TXL 221: Yarn Manufacture I

3 Credits

Course Coordinator: **Prof. Sohel Rana**
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Marks Distribution

Minor: 40

Quiz :   20

Major: 40

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Attendance Policy

- **Minimum Attendance** : 75%

- **Attendance less than 75%** : One grade down

- **Attendance more than 95%** : 5 bonus marks will be added to the final marks.

- **Late attendance** : Will be marked as absent after attendance has been already registered.

Course Outline (Lecture)

Opening/Blowroom:

- ✓ **Principle of fibre opening in blow room**
- ✓ **Principle of fibre cleaning in blow room**
- ✓ **Opening and cleaning machines**
- ✓ **Principle of fibre blending**
- ✓ **Recent developments**

Course Outline (Lecture)

Carding:

- **Objective and principle of carding**
- **Machine elements and operations**
- **Sliver formation and fibre configurations in sliver**
- **Automation and recent developments**

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Course Outline (Lecture)

Drafting/Drawframe:

- ✓ **Objectives, principles and methods of roller drafting.**

- ✓ **Purpose and principle of condensation of fibres.**

- ✓ **Causes of mass variation of sliver and control.**

- ✓ **Automation and recent developments in draw frames**

Reference Books

- ✓ **A Practical Guide to Opening and Carding, Short-staple Spinning Series (Volume 2), By W. Klein**

- ✓ **A Practical Guide to Combing and Drawing, Short-staple Spinning Series (Volume 3), By W. Klein**

- ✓ **Fundamentals of Spun Yarn Technology By Carl A Lawrence**

- ✓ **Handbook of Yarn Production-Technology, Science and Economics By Peter R. Lord**

- ✓ **Spun Yarn Technology By Eric Oxtoby**

- ✓ **NPTEL lecture series, IIT Delhi**

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Introduction

What is a yarn?

"A yarn may be defined as a product of substantial length and relatively small cross-section of fibres and/or filament(s) with or without twist, used for interlacing in processes such as knitting, weaving, or sewing"
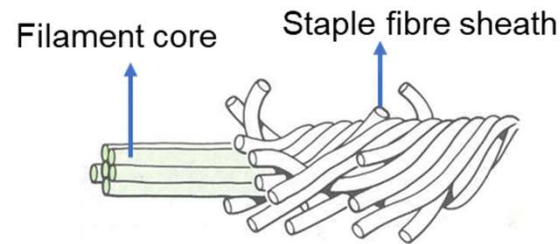
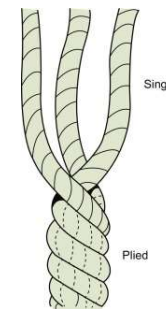## Different Types of Yarn

- **Continuous filament yarns**
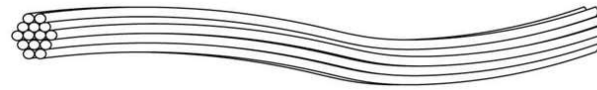
- **Staple spun yarns**

- **Composite yarns**

- **Folded/plied/doubled yarns**

Filament core   Staple fibre sheath

Single

Plied

Production of Staple Yarn: Cotton and Blends

Removal of cotton
fibre from seeds

Ginning process

227 kg each
0.2 g/cm^3

Cotton Bale

Seed fibre, cellulosic, hydrophilic

How to make cotton yarn from bale?

✓ **Opening**
✓ **Cleaning** why?

Impurities in Cotton Fibre

- **Vegetable matter (50-80%)**
  Seed fragments, stem fragments,
  leaf fragments, etc.

- **Mineral matter (10-20%)**
  Dust, sand, soil, etc.

- **Fibre fragments**

- **Others**
  Metal particles, cloth fragments,
  packaging materials, etc.

Problems?

Yarn fault, damage to machines, health hazard to the workers
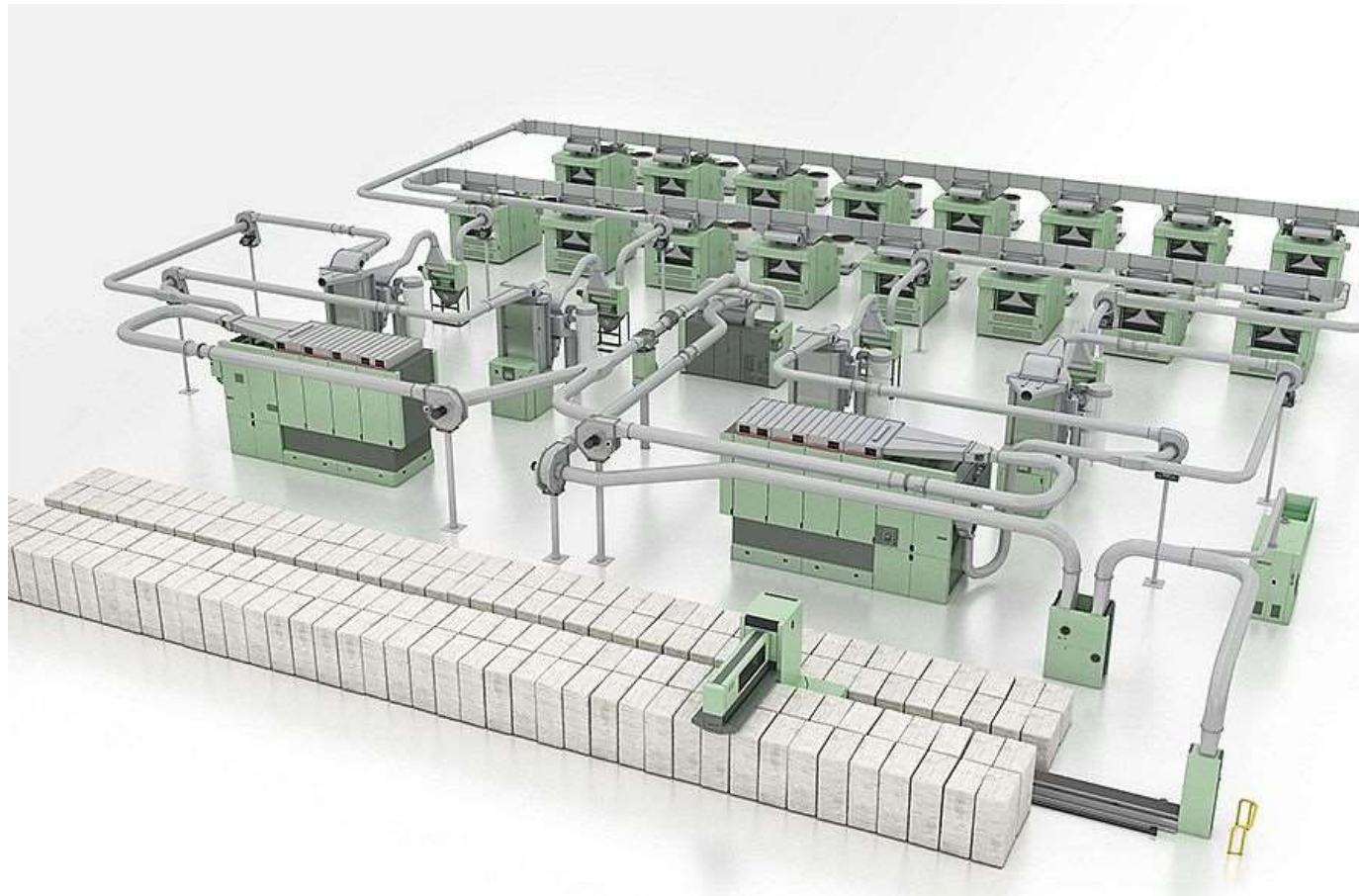
Trash size > 500 micron
Dust < 50 micron
Micro dust < 15 micron

How staple yarns are produced?

Fibres in compressed form → Opening, cleaning, blending → Individualization

Individualization → Attenuation → Parallelization → Twisting → Yarn
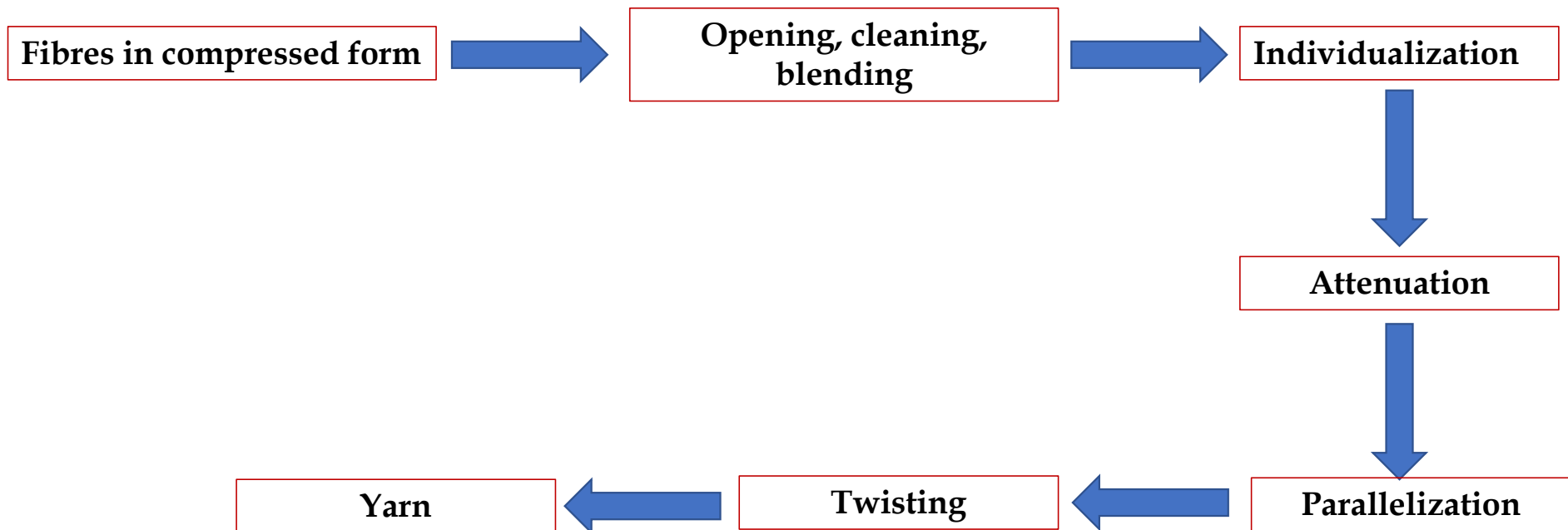
Spinning Process Flowchart
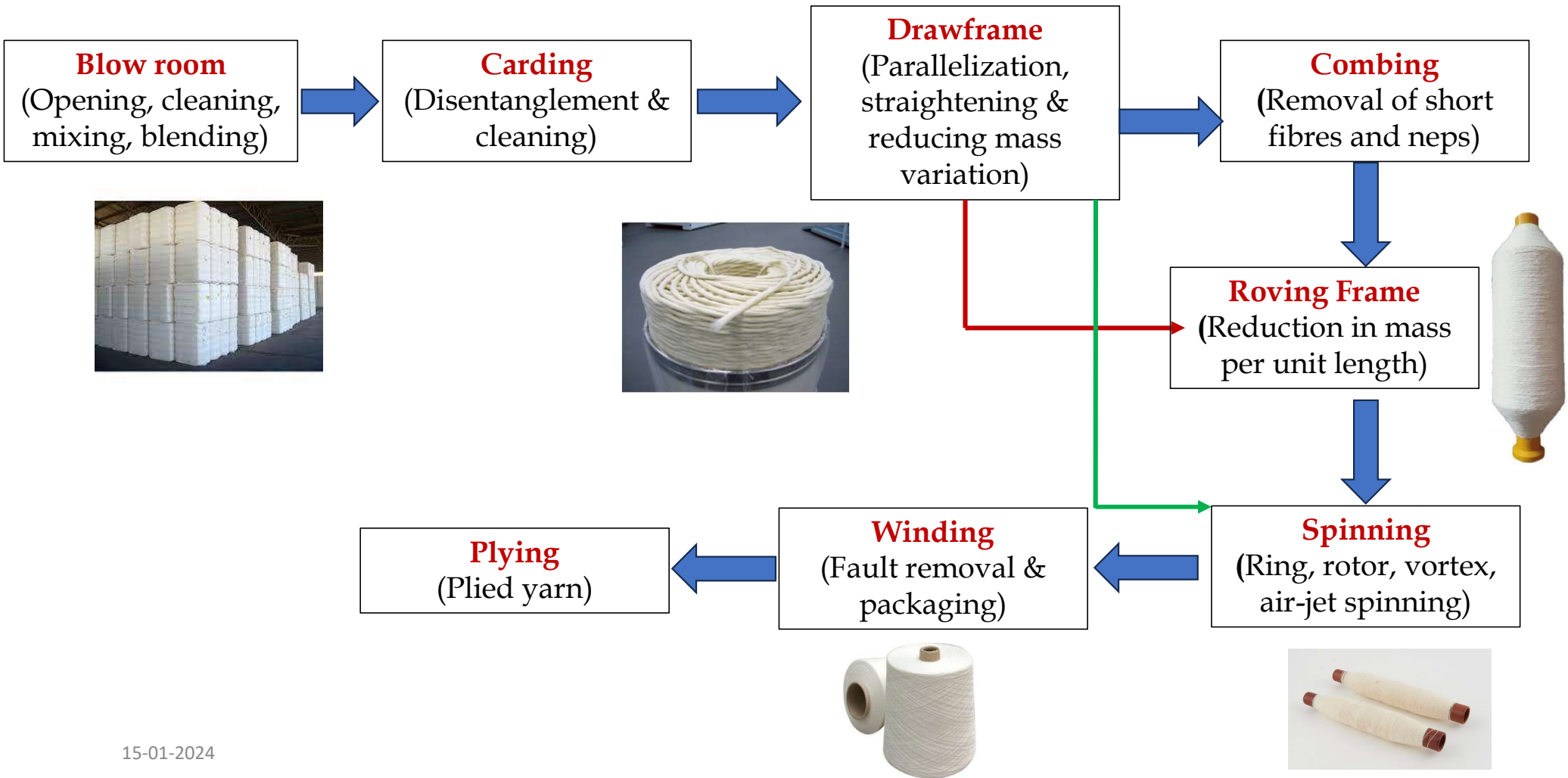
Blow room
(Opening, cleaning, mixing, blending)

→

Carding
(Disentanglement & cleaning)

→

Drawframe
(Parallelization, straightening & reducing mass variation)

→

Combing
(Removal of short fibres and neps)

↓

Roving Frame
(Reduction in mass per unit length)

↓

Spinning
(Ring, rotor, vortex, air-jet spinning)

←

Winding
(Fault removal & packaging)

←

Plying
(Plied yarn)

Blowroom

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Blowroom

Introduction to Blowroom

Fibres come to spinning mill in bale form.

BALE
Compact
Easy for transportation

Opening

Cleaning

Blending

Further processing
(Lap formation/chute feed to card)
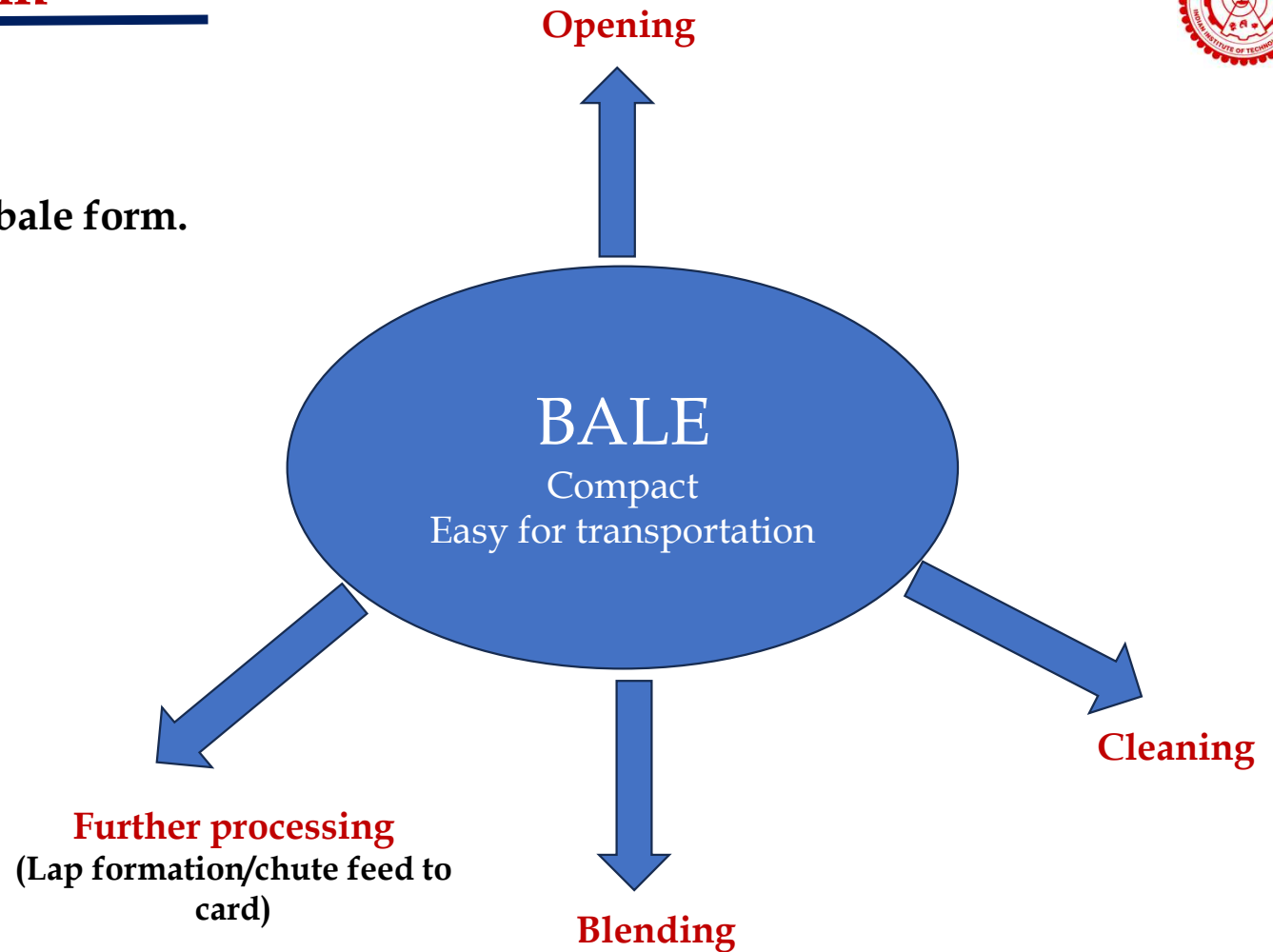
Blowroom Operating Zones
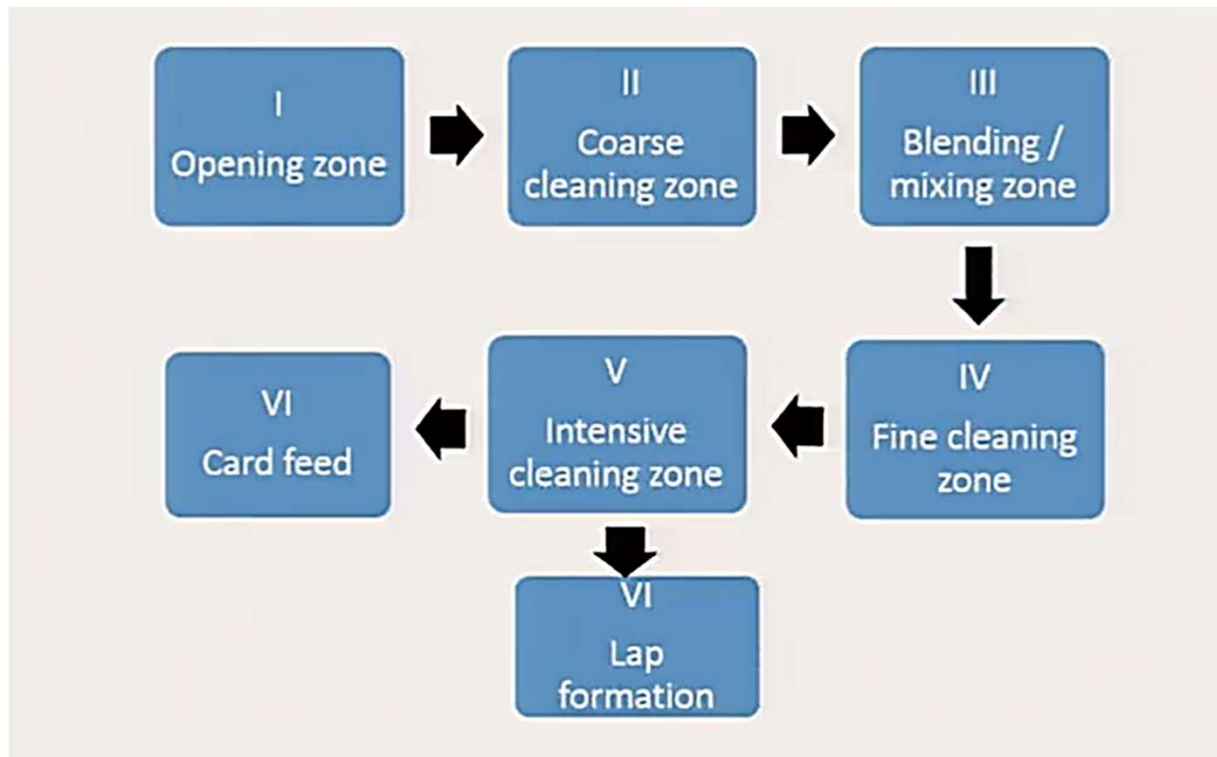
Why Blowroom has different zones and machines?

Opening of Bale

How to open bale?

    ✓ **Removing individual fibres from bale ?**

    ✓ **Dividing and subdividing bales?**

Question: In a spinning mill, cotton fiber is supplied in compacted bales of about 226.8 kg each. The bale dimensions is typically 1.4 ×0.53×0.64 m, and the bale density is 478 kg/m³. If the individual fibers are 30 mm in length and 1.7 dtex fineness and the production rate of the plant is 500 kg/h, then how many fibres need to be separated per second from the bale?

Ans:

No. of fibres in each bale = 45 billion (approx.)

No. fibres to be separated per hour = 98 billion, 27 million fibers per second

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Opening of Bale

How to open bale?

Removing large clumps of fibres from a bale

⬇

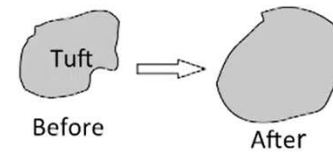| Progressively dividing the large clumps into many smaller pieces. |
| :---: |

➡

Option 1

Option 2

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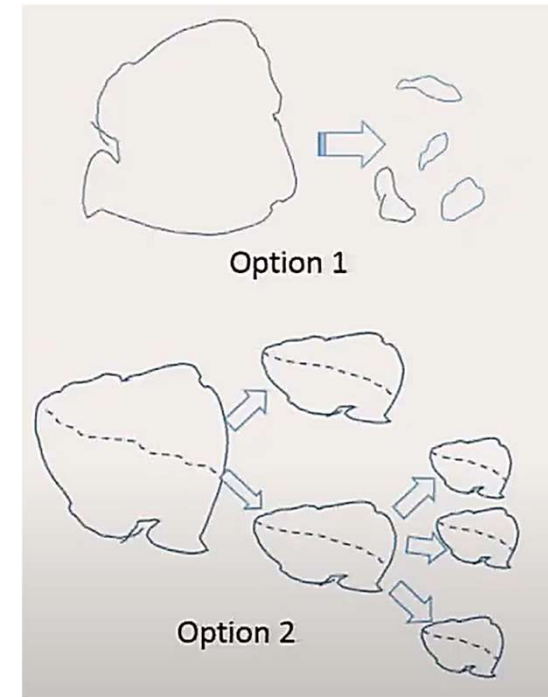
Opening of Tufts

Different Possibilities

✓ **A large tuft is divided into several smaller tufts**

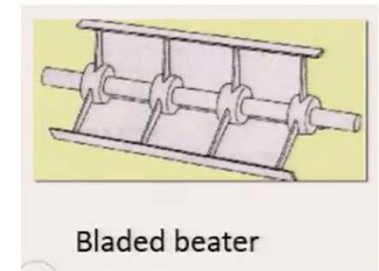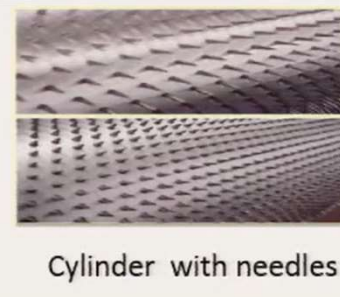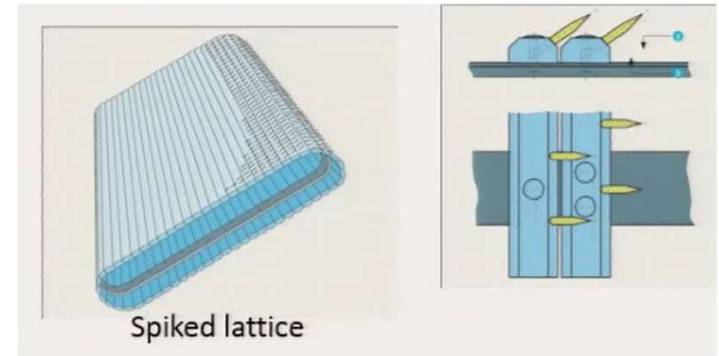✓ **Volume of tuft increases without disintegration**
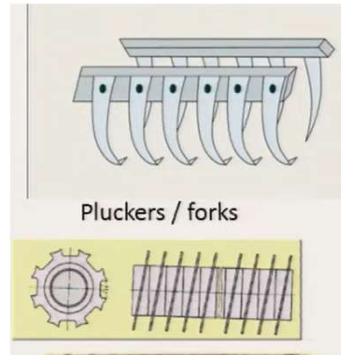
✓ **Shape of the tuft changes**

Before → After

Tuft Before → After

Before → After
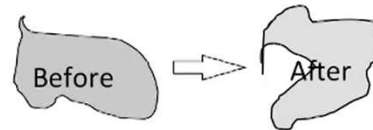
How to measure fibre openness?

- By measuring specific volume

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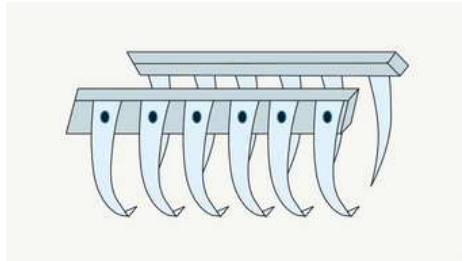
Opening of tufts: different principles

- ✓ **Plucking**

- ✓ **Tearing between oppositely moving spikes**

- ✓ **Teasing in nipped state by needles or saw tooth**

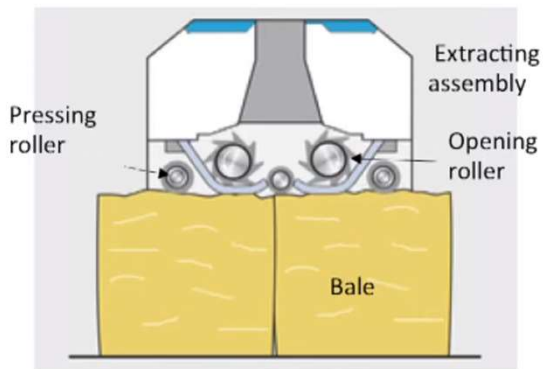- ✓ **Using impact force at nipped state or free flight**

Pluckers / forks

Spiked lattice

Drum with saw tooth

Cylinder with needles

Bladed beater

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Opening of tufts: different principles

Plucking out

Forks or Plucker
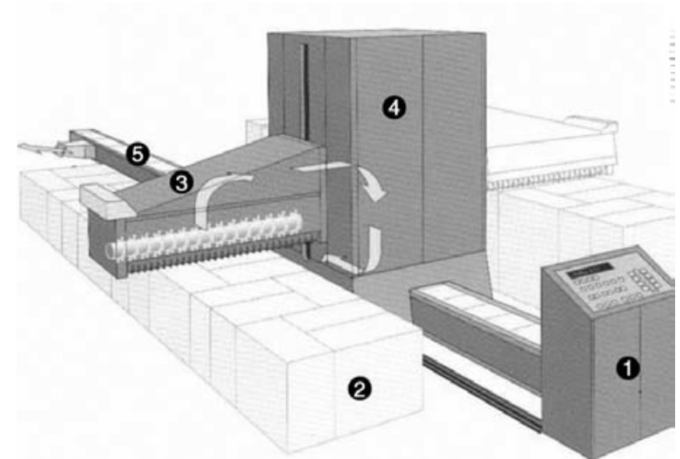
- Two spring systems facing each other.
- Material is grasped like finger
- Very gentle action
- Produces large tufts of uneven size

Rotating discs

✓ Two rotating disc picks up fibre tufts from bale surface
✓ Tuft size: 30-80 mg

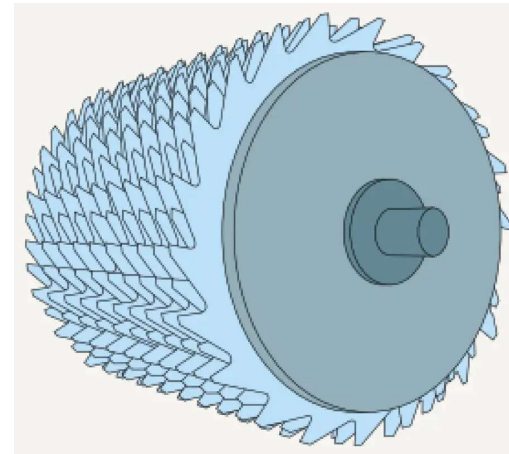

How blending is possible?
- Bale layout

Opening of tufts: different principles

Teasing out by Tooth disc

- ✓ **Tooth discs have triangular plucking elements**

- ✓ **The discs are secured to a shaft**

- ✓ **Asymmetrically formed**

- ✓ **Operate only in one direction**

- ✓ **If the disc needs to operate in both direction ?**

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Opening of tufts: different principles

Tearing

✓ **Tufts are acted by oppositely moving spikes and torn apart into pieces**

✓ **Thorough mixing How?**

✓ **Formation of neps**

✓ **The intensity of opening action depends on**

- **Distance between the spiked devices**
- **Speed relationships**
- **Total working surface**
- **No. of points**
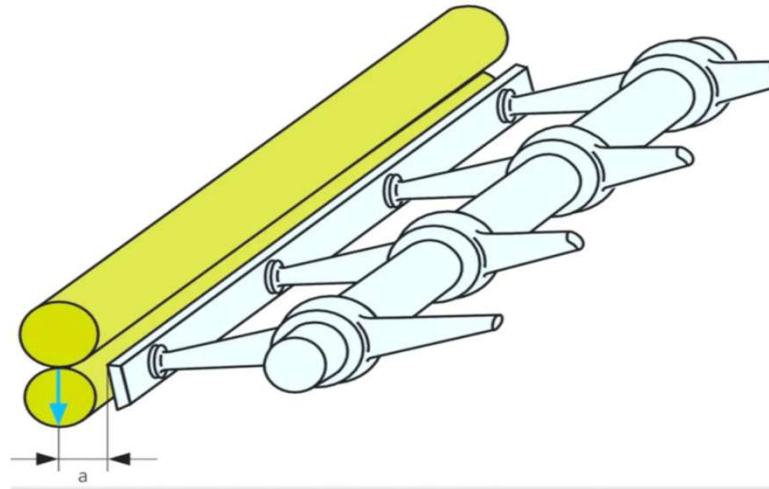

Evener roller
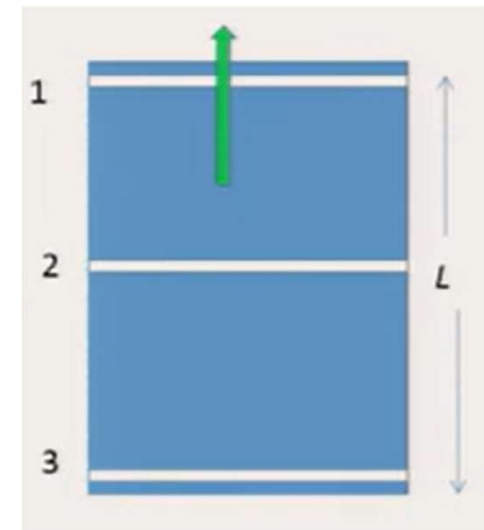
Spiked lattice
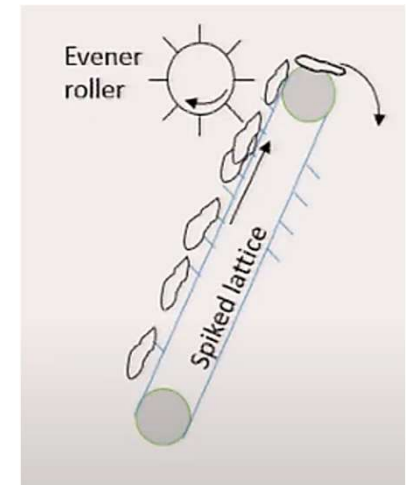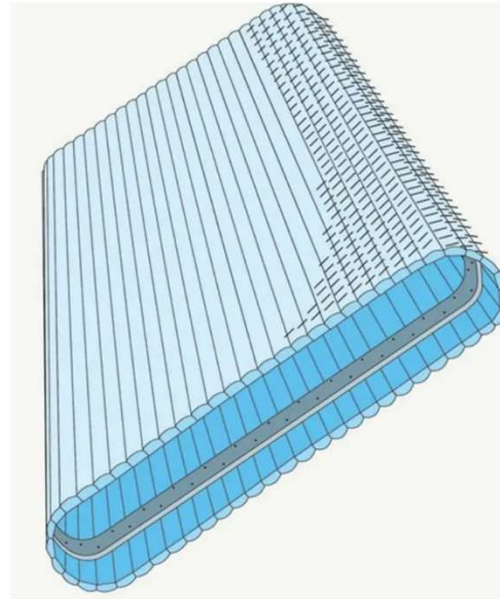
Mild action

Opening of tufts: different principles

Impact by Bladed Beaters

✓ **Consists of 2-3 beater bars**

✓ **In one rotation, the feed sheet receives 2-3 blows across the full width**

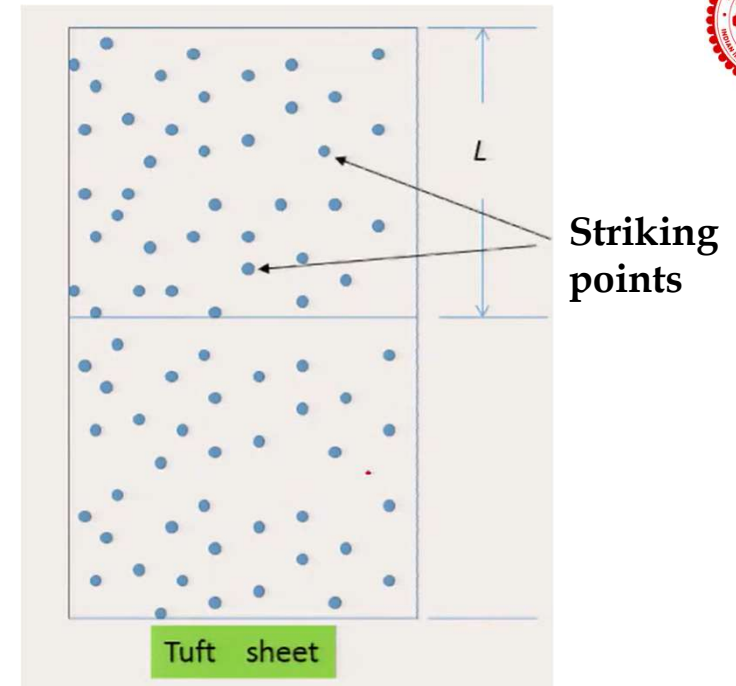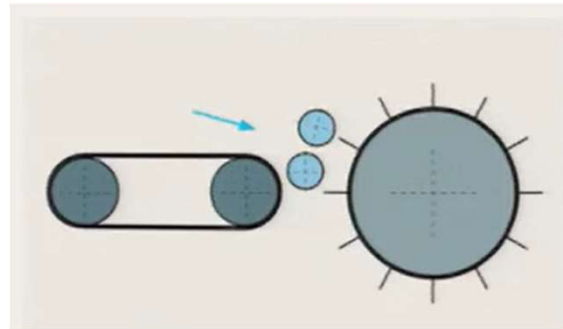
Opening and cleaning effect?
Low

Beating lines on tuft sheet

Feed length in one rotation

Opening of tufts: different principles

Impact by Strikers

Striking points

✓ Flat, oval or round bars are riveted or screwed to a cylinder

✓ Various spacing of the strikers elements may be used. **Why?**

✓ Speed: 600 – 1000 rpm

Opening intensity depends on
   ✓ Distance between feeding and opening elements
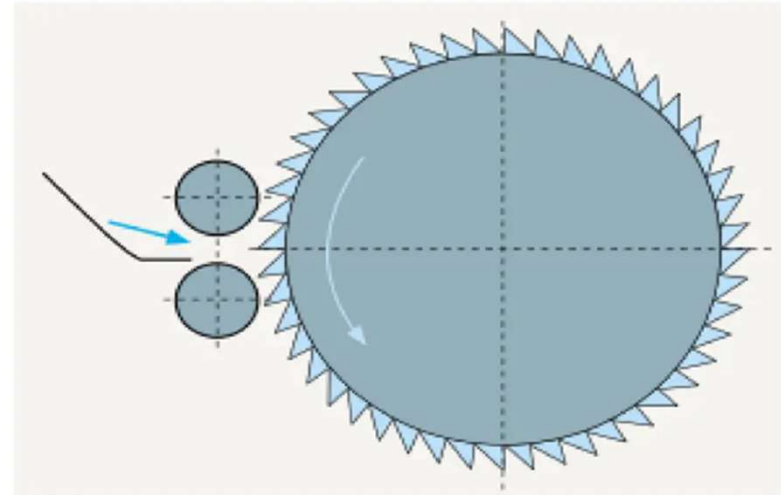   ✓ Speed ratio
   ✓ Number of striking elements

Why are the striking elements staggered?

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Opening of tufts: different principles

Teasing out by Saw teeth

- ✓ **A cylinder surface filled with saw tooth**

- ✓ <u>**Fine setting**</u> **between the elements**

- ✓ **Suitable for smaller flocks**

- ✓ **Generate new surfaces**

- ✓ **Spacing between teeth : 6 - 8.5 mm**
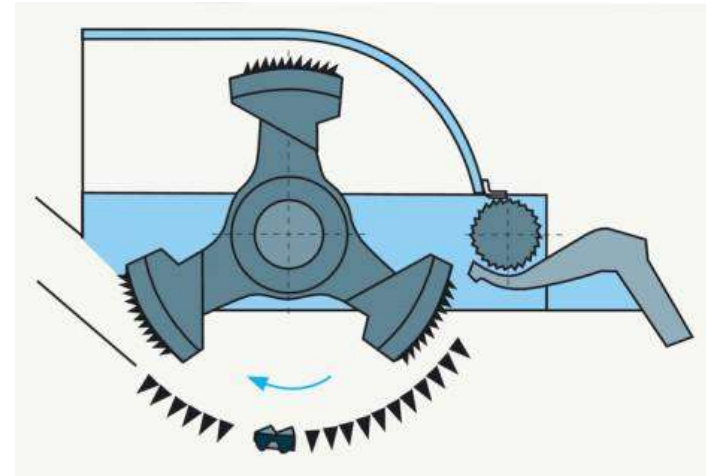   **Tooth height: 4.5 - 5.5 mm**

Suitable for finest opening and best cleaning.

Opening of tufts: different principles

Teasing out by Needles

- ✓ **Pinned bars are secured to the cast iron arms**

- ✓ **The inclined pins penetrate and combs through the fibres**

- ✓ **Generates new tuft surface and liberates trash particles**

- ✓ **Operates at 800-900 rpm**

Kirschner Beater

Cleaning efficiency is very high

Opening Intensity

✓ **Fibre Mass/Striker**

$$\text{Intensity of opening } (I) = \frac{P \times 10^6}{60 \times n_b \times N}$$

P = production rate (Kg/h), n_b = beater speed (rpm), N= number of strikers

✓ **Blows/Kg**

$$N_k = \frac{Blows\ per\ hour}{Production\ per\ hour\ (Kg)} = \frac{1}{P}(60 \times n_b \times N)$$

✓ **Beats/inch**

$$\text{Intensity} = \frac{Speed\ of\ beater \times number\ of\ blades\ on\ beater}{Delivery\ of\ feed\ roller} = \frac{Speed\ of\ beater \times number\ of\ blades\ on\ beater}{Circumference\ of\ feed\ roller \times speed\ of\ feed\ roller}$$

Typical beats per inch: 30-50

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