Using Online Tools to Predict Finished Products Physicals in Pulp Slurries

By

David Zerr
Pulmac Systems International

PULMAC

Seeq®

Session 7: Pulping and Fiber Properties
Tuesday Nov 7, 2023 @ 11:00 AM

Abstract: Pulp mill and paper machine personnel are challenged to keep an eye on variations of incoming pulp and whitewater returns. PM breaks are often the first and sometimes only indication that the pulp slurry hitting their paper machine has changed. While there can be several likely causes for these variations, there are few on-line systems that can provide an early warning system to operators or management of upcoming issues, let alone control the process to prevent these upsets.

Keywords: Edge technology, advanced APCs, predictive analytics

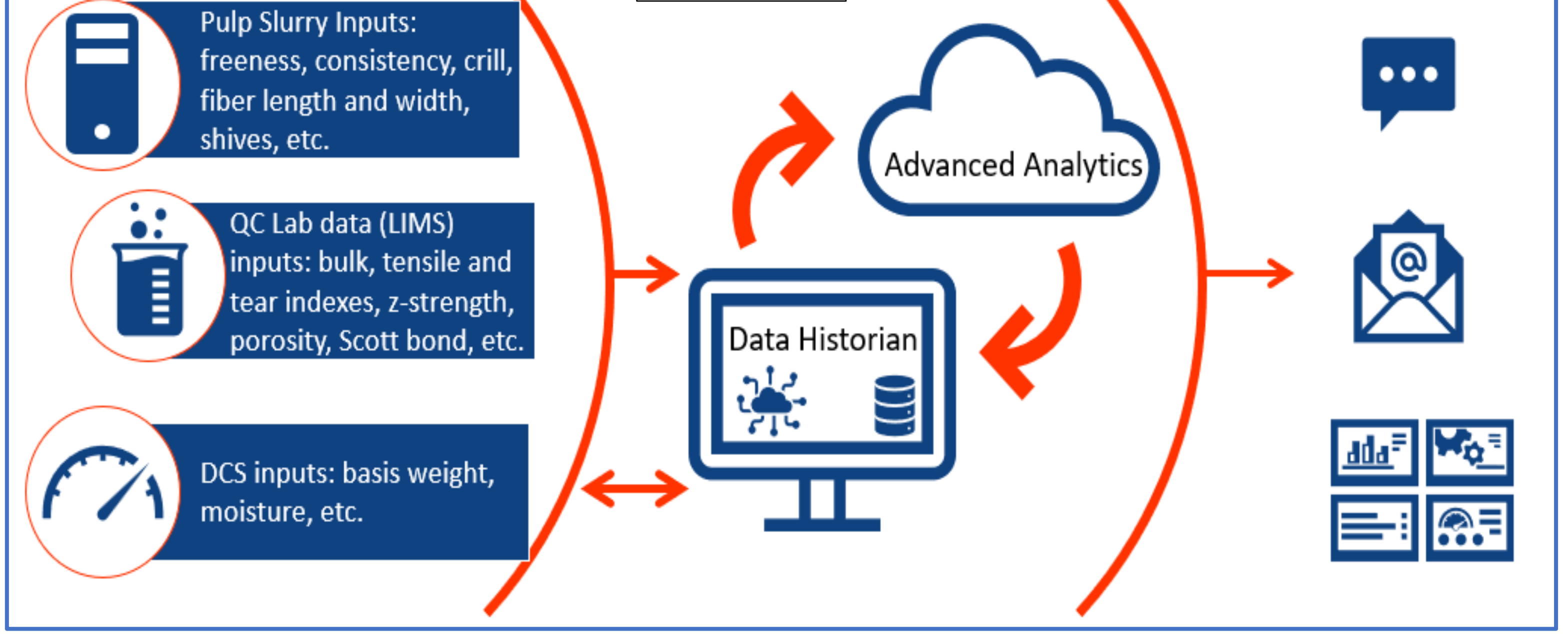
Key Discussion Points

- New edge technology predicts key process variables before the pulp slurry is sent to the paper machine.
- Most mills see on average three breaks per day. This can reduce this to one per day or less.
- This technology can be tied to refiner automation controls to maintain properties such as freeness, strength properties, etc.
- Key variables such as freeness, tensile, crill, tear, burst, Scott bond, z-strength, bulk, and density are provided in 15-minute intervals before the pulp hits the headbox.

Technology behind this measurement system:

- Collect pulp samples
- Run handsheets
- Compare to corresponding lab data
- Correlate and model pulp samples to finished QC lab data
- Repeat process until R^2 variations are within 95% confidence interval or higher.

Figure 1



Graphs show the correlation between QC lab and predicted values for freeness and tensile.

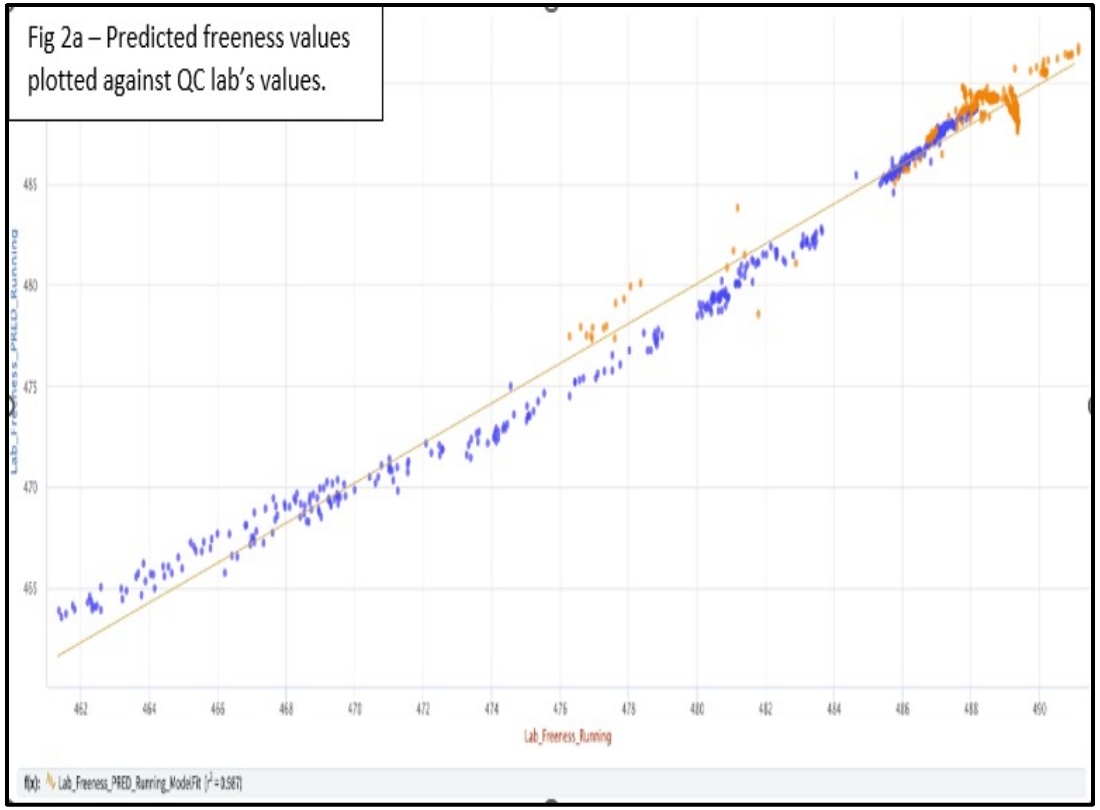


Fig 2a – Predicted freeness values plotted against QC lab's values.

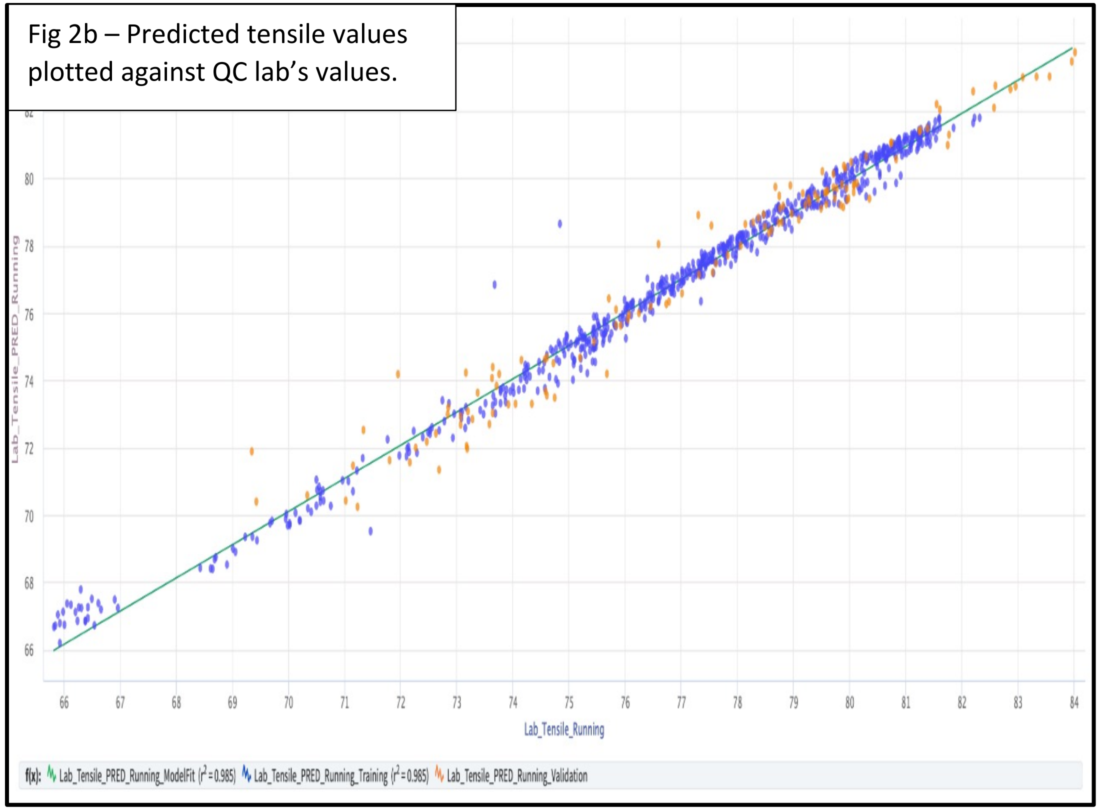


Fig 2b – Predicted tensile values plotted against QC lab's values.

Graphs show the correlation between QC lab and predicted values for tear and ring crush

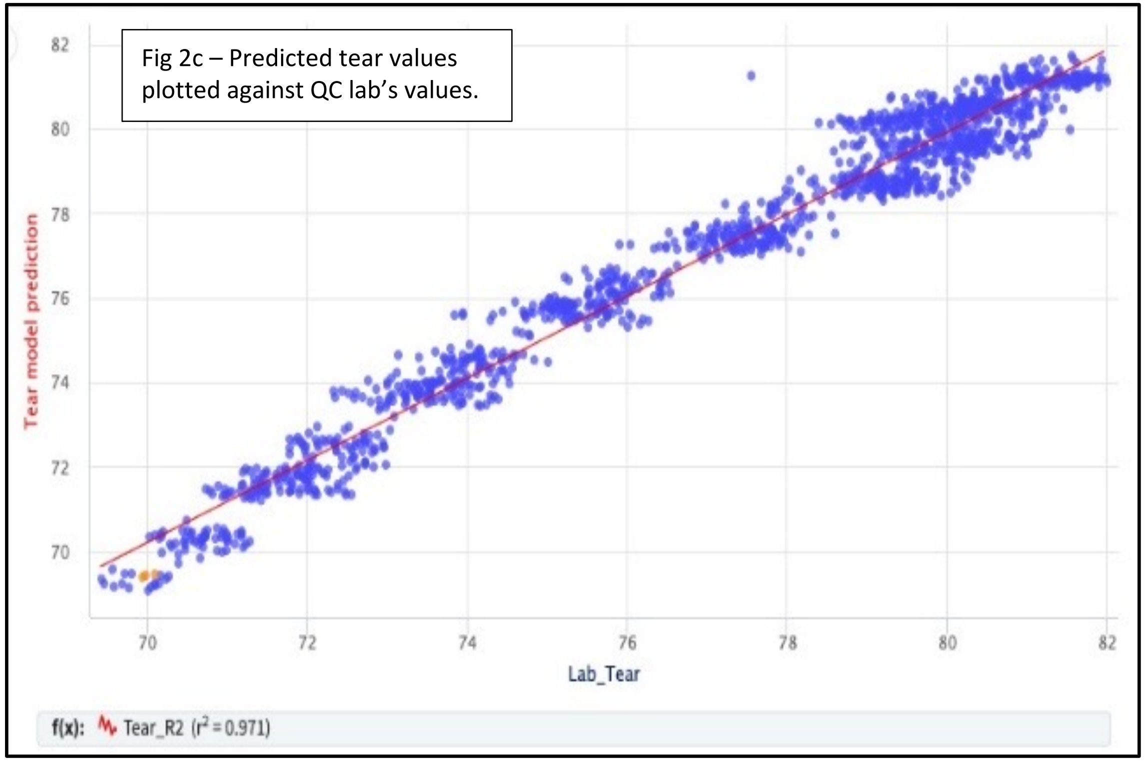


Fig 2c – Predicted tear values plotted against QC lab's values.

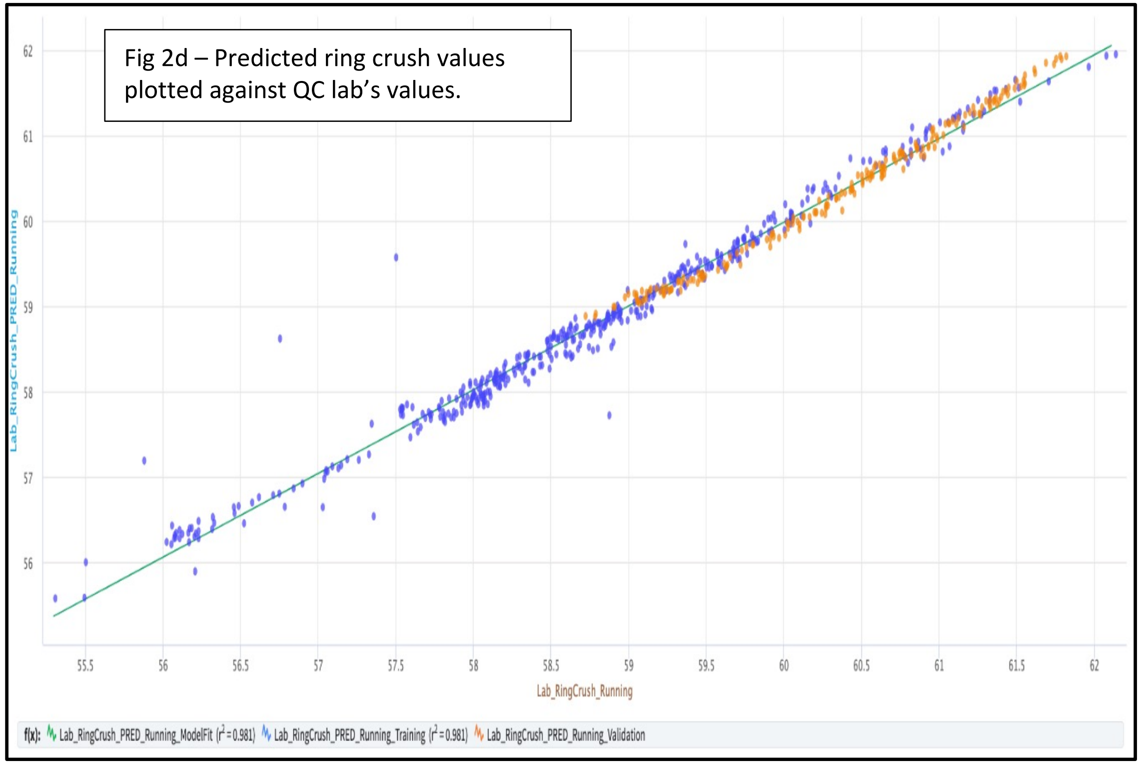


Fig 2d – Predicted ring crush values plotted against QC lab's values.

What's the typical R^2 valued using this technology?

- Typical R^2 values are in the 90% to 95% confidence range

Highlights of this technology include:

- Pulp properties are obtained every 15 minutes.
- Calculated quality data such as freeness, crill, bulk, strength properties and porosity in real-time.
- Alarms note when the process goes outside of process limits.
- Energy savings can be obtained.
- Calculated data can be supplied to pulp customers providing them with useful information.

What is crill and why is this highlighted?

- Crill is a by-product of refining.
- In Figure 3, fibers are quickly recognized. The much smaller fibers, called crill, that are roughly hundred times smaller than the fibers themselves.
- There are two types of crill:
  - Bound to a fiber
  - Free of a fiber

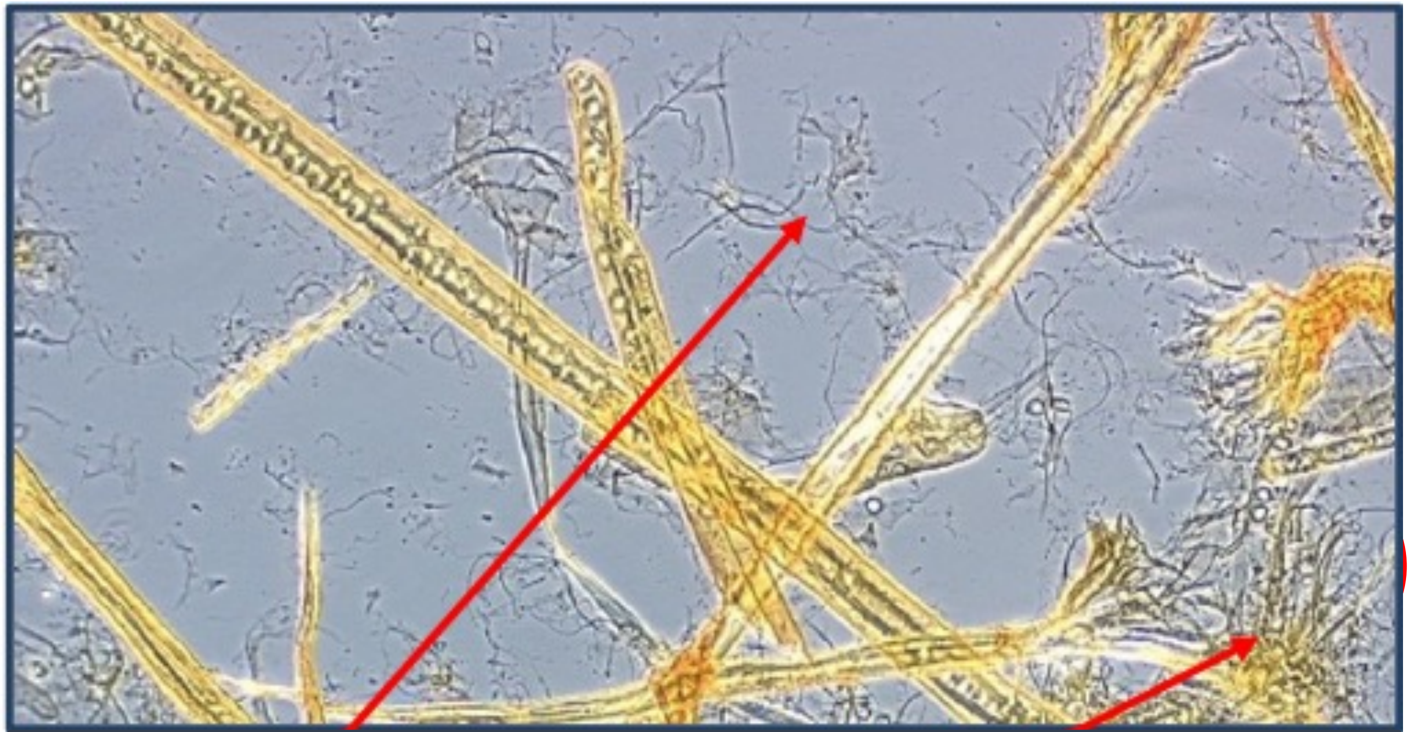
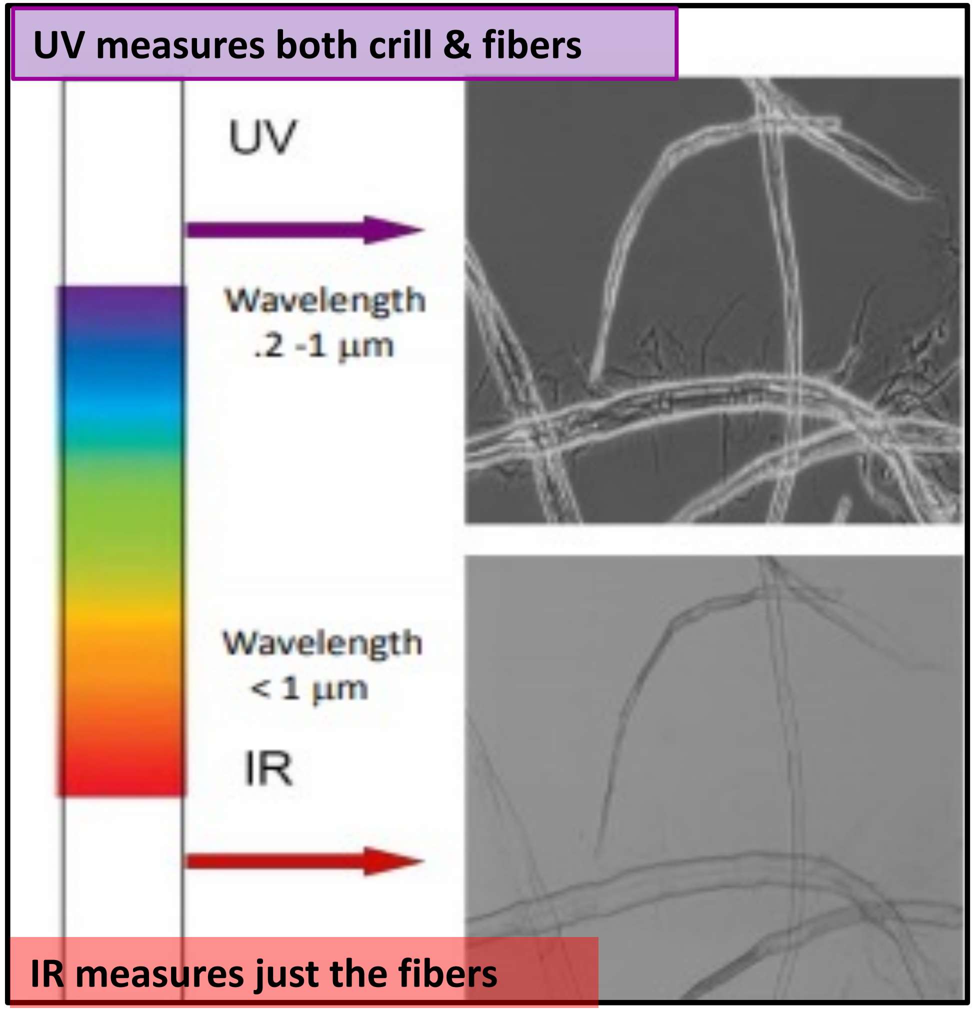


Figure 3 – Crill in pulp solution. Crill is defined as "bound' or attached to a fiber or "free" of fiber. The key benefit of analyzing crill is to monitor and control the amount of refining and dewatering in pulp.

Technology used to measure crill: UV and IR wavelengths



Crill measurements are based on comparing two optically measured surface areas (light absorption).

- Total area of fibers and crill is measured with UV.
- The total area of the fibers only, is measured with IR.
- Crill is measured on refined pulps before and after washing.
- More crill, more bonds.
- 150 measurements taken per sample

Review of Fiber Properties That Can Be Measured Online

Besides the normal fiber property attributes of:

- fiber length, width, curl
- freeness, bulk, tensile, burst, porosity
- brightness, dirt and shives

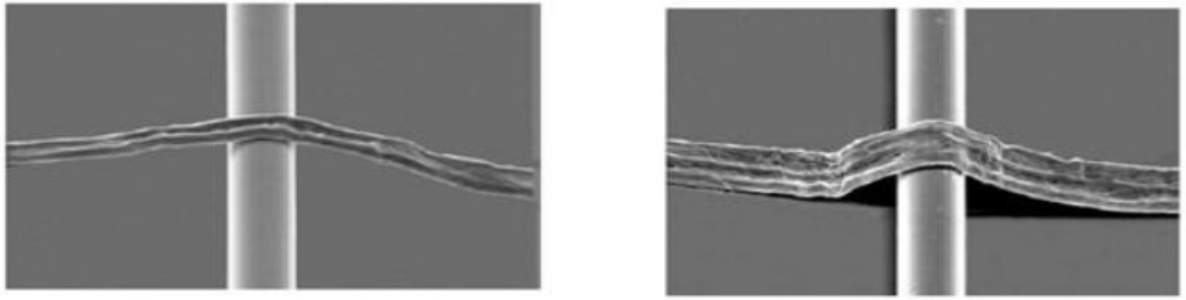
This same online technology can now measure

- fiber wall thickness
- coarseness
- crill
- kappa number

Review of Fiber Coarseness Properties

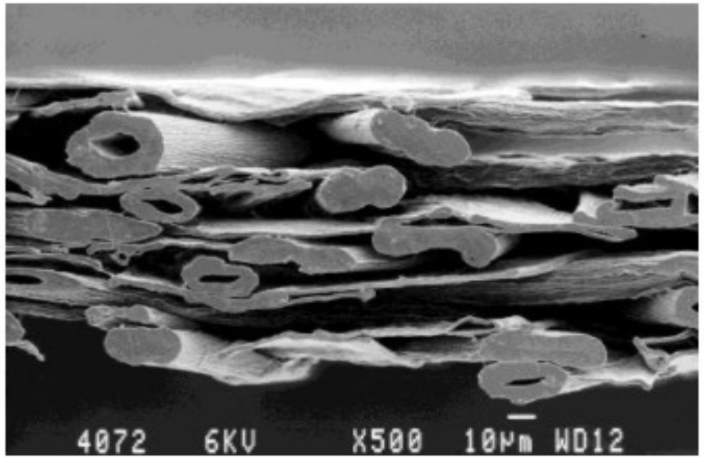
Fiber coarseness:

- Highly indicative of fiber flexibility and is the inverse of density.
- High coarseness pulps are related to fiber with thicker fiber walls.
- High coarseness fibers (HW pulps) will have improved bulk, porosity, absorbency, drainage but low fiber bonding strength and potentially increased picking and linting.
- Low coarseness fibers (SW pulps) will have improved fiber-bonding, increased wet web strength, improved opacity, and improved formation, better coating holdout, higher overall strength, and increased water retention value.

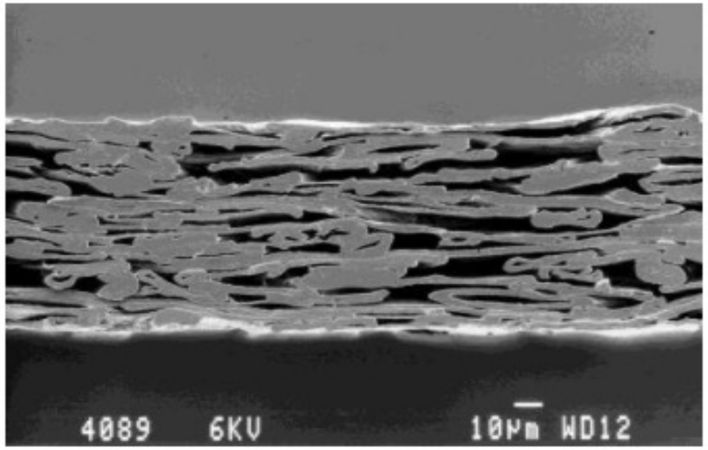


High Coarseness Fiber   Low Coarseness Fiber

Photos from Eucalyptus Online Book and Newsletter, ABTCP



An example of High Coarseness (HW) Pulp



An example of Low Coarseness (SW) Pulp

Importance of Fiber Coarseness

From FP Innovation's Dr. H.F. Jang's groundbreaking work on measuring fiber wall thickness, he also made discoveries related to fiber length, fiber coarseness as well as fiber wall thickness.

Traditionally, fiber length was always thought to be *the* leading indicator of strength. Surprisingly, it isn't. When several softwood market pulps were tested, conclusions were:

- Fiber length only shows a 20% correlation
- Fiber wall thickness shows 40% correlation
- **Fiber coarseness shows a 58% correlation**

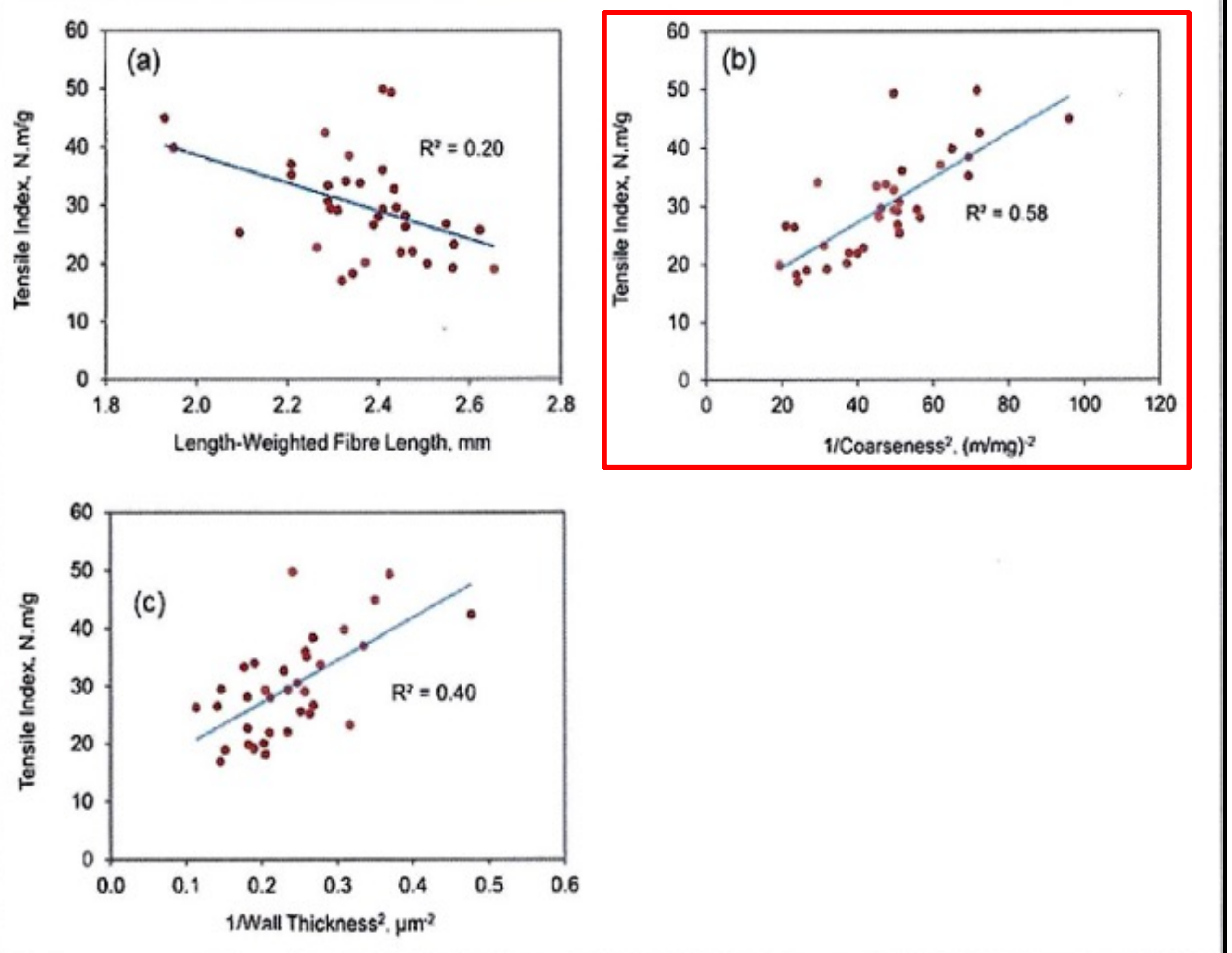
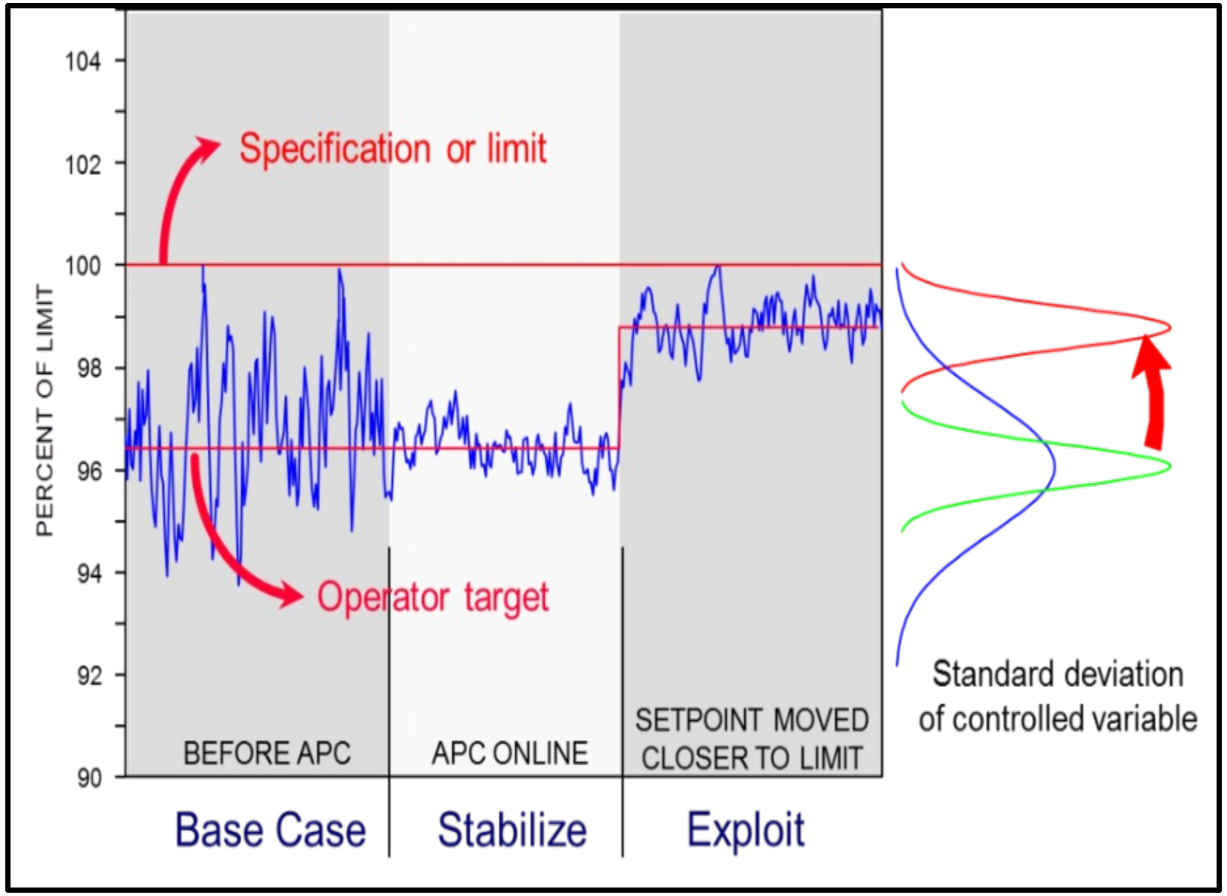


Fig. 2 - (a) Tensile Index versus fibre length, (b) Tensile index versus 1/coarseness², and Tensile index versus 1/wall thickness².

Benefits



Allows tighter control of the process.

- Allows dropping basis weights by grade.
- Provides confidence that grade data & specs are met.
- Dynamics at play at the first mill in Sweden, Waggeryd Cell, to implement this.

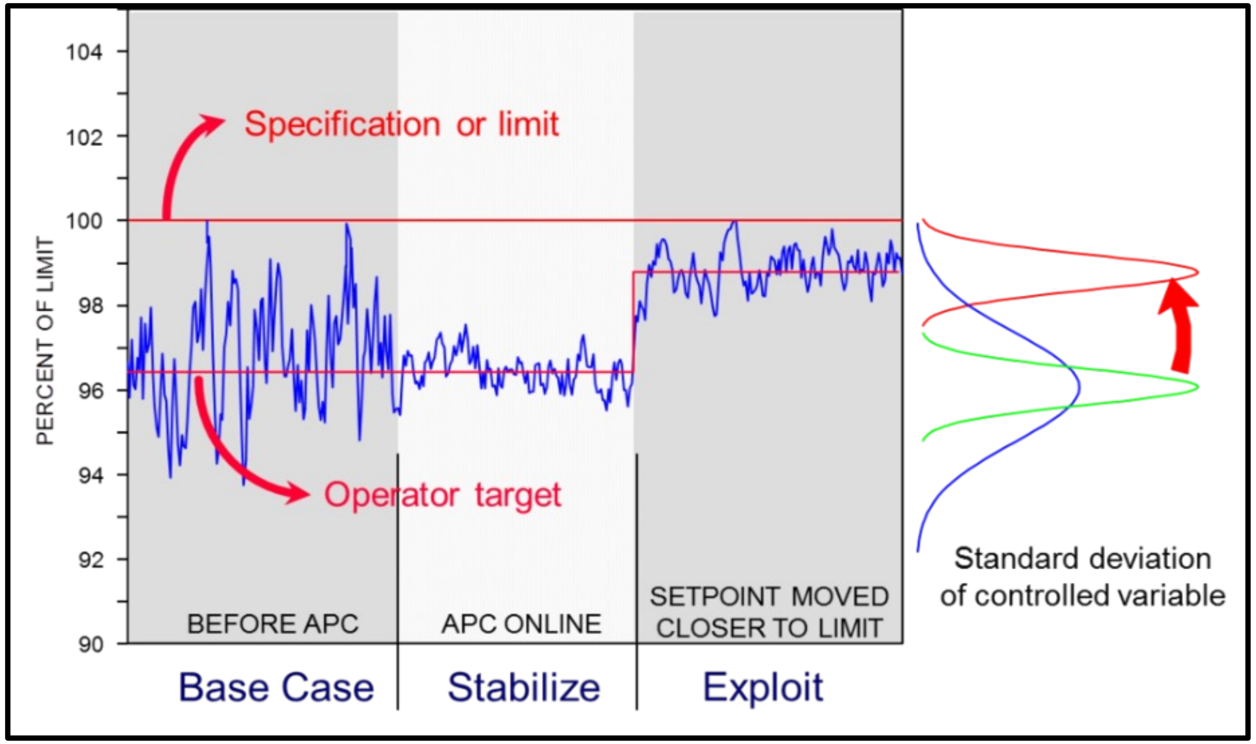
What end users can expect

- Product physicals can now be predicted after refining while still in the pulp slurry state.
- If a customer wants a certain combination of bulk and strength, this can be dialed in with this process. Recognizing that most producing pulp mills do not have refiners in their mills, studies can be developed to optimize refiner settings, plate designs and furnish to optimize the process.
- This contributes to stable pulp quality, quicker grade changes and reduces lab testing.

In Summary

- Technology permits readouts of key variables every 15-minutes.

- Tightening of targets is high on the list. With less process variation, fewer chemicals are needed; switching to less expensive fibers is possible; or lowering basis weights.
- Achieve faster grade changes.



Thank you.

Questions?