Elevating Paper Quality and Production Efficiency with Advanced Process Controls

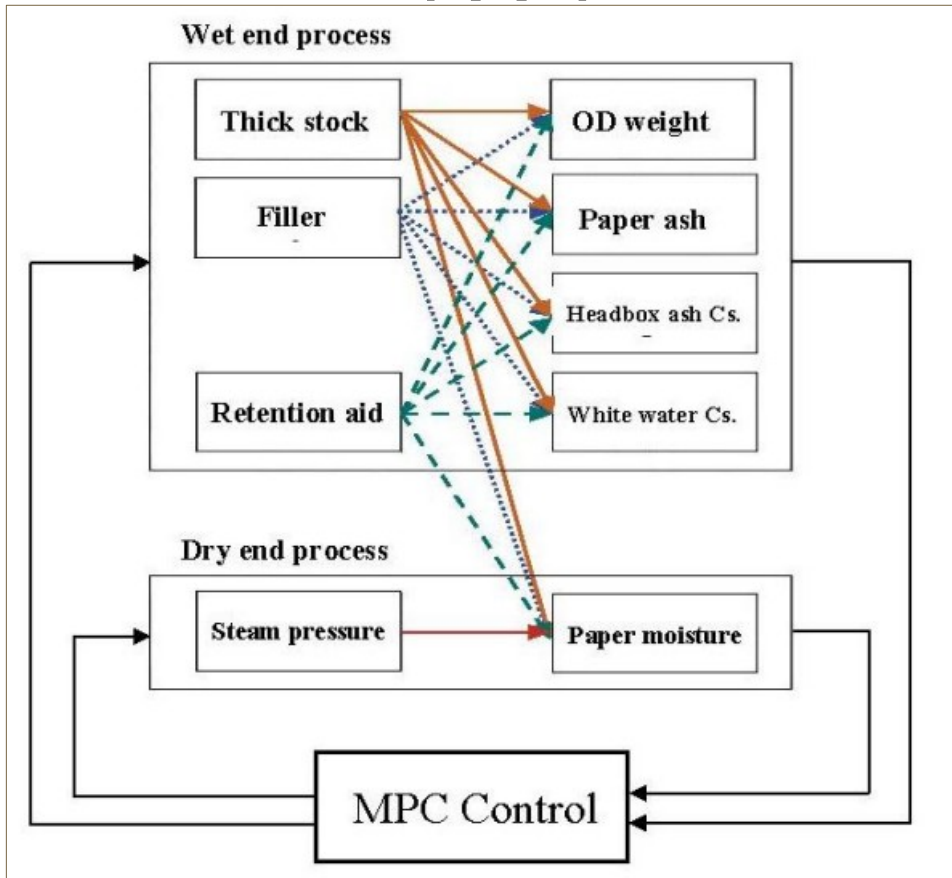Juuso Palonki, Valmet Automation

Motivations

- The industry evolves towards greater efficiency

- At the same time, due to the change of generation, the expertise and numbers of operators and engineers are changing

- Control systems need to be straightforward and easy to use

- Increases the demands for the MD control requirements

What is required from controls?

- High performance
  - Steady state, transition (grade changes), breaks
- Intuitive user interface (UX)
- Tools need to support the agile commissioning
  - Simple configuration
  - Automodelling
- Flexibility to modify and retune the controls
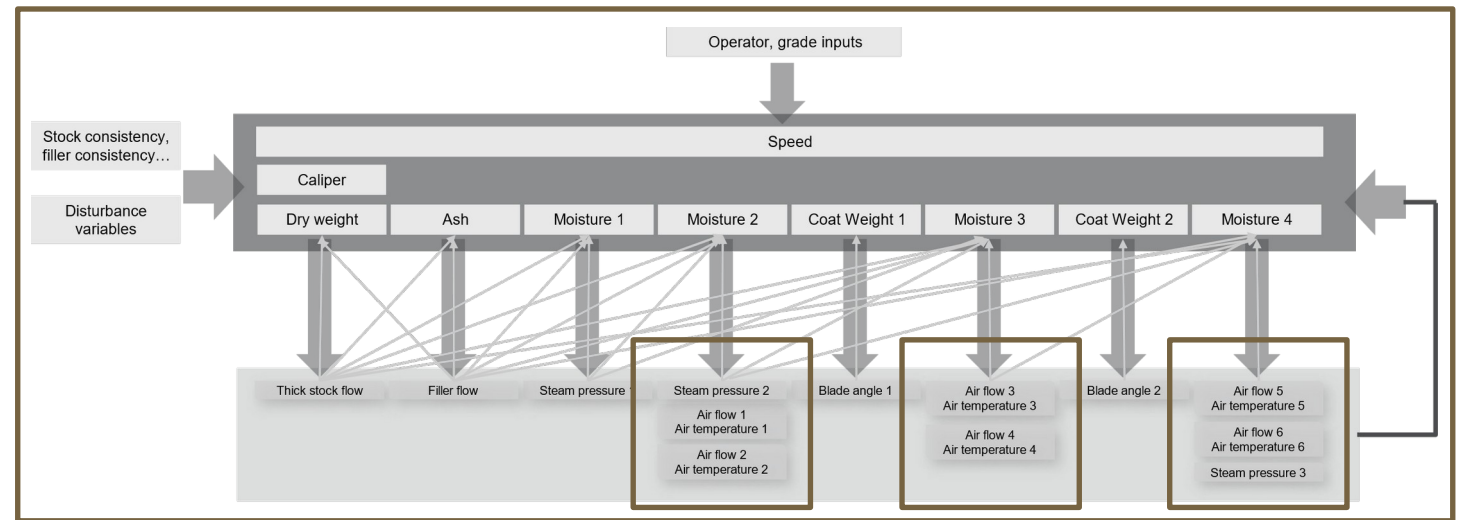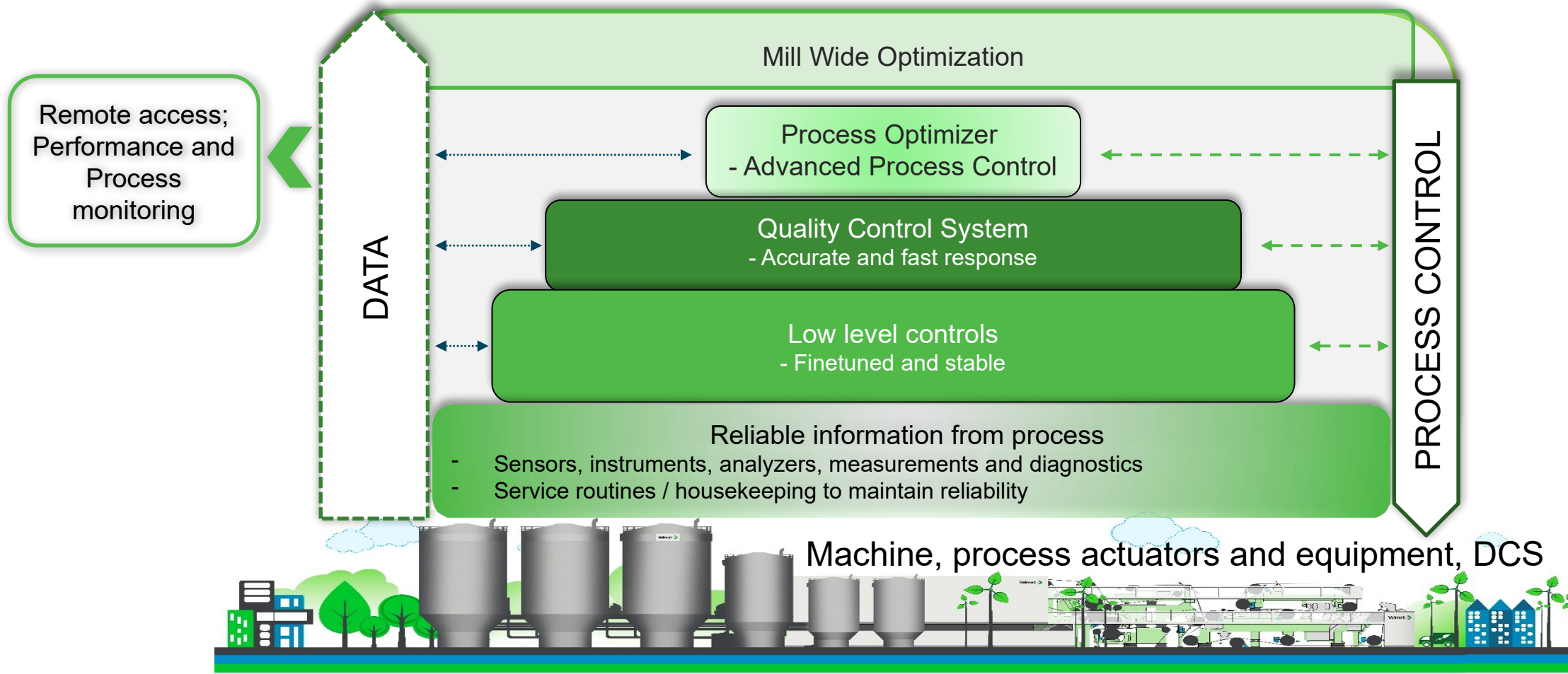 - Upkeeping the performance

MD control

4 X 4

- TAPPI 2007

13 X 9

The control structure

Modern Solution

Solid layers are essential for the future

Mill Wide Optimization

Remote access; Performance and Process monitoring

DATA

PROCESS CONTROL

Process Optimizer
- Advanced Process Control

Quality Control System
- Accurate and fast response

Low level controls
- Finetuned and stable

Reliable information from process
- Sensors, instruments, analyzers, measurements and diagnostics
- Service routines / housekeeping to maintain reliability

Machine, process actuators and equipment, DCS

Brightness Optimizer - Solution
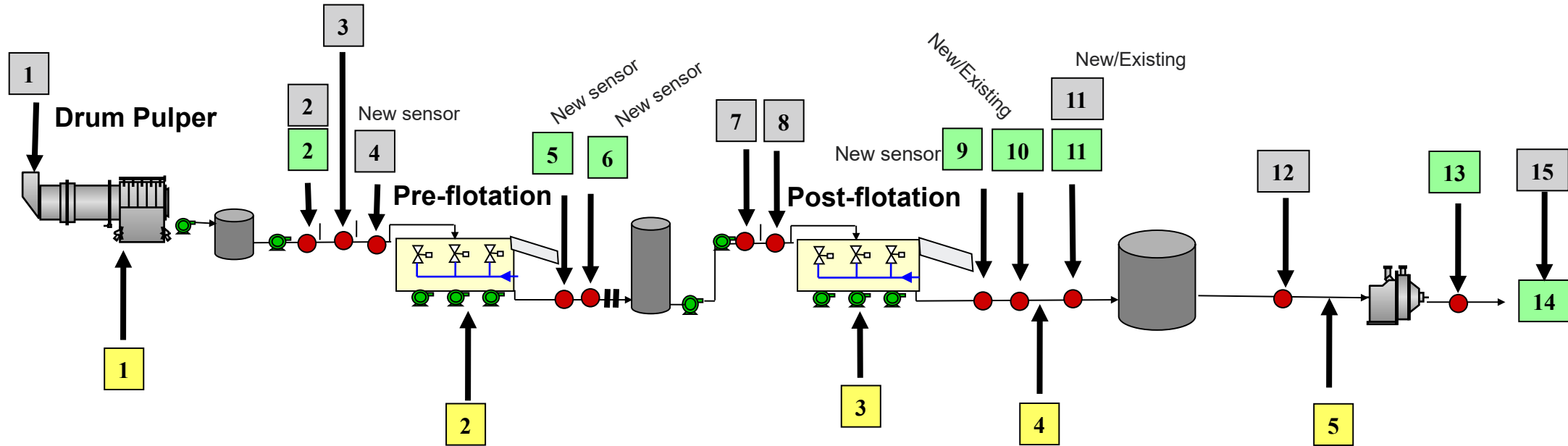
Manipulated Variables:

1 – Caustic, Peroxide & Soap
2 – Reject/Feed – ratio & Soap
3 – Reject/Feed – ratio & Soap
4 – Peroxide, Caustic
5 – Hydrosulfid

Primary & secondary flotation lines
Brightness = Y

Feedforward Variables:

1 – pH
2 – pH
3 – Brightness & Residual Ink
4 – Ash/Consistency new RM3
7 – pH
8 – Brightness
11 – Brightness
12 – Brightness
15 – Other parameters with impact on 14

Controlled Variables:

2 – pH
5 – Ash/Consistency. RM3
6 – Brightness/Residual Ink/Ash New
9 – Ash/Consistency. RM3
10 – Brightness/Residual Ink/Ash
11 – Brightness/Residual Ink/Ash
13 – Brightness
14 – Brightness final Paper

August 7, 2024
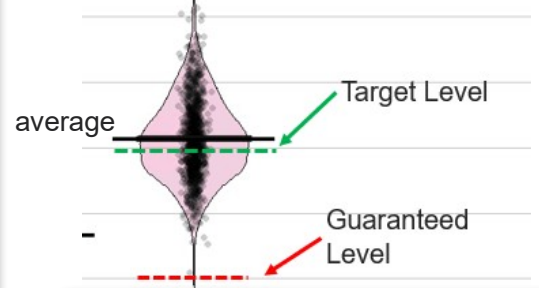
Modern Solution
End Quality predictions
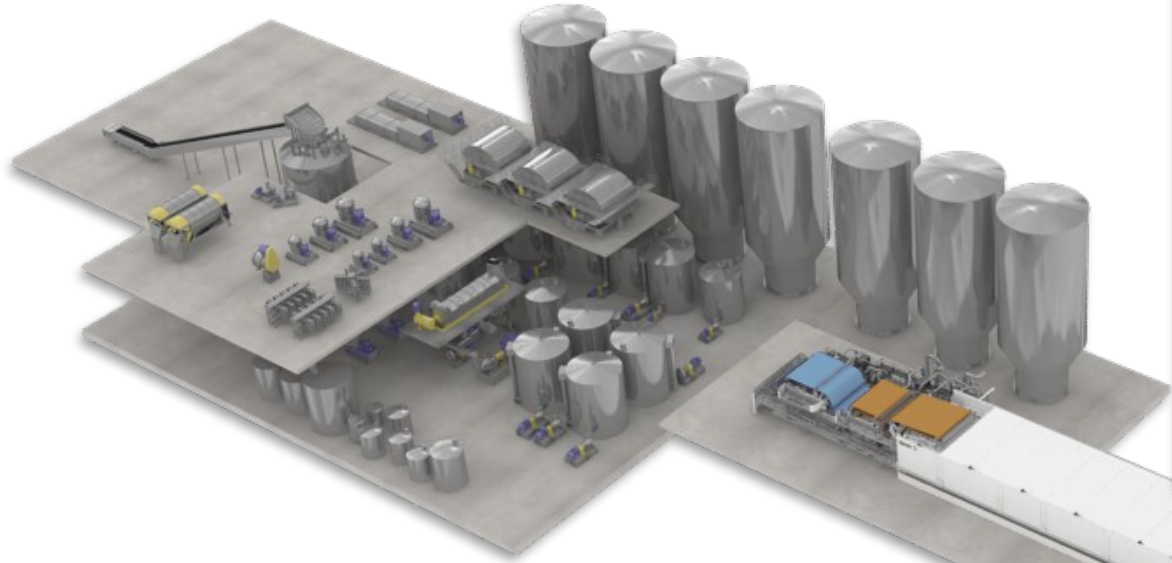
PRODUCT SPECIFICATIONS

	target	min/max
Tensile MD	4,0	+15% / -15%
Tear CD	500	
Burst	300	
SCT CD	2,2	
Stiffness MD	20	
Internal Bond	150	
IGT	0,90	
Porosity Gurley	20	
Cobb60 TS	< 30	

Tensile (kPa) measurement for 12 months for one grade

average — Target Level — Guaranteed Level

Tambour 025 11:25

Tensile   4,1

Target	Alarm Lo/Hi	Actions Lo/Hi
4	3,8 / (4,3)	3,6 / (4,5)

3 months data

Laboratory Tensile (kPa)

Model based prediction Tensile

2021-12-06 klo 0.00.00   2021-12-20 klo 0.00.00   2022-01-03 klo 0.00.00   2022-01-17 klo 0.00.00   2022-01-31 klo 0.00.00   2022-02-14 klo 0.00.00

TAG_TIMESTAMP

Estallido/Burst (kPa)   Predicted Burst (kPa)

Pulp to Paper Optimizer
Advanced Process Control

Minimize cost by

1. Minimize SoftWood
2. Maximize ash content
3. Minimize starch
4. Minimize refining energy

Controlled Variables

Variable with measured value and target.

Online | Lab/Analyzer

Manual Lab measurement

Cobb
ScottBond

Caliper
Smoothness

Burst
Stiffness
Tensile
Tear

Freeness
Fiber length
Fibrillation
Curl
Kink
Fines A/B
Etc.

MAP Q pulp
sampling lines

Disturbance Variables

Variable, the controller monitors but cannot manipulate. Helps to predict the process response.

OPTIMIZER
Multi Predictive Control

Soft Sensor
Model based predictions

Process measurements

Manipulated Variables

Variable that controller can move.

SW Refining power / SEC

HW Refining power / SEC

SW Portion / dosing

HW Portion / dosing

Ply ratios (board machine)

Starch flow / Chemical dosing

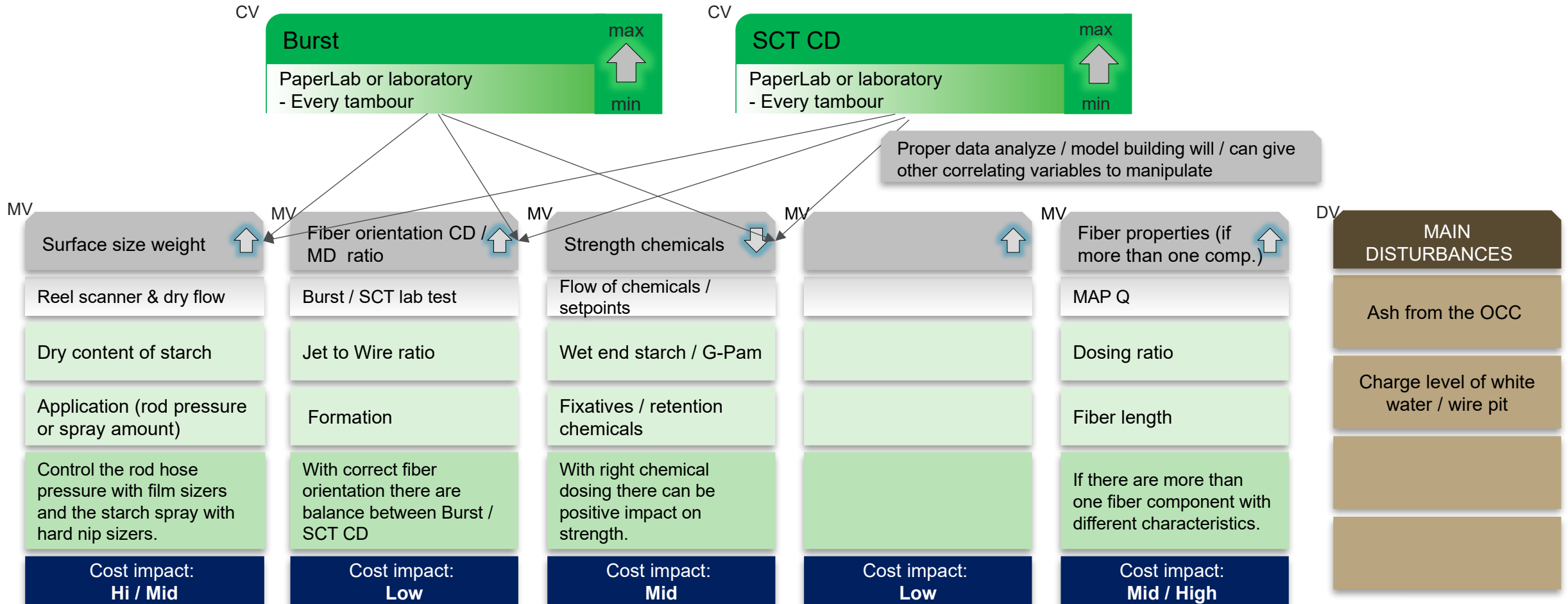Ash setpoint (QCS)

Jet to Wire ratio (QCS)

Pulp to Board / Paper Optimizer
Testliner / CV – MV matrix

OCC (100%) based Testliner´s strength properties is dependent on the raw material quality. There are no too many things to manipulate after OCC bales are pulpered. Strength properties has main correlation to basis weight and surface size weight.

CV

Burst	max
PaperLab or laboratory - Every tambour	min

CV

SCT CD	max
PaperLab or laboratory - Every tambour	min

Proper data analyze / model building will / can give other correlating variables to manipulate

MV	MV	MV	MV	MV	DV
Surface size weight	Fiber orientation CD / MD ratio	Strength chemicals		Fiber properties (if more than one comp.)	MAIN DISTURBANCES
Reel scanner & dry flow	Burst / SCT lab test	Flow of chemicals / setpoints		MAP Q	Ash from the OCC
Dry content of starch	Jet to Wire ratio	Wet end starch / G-Pam		Dosing ratio	Charge level of white water / wire pit
Application (rod pressure or spray amount)	Formation	Fixatives / retention chemicals		Fiber length	
Control the rod hose pressure with film sizers and the starch spray with hard nip sizers.	With correct fiber orientation there are balance between Burst / SCT CD	With right chemical dosing there can be positive impact on strength.		If there are more than one fiber component with different characteristics.	
Cost impact: **Hi / Mid**	Cost impact: **Low**	Cost impact: **Mid**	Cost impact: **Low**	Cost impact: **Mid / High**	

Pulp to Paper Optimizer
Example of soft sensor tensile strength predictions

Pulp to Paper Strength Optimizer

- Controlled Variables are MD Tensile and CD Tear (+ Cost)

- Soft Sensor calculates the predictions for the strength (in the picture Tensile prediction)

- Manipulated Variables are long fiber pulp-% (kraft), filler-% and refining's SEC

Mondi Ružomberok PM 19 – Industrial Internet

## Advanced Process Controls (APC) for mottling – Ensure stable quality at the targeted level

Grade	White Top Liner, Recycled Liner
Wire width	5,900 mm
Design speed	1,400 m/min
Basis weight / Annual Production	125 g/m² / 300,000 Tons/a
Start-up	Jan 2021

Up to 3gsm Top Ply Savings with Pulp to Paper Optimizer and MAP Q
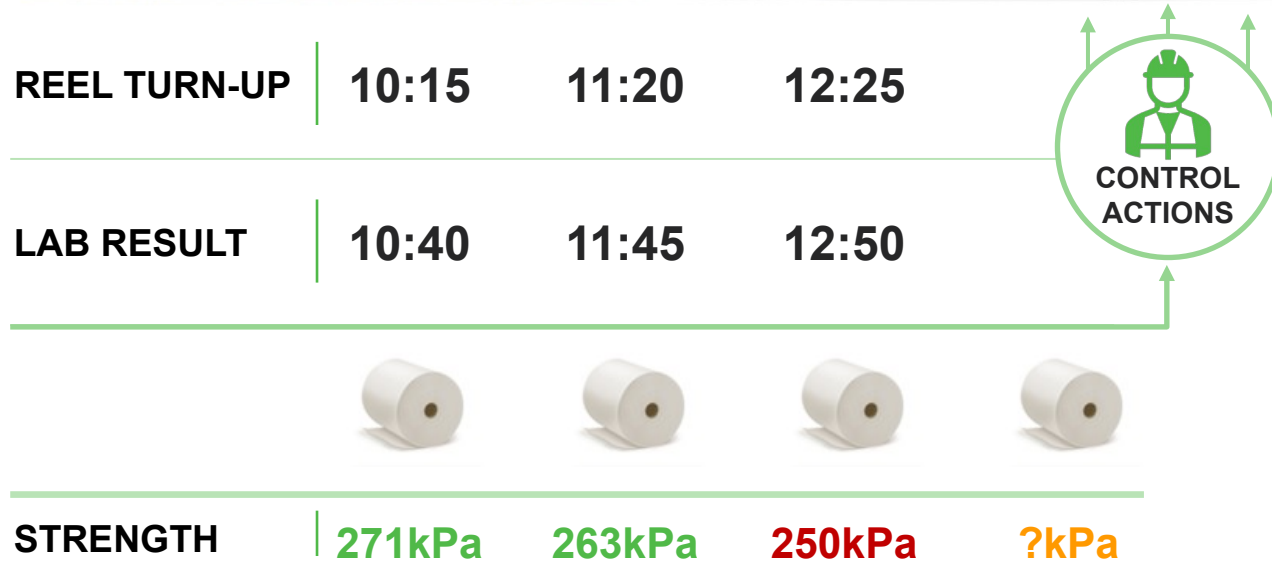
Yearly saving level **1,0 – 1,5 million euros**

Dynamic Centerline Advisor & VPC support continue to bring additional savings through model tuning `

> " We have a virtual model for all three main parameters, SCT, Burst and Kheops. And I am especially happy that we and Valmet developed the Kheops measurement, as this measures appearance and mottling. We built this together from scratch, and it's working very, very well. *Peter Demčák, Operations Director, Mondi Ružomberok*
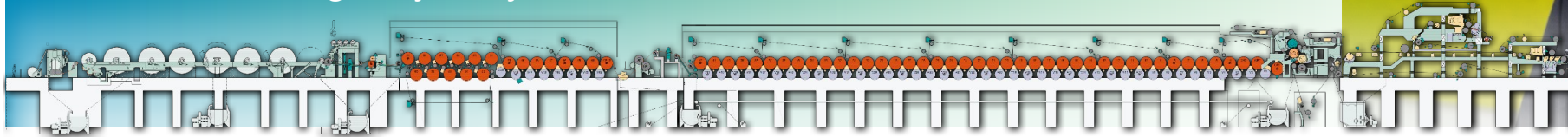
Challenge in Board machine quality control:
Critical Quality information has low frequency and it arrives late

REEL TURN-UP	10:15	11:20	12:25
LAB RESULT	10:40	11:45	12:50
STRENGTH	271kPa	263kPa	250kPa	?kPa

CONTROL ACTIONS

Quality Sweet Spot

Overquality → Waste of resources & money

Specification Minimum Quality Limit

Underquality – lower than specification minimum

SCT CD Strength [kN/m]

Burst Strength [kPa]
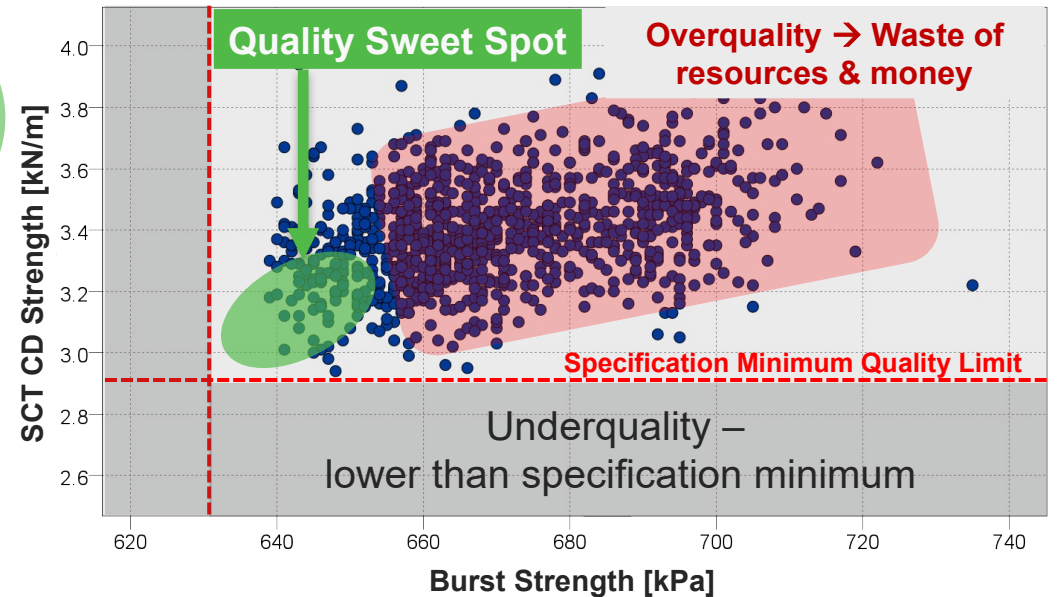
In traditional laboratory-based quality control **data frequency is low and significantly delayed**

Traditional quality control requires safety buffers which easily **leads to high amount of overquality**

APC – Application

- Sheet-break (SB): automatically handled
  - When SB, APC OFF temporarily by itself.
  - After SB, APC will wait for another 5 minutes, then returns back ON automacally.

- Machine speed change: automatically handled
  - When machine speed change, APC OFF temporarily by itself.
  - After speed change, APC will wait for another 10 minutes, then returns back ON automacally.

- Grade change (GC):
  - When GC, APC OFF, all controls back to operator.
  - After GC, 10-minute waiting (operator can check new setting values for "starch cons", "rod-hose prss", "JW ratio")
  - After GC+10 minutes, APC resumes automatically.

GC   10m

- Any time, operator can switch OFF any of APC controls, and do manual change
  - Switch OFF starch cons (page 1.7.5 or 1.7.7), set new target value, and then turn APC ON
  - Switch OFF rod-hose press (page 8), set new target value, and then turn APC ON
  - Switch OFF J/W ratio (page 60, C→L), set new J/W value, and then turn L→C (APC ON)
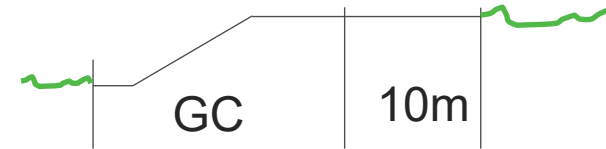
Value: Reducing variation in Burst by utilizing Pulp to Paper Optimizer
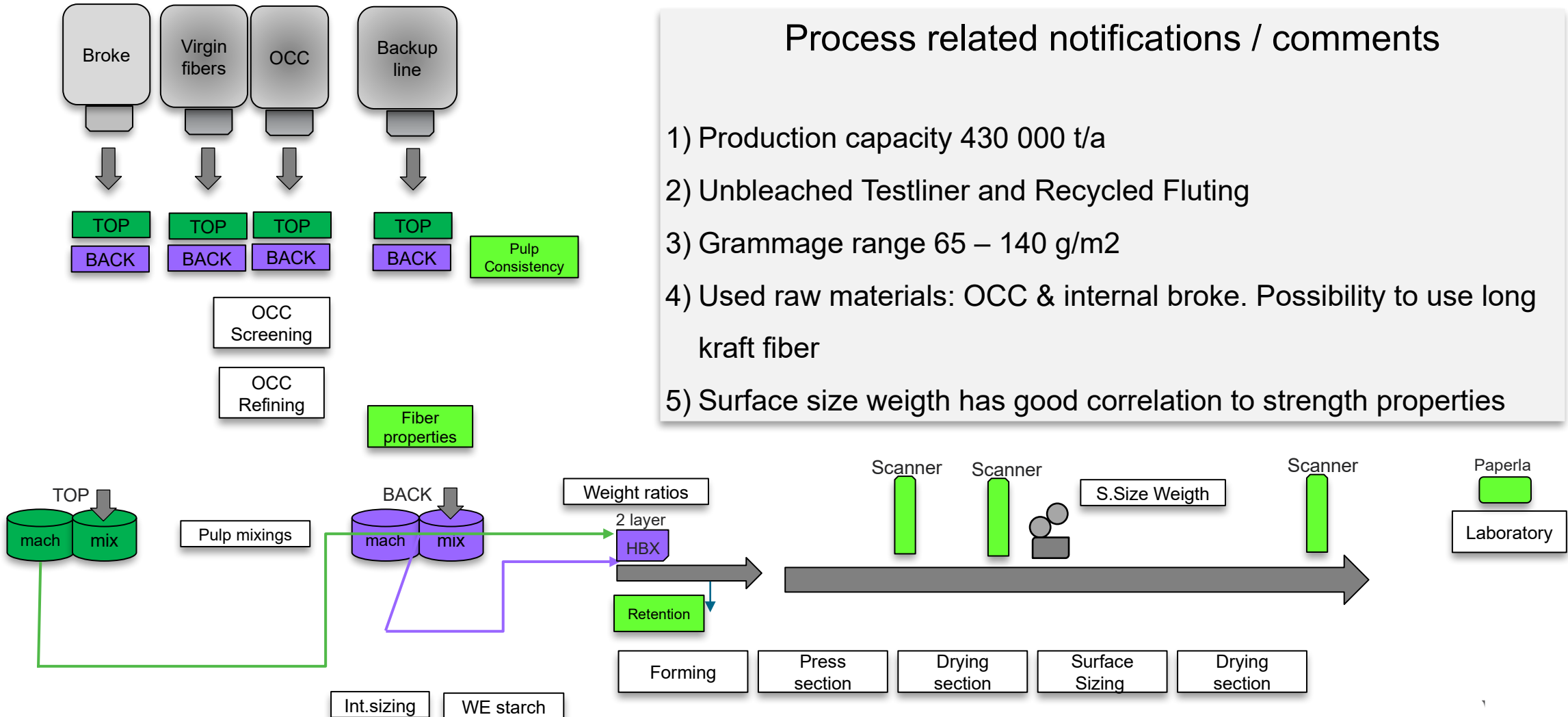
Test liner machine in Europe

© Valmet | Author / Title
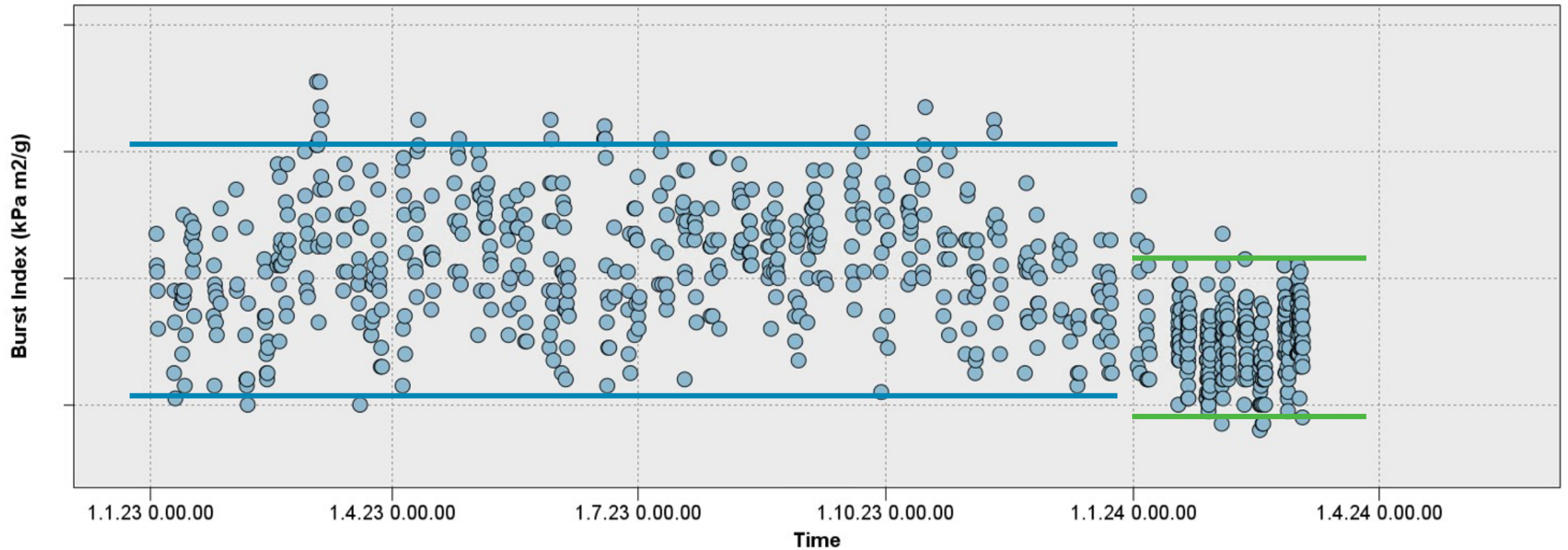
APC – Control Matrix

	Starch cons. (MV1)	Rod-hose prssure (MV3)	J/W ratio (MV5)
CV1 Burst	+	-	+
CV2 SCT CD	+	-	-
CV3 MD/CD tensile ratio			+
CV4 Starch amount	+	-	

Pulp to Paper Optimizer
Needed analyzers, scanners and measurements

Process related notifications / comments

1) Production capacity 430 000 t/a

2) Unbleached Testliner and Recycled Fluting

3) Grammage range 65 – 140 g/m2

4) Used raw materials: OCC & internal broke. Possibility to use long kraft fiber

5) Surface size weigth has good correlation to strength properties

Broke

Virgin fibers

OCC

Backup line

TOP

BACK

TOP

BACK

TOP

BACK

TOP

BACK

Pulp Consistency

OCC Screening

OCC Refining

Fiber properties

TOP

mach

mix

Pulp mixings

BACK

mach

mix

Weight ratios

2 layer

HBX

Retention

Int.sizing

WE starch

Forming

Press section

Drying section

Surface Sizing

Drying section

Scanner

Scanner

S.Size Weigth

Scanner

Paperla

Laboratory

Analytics dashboard configuration and built-in analytics tools

Edge Cloud Process Insight

Features

- Dashboard Creator allows users to intuitively visualize data and understand events in processes and operations

- Process Analysis Tool gives easy access to stakeholders for straight-forward evaluation of intuitive process data analysis

- Data analytics available in both on-premise and cloud environment. In on-premise results can be used directly in DCS. Additional analysis services available through Cloud Based services

Benefits

- Fast data visualization and analysis for follow-up, troubleshooting, and information sharing

- Easy access to analytics dashboards and tools through Distributed Control System

- Autonomy to efficiently build fit-for-purpose visualizations to meet specific needs beyond self-sevice dashboards

Easy to use Dash Board and Analytical tools

Process Analysis Tool
For efficient process analysis

- An easy-to-use trending, analysis and filtering solution for process studies

- Follow, study or troubleshoot processes by
  - comparing different production levels
  - searching high peaks from data
  - studying long-term systemic changes and variations
  - filtering unnecessary data away

- As the tool is easy to use, fast and can be used with all process data tags, it helps to speed up process monitoring and troubleshooting

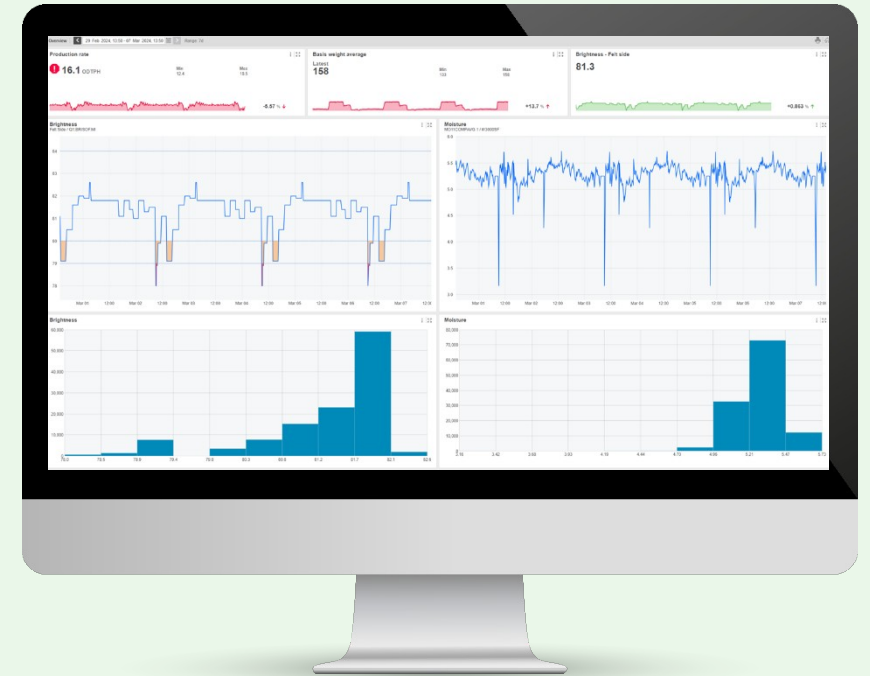Process Analytical Tools (On premises / Cloud Based)

- Fast trending
- Versatile and fast data filtering
- Histogram with bin amount entering
- Binary analysis mode
- Calculated tag creation
- X-Y scatter trend
- Sliding coefficient of variation trending functions

© Valmet | Data Management and Analytics

Dashboard Creator
For process data analysis and visualization

User build Dash Boards from Plant's Data (On premises / C

- A powerful self-service data visualization tool for reporting, analysis and monitoring purposes

- Easy to use with ready-made templates and graphical components

- Designed specifically for industrial data and use cases

- Customized and flexible dashboards allow you to follow up metrics or KPIs in the long term or create quick views to study process deviations or identify root causes

- The dashboard views can be easily saved and shared to collaborate within the organization or accessible through Cloud based online platform

Return of Investment – calculations for the APC benefits

- Confidential Customer
- **Sales ₹/a 2,100,000,000**
- **Sellable tons annually 346 889**

- Speed on Pope 900m/min
- Width of the machine 6100mm
- Grammage 141g/m^2

- Production day is 1440 min
- Prod year is 340 days
- Board sale price is 61 000₹ /ton

- Fiber ratio before APC:
  - 90,5% of Local OCC (13 000 ₹/ton), 9,5% of Kraft Pulp (63 000 ₹/ton)
  - This means that the mill is using 255 680 tons of local OCC per year and 26 800 tons of Kraft Pulp

- Fiber ratio after APC:
  - 91% of Local OCC (13 000 ₹/ton), 9% of Kraft Pulp (63 000 ₹/ton)
  - This means that the mill is using 257 900 tons of local OCC per year and 25 500 tons of Kraft Pulp

- **Cost effect ₹ annually is 5,400,000**

- Web breaks:
  - Daily web breaks before APC 43 minutes on the wet end and 51 minutes on the dry end
  - Daily web breaks after APC 40 minutes on the wet end and 49 minutes on the dry end

- Grade change:
  - Daily grade change average before APC 12 minutes and after APC 10 minutes

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- Total average production time saved daily: **7 min**

- Time efficiency of machine rises to **93,8%** from 93,5% and total efficiency rises to **90,2%** from 89,9% meaning 5000 tons more production every year and with 10,0% GP **40,000,000 ₹** more profit every year

Conclusion

Data Creation	• Reliable and accurate Instrumentation • Creation of accurate data from Process
Data Utilization	• Effective utilization of data using various digital tools like Self Service Analytics and APC
Advanced Process Controls	• Creating mill specific predictive models using soft sensors • Implementing Advanced Process controls
Industrial Internet Tools	• Using Self Service Analytical tools • Implementation of Industrial Internet Applications
Optimized Production	• Raw material and Energy Consumption Optimization – Leading to Cost Savings • Consistency and Increase in Final Pulp / Paper / Board quality
Facts and Figures from Reference Case(Mondi Ružomberok PM 19)	• Product : Recycled Test Liner • Anchor GSM – 125 • Speed – 1500 MPM • Annual Production – 300,000 TPA • Annual Savings - Over 1 Million Euro