

CROSS-MACHINE QUALITY INTELLIGENCE — WHAT YOUR QMS AND PLC CANNOT TELL YOU

Cut the waste. Keep the knowledge.

Every box plant runs jobs that drift before the quality check catches it, solves the same defect twice in two plants without connecting it, writes the fix into one operator's head instead of the system, and never quite reconciles the waste number to something a CFO can defend. **These look like four problems. They are four readings of one signal** — the trajectory of the run itself. And in corrugated, the signal walks out the door at the end of every shift.

01 Defects form before the check catches them

02 One root cause, hidden across machines and plants

03 The fix lives in an operator's head, not the system

04 Waste absorbed as the run rate

01 — THE STATE OF PLAY

The data is already on your floor

You don't need new sensors, a new QMS, or a new IT project. The signal that predicts each run's outcome exists hours to weeks before the board tells you — sitting in the systems you already run, on every corrugator and every converting line.

QMS CHECK RESULTS • EVERY MACHINE

Checks, complete

Warp, pin adhesion, soak test, board moisture, caliper, starch viscosity, liner temperature, ink pH, gap measurement — well over a hundred check definitions across corrugator wet end, dry end, die cutter, and flexo. Already defined, already recorded, already yours.

CORRUGATOR PLC + STARCH KITCHEN

Telemetry, continuous

Heat-section temperatures, steam, line speed, glue applicator settings, wrap-arm positions, starch cook and viscosity parameters. High-frequency machine telemetry logged every second the line is running.

ROLL AND GRADE METADATA

Inputs fingerprinted

Paper roll metadata, mill of origin, grade, basis weight, incoming moisture, delivery date, plus ambient temperature and humidity. The upstream fingerprint of every run — recorded before the job is even queued.

VETERAN OPERATORS • EVERY SHIFT

Signal held in heads

Which mill's rolls run wet. Which heat section drifts on second shift. What to do when humidity is high and the board is fighting you. The pattern lives in the memory of your most experienced corrugator crews — carried in conversation, not captured in any

system, and lost every time one of them leaves. In an industry running high annual turnover, that is not an occasional event. It is the baseline.

Read it against your own plants

If you run a **quality management system, corrugator PLC telemetry, and roll-level paper data** — and you do — you already have three of the four inputs the platform reads. The fourth lives in the heads of your veteran crews. What you don't have is a layer that reads them together, in real time, across machines and across plants, against the pattern of your own history. The signal is not missing. It is scattered — across three systems and the memory of the people who know how to run your lines.

02 — WHY CORRUGATED IS NOT LIKE THE REST

The constraint isn't the machine. **It's that nothing learns.**

Nobody runs a corrugator meaningfully faster than it already runs. Board speed is close to fixed, paper is paper, and the equipment is largely a solved problem. The order-of-magnitude gain left in a box plant is not mechanical. It is in how fast a plant sees a problem forming, and how fast a fix travels.

Consider what happens today when a plant genuinely solves something — a warp pattern tied to a particular mill's rolls in a particular humidity range, and the specific heat and speed adjustment that fixes it. That solution exists in one crew, on one shift, at one site. It is not written down in a form another plant can use. It does not reach the plant two states over that is fighting the identical pattern this week. And when the operator who found it moves on, it leaves with them.

Every breakthrough starts over. A defect pattern solved at one plant is re-learned the hard way at the next — and the learning curve never compounds.

That is the difference between a fleet of good plants and a fleet that learns. In the first, each plant's intelligence is capped by the tenure of its current crew. In the second, every run on every line makes the shared model sharper, and a new plant is born knowing what every plant before it learned. The asset that appreciates is not the equipment. It's the intelligence.

03 — THE COST IS REAL, AND MOSTLY INVISIBLE

One drift, four department problems

The loss is never labeled "loss." It shows up as a rerun, a credit, a downgraded load, a line stopped for an hour. Here is the same underlying drift, surfacing as four separate departments' problems.

QUALITY

The warp that fails the check

Board quality defects — warp, bond failure, splice misses, blowouts — are driven by moisture differential across interacting variables: steam heat, incoming paper moisture, ambient humidity, line speed, starch rate.

Veteran operators manage that interaction intuitively. New operators manage the parameter in front of them, and the check catches it after the board is made.

Owned by: quality

CONVERT

The defect that surfaces on the wrong machine

A bond test fails on the corrugator — fiber tear drops below threshold. Three days later, finished-blank dimension errors appear on the converting line. A QMS siloed by machine sees two unrelated events on two machines. It is one event, separated by a lag, and nothing in the plant is watching both together.

Owned by: converting & production

MAINT.

The stoppage nobody saw coming

Motor current drift, vibration signature change, bearing temperatures creeping across weeks. Individually, each stays inside its alarm band. Together, they describe a component heading for failure — and the line goes down mid-run, at the hourly cost of unplanned downtime rather than the cost of a planned swap.

Owned by: maintenance & reliability

The roll that should never have run

A mill's rolls arrive technically on-grade but drifting on incoming moisture. Receiving accepts them; nothing flags them. They run — and warp rates climb, amplified on older corrugators, across every plant that mill supplies. Weeks later the pattern connects. The signal was in the roll metadata and your own defect history all along. Nobody read them together against your run outcomes.

Owned by: procurement & incoming inspection

04 — THE STRUCTURAL FRAGMENTATION

The run is one process. You see many.

This is the core of it. A job moving from roll stand through corrugator, die cutter, and flexo is a single, continuous multi-parameter process. Your plant is built to experience that process as a set of disconnected signals, each captured by a different system and routed to a different team.

HOW THE BOARD EXPERIENCES IT

One continuous multi-parameter trajectory.

HOW YOUR SYSTEMS EXPERIENCE IT

Four disconnected signals.

The same trajectory is split at the door and handed to teams who never compare notes:

QMS sees a failed check.

Every parameter connected to every other. The roll that came off the truck connected to the blank that fails three days later on the converting line. To the board it is one process, one story, drifting or holding across dozens of dimensions at once — mill and grade, incoming moisture, ambient humidity, steam and heat-section profile, line speed, starch cook and viscosity, tooling condition, shift, and crew.

PLC / SCADA sees a trend.

ERP sees a waste number.

The crew sees a run that fought them.

Every run has multiple stakeholders across many systems — and the industry has quietly accepted the waste that follows as the run rate.

Every system in that list is doing its job. The QMS records the check. The PLC controls the machine. ERP books the waste. The crew makes the call. None of them is broken — and none of them is looking at the run as one continuous trajectory across machines, across shifts, and across plants. The next section is what that costs.

05 — THE FOUR SYMPTOMS

What the split costs you

Each disconnected signal becomes its own chronic symptom — and each maps to value that was recoverable, if anyone had read the trajectory in time.

01

Board that fails after it's

02

The same defect, two

made

The run drifted before the check flagged it. The signal was in the trajectory — roll moisture, heat profile, humidity, speed. It was just unread until the test came back, and by then the board was already on the floor.

plants, no connection

The pattern is diagnosed at one plant, never travels, and is diagnosed again from scratch somewhere else. Each diagnosis costs weeks of scrap and downgrade. Every one after the first was preventable.

03

Knowledge that leaves with the shift

Documented procedures capture the what, not the why, and never the intuition that guides a real-time trade-off at the wet end. When a veteran leaves, the plant does not lose a headcount. It loses a model — and the next hire starts guessing.

04

Waste variability absorbed as the cost of doing business

Plant-to-plant and month-to-month waste swings treated as inherent to corrugated. The pattern of what drives the low-waste weeks is sitting in your own historical data — read once and never revisited.

06 — WHY THE CURRENT MODEL KEEPS LOSING GROUND

The gap widens on its own

None of this is a failure of effort. Plant teams work hard inside the tools they have. The model itself is what keeps losing ground — for four compounding reasons.

01 You find out too late

Conventional QMS reporting is a rear-view mirror. The check is a verdict on board that already exists. By the time the failure lands on a dashboard, the roll is consumed, the shift is over, and the moment to act on it has passed.

02 Your QMS is siloed by machine

Check definitions are organized per machine, because that is how checks are performed. But the causes cross machines and cross days: a corrugator condition explains a converting-line defect three days later. A per-machine view is structurally incapable of seeing a cross-machine, lagged pattern — not because it is badly built, but because it was never asked to.

03 Turnover resets your baseline every year

The industry's answer to tribal knowledge has been documentation and training. Both are necessary and neither transfers judgement. With turnover running at the levels most box plants now see, the plant's real capability tracks the tenure of its current crew — which means it resets, quietly, every year.

04 Nothing carries intelligence between plants

A fleet of eighty plants that do not share a model is eighty separate learning curves, each starting near zero. Consolidation makes this sharper, not softer: two merged operational cultures produce two sets of good practice and no mechanism to decide which one should become the standard.

07 — ONE SIGNAL, FOUR RECOVERIES

Read the trajectory once

Here is the shift. The same run trajectory — read once, from data you already own — surfaces across all four problems at the same time. Not four tools. One reading, four uses, sitting alongside your QMS without touching it.

THE UNIFIED RUN SIGNAL

One run, surfaced four ways the moment its trajectory shifts

RECOVERY 01 • PREDICTION

Cross-signal early warning

Roll moisture, mill and grade, heat-section profile, line speed, starch viscosity, humidity and check history read simultaneously. A Warp Risk Score and Bond Failure Risk Score per run — before the board leaves the corrugator, and across machines a per-machine QMS cannot connect.

RECOVERY 02 • BLUEPRINT

Gold Standard, reverse- engineered

Your best-performing runs, reverse-engineered — the corrugator configurations, operator setups, and supplier grades that produce them, with specific targets and thresholds. Not “watch the moisture.” Rather: hold this parameter in this range, for this grade, at this humidity.

RECOVERY 03 • PREVENTION

Operator-ready actions

Ranked corrective actions delivered during the run, in the units the crew already works in — raise heat section 2 by three degrees, drop speed by ten feet per minute — not a defect report assembled after the load ships.

RECOVERY 04 • NETWORK

One model, every plant

One drift signal connected across machines, shifts, and sites. A mill drifting on moisture flagged across every plant it supplies. A pattern solved at one plant available at the next the same week — so the fleet’s learning curve compounds instead of restarting.

Today you pay four teams to chase four versions of this signal, and none of them sees the other three. **The recovery is not new instrumentation. It is reading the trajectory you already have — once, and together, across every machine and every plant.**

One more thing — and it may be the largest. The same reading that predicts a defect can also capture how your best operators decide. Condition, action, outcome: what a veteran adjusts when humidity is high and a particular grade is running, and how often it works. That turns judgement into something the plant owns rather than employs — and delivers it to a new hire on their first week instead of their fifth year. It is the one asset in a box plant that has never been captured, and the only one that appreciates.

08 — WHAT IT TAKES TO INSTALL

A wrapper around your systems, **not a replacement**

The first question a plant asks is what this does to the plant. The answer is nothing. FyndEm Quality reads from your existing systems and never writes back.

01

Reads existing data

Connects to your QMS check results, corrugator PLC telemetry, starch-kitchen parameters, and roll metadata by file export or direct connector. No new sensors, no new hardware, no changes to current data flows.

02

Never writes back

Zero mutations to any source system. No writes to the PLC, no changes to control loops, no changes to your QMS. Machine control stays exactly where it is today.

03

04

Decision support, not decision making

Intelligence surfaces through a separate interface and a weekly Quality Blueprint for plant leadership. The crew acts on it or doesn't, at their discretion, inside your existing procedures.

Deterministic, reproducible, explainable

The production decision path is pure mathematics and statistics — no AI or LLM in the live path. The same inputs produce the same outputs, and every alert traces back to the parameters that generated it. A plant manager can ask why, and get an answer.

09 — WHAT IT'S WORTH TO YOU

A number from data you already run

The natural question is “what is this worth for us, specifically?” — and you can get a defensible answer before any engagement, any contract, or any raw data leaving your building.

Your estimate comes from your own history

Waste is the one number every box plant already tracks and already argues about, which makes it the right anchor. Most operators carry a rule of thumb for what a single point of waste costs per month at a large plant, and a working view of the gap between their current rate and a world-class one. We don't supply those numbers — you do. Using 18–24 months of your QMS, PLC, and roll data, the four recoveries are sized against your own waste baseline and your own cost per point, into a conservative Year-1 range with every assumption stated.

STEP 01

Start from your runs

18–24 months of QMS check results, PLC telemetry, and roll metadata supplies run genealogy, upstream signatures, defect outcomes, and downtime — per machine, per plant.

STEP 02

Anchor to your waste number

Your current waste rate, your cost per point per plant, your downtime cost per hour. Every recovery stream is sized with deliberately conservative, fully disclosed realization assumptions.

STEP 03

See your range

You receive a Year-1 recoverable range for a defined plant footprint — decomposed by recovery stream and by plant, every assumption disclosed, and a scaling path across the fleet.

All quantifications are produced individually — from your own historical data and your own cost drivers, under a data-use agreement. No figure in this paper is presented as your number.

THE NEXT STEP

The first plant network that learns

CentroidAI's FyndEm Quality is a predictive intelligence platform for manufacturing quality and waste reduction — built to provide the intelligence, the lead time, the specific actions your crews can take, and the \$ quantification. In corrugated it starts at one plant: connect the data, prove the lift against your own waste baseline, then let the next plant inherit the model on day one. How this is done — the data sources, the deterministic models, the confidence levels — is a conversation we would welcome.

YOUR CENTROIDAI CONTACT

Raj Subramanyam

Founder & CEO, CentroidAI · raj@centroid-ai.com

Contact Us

FyndEm Quality — Corrugated is one variant within the broader FyndEm Quality suite. **Solid Dose** covers small-molecule and biosimilar manufacturing, including API; **Biologics** covers mammalian and microbial bioprocessing; **Plasma** covers fractionation and plasma-derived therapies. One platform, one architecture, tuned per industry.

CentroidAI · FyndEm Quality — Corrugated

Industry references: TAPPI and FBA test methods for warp, pin adhesion, soak, ECT and flat crush; published containerboard and box-plant waste and turnover benchmarks. Cross-signal analysis and \$ quantification are produced from each operator's own historical data, waste baseline, and cost drivers, under a data-use agreement.