OPTIPID CONSULTING

INTELLIGENCE • OPTIMIZATION • PERFORMANCE

PAPER MACHINE OPTIMIZATION

AI INTELLIGENCE

CONTINUOUS MONITORING

AI-DRIVEN PAPER MILL OPTIMIZATION SOLUTION

IPPTA – ZONAL SEMINAR-I 2026

INDUSTRY CHALLENGES

Hidden process inefficiencies cost large paper machines millions annually ($1–3MUSD)

STABILITY LOSS: SHEET BREAK & VARIABILITY LOSSES

- ~50 breaks/month
- 12+ hours downtime
- ~500 tons production loss
- $500K–$800K annual impact

QUALITY LOSS: REJECTS DUE TO MD/CD VARIABILITY

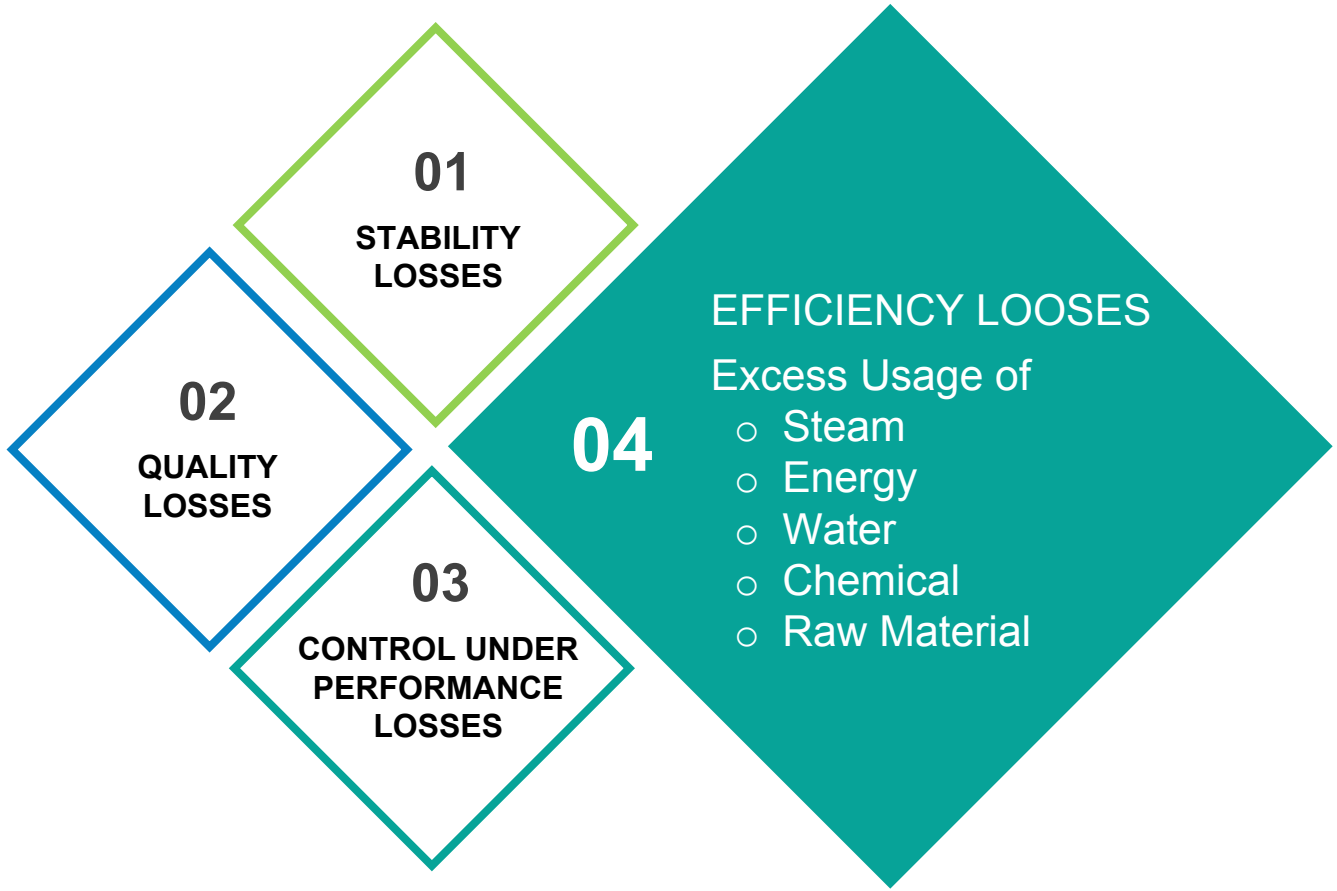
- High 2 Sigma variation (BW, Moisture, Ash, Caliper)
- 200–400K USD annual reject losses

CONTROL UNDER PERFORMANCE LOSSES:

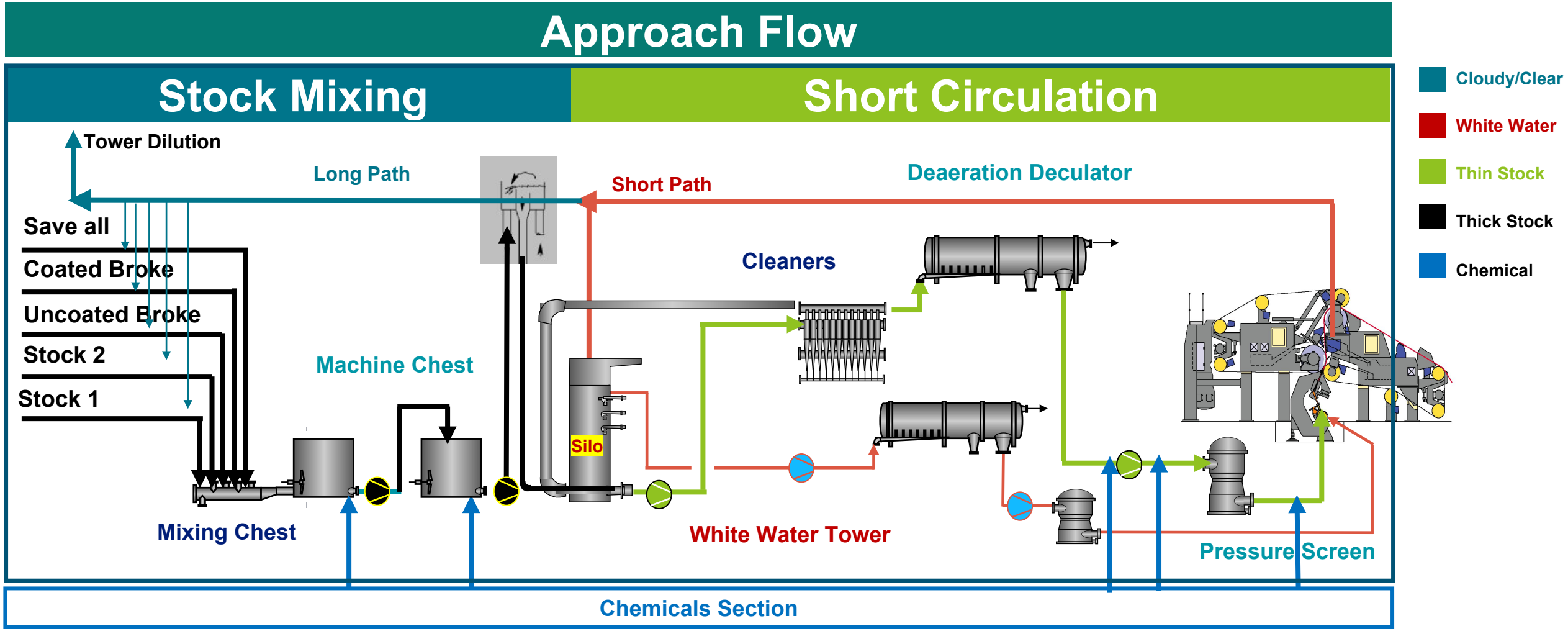
- Slow grade/shade transitions
- Startup rejects
- 500–600K USD annual opportunity

EFFICIENCY LOSSES: APC HELPS IN SAVING

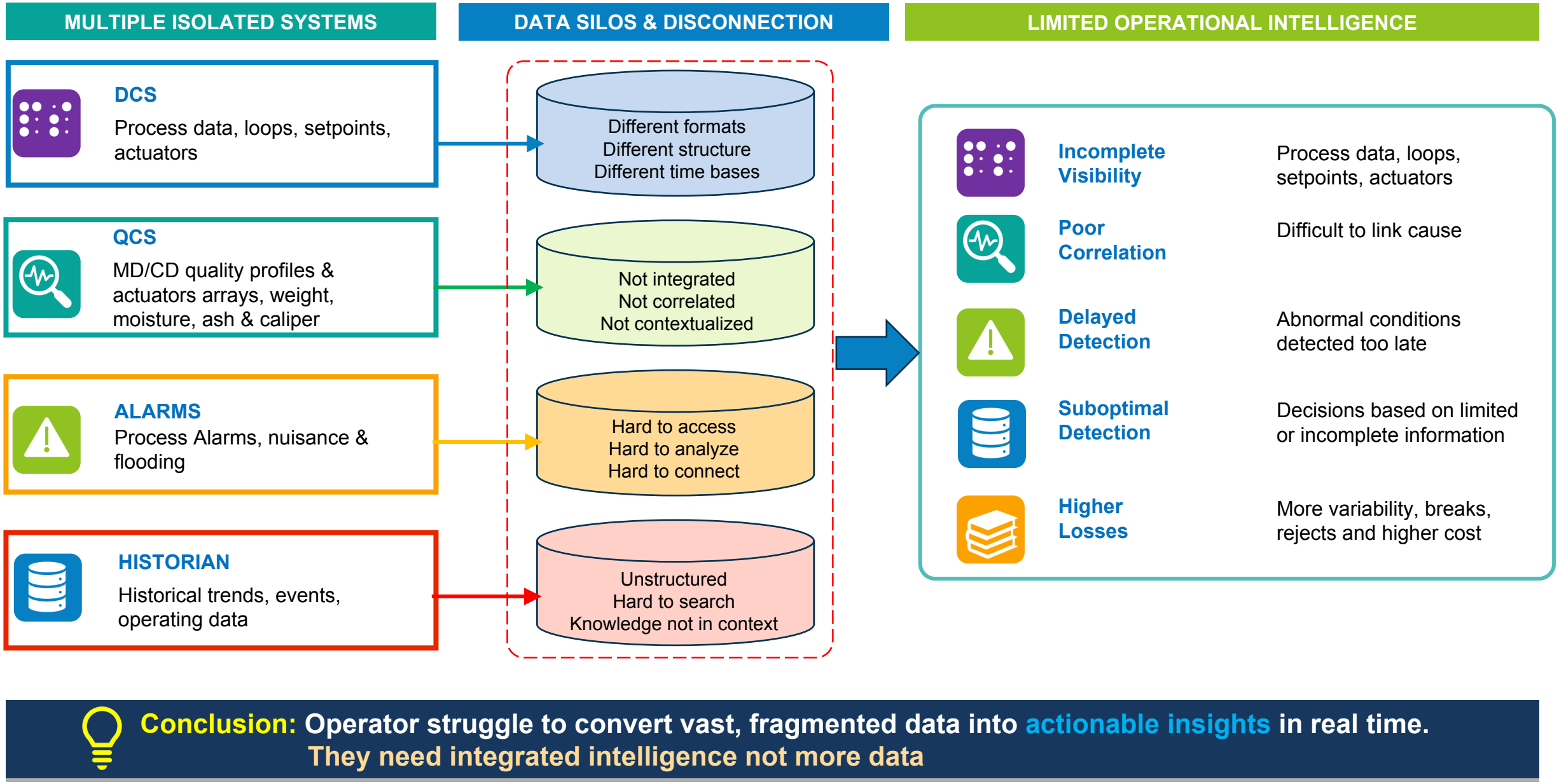
- 250-400K USD savings a year
- Chemicals - 40% reduction in retention aids
- Energy - >10% reduction in dryer steam
- Fiber - 3-7% fiber savings via increased filler
- Quality - 60% reduction in white water variability



PROCESS HIDDEN CONTRIBUTORS

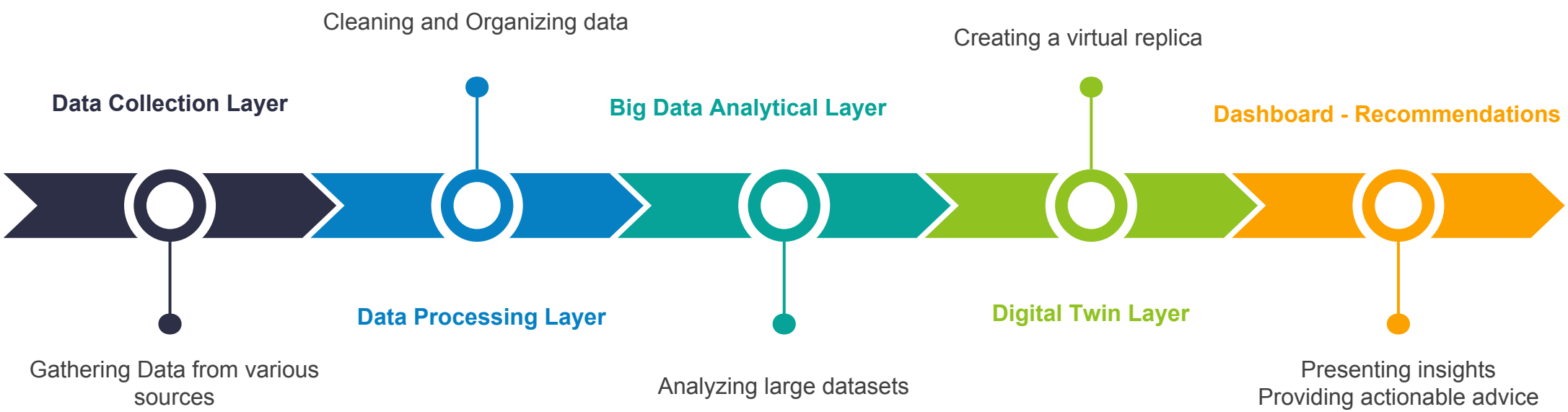


WHY TRADITIONAL SYSTEM ARE NOT ENOGUH



Conclusion: Operator struggle to convert vast, fragmented data into actionable insights in real time.
They need integrated intelligence not more data

PROPOSED SOLUTION ARCHITECTURE



TECHNICAL INNOVATION

INPUTS

DCS
Process data, loops, setpoints, actuators

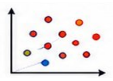
QCS
MD/CD quality profiles & actuators arrays, weight, moisture, ash & caliper

ALARMS
Process Alarms, nuisance & flooding

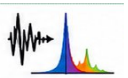
HISTORIAN
Historical trends, events, operating data

SOPs & MANUALS
Operating procedures, expert knowledge

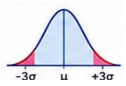
METHODS (AI ANALYTICS)



PCA (PRINCIPAL COMPONET ANALYSIS
Identify dominant source of variation, Reduce dimensionality, reveal patterns

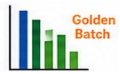


PSA (POWER SPECTRUM ANALYSIS)
Detect cyclic disturbances, identify dominant frequencies



Z-SCORE ANALYSIS
Detect abnormal deviations, real-time anomaly detection

ML (RANDOM FOREST)
Predict & alarms, Classify root causes



GOLDEN BATCH COMPARISON
Compare with best operating window, Identify gaps & improvement areas

AI + PROCESS KNOWELDGE + ADVANCED ANALYTICS

OUTPUTS (BUSINESS IMPACT)

ROOT CAUSE
Pinpoint the true drivers of variability

RECOMMENDATIONS
Actionable steps for operators

APC ACTIONS
Setpoint / Control adjustments

PERFORMANCE & QUALITY
Reduce Variability, breaks & rejects

BUSINESS IMPACT
Reduce Variability, breaks & rejects

Our Innovation: Combining Advanced Analytics, AI & Process Expertise to deliver
Real-time Intelligence → Better Actions → Measurable Results

AI OPERATOR ASSISTANCE

QUESTION

Operator asks a question in natural language

Why is basis weight variability increasing?

CONTEXT RETRIEVAL

AI retrieves relevant context from integrated sources

- ✓ DCS Process Data
- ✓ QCS Data
- ✓ Alarms & Events
- ✓ Historical Trends
- ✓ SOPs / Operating Procedure

AI REASONING

AI analyzes and reasons using advanced models

- ✓ Pattern & anomaly detection (PCA, PSA, ML)
- ✓ Cause correlation
- ✓ Golden batch comparison
- ✓ Process knowledge reasoning

RECOMMENDATION

AI delivers, clears, actionable recommendations

- ✓ Root Cause Identified – Most probable cause with evidence
- ✓ Relevant SOP retrieved – Step by step procedure from operating manual
- ✓ Corrective Action – Actionable steps to stabilize the process

EXAMPLE

AI Assistance Response

Operator Question

Why is basis weight variability increasing?

Root Cause Identified

- ○ High variation in stock consistency from Mixing chest
- ○ Unstable Silo level
- ○ Stock Flow (FIC-102) showing oscillation

Confidence 87%

Relevant Manual

SOP: BWV-07 – Basis Weight variation troubleshooting

- ○ Check stock consistency
- ○ Verify dilution
- ○ Check Silo level variation

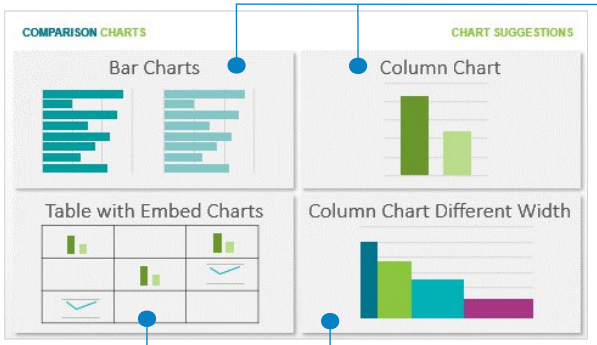
Source – BW Operation Manual

Recommendation

- ○ Stabilize thick stock consistency at 3.5%
- ○ Retune stock flow control (FIC-102)
- ○ Retune Silo level
- ○ Monitor Weight trend for 60 mins

Give Feedback

ROOT CAUSE FINDINGS



Production Summary

Process Issues

History

Losses summary

MD issues

Grade Change summary

Dashboard

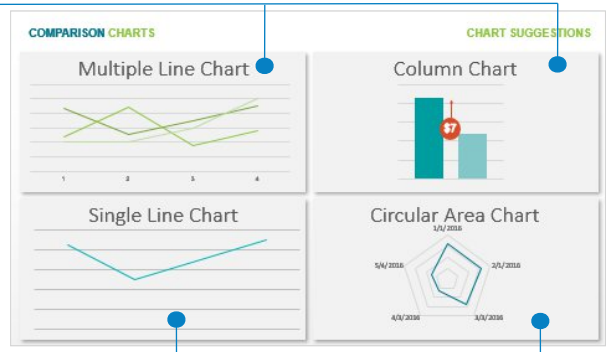
228 Control Loops Monitored to Identify Hidden Sources of Variability

Health Score

Decides process are problems

Every Day analysis

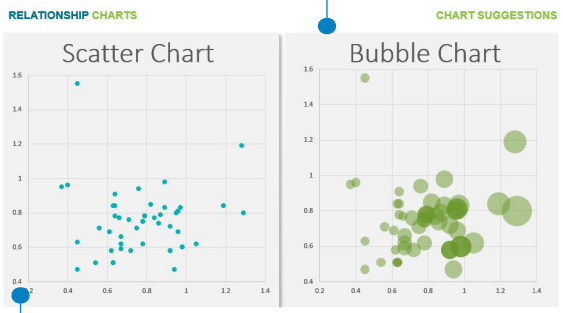
Process Index



Control / Process / Signal Problems

Process Analysis

Color Map



Statistics

Profile Analysis

OptiPap
Intelligent Insights. Better Paper.

Loop tuning

Various tuning techniques

Process model

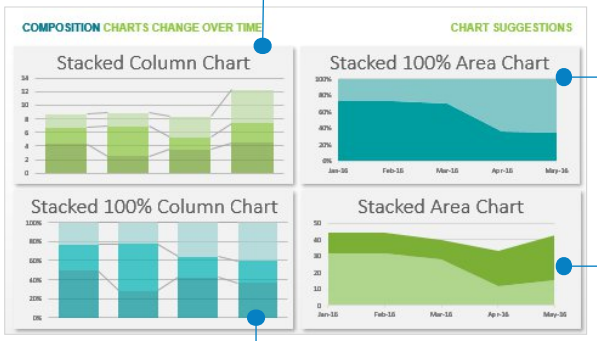
Process Variable / Actuator

Closed Loop / Open Loop Identification

Two Variables

MD Analysis

Few Periods – Relative and Absolut Difference



Relative Difference

Relative and Absolut Difference

Many Periods

Change over time

Few Periods – Relative Difference

Static over time

Simple Share of Total

Accumulation Subst. of Total

Components of Components

Profile Analysis CD_2026-05-11_09-29-42.txt · 512 scans × 150 CD bins

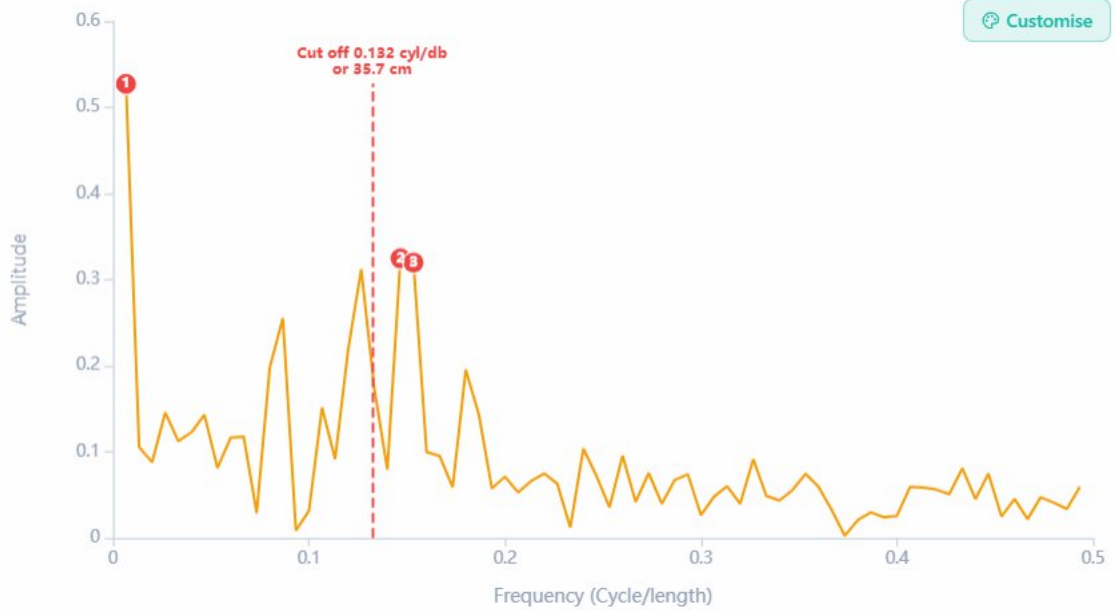
PROFILE Profile 1 | Profile 2 | Profile 3 | Profile 4 | Dark

Distribution & Frequency

Frequency Table | Config

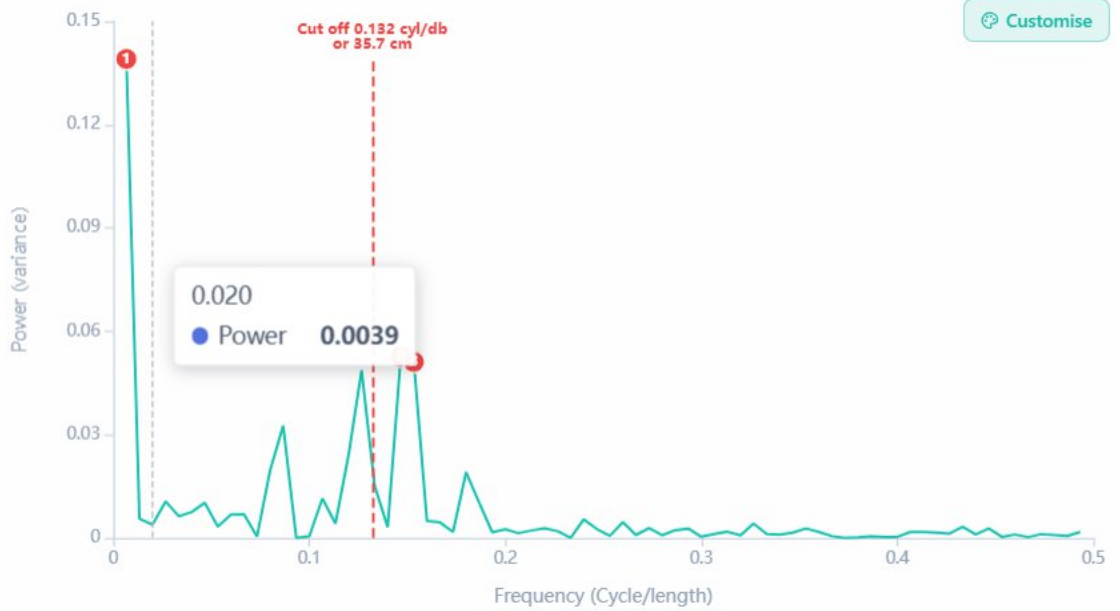
Amplitude Spectrum TOP 3 1 0.007 cyl/db · 708.0 cm 2 0.147 cyl/db · 32.2 cm 3 0.153 cyl/db · 30.8 cm

Customise



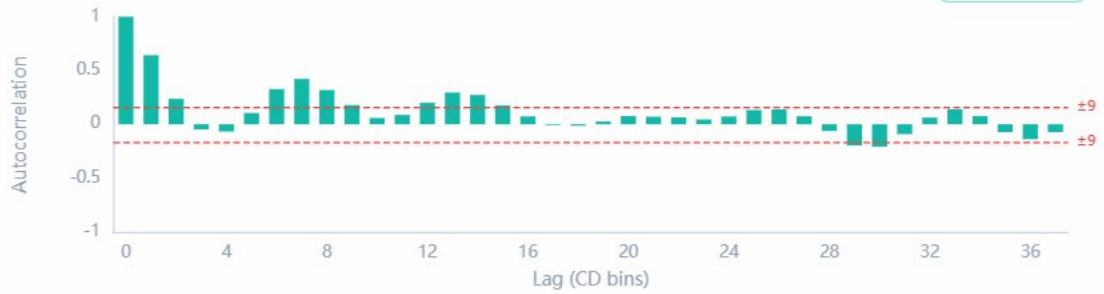
Power Spectrum TOP 3 1 0.007 cyl/db · 708.0 cm 2 0.147 cyl/db · 32.2 cm 3 0.153 cyl/db · 30.8 cm

Customise



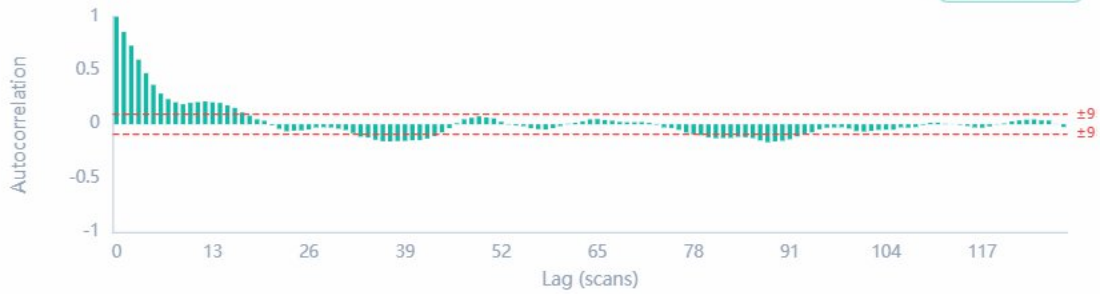
MD Trend Autocorrelation

Customise



CD Profile Autocorrelation

Customise



Max CD Spread 1.5211

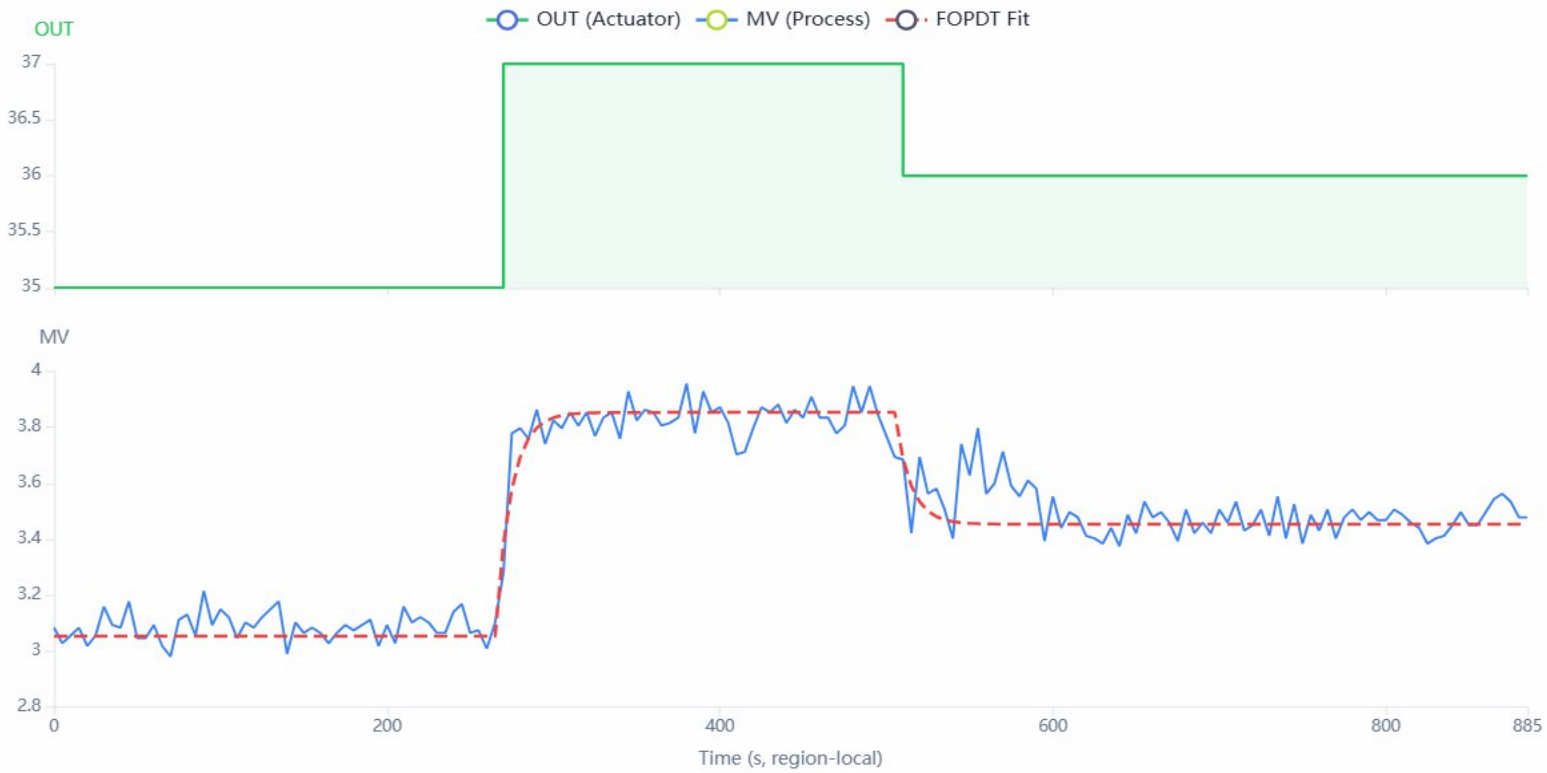
LOOP TUNING

Loop Tuning Tool Test11.csv · 1,323 rows

Dark

Identify Model · First Order Rows 973–1150 · 178 samples · Ts 5s

Kc 0.610 · Ti 12.1s · Td 0.0s | Auto Model | Next · Simulate →



Kp = 3.994E-1, taup = 12.05739, Tdt = 0.00, Points = 178, Ts = 5

MODEL PARAMETERS

MODEL OFFSET	DELAY	GAIN	TAU P	
3.054	0.002	0.3994	12.057	Update Model

Tuning Setup

PROCESS

MODEL: First Order

DELAY	GAIN	TAU P
0.002	0.3994	12.057

☐ Use as Initial Model Settings

☐ Overlay Multiple Model Trends

TECHNIQUE

METHOD: Direct Synthesis

TAU RATIO: 2

CONTROLLER

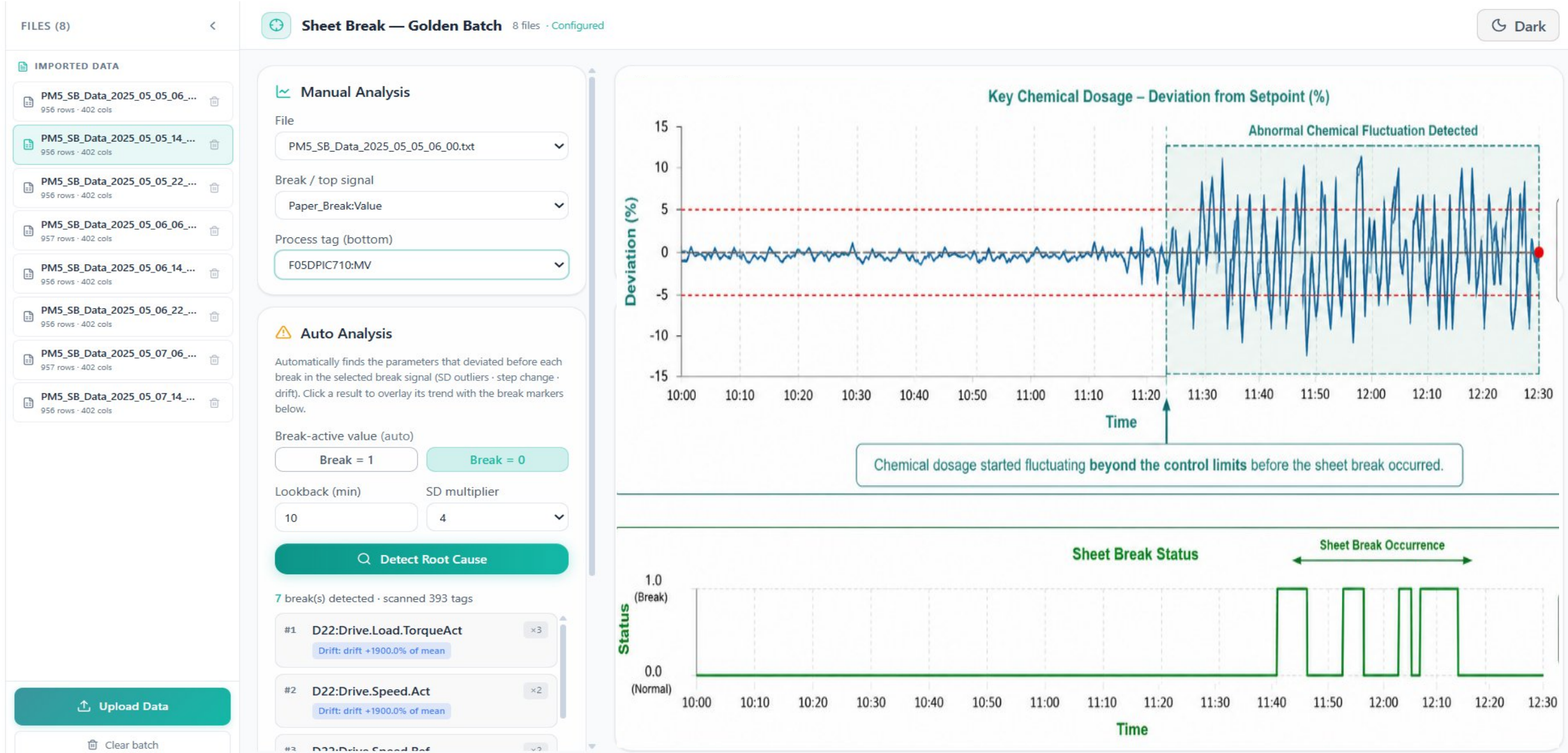
SYSTEM	CONTROLLER
Generic	PID Standard

PV RANGE	MV RANGE
0.975	2

Apply

Identify Model

SHEET BREAKS



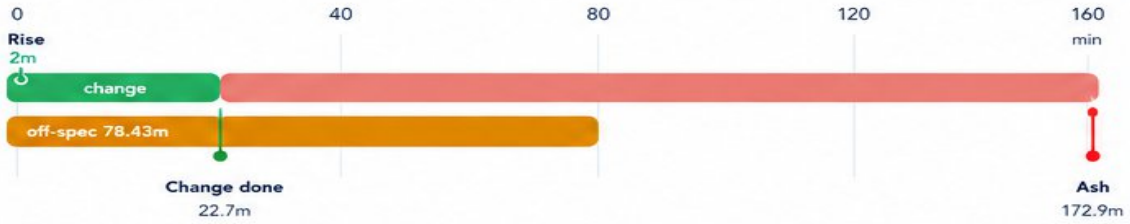
GRADE CHANGE SUMMARY

1. GRADE CHANGE SUMMARY

TRANSITION TIMELINE

- Grade change completed in **22.7 min**
- Ash loop dragged on to **172.9 min.**

Legend: dead-time – rise – overshoot – settling tail



GRADE CHANGE ASSESSMENT

67.9 / 100

AVERAGE TRANSITION

Some loops worth a closer look.

WHAT HAPPENED

- Rise time: **2 min** (fast ramp)
- Dead time: **0.08 min**
- Off-spec time: **78.43 min**
- Oscillations: **977 times**
- Ash loop settled after: **172.92 min**

ROOT CAUSE

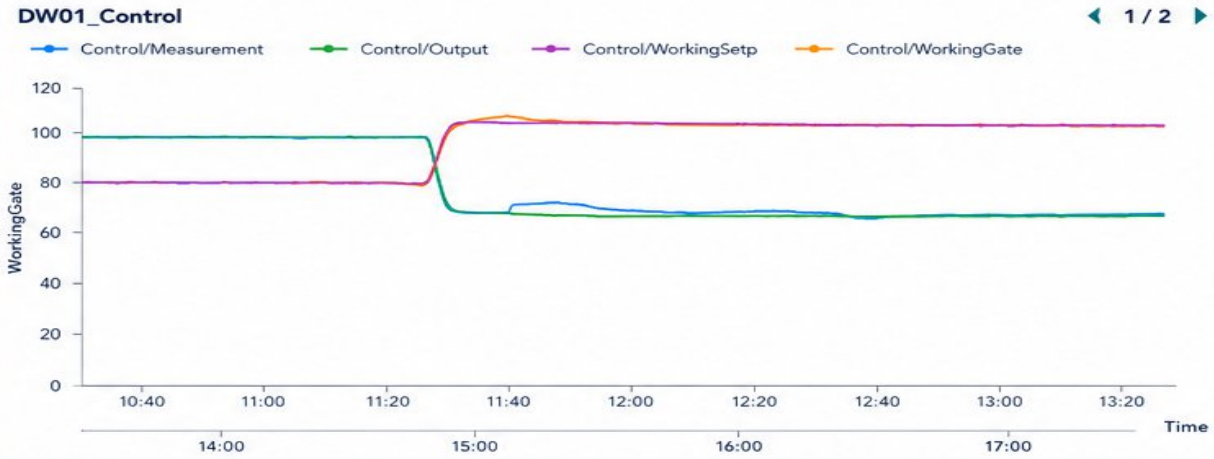
Quality spent a long time off-spec due to slow settling of the Ash loop (bottleneck).

ACTION PLAN

1	**Re-tune the Ash controller** Limiting loop — worst settling on the line	172.92 min
2	**Improve loop damping** Directly targets oscillation & slow recovery	977 osc.
3	**Review coordinated ramp strategy** Cut off-spec product time during transition	78.43 min

2. GRADE CHANGE TRENDS

Stack Y Axis: Yes | Update | Clear | Reset Zoom | Customise | 4 series



KEY INSIGHTS

- Quick rise but long dead time and settling.
- Off-spec time dominated by Ash loop.
- High oscillation count (977) indicates loop tuning opportunity.

RECOMMENDED ACTIONS

- Re-tune Ash controller and improve damping.
- Optimize coordinated ramp strategy.
- Reduce off-spec time and improve stability.

EXPECTED IMPACT

- Faster transitions with less off-spec.
- Improved loop stability & fewer oscillations.
- Better quality and higher productivity.

NEXT STEPS

- Implement action plan.
- Monitor trends & validate improvement.
- Continuous optimization.

PROCESS HEALTH PERFORMANCE

Process Health Assessment

Real-time KPIs, trends, and issue diagnosis across all monitored loops

Download Report | Export to Excel

KPI View

TOTAL LOOPS	LOOPS WITH ISSUES	HEALTHY LOOPS	HEALTH SCORE
133	132	1	0.8%
Monitored loops	99.2% of total	0.8% of total	1 of 133 healthy

DATE RANGE — Reset to Latest

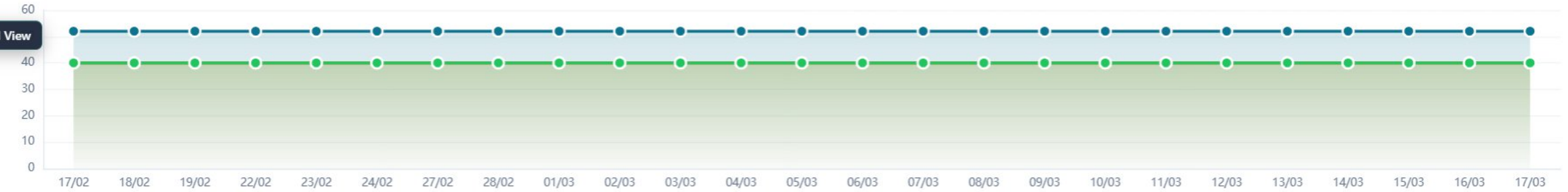
17/02/2026 → 17/03/2026

Trend Band 71 files → 25 points

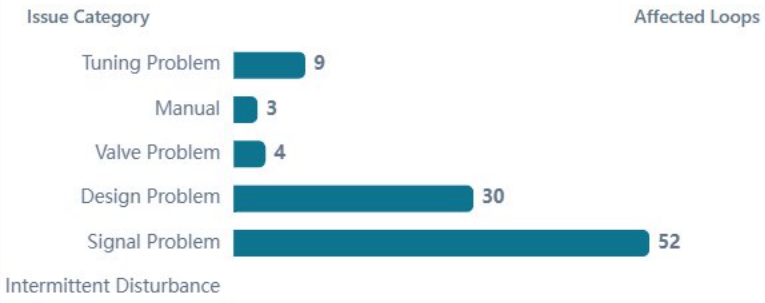
Stock Prep | Wet End | Dry End

Daily | Weekly | Monthly | Yearly

Affected Loops

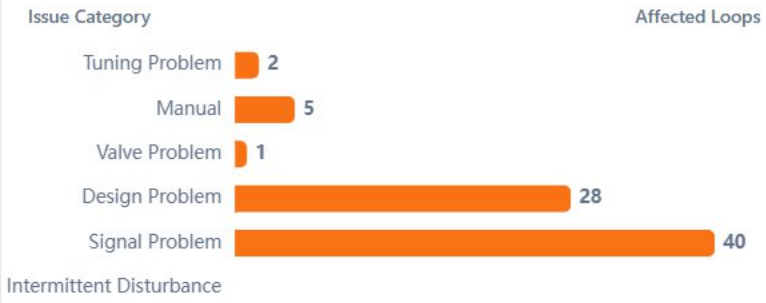


Stock Prep — Total Affected: 52



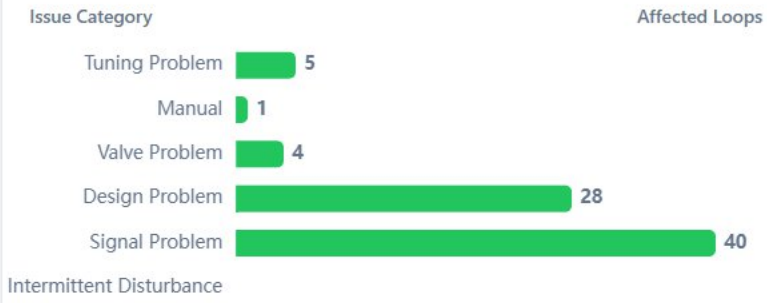
Click a bar to filter loops below

Wet End — Total Affected: 40



Click a bar to filter loops below

Dry End — Total Affected: 40



Click a bar to filter loops below

PERFORMANCE DASHBOARD

PM3 | Customer Name | 02-Jun-2026 | Shift A (Current)

Today | Yesterday | Week | Month | Year

PRODUCTION SUMMARY

Production	742 TPD
Throughput	31.2 T/hr
Machine Efficiency	93.5 %
OEE	88.2 %
Energy/Ton	825 kWh/T
Steam/Ton	1.42 T/T

OVERVIEW SUMMARY

METRIC	GOAL	ACTUAL
CD Stability Index	< 20	12.4
MD Stability Index	< 0.3	0.18
Process Index	< 20	14.6
Weight 2 Sigma	< 1.5	1.12
Moisture 2 Sigma	< 10	7.1
Ash 2 Sigma	< 4.5	3.2

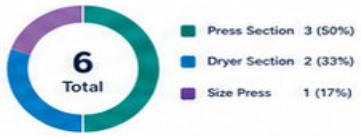
PROCESS LOOP HEALTH

Total Loops	:	248
Healthy	:	186
Tuning Problem	:	31
Valve Problem	:	14
Transmitter	:	9
Oscillating	:	8

SHEET BREAK DASHBOARD

Sheet Breaks Today	:	6
Break Loss	:	18 Tons
Avg Run Time	:	5.3 hrs
Break Area	:	Press Section
Most Frequent Cause	:	Moisture instability

BREAKS BY SECTION



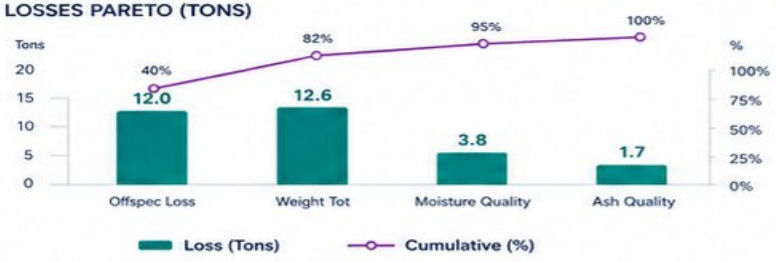
LOSSES PANEL

Weight Tot	:	12.6 Tons
Moisture Quality	:	3.8 Tons
Ash Quality	:	1.7 Tons
Offspec Loss	:	12.0 Tons
Total Losses	:	**30.1 Tons**

GRADE CHANGE PERFORMANCE

Grade Changes Today	:	8
Good Transitions	:	6
Bad Transitions	:	2
Average Settling	:	14.5 min
Offspec Loss	:	12 Tons
Worst Limiting Loop	:	Ash

LOSSES PARETO (TONS)



CD STABILITY INDEX TREND

SHEET BREAKS TREND

KEY INSIGHTS

- Offspec Loss and Weight Tot contribute to 82% of total losses.
- CD Stability Index is within goal.

RECOMMENDED ACTIONS

- Focus on reducing offspec transitions.
- Improve Ash loop tuning to reduce settling time.

EXPECTED IMPACT

- Reduce losses and improve efficiency.
- Improve product quality and runnability.

NEXT STEPS

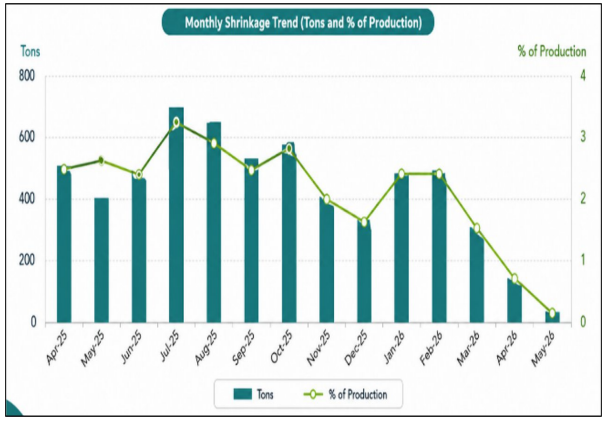
- Investigate moisture instability in press section.
- Monitor key loops and validate improvements.

RESULTS – MEASURABLE IMPACT

Case Study **AI-Driven** Optimization of a Paper Machine

AI-based diagnostics and Improvements

Wet-end variability was identified as the primary contributor to process instability and quality deviations. Targeted optimization of wet-end controls, together with enhanced QCS performance and grade change tuning, significantly improved process robustness and reduced production losses



80% Reduction in Rejects

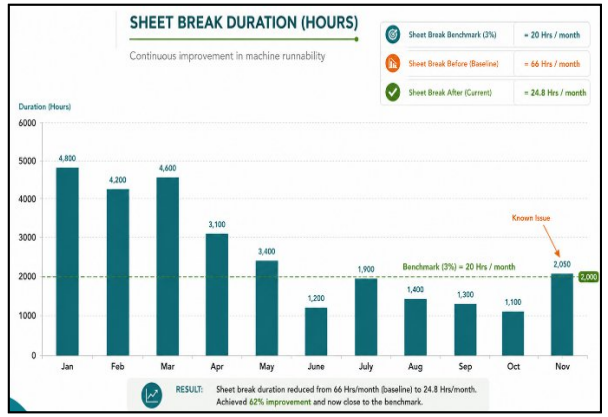
★★★★☆

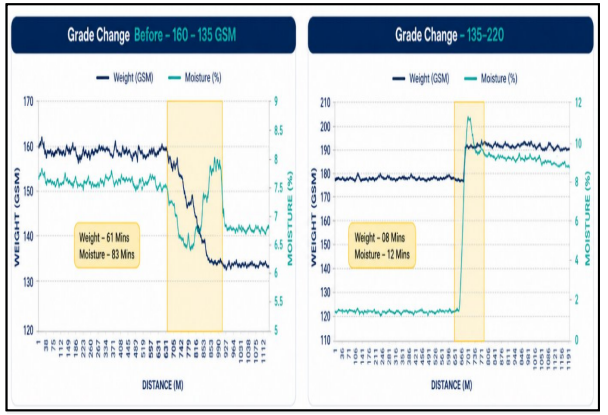
Paper rejects were reduced from approximately 500 tons/month to below 100 tons/month

Reduction in Sheet Breaks 63%

★★★★★

2-sigma deviation monitoring, drift detection, pattern recognition, good-vs.-bad run classification (RF – Random Forest Algorithm) and z-score analysis to identify abnormal operating behavior leading to sheet breaks.





50% Faster Grade Changes

★★★☆☆

The machine also achieved improved quality stability with 46% product variability and Grade change recovery time was improved to approximately 12–18 minutes

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CONSULTING
INTELLIGENCE • OPTIMIZATION • PERFORMANCE

THANK YOU

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