EVENNESS

Methods of Measuring Yarn Evenness:

In fact, to measure irregularity, many methods are available involving from no equipments to electric instruments.

Of all these we are to see,

Visual Examination Methods:

Using Black Boards, Drums, Photographic Devices, Projectors, and Lap Meter.

Cutting and Weighing Methods:

Lap Scale, Lap meter, Sliver, Roving, and Yarn Wrapping.

Electronic Capacitance Testers:

Fielden- Walker Evenness Tester and Uster Evenness Tester.

Variation In Thickness Under Compression:

WIRA Roving Levelness Tester and LINRA Roller Yarn Diameter Tester.

Photoelectric Testers:

WIRA Photoelectric Testers and LINRA Tester.

Miscellaneous Methods:

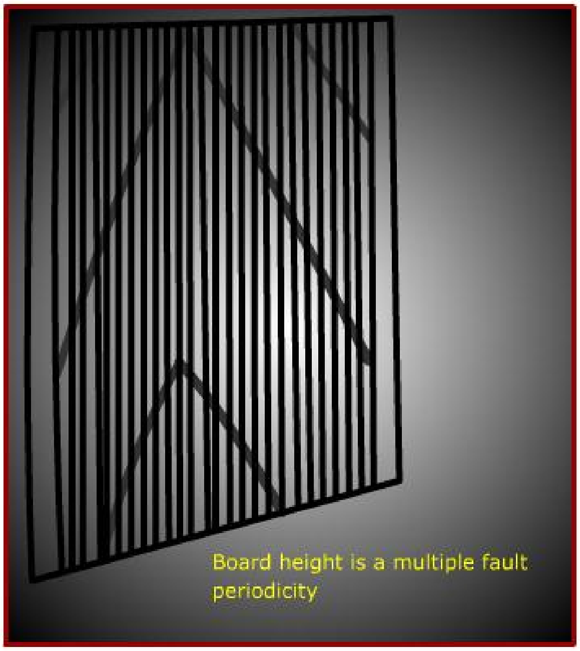
Airflow, Mercury Displacement, etc.

Before actually going into the methods in detail it must be kept in mind that the most important property of a yarn is the number of fibres in a cross-section and the variation of this number along the yarn is the fundamental measure of irregularity.

1. Visual Examination Method:

(a) Yarn appearance board:

- Yarn to be examined is wrapped onto a matt black surface in equally spaced turns.
- The black boards are then examined under good lightening conditions using uniform non-directional light. A.S.T.M. has a series of Cotton Yarn Appearance Standards which are photographs of different counts with the appearance classified in four grades.
- The test yarn is then wound on a blackboard approximately 9.5 x 5.5inches with the correct spacing and compared directly with the corresponding standard.



- Motorized wrapping machines are available: the yarn is made to traverse steadily along the board as it is rotated, thus giving a more even spacing.
- It is preferable to use tapered boards for wrapping the yarn if periodic faults are likely to be present.
- This is because the yarn may have a repeating fault of a similar spacing to that of one wrap of yarn.
- By chance it may be hidden behind the board on every turn with a parallel sided board whereas with a tapered board it will at some point appear on the face.

- Subjective measuring technique
- Provides important additional information that can be correlated with the appearance to be expected in fabrics made from yarn.
- Grading after viewing a sample of yarn wound with a designated traverse (depend on count) on a black board.
- ASTM standard test method describes the yarn appearance into five grades. The board is compared with standard photographs and then graded.

Grade A**:** No large neps, very few small neps, must have very good uniformity, less fuzziness.

Grade B**:** No larger neps, few small neps, less than 3 small pieces of foreign matters per board, slightly more irregular and fuzzy than A.

Grade C**:** Some larger neps and more smaller neps, fuzziness, foreign matters more than B, more rough appearance than B.

Grade D**:** Some slubs (more than 3 times diameter of yarn). More neps, larger size neps, fuzziness, thick and thin places, foreign matters than Grade C yarn. Overall rougher appearance than C.

Grade E**:** Below grade D, more defects and overall rougher appearance than grade D yarn

2.Gravimetric Method (Cutting and Weighing Method):

Lap-to-lap variation:

- By weighing individual laps, i.e. cut length in this case being the lap length.

a) Lap meter:

- Automatically unrolls the lap, break off a 1 yard length, and deposit into the pan of a scale
- Weights are recorded subsequently.
- Data analysis.

b) Slivers, roving and yarn:

- The count (hank) and count CV% are checked by measuring a test length and weighing it on an accurate balance.

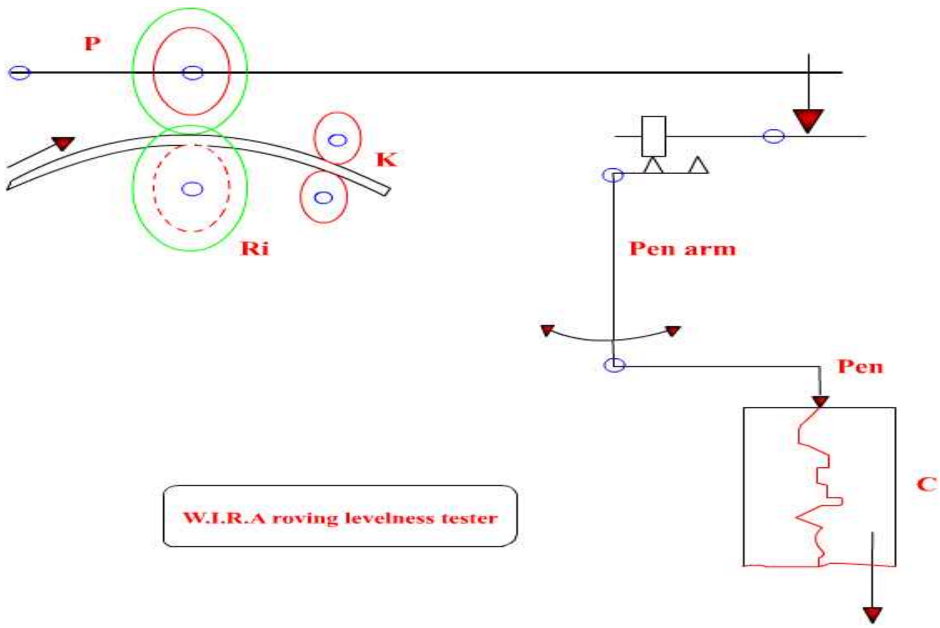
Normally, for sliver - 6 yard– by wrap block

For roving -15 yard – by wrap block

For yarns - 120 yard– by wrap reel

3. By Measuring Variation in Thickness Under Compression:

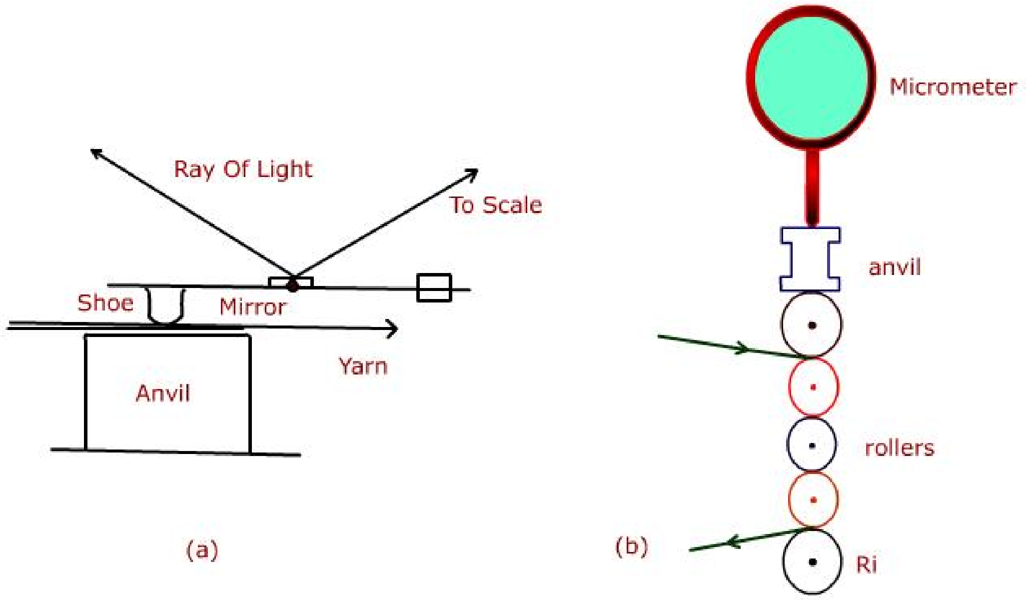
(a) *WIRA Roving levelness tester (sliver may also be used):*



b) Yarn testing by compression method:

i) Anderson yarn tester:

- The recording of yarn thickness variation taken from an optical arrangement.



Yarn testing by compression (a) Anderson yarn tester (b) the LINRA roller yarn diameter

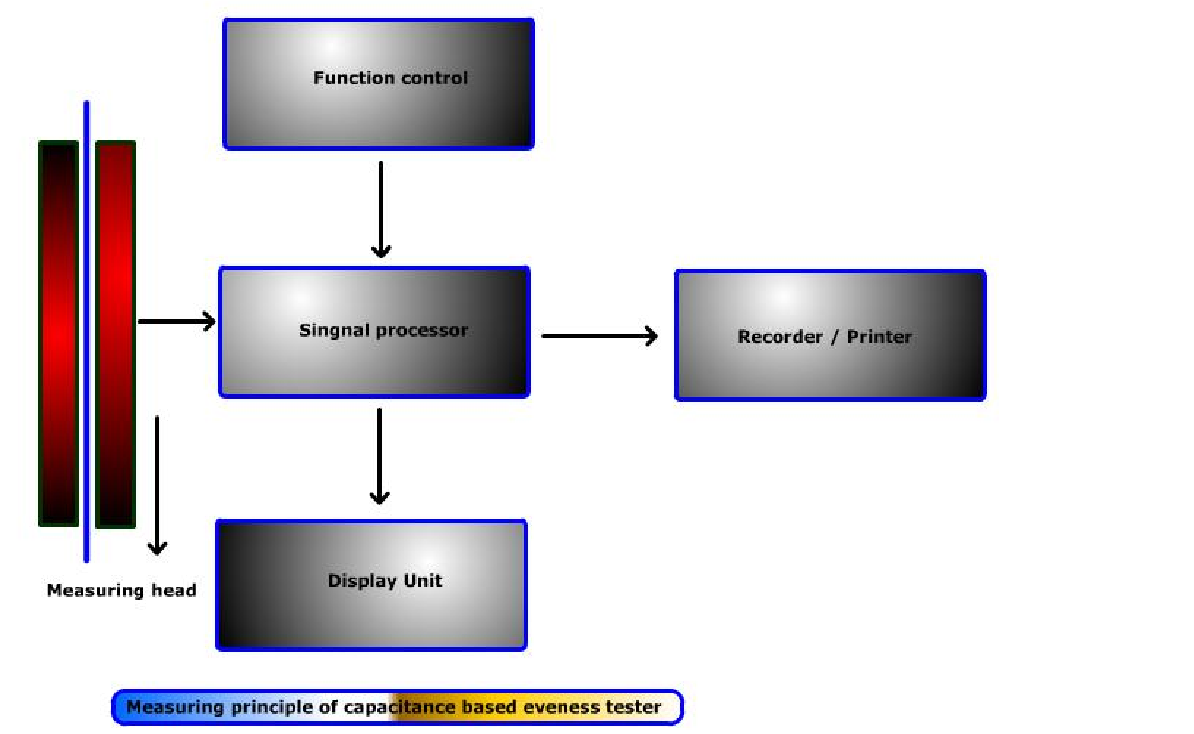
- The reflected light beam falls on a strip of moving photographic paper and trace is generated.

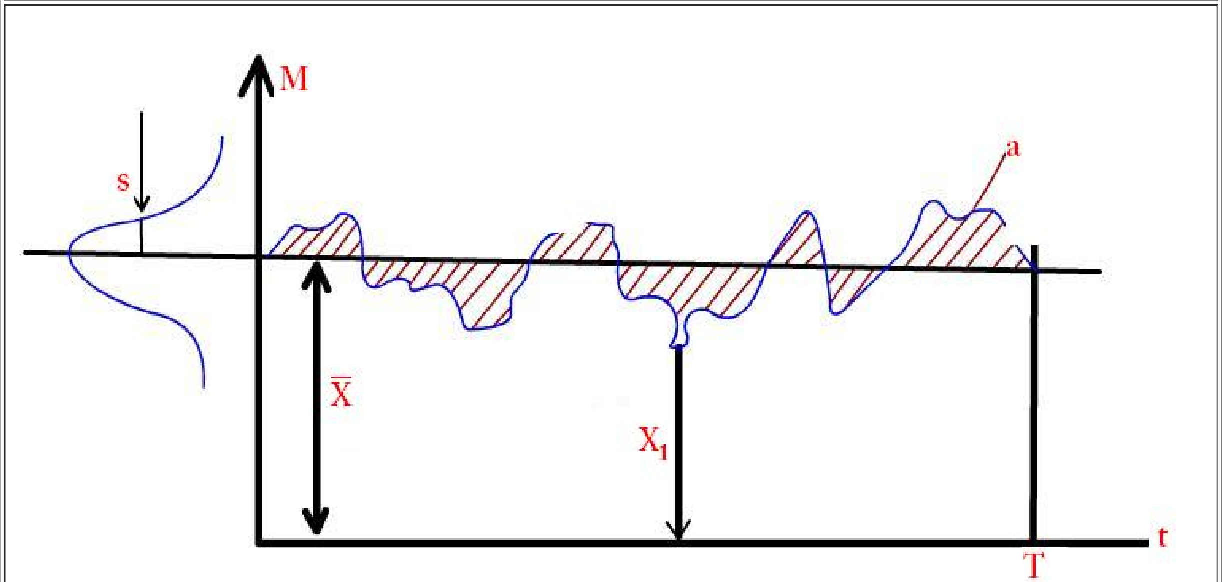
ii) Roller yarn diameter tester (LINRA):

- Four thicknesses so measured are equally spaced within 1''.
- The movement of top roller can also be measured by mechanical or electrical pen recorder.

4. Electronic capacitance method: (USTER Tester 3 or 4):

- Indirect method of measuring the change in mass per unit length
- The yarn is passed though a parallel plate condenser in a continuous fashion
- Change in capacity are monitored electronically
- A change in mass of the dielectric (non-conducting material) in the condenser changes its capacitance.
- Change in capacitance **'a'** mass of material





If the material is drawn at constant speed through the condenser continuously, the changes in capacitance will follow the variation in weight/unit length of the strand.

The unit length being the length of the capacitor (e.g. for Zellweger USTER it is 8 mm).

$$U\% = [a/(X \times T)] \times 100\ ]$$

$$= (100/X \times T) \times \int |x - x_i|\ dt$$

$$CV\ \% = 100 \times \sigma / X = 100/X\ [1/T \int (x - x_i)^2 dt]^{0.5}$$

Larger deviation from mean in case CV% (as it is in squaring)

CV% values have greater impact of yarn appearance and their processing behavior, so CV% is a better measure of unevenness than U%.

Diagram:

The graphical representation of mass per unit length variation along the length of sliver, roving or yarn is referred as diagram.

It indicates the nature of variability present in the material.

We get following information from diagram:

1. Long wavelength variations, even with periodic variation which spectrogram cannot confirm.

2. Extreme thick and thin places.

3. Slow changes and step changes in the mean value.

4. In many cases, it can confirm the numerical values of instrument.

Imperfections:

Staple fibre yarns, at a number of places along their length, contain large variations in mass per unit length which are referred to as "imperfections" - ***thick, thin, neps***

Causes:

Due to defective raw material or manufacturing process.

1. Thick places: +50% If the counter is actuated, the mass per unit length (cross section) at the thick place is 150% or more of yarn mean value (> 4 mm length)

(Ranges: +100%,+70%,+50%,+35%)

2. Thin places: -50% only 50% of yarn mean value or less.

(Ranges: -60%, -50%, -40%, -30%)

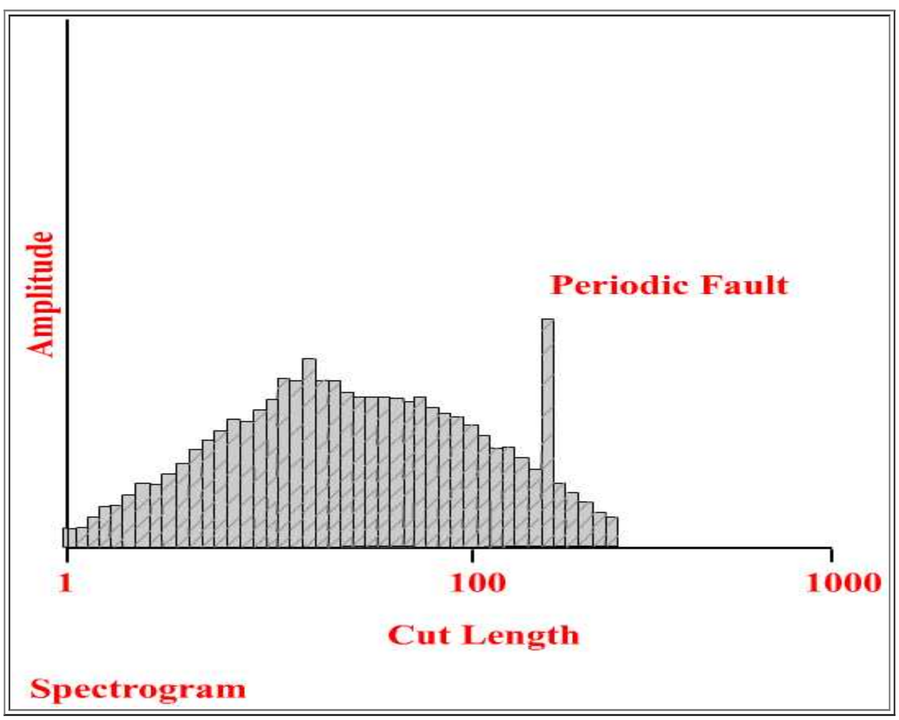
3. Neps: +200% The thick place based on 1 mm length, is 300% of the yarn mean value or more. Length shorter than 4 mm (however refers as a reference length of 1 mm)

(Ranges: +400%,+280%,+200%,+140%)

Spectrogram:

Amplitude of periodic mass variation is plotted against the wavelength in a spectrogram.

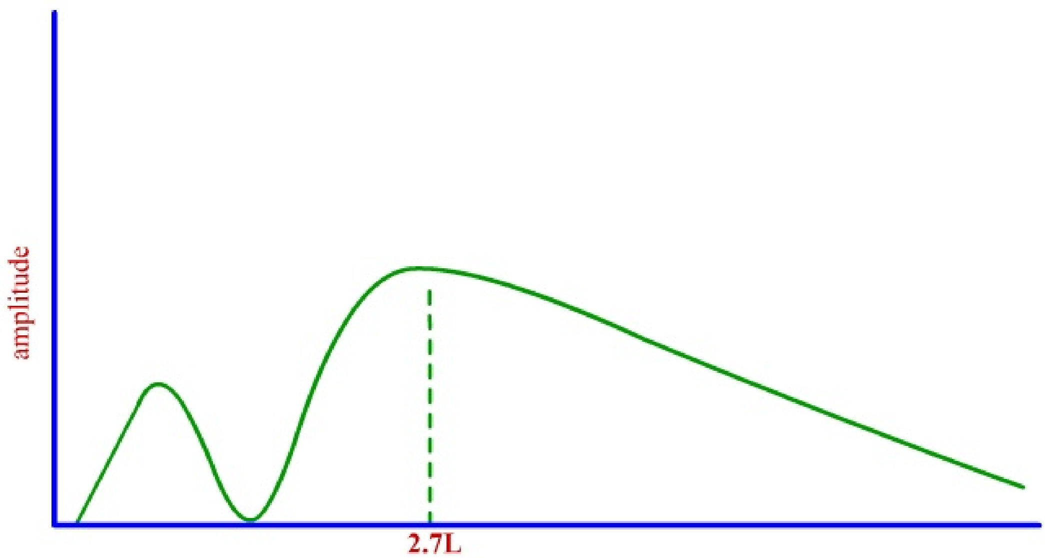
From the speed at which the yarn is running (through capacitance type sensor) the frequencies are converted to wavelengths and plotted into a finite number of discrete wavelength steps.



- Histogram is then plotted automatically.
- Amplitude is a measure of the number of times a fault of that repeat length occurs.
- Helps in locating the generating point of a periodic fault.
- Spreading of humps are due to periodic faults generated due to "drafting waves" and the wavelength due to drafting wave will be around 2.5 – 3.0 inch for cotton.

Theoretical spectrogram:

For yarn with its staple fiber all the same length L (but in actual practice it is different, due to fault induced during processing)



A theritical spectrogram for yarn with staple fibre all the same length L

$$S = f(\lambda) = (1/\sqrt{\pi n}) \times \sin(\pi l_0 / \lambda) / \sqrt{(\pi l_0 / \lambda)}$$

Where,

n = No. of fibers in cross section,

l_0 = *Fiber length,*

λ = *Wavelength*

For natural fiber with variable length (L = mean fiber length)

Deviation rate:

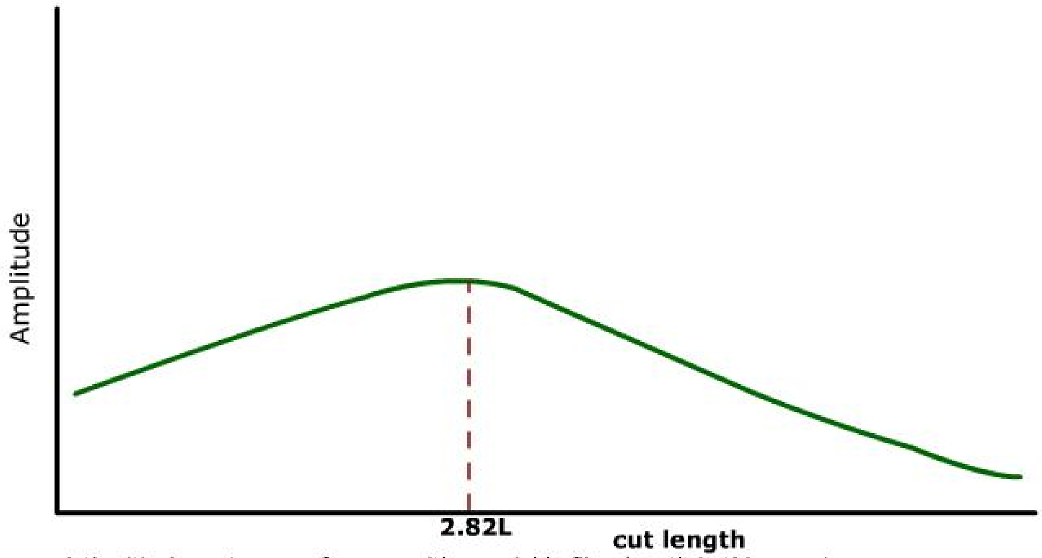
It indicates the ratio of the total length of yarn irregularities determined on the basis of the yarn irregularity signals averaged over certain length (small reference length) which exceeds the preset level to the total measured yarn length.

$DR\ \% = [\Sigma d / L] \times 100$

It shows correlation with the evaluation by the naked eye of the appearance of fabric.

Uster statistics:

- A comprehensive data bank on quality parameters of yarns or fibres.
- Large number of samples are collected and tested for various parameters in a standard testing laboratory.



A theritical spectrogram for yarn with a variable fibre length in this case L is mean fibre length

In 1997 Uster statistics total 5840 samples were collected

(8% from North America, 12% from South America 40% from West Europe, 5% from East Europe, 13% from Africa and Middle east and 22% from Asia Pacific zone)

All data are entered into data bank and with the help of application software the percentile curves are plotted.

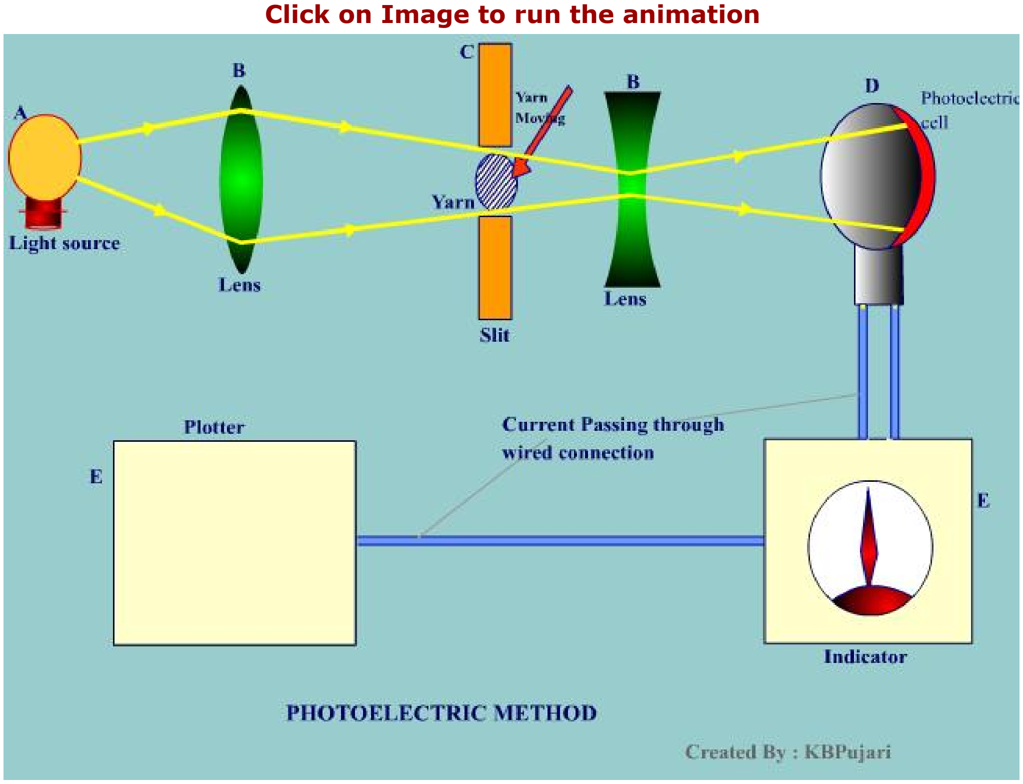
It helps in assessing the level of the quality of product with international standards.

The Uster Statistics value changes in every 5 years.

5. Photoelectric method:

When the beam of light is directed onto photoelectric cell, an electric current is produced.

Click on Image to run the animation



The magnitude of the current is proportional to theintensity of light falling.

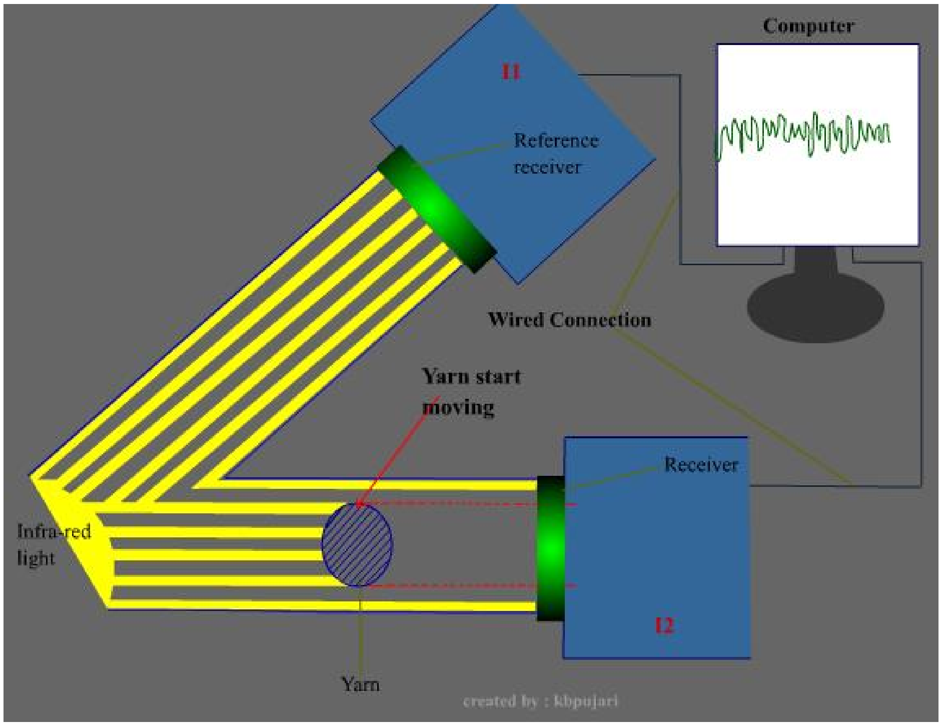
If path of light is cut off by the yarn /roving/ sliver, the current flowing will vary as thickness of light will varies.

6. Optical method (IR Method): Zweigle G580:

Optical method of determining the yarn diameter and its variation.

The instrument consists of IR-Transmitter and two identical receivers.

Click on Image to run the animation



The yarn passes at speed through one of the beams, blocking a portion of the light measuring receiver.

Intensity of this beam is compared with that measured by the reference receiver and difference in intensities is a measure of yarn diameter.

Optical method is claimed to be nearer to the human eye in the way that ***it sees fault***. (The capacitance method ***feels the faults***)

7. Yarn faults classification (Capacitance method):

The yarn imperfections which have greater size (>100% mass) or longer lengths or both are regarded as ***Faults***.

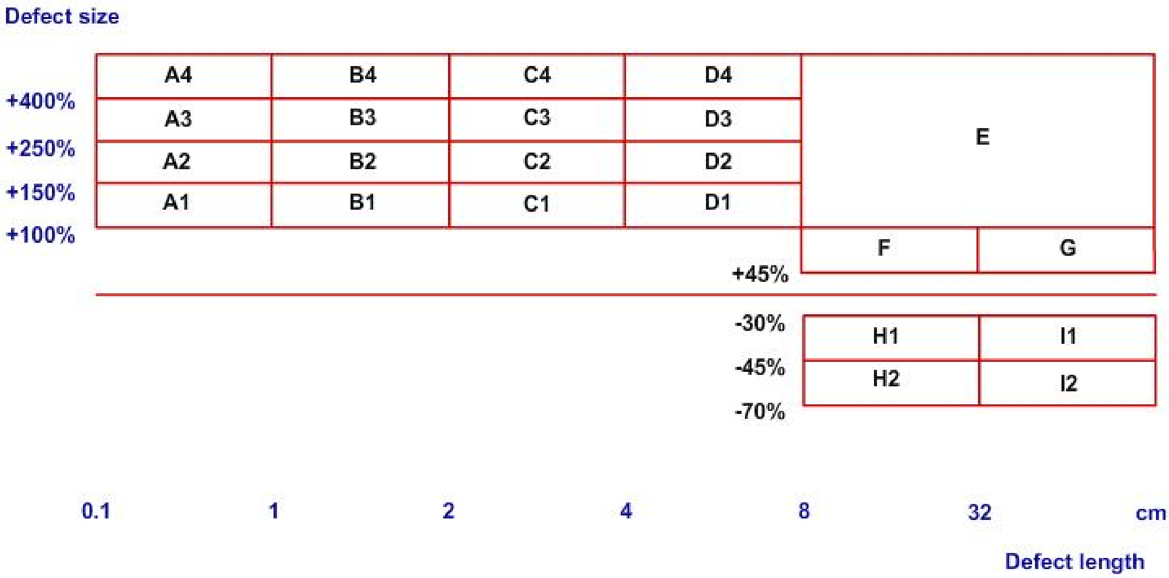
Imperfections are more frequent, while faults are seldom events.

Faults have greater impact on performance of yarn.

Faults are classified in different groups, and based on the requirements some of them can be removed at the winding stage by yarn clearer.

In Uster Classimat-II: 23 Categories of Faults

Uster CLASSIMAT defect classification matrix:



Short thick faults:

A4, B4, C3, C4, D3, D4 are objectionable faults.

Stricter norms: A3, B3, C2, D2 are also considered as objectionable.

Long thick faults:

E & G are objectionable.

Thin faults:

H2, I1 & I2 are more critical, because they cause break during further processing. They also show up as thin lines in fabric.

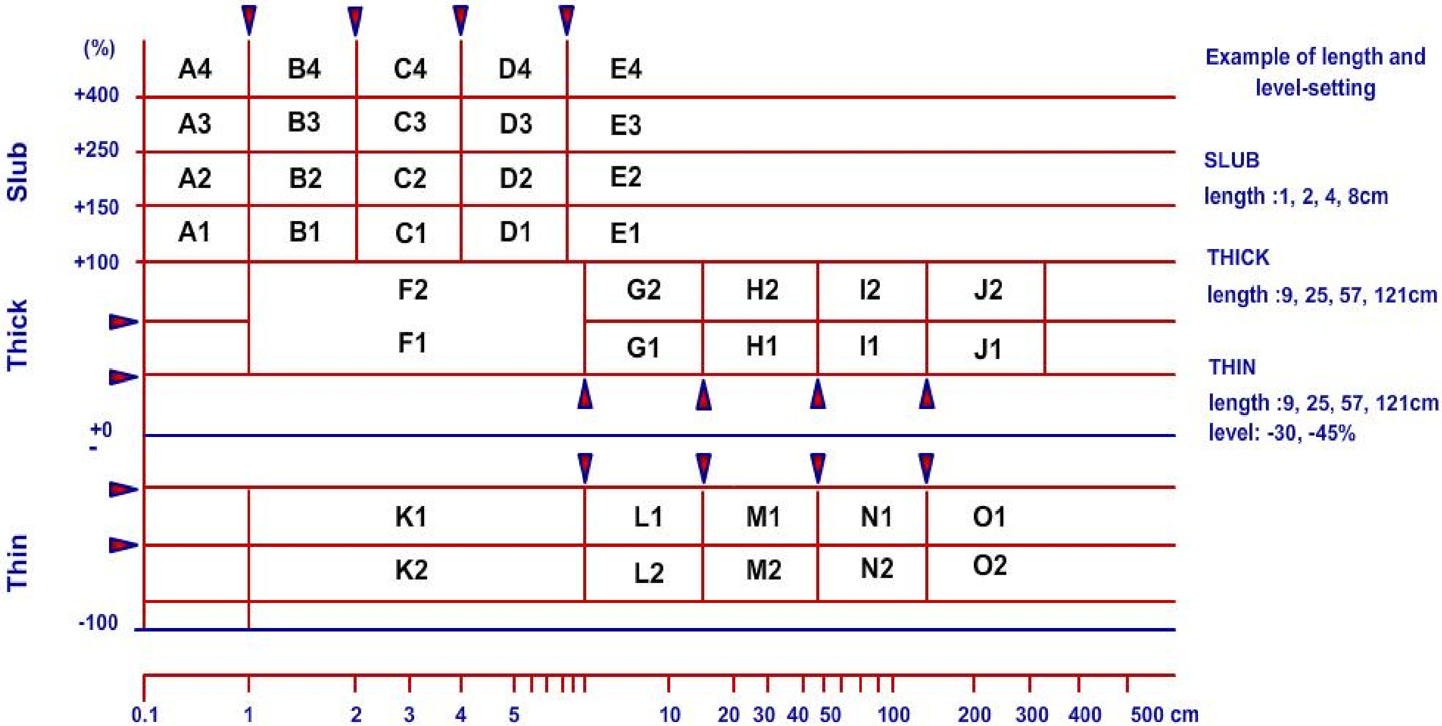
The objectionable faults are cleared by yarn clearer

CLASSIMAT III: classifies the faults in 33 categories.

KEISOKKI Class fault II: Classifies in 40 categories.

Here option of free choice of limits.
A1 - E4: 20 Slub
F1 – J2: 10 Thick faults
K1 - O2: 10 Thin faults

Keisokki CLASSIFAULT defect classification matrix:



8. Electronic inspection board:(EIB- by Lawson-Hamphill):

Objective method of grading yarn appearance electronically : It can store the images of yarns for future comparison.

- Yarn is run and scanned between the light source and the camera at a rate of 2 scans per mm when running at speed of 100m/min.
- Information from the camera is digitized and transmitted to a computer.
- The *yarn profiler program* produces a profile image of the yarn as well as a graph of variation of the diameter- *gives visual understanding about the structure.*
- The *inspection board program* allows counting an event or defect based on the event's diameter and length and analysis of defects to assign an appearance grade to the yarn.

9. Online monitoring of yarn evenness and faults:

- ***Schlafhorst*** has incorporated yarn monitoring system on the rotor spinning machines using a opto-electronic sensor '*Corolab7*' - It measures yarn diameter online and can provide details about the evenness, imperfections, detection of faults etc.
- ***Uster polyguard*** is an online yarn supervisory attachment for the automatic rotor spinning machines

- Based on capacitive measuring principle.

- Gives detail information for all the rotor heads.