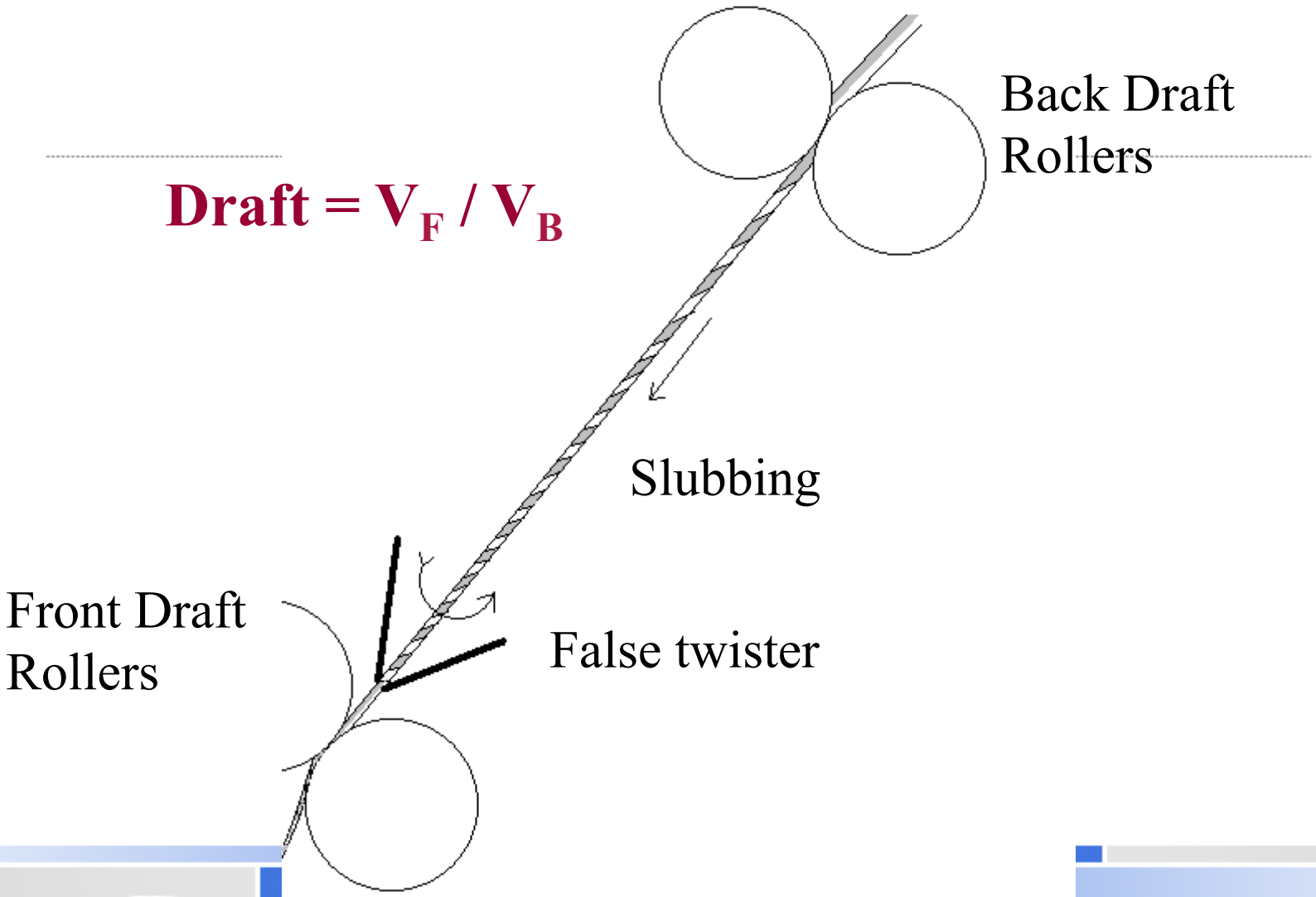
- Yarn Structure:
  - entangled, fibre loops & surface hairs provide “Woollen Character”
  - Gives BULK and HANDLE
  - Fabrics Often Milled & Raised
  - fewer fibres contribute to the yarn strength compared to Worsted Yarns
  - Many more fibres required in cross-section: usually >100

Woollen Spinning

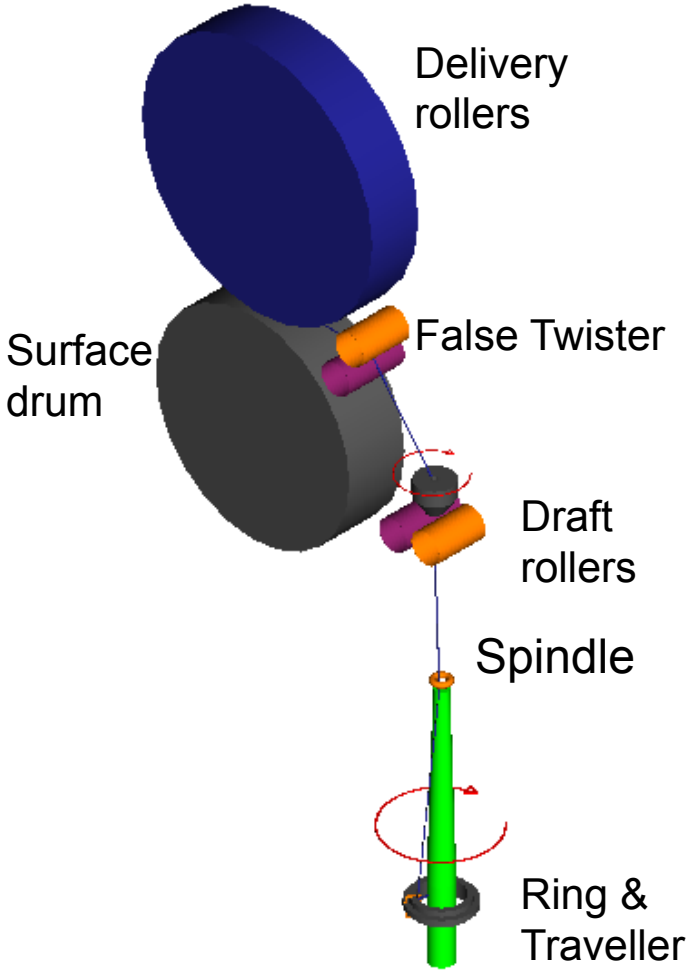
- Card Produces “Slubbings” [rovings]
- Slubbings drafted against “false” twist on Spinning Frame or Mule and “real” twist inserted to form a yarn
- Maximum draft in Woollen Spinning is about 1.3 to 1.5, slightly higher on Mules

Woollen Ring Spinning Draft

Draft = V_F / V_B

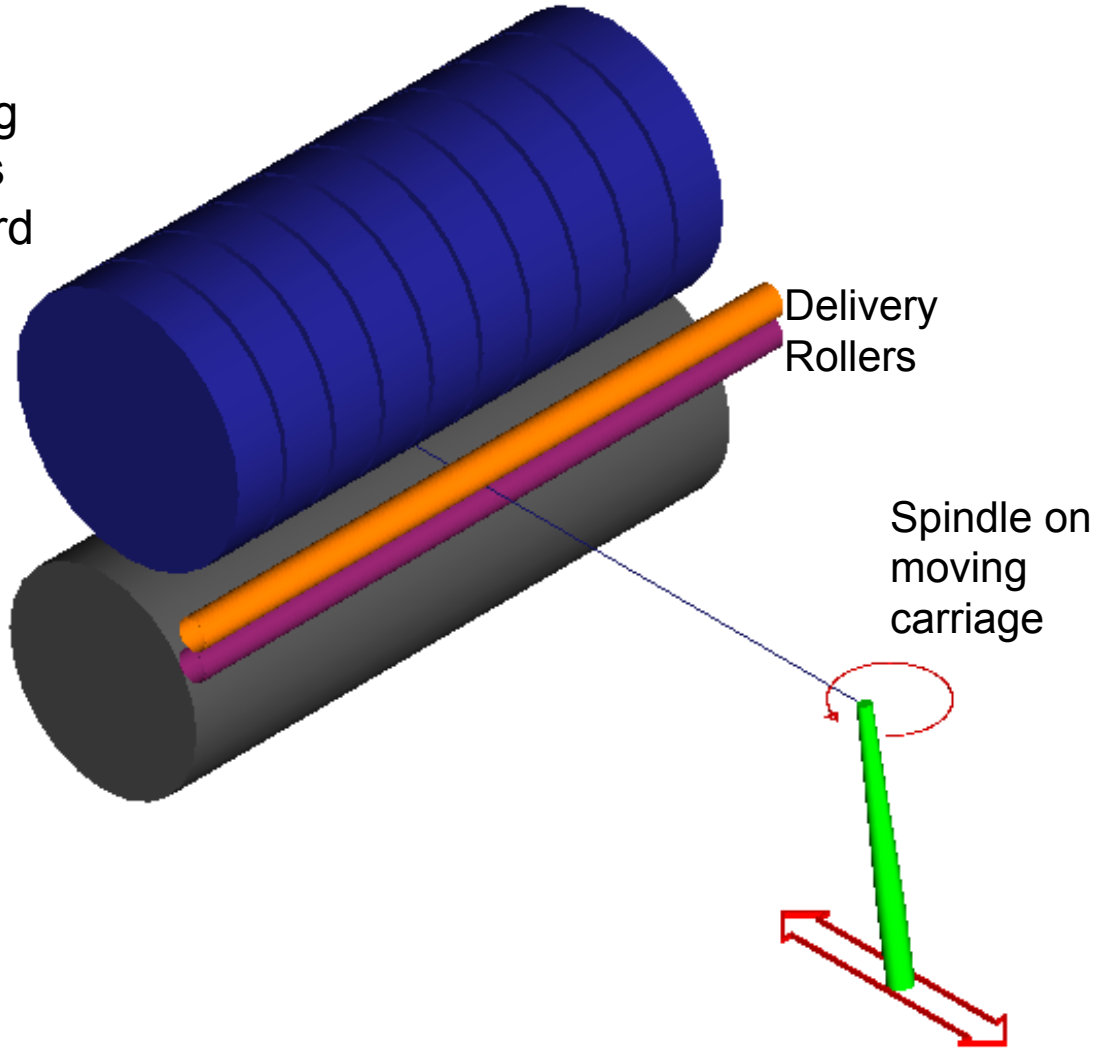


Woollen Ring Spinning



Mule Spinning

Slubbing
Bobbins
from card



Woollen Spinning Draft

- As Draft Increases up to ~1.35:
  - Fibres straighten
  - Strength Increases
  - Extensibility decreases
  - Above ~1.35 Quality decreases
- Drafting twist level affects draft quality
  - varies according to Spinning frame
  - α_m~30 is optimal on CSIRO's frame

Dilemmas:

Increased Fibre Quality

Increases Input costs

BUT

Increases Efficiency

Increases Product Quality

Decreases Conversion Costs

Dilemmas:

Increased Card Production Rate

Decreases Carding Cost

BUT ALSO CAN

Decrease Quality

Decrease Spinning Efficiency

Decrease Weaving Efficiency

Increase costs

Dilemmas:

Higher Spindle Speed

= Higher Productivity

= Lower Cost

BUT ALSO

= higher tension

= higher end breakage rate

=higher labour cost

= more joins

=lower quality

Woollen Products

- Knitted fabrics
- Woven fabrics
- Carpets: Tufted and Woven
- Felts

Metric Twist Factor
α_m = t.p.m./ √Nm

- Knitting Yarns: softer, lower twist
  - Knitting Twist Range

    α_m = 65 to 85
- Weaving Yarns need strength
  - Warp α_m = 85 to 120
  - Weft α_m = 75 to 95

After Spinning

- Similar to Worsted, thin & thick faults removed
- Twisting:
  - Two-fold or Three-fold common for knitting
  - Provides twist balance - no Spirality
  - Two-fold sometimes used for warp yarns
- Hanking:
  - Allows yarn to be dyed and set in relaxed state providing desirable YARN BULK

After Spinning

- Steaming:
  - Occurs at various stages to set twist
- Balling:
  - for hand knitting yarns only
- Tufting
  - To make carpets and specialist products like polishing discs and car seat covers

Woollen Yarn Units

Counts:

- Tex = g/km = 1000/Nm
- Metric Nm = m/g = 1000/Tex
- YWS, Yorkshire Woollen Skein
  = 1942 / Tex = Nm / 1.942

(YWS = length in yards that balances a 1/16 oz.)

Woollen Yarn Units

Twist:

- tpm = turns per metre
- tpi = turns per inch = tpm/39.4

Twist Factors:

- metric, α_m = t.p.m./ √Nm
- Twist multiplier = tpm √tex
- Twist multiplier = tpi / √YWS