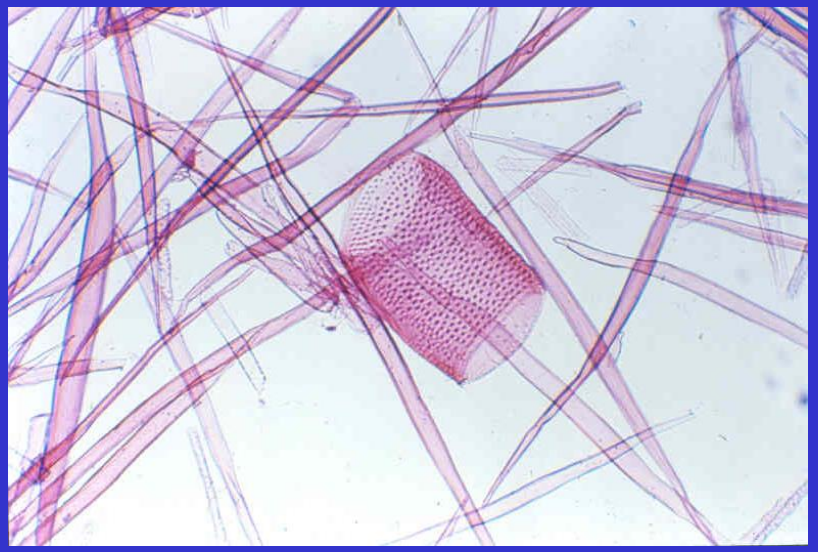
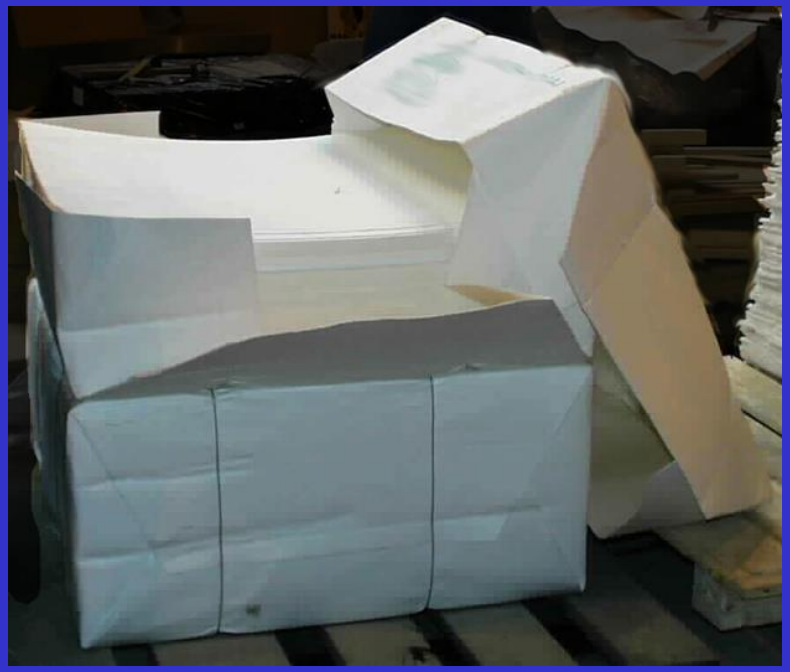
Celsius Degree / Grau Celsius

Advances in *Eucalyptus* Fiber Properties & Paper Products

Celso Foelkel



The different viewpoints



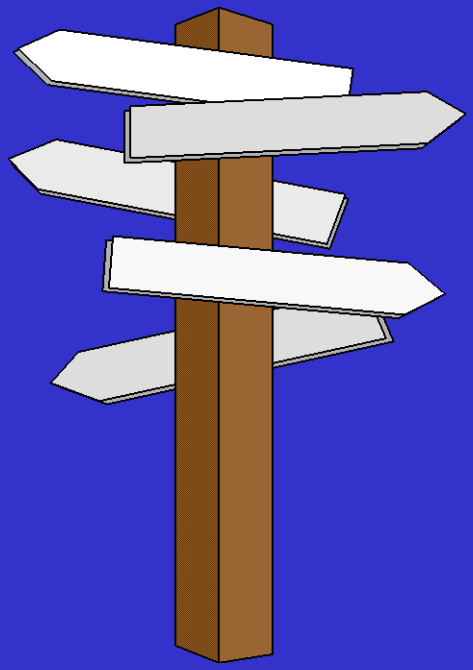
The different viewpoints

The different viewpoints

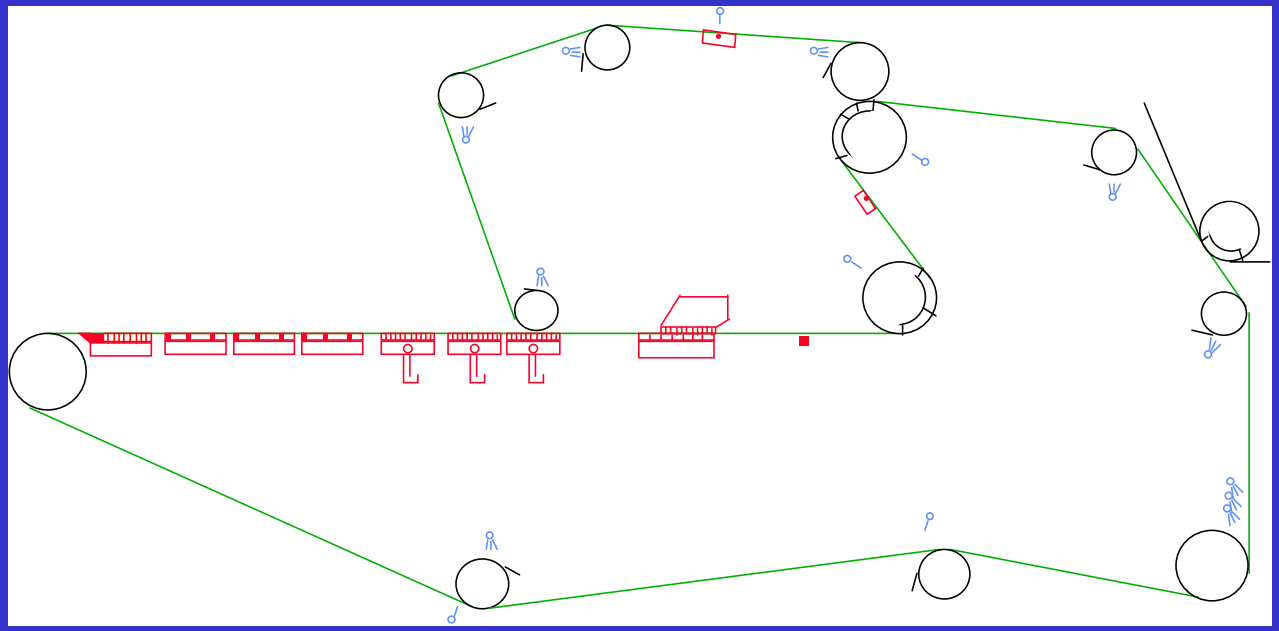
The different viewpoints

$ $ $ $ $ $ $ $ $ $ $ $

Is there a single and most correct way to see our mills, products and customers ?



"Each paper-machine, each pulp mill, any pulp & paper process, any fibrous raw material although similar are specific and unique.
They all have own key-factors to be controlled and optimized"



- Why are some eucalyptus fibers different from others ?
- Why are some eucalyptus fibers preferred by customers ?
- Why some pulps, even when offered by lower prices, are not attractive to the papermakers ?

- What makes a market pulp more suitable or attractive than the competitor one ?
- How to work our processes to give uniqueness to our product ?
- Do I need to be unique on quality?
- Do I have more or less power when competing by volume and price?

What makes a pulp special?

"Best fitness to the papermaker"

- End product specifications ?
- Paper-machine runnability ?
- Easy-life to the papermaker?
- Overall cost reductions ?

This means that we are not focusing only the pulp price, but the paper operational production cost.

We are also affecting all the paper production chain.

The world today:

- over 100 different brands of market pulps

- close to this numbers are the pulp quality categories

WHY?

- different raw materials;
- pulpwood blends;
- different pulp-making processes.

The real world:

Lots of variability everywhere

- How to tame variability?
- How to cope with variability?
- How to live together with variability?
- How to use it in our favor?

Causes for pulp quality variability:

- wood differences
- chip quality management
- pulping processes
- bleaching line
- washing presses
- drying (flakt, drums, flash)
- never-dried versus dried pulps

Some causes for pulp quality variability:

- pH
- fiber charges
- fiber population
- individual fiber strength
- fines
- water retention value
- fiber flexibility
- cell wall thickness
- bonding ability

Because of these wide variations in different pulp qualities:

The pulp or the papermaker develop a recipe or a secret potion and he is resistant to change (very understandable)

He has as objectives:

- costs savings
- fewer stops
- less off-graded products or broke
- better runnability
- end product requirements

The papermaker is always squeezed by:

- Commercial demands
- Cost reduction demands
- Production objectives

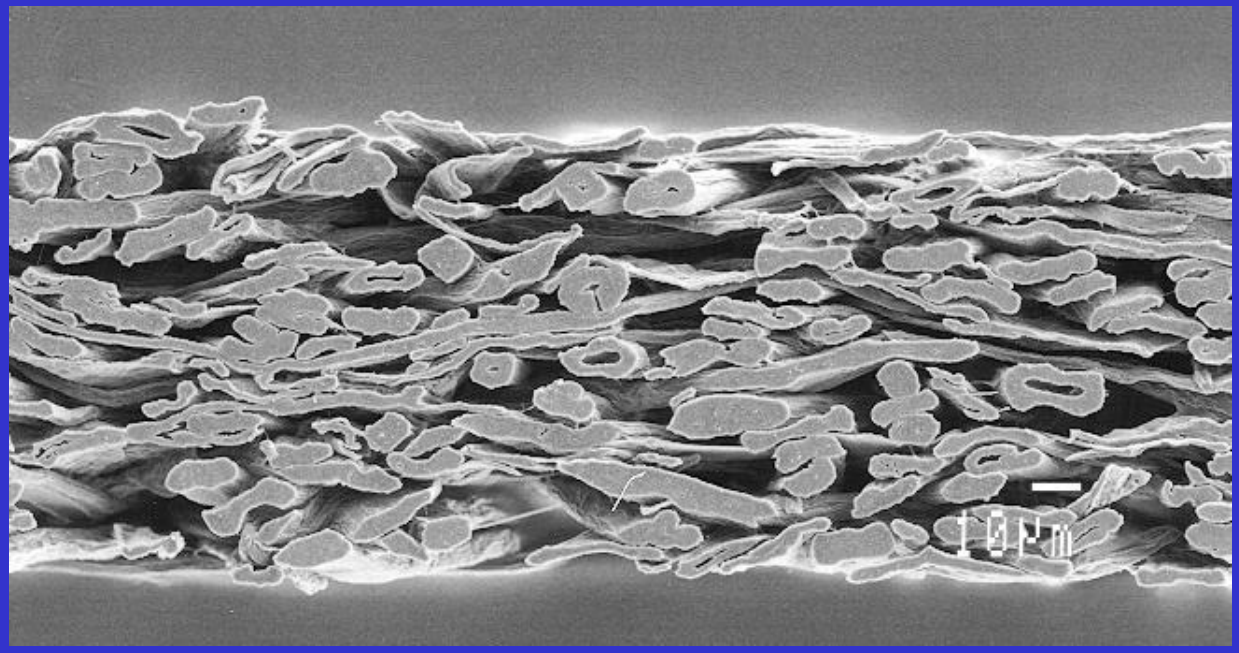
- He hates variability, but

he is always obliged to look for better process conditions, and less expensive manufacturing

(new fillers, new refiner discs, new retention aids, new brightners agents, new quality demands from the customers, etc)

The papermaker is always squeezed :

"Please, give me a stable quality pulp or one I may predict behavior"



What papermakers most dislike:

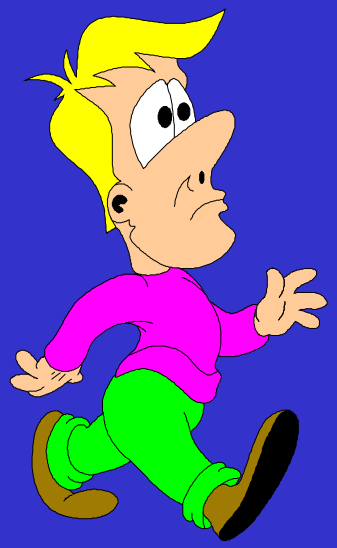
- breaks, breaks, breaks
- energy consumption
- chemical consumption
- poor drainage
- machine speed
- broke
- second class quality (below standards)

All representing HIGHER COSTS & PRESSURES

Definitions

Machine productivity:

- fast speed
- fast drainage
- high consistency after the wet end
- excellent sheet consolidation
- minimum breaks



Quality

- maximum achievements in paper specifications
- minimum generation of off-grades

No matter the papermaker is manufacturing
a commodity or a specialty product,
his dreams are the same

Papermakers want to have:

- a predictable pulp
- a "saving cost" pulp (I'm not making reference only to the market pulp price)
- a pulp recipe that allow them to reach the paper specifications 100% of the time
- high operational efficiencies

In case we provide these gifts to them, do they consider to pay a premium for ?

- better machine performance
- higher productivity
- lower energy, chemicals, etc
- better quality
- less broke generation
- no complaints from customers
- better sleep at night
- no problems with the wife (or spouse) due to machine running problems at night

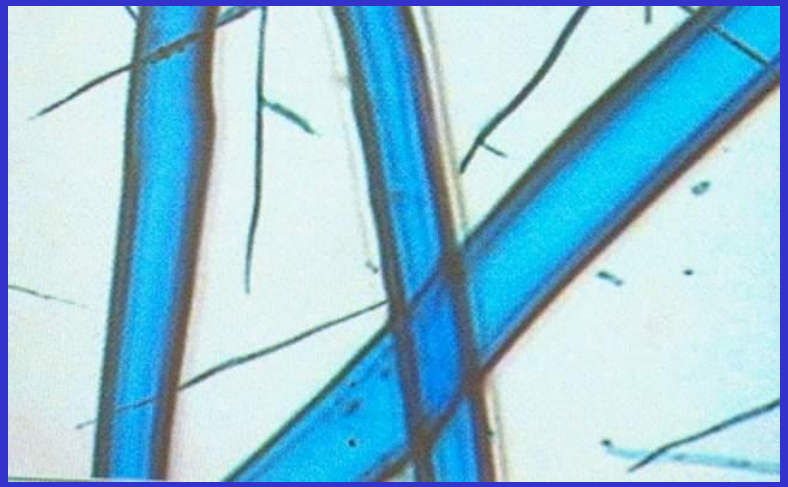
What is really an *Eucalyptus* pulp ?

- Fibers (over 90% on weight)
- Vessel elements
- Fines (Parenchyma cells and debris)

Fiber properties:

- fiber population
- coarseness
- curl index
- kinks & deformations
- zero-span breaking length
- hemicellulose content
- fiber charges
- fiber flexibility
- fiber rigidity
- fine content,
- cell wall thickness
- pulp viscosity

Most important quality properties to papermakers



Paper-machine

- drainage speed
- refining ability
- WRV
- swelling ability
- formation
- wet web strength
- pH
- dry handsheet properties:
- bulk;
- porosity;
- opacity;
- stiffness;
- tensile; etc.

How to tame variability?

Many times, the variables and properties being evaluated mean close to nothing

To control variability the papermaker depends on laboratory evaluations and machine performance indexes

Pulp performance is vital

However

Many properties are measure just to provide numbers for justifications

Peripherical pulp properties:

- viscosity
- moisture
- beating runs
- ash content
- cleanliness

The three management levels

- Management of the peripherical pulp quality properties
- Management of pulp variability (and machine performance)
- Management of product differentiation

Management of product differentiation

Only possible when the other two physiological basic needs have been fulfilled.

How can we manage product differentiation ?

- Pulp quality (types, blends, fractioning, fines, etc.)
- Pulping processes (ECF Light or TCF, etc)
- Wood quality (forest certification, wood yard, etc)
- Papermaking process (refining, use of never dried or dried pulps, etc)

How can we manage product differentiation ?

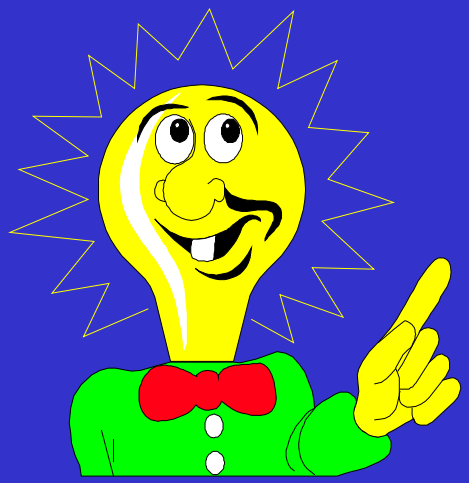
Silviculture, genetics and wood quality are only part of this game, they are important, but there are other interested parties to be involved.

Differentiation is more easily achieved in mills with more than one paper-machine

- no transitions
- interchangeabilities
- better controls
- specific care

How can we be winners in this game?

- fulfillment of the papermaker basic needs
- supplying a uniform and stable pulp



In general, tailor making brings conflicts:

- commercial area
- production area
- product development area
- fiber supply area (foresters or pulp buyers)

"A good start should be an excellent program of people relations and human behavior"

In general, tailor making brings conflicts:

- Everyone would like to have a single product, with no variability, and being able to be successful anywhere and to anybody.

"However, this is not the real life"

Is there a single and most important pulp characteristic or fiber property?

The mill bottlenecks will define what is important...

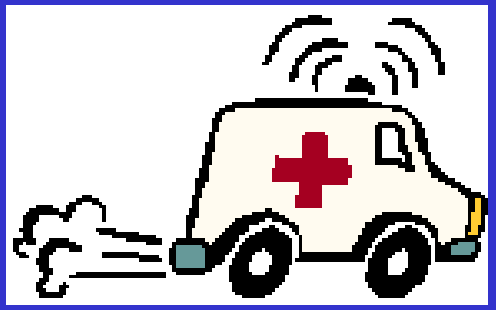
"This is real life"

"This is real life"

- refining capacity
- steam availability
- electricity availability
- short wet end
- wet presses deficiencies
- out-of-dated headbox
- etc

As a result:

Each paper grade, each paper-machine, each papermaker may have different needs about the quality and performance requirements of the pulp being used.



Back again to the papermaker physiological needs:

How may we provide happiness and good will to our papermaker friend ?

Need # 1: Drainage and retention in the wet end

- **Fiber population**
- **Freeness level**
- **WRV**
- **Fiber flexibility**
- **Fines**
- **Fiber charges**
- **Wire design**
- **Machine cleanliness**

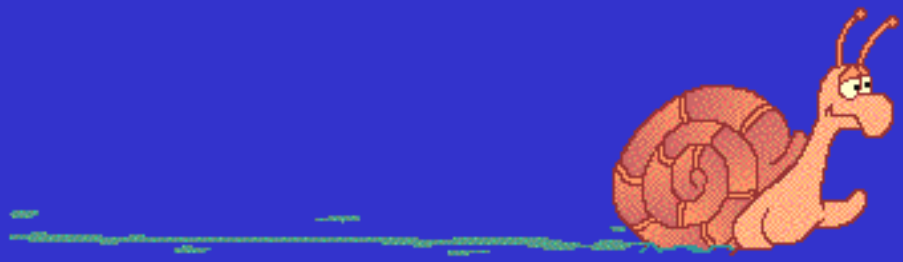
Need # 2: Sheet strength along the paper-machine, specially at the wet end and wet presses passes

- **Individual fiber strength (cell wall, fiber deformations, microfractures)**
- **Fiber bonding**
- **Consolidation of the web**
- **Contaminants**
- **Moisture content**
- **Wet Web Strength**

Need # 3: Final paper specifications as defined by customers and end-users

- **Strength properties**
- **Tactile properties**
- **Formation**
- **Brightness**
- **Bulk**
- **Porosity**
- **Absorption**
- **Aesthetical properties**
- **etc.**

The Dilemma or the Enigma...



The most important *Eucalyptus* Fiber or Pulp Properties

Fiber Population
(associated to fiber coarseness)

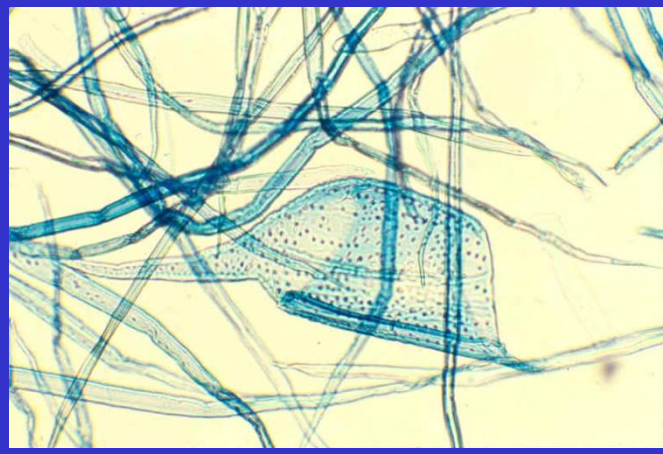
Related to a number of other fiber properties:

- cell wall fraction
- Runkel index
- wood basic density
- fines content

Fiber Population
(associated to fiber coarseness)

Related to a number of paper-machine performance indexes and paper quality:

- drainage
- speed
- retention
- bulk, porosity, opacity, etc
- formation
- smoothness

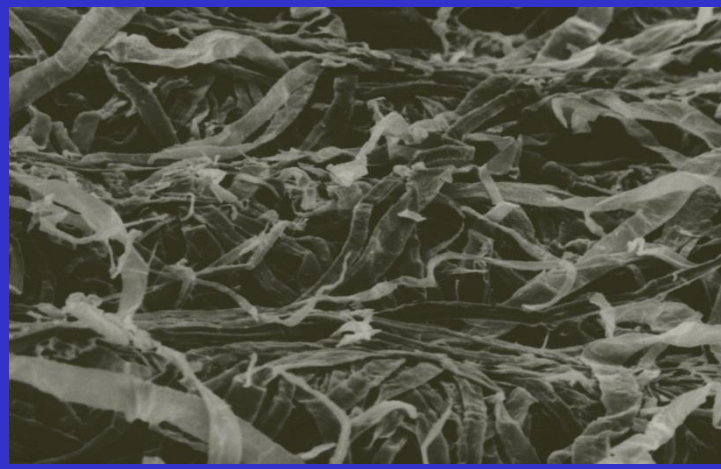


Just to refresh ideas...

Wood Density g/cm³	Fiber Coarseness mg/100m	Fiber Population Nº in million/g
0,43	5,8	25,4
0,46	6,4	21,6
0,51	7,4	19,7
0,54	9,3	17,5
0,60	11,8	13,0

Suggestions for High Corseness Fibers (Heavy Fibers)

- Decor papers
- Filter papers
- Tissue papers
- Cigarette papers



Suggestions for Low Corseness Fibers (Light Fibers)

- Base paper for coating
- Label papers
- Release papers
- Glassine papers
- Thermal papers
- Highly bonded papers
- Some P&W papers

However, this is very much dependent on the customers limitations (machine speed & design, porosity and bulk specifications, etc.)

Individual Fiber Strength

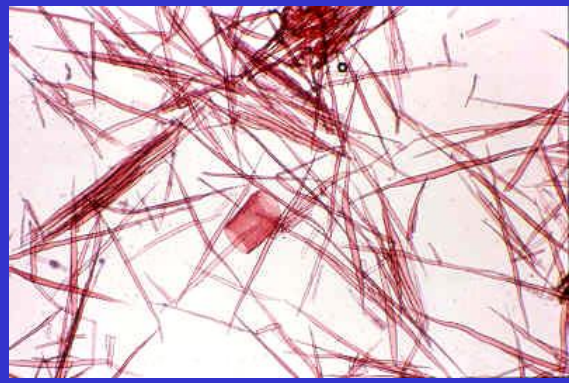
Related to a number of fiber quality and final paper parameters:

- cell wall fraction
- micellar angle
- Zero span
- fiber deformations
- Wet Web Strength
- dry paper strengths

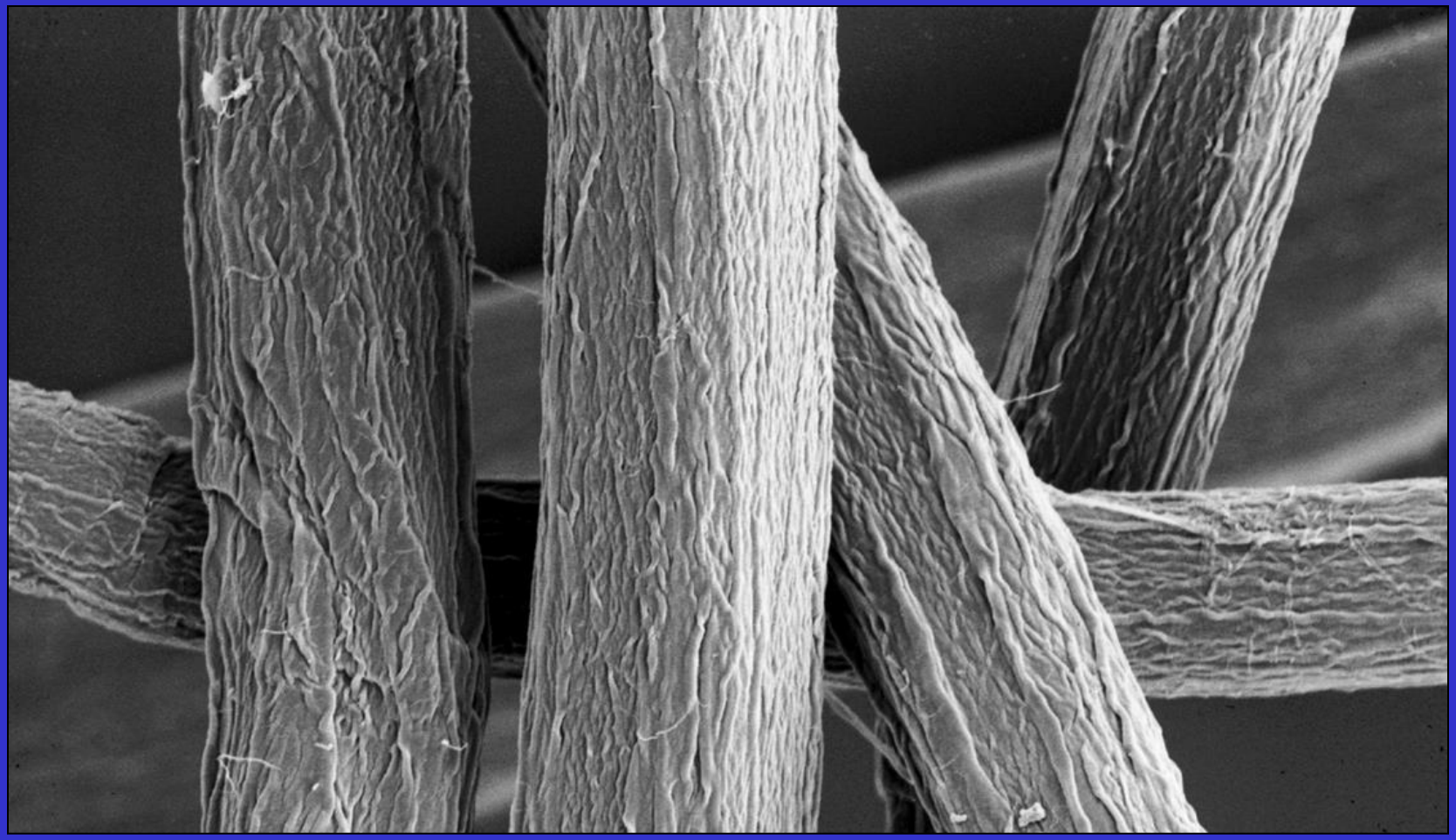
Fiber Collapsibility
(associated to wet sheet compactability)

Related to a number of fiber quality and final paper parameters:

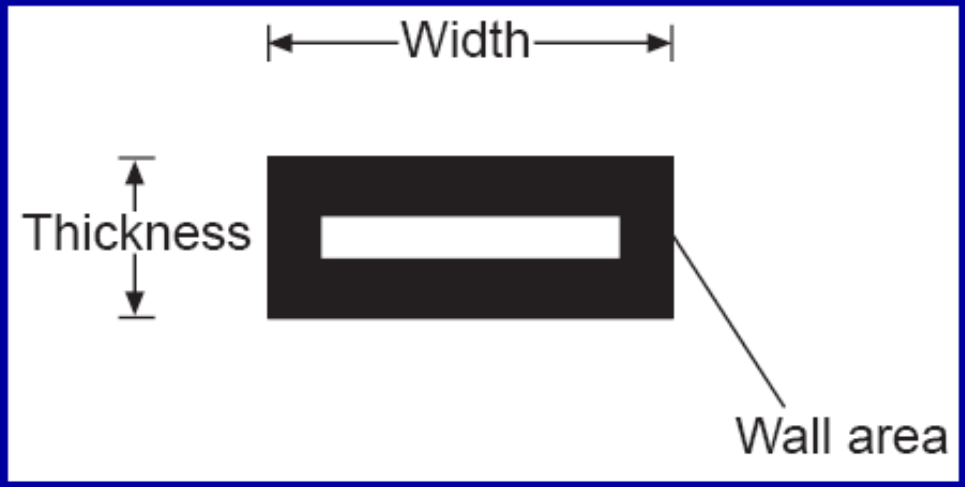
- cell wall fraction
- fiber resistance to collapse
- fiber coarseness
- bonding strengths
- dry sheet bulk at a given level of freeness

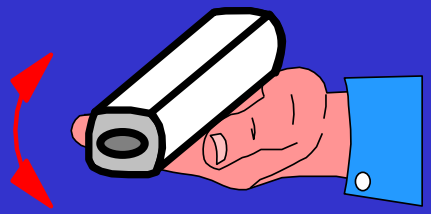


Eucalyptus Chemical Pulp Fibers

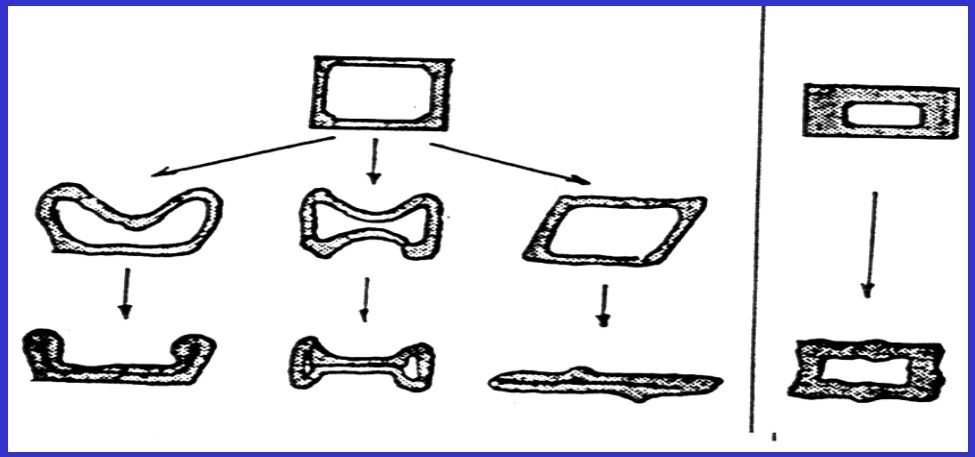


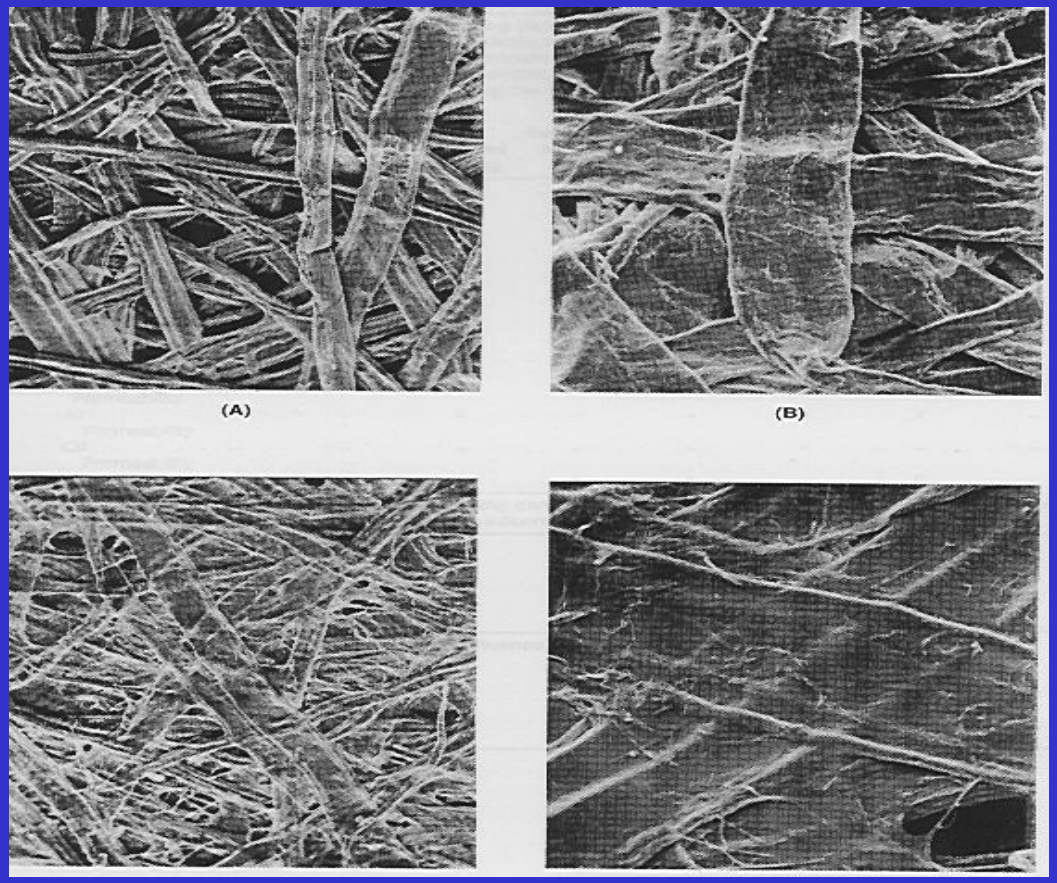
Fibre property interrelationships



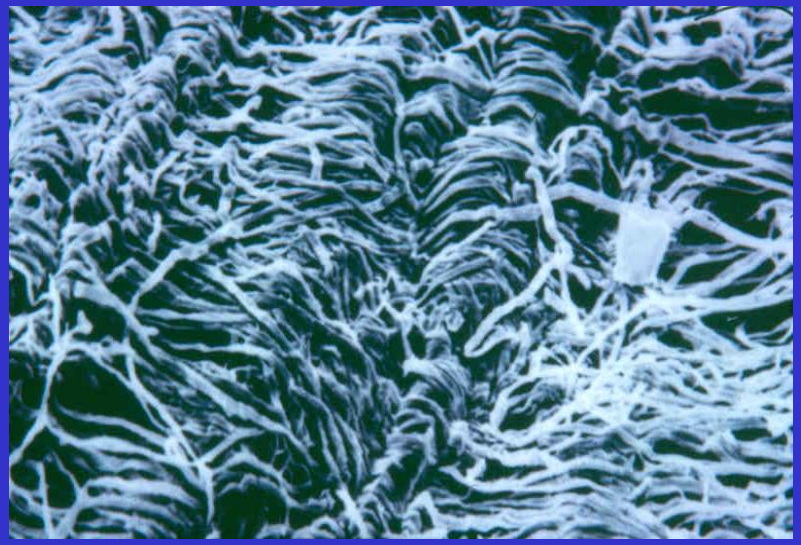


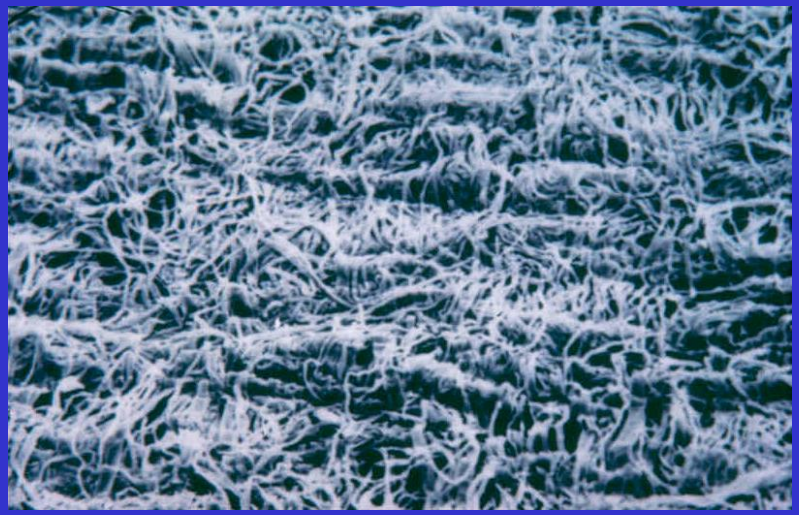
Collapsible and collapse resistant fibers



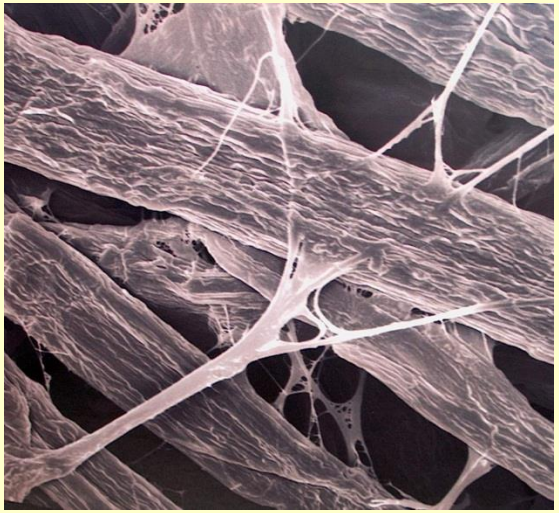

(A)
(B)

°Celsius Degree / Grau Celsius





Fiber Bonding
(associated to paper cohesiveness)



Related to a number of other fiber properties:

- beating (fibrillation and collapsibility)
- fines and fiber debris
- dry/wet short span
- wax picking test
- fiber population
- fiber coarseness
- cell wall fraction

Fiber Swelling & Hydration Capacity

Related to a number of fiber quality and final paper parameters:

- Water Retention Value
- hemicelluloses
- fiber charges
- carboxyl groups
- fines content
- pulp degradation (viscosity)
- fiber wall micro-porosity and damages

Pulp Swelling and Hydration
may become a real problem in integrated paper mills

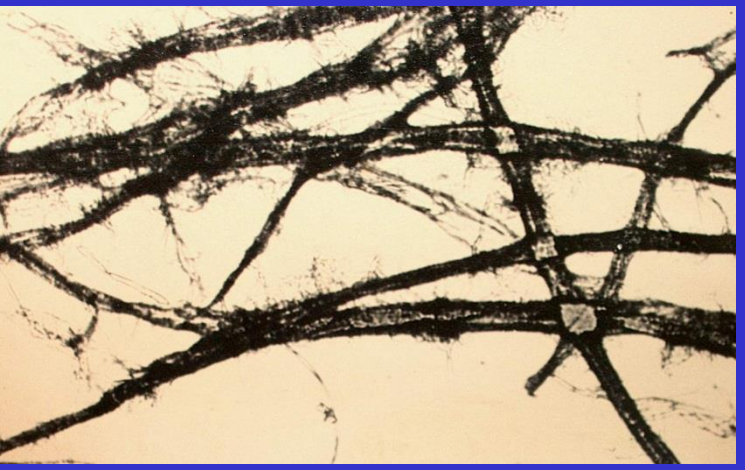
Fiber Swelling & Hydration Capacity

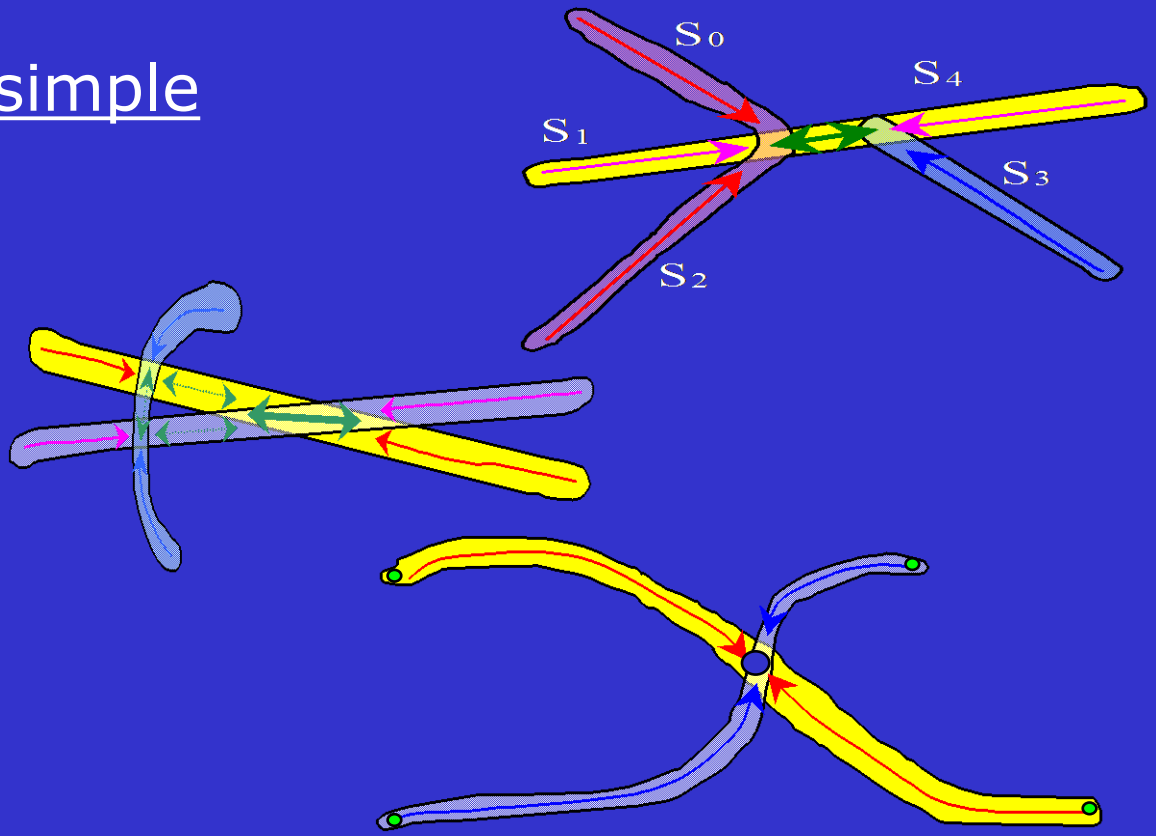
A very strong relation between WRV and Hysteresis

For this reason, many papermakers prefer to have some percentage of dry paper broke in the furnish. With this candour thinking, they believe that the generation of dry broke is required (sic..)

Fiber Deformations

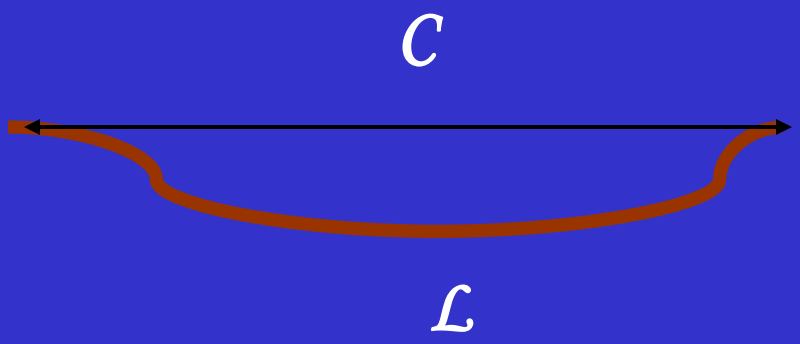
Fiber life is not that simple

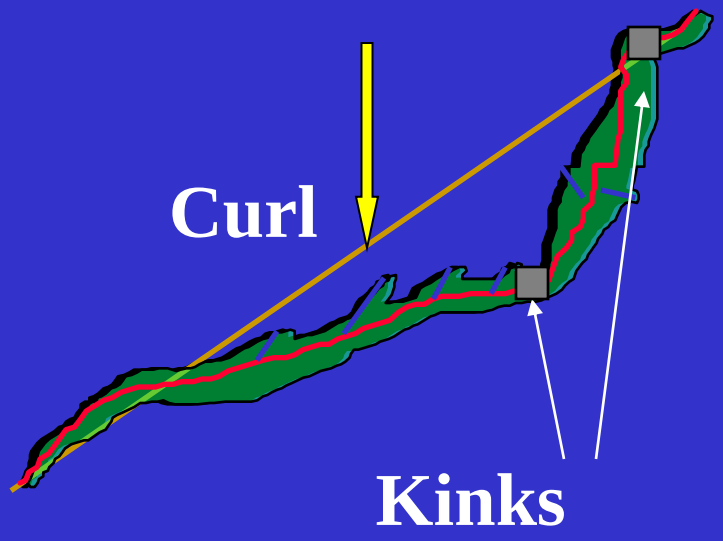




CURL

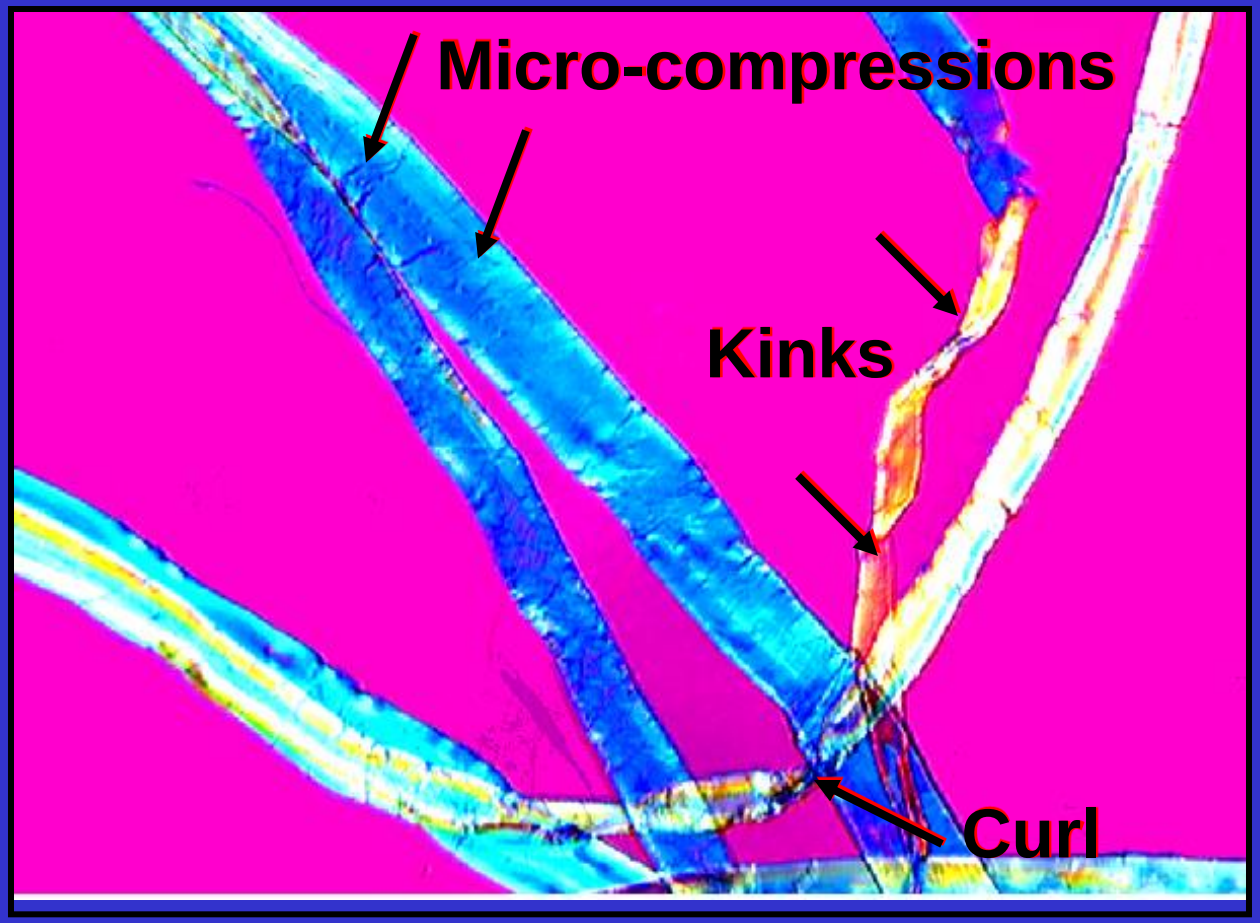
Form Factor of a Fiber = $100 \times C/\mathcal{L}$





And also Fiber Latency...

Fiber new attributes



How to add these attributes to a pulp?

Fiber Deformations

They provide improvements in porosity, bulk, absorption, and other tissue and filter properties

Fiber deformations may be artificially generated at the manufacturing processes

Fines

Always discarded as an important pulp property, but perhaps one of the most relevant

Fines management is a real new opportunity to papermakers

The most usual *Eucalyptus* paper products

- Printing and Writing
- Tissue, filters, decor, base for impregnation
- Multiply cardboard
- Cigarette papers
- Specialty papers

Tissues and Porous Papers

"what do we need on them?"

- Bulk
- Porosity
- Softness
- Tactile feeling
- Fast drainage
- Absorption
- WWS

Tissues and *Eucalyptus* Fibers

"what do we need on them?"

- low fines
- high coarseness
- low fiber population
- low hemicellulose content
- low bonding
- low WRV
- high fiber deformations
- high bulk at a given tensile

Fortunately, we are able to control and to design all of these pulp properties

P & W Papers

"what do we need on them?"

- Formation
- Strength
- Porosity
- Opacity
- Surface smoothness
- Dimensional stability
- Bonding

P&W and *Eucalyptus* Fibers

"what do we need on them?"

- high fiber population
- bonding
- fines
- low content and small vessel elements
- hemicellulose content
- high strengths at low level of refining (fast beating response, for example 25º or 30º SR)
- strengths properties at a given bulk level (for example 1.8 or 1.6 cm^3/g)

P&W and *Eucalyptus* Fibers

"what do we need on them?"

There are limits for all these characteristics, and they depend on bottlenecks, available machinery and operator skills.

Eucalyptus Fibers

"why do papermakers love them?"

- Unique fiber properties
- Excellent paper-machine behavior
- Lower cost in relation to long fibers
- Stability on general properties (brightness, dirt, strengths, etc.)

Eucalyptus fibers are not to be highly refined: we may lose all their most important features

What can we do to bring an unique reference to our pulp products in the competitive market?

Coarseness & fiber population
Fiber deformations
Fiber collapsibility
Fines management
Individual fiber strength
Hysteresis management
Pulpwood recipes
Brightness & cleanliness
Paper-machine drainage. cleanliness & speed
Bonding and strengths

Well, this is all my friends.

Thank you very much.

Good luck with the utilization of *Eucalyptus* pulps in your furnishes