Gain Delay Retune in Multivariable Controls for the Paper Making Process

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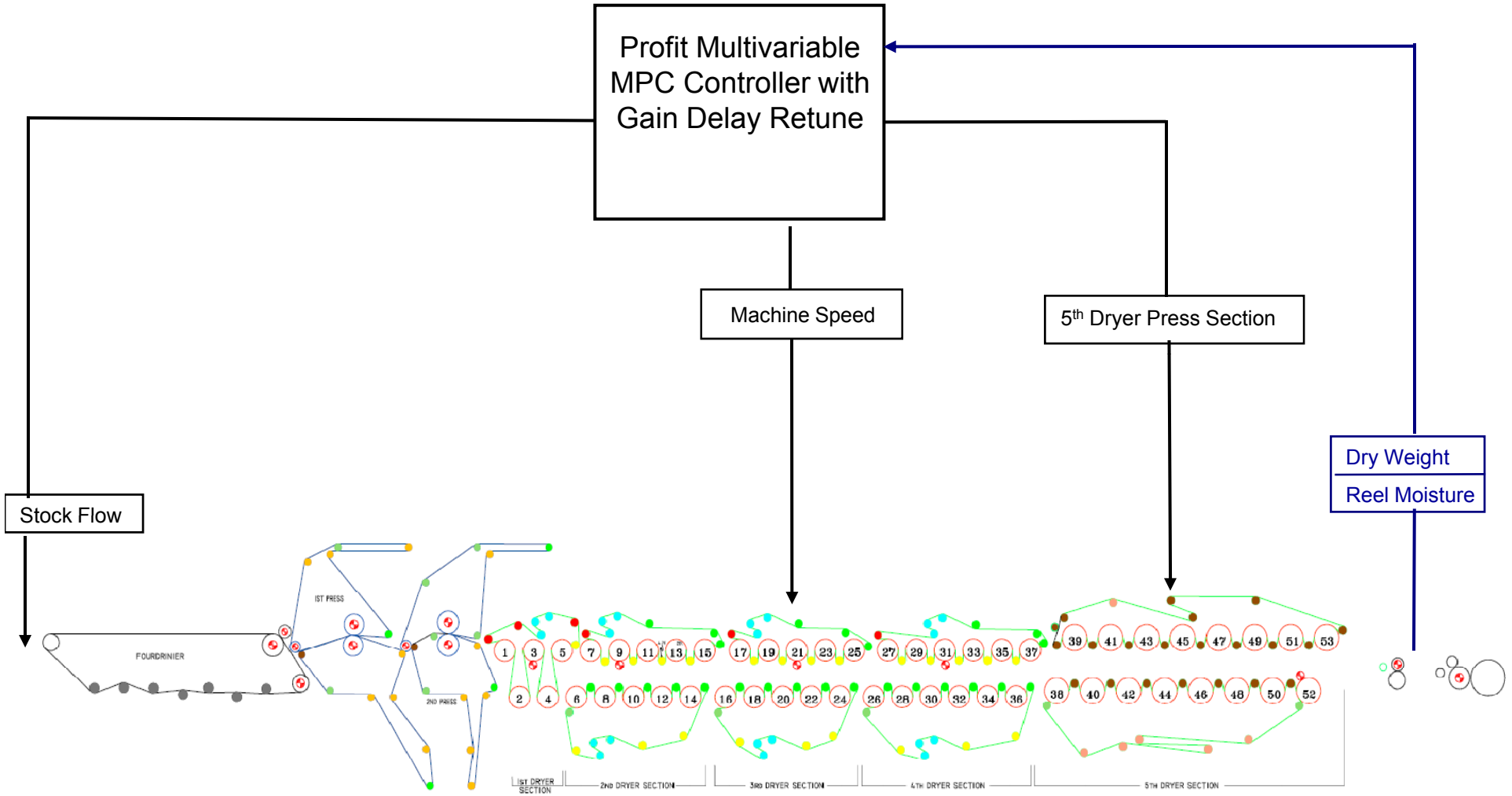
Lean and Green

Model Predictive Control on the Linerboard Process

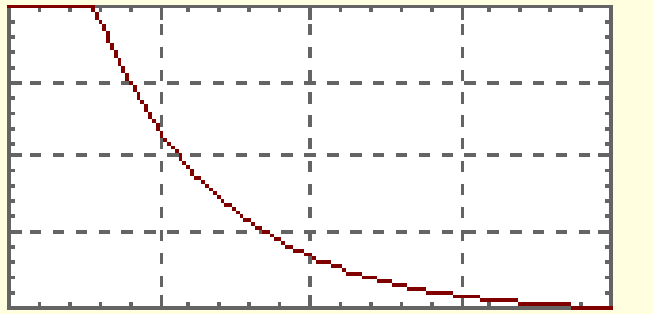


The MPC Matrix

	Stock Flow	Machine Speed	5th Dryer Pressure Section
Dry Weight			
Reel Moisture			

MPC Linerboard Transfer Function – Nominal Baseline

Final Trials	MV1 - m5thDryPress
CV1 - cMoisture Final Error: 0.0732 Pending Error: Final Source: Mixed	CLid Ord = 5 Lap Order 1 Settle T = 9.80 TfSettle = 9.90 CLid Form = iBJ Rank = 1 Trial 1 $G(s) = -.191 \frac{1}{2.1s + 1} e^{-1.4s}$



Gain Delay Retune on Machine Speed

- Gain Retune

$$\text{Speed Gain Retune Factor} = 1 - \frac{(\text{Current Machine Speed} - \text{Nominal Machine Speed}) \times \text{Speed Gain Retune Factor Weight}}{\text{Current Machine Speed}}$$

Where the Speed Gain Retune Factor Weight = 1

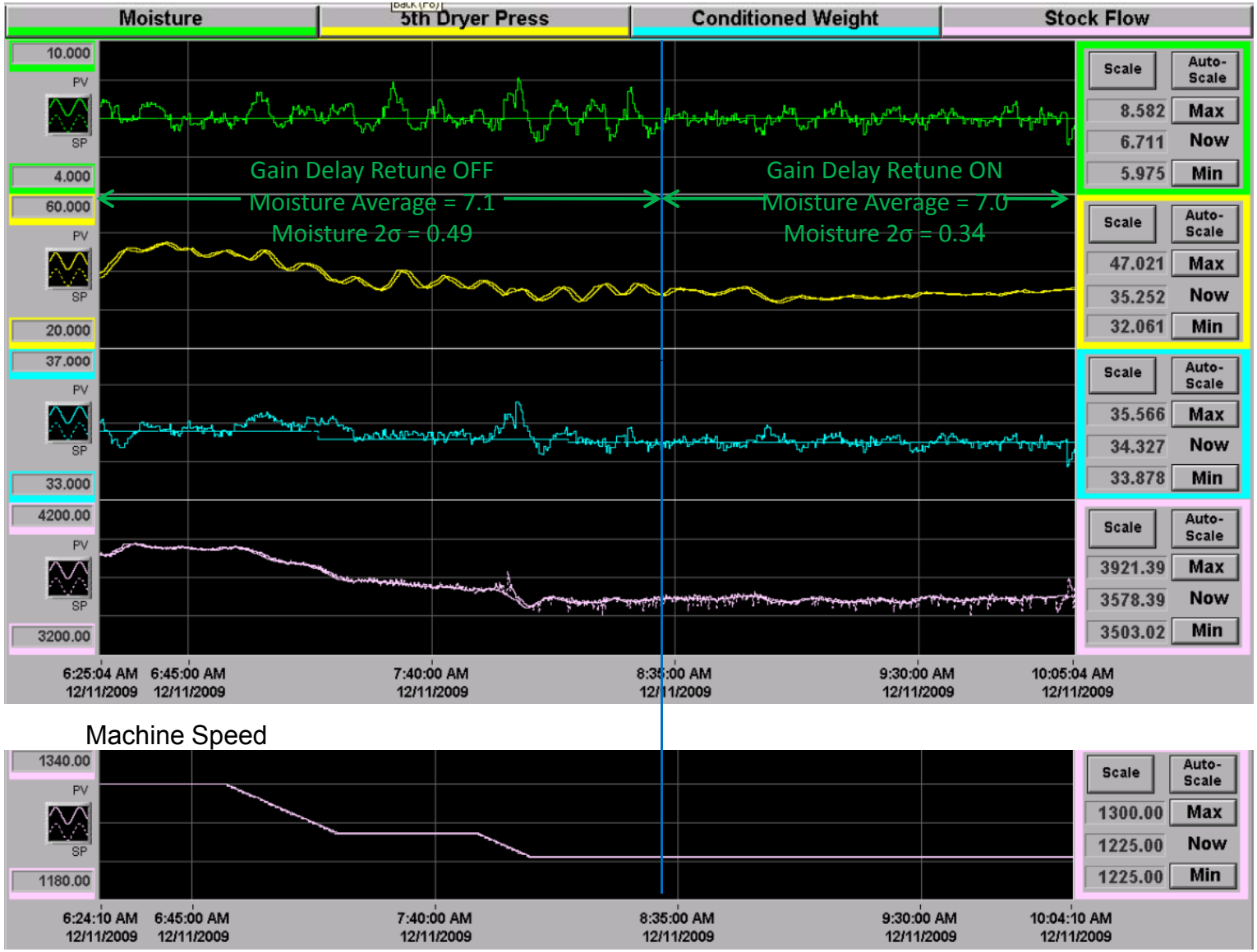
Effective Gain = Speed Gain Retune Factor X Nominal Gain

- Delay Retune

Gain Delay Retune Function calculates Delay Offset

Difference between the delay calculated by the Gain Delay Retune Function and the nominal delay.
The Delay Offset is the result of the change in variable (transport) time delay due to the change in machine speed.

Gain Delay Retune on a Linerboard Machine



Conclusions

- There are great benefits of using MPC for MD control in the paper industry.
- However, the limitation in using MPC is that the transfer functions assume the paper process to be linear in the operating range.
  - This is more than adequate during normal operations, but in today's economy where paper demand fluctuates, the papermakers are asked to reduce production in a "slow-back" mode.
- These operating conditions are beyond the linear range and the papermakers are forced to produce lower paper quality and risk stable runability.
- The Gain Delay Retune Function in the MPC MD controls addresses this issue by automatically retuning the gain and time delay based on a nominal machine speed and the current "slow-back" machine speed.
- The studied linerboard machine showed a significant reduction (30%) in 2σ spread in moisture when the Gain Retune Function was enabled thereby increasing the paper quality and runability.