Empowering Productivity And Quality In AI Era

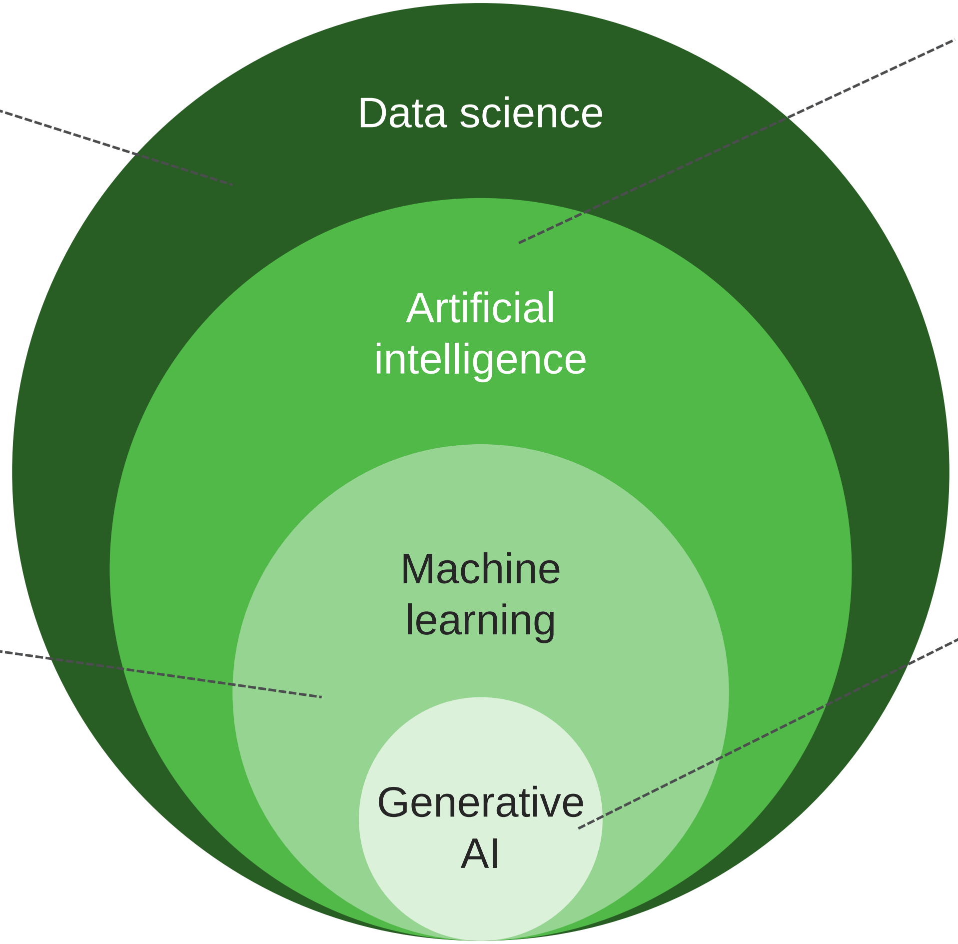
Valmet

What is Artificial Intelligence?

Our definition of AI

Data science

- Collection, preparation, and analysis of data
- Leverages AI/ML, research, industry expertise and statistics



Artificial intelligence

- Technology for machines to understand/interpret, learn, and make intelligent decisions
- Includes machine learning and other fields

Machine learning

- Algorithms that help machines improve through supervised, unsupervised, and reinforced learning

Generative AI

- Generates content such as text, images or code based on provided input

Experience with analytical AI- great foundation going forward

Analytical vs. generative AI

- Uses real-time data analysis without recollection of past outcomes
- Ideal for rule-based decision-making and data analysis in real-time scenarios.

- Creating new content/insights by leveraging past and present data to inform decisions.
- The model learns and gets better over time, making it adaptable and strategic.

Proven applications

- Computer vision, Fiber Image Analysis
- Machine Learning, Process Optimizers
- Data Validation Applications

Emerging opportunities

- Field service engineers' virtual support
- Complex engineering task assistant
- Code generation & documentation

AI supports industries to move towards autonomy

Key value drivers for autonomous operations

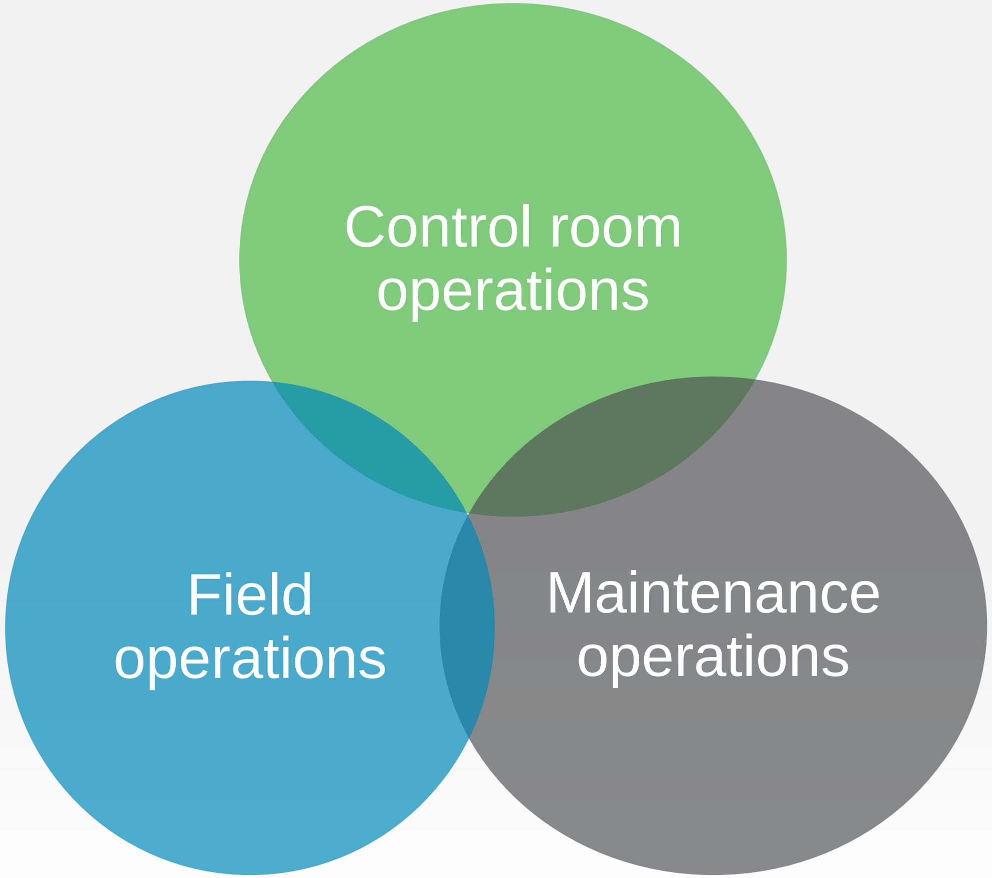
Improve safety

Maximize asset performance over the life-cycle

Reduce impact of aging workforce & overall workforce scarcity

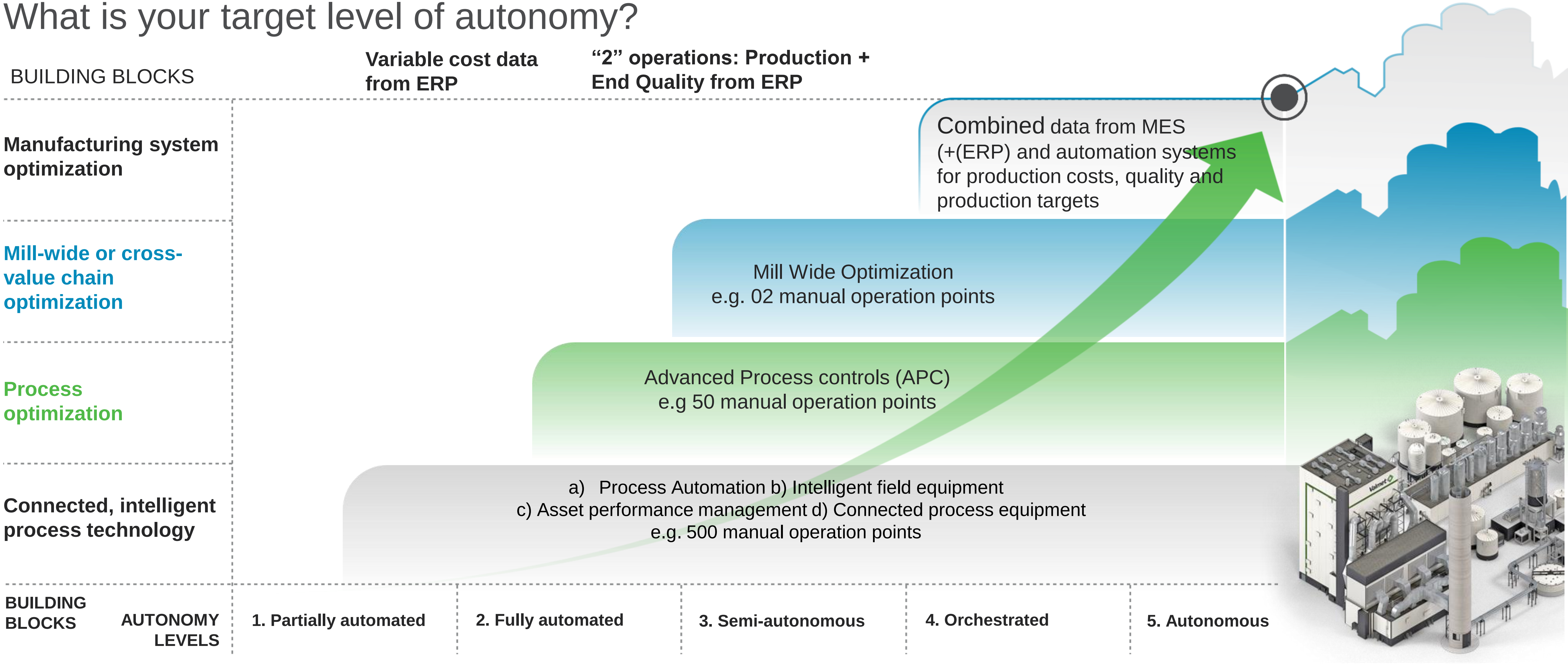
Reduce fixed costs by centralizing operations

Improve sustainability



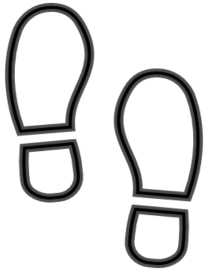
Typical framework for autonomous operations

What is your target level of autonomy?



While applying AI we must ensure fairness, privacy and security

Responsible AI principles



TRACEABILITY

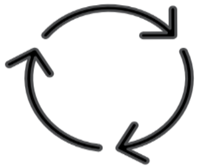
Investigate how AI has been trained, what information it has access to, and study the code libraries

TRANSPARENCY

Guidelines about how AI-generated work can be used, who is accountable and how it will be labelled

OVERSIGHT

Regularly audit & assess the actions of AI Take further actions where necessary



GOVERNANCE

Continuously follow the development of the field and review and update guidelines

SECURITY

Adequate safeguards, mitigate potential cyber threats & vulnerabilities

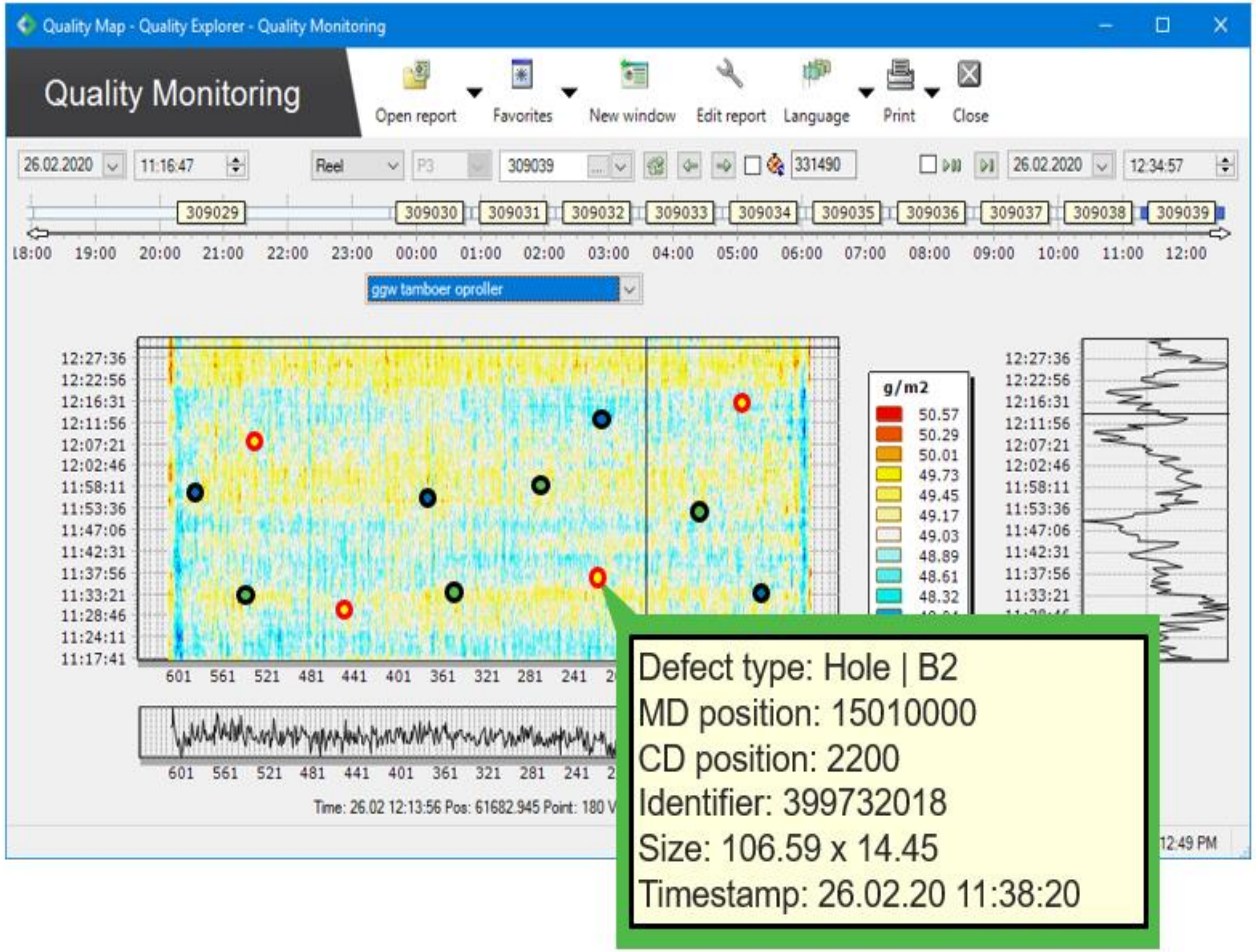
AI-driven Data Integration and Optimization of Process Areas

- Each sub-process within the paper making process has potential for improvement & optimization.
- Reliable data collection and processing through respective optimizers is the key to optimization.
- Major influence on runnability and quality of a paper machine comes from stock preparation, wet end and dry end measurements.
- Input data to quality predictor modelling tool from the stock preparation and wet end of a paper machine helps to visualize the end quality of paper that will be made finally. This forms a part of analytical AI model.
- Input data to the model consists of key measurement from freeness, retention at the wet-end and gsm, moisture etc from online quality sensors. Adding to these the web monitoring system (runnability analysis), web inspection data (defects) and lab quality parameters form the basis of the quality predictor.
- Typical decision- making single window tool for operator comes in next slide.

AI-driven Data Integration and Optimization of Process Areas

Integrated reporting

- Key production figures on the main page
- Multiple reports for production, maintenance and management needs are included
- Database included in all deliveries to automatically store the reported results
- See the real final quality
  - Ability to see IQ WIS results on top of measured profile maps

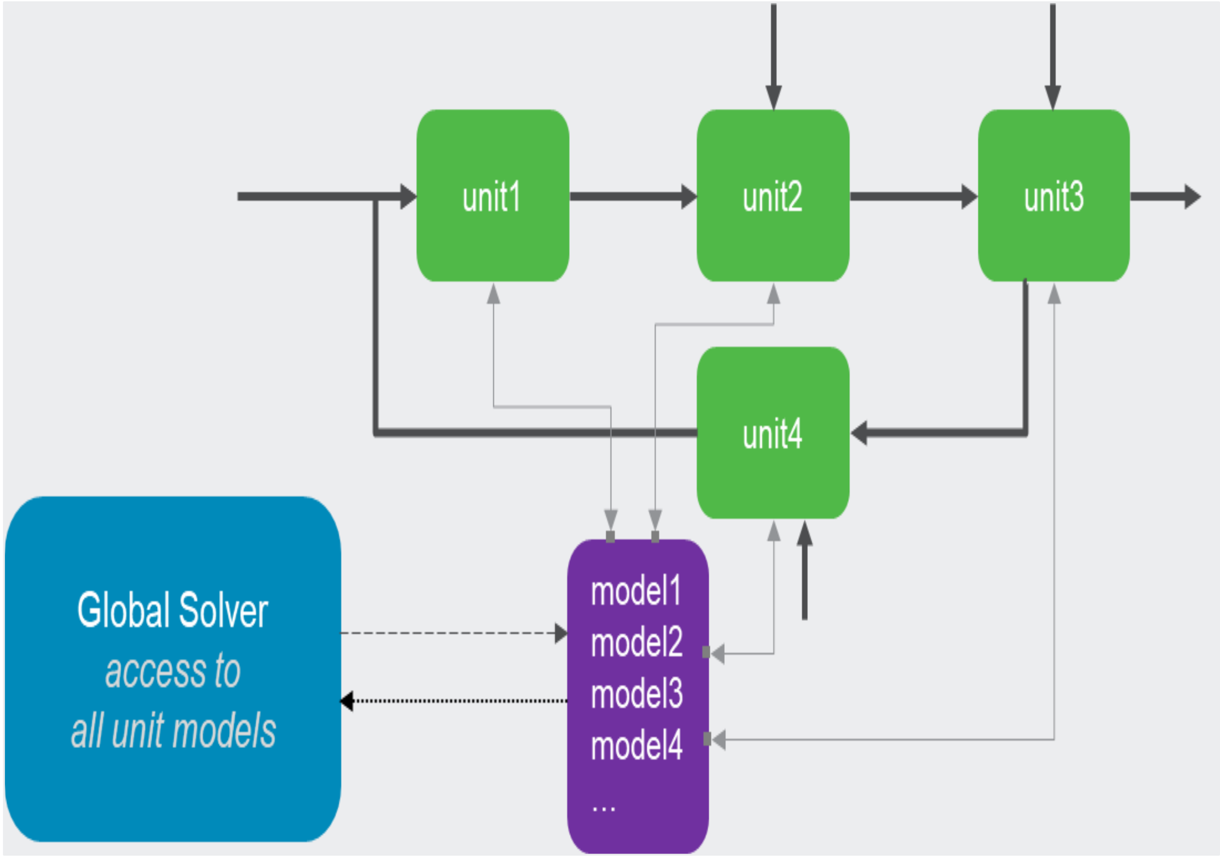


How does MWO work?
Case examples

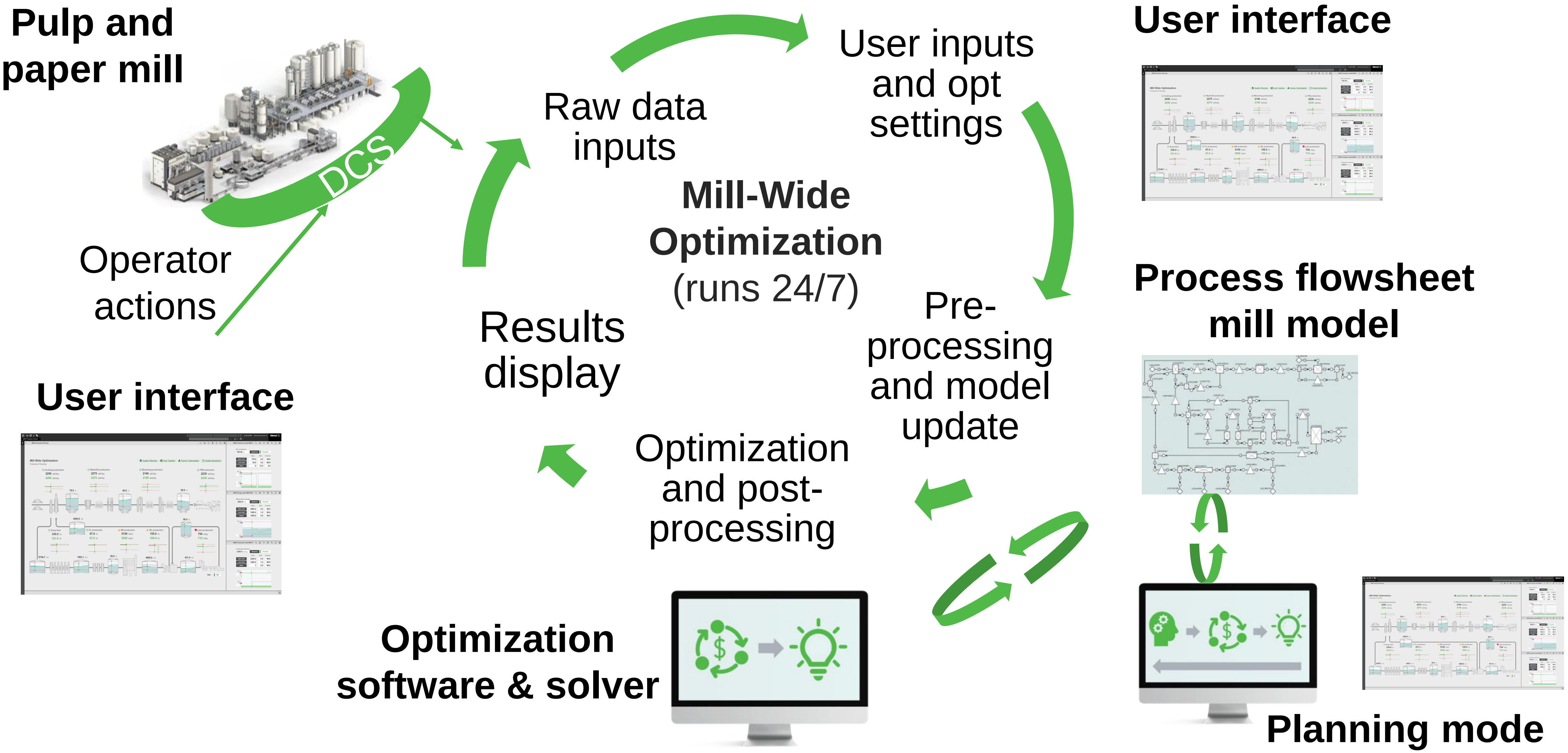
High-level digital twin of the whole mill

Process flowsheet optimization

- Mill is modeled as a flowsheet of connected unit operations
- Process models are embedded in unit operation modules with relevant input-output relationships
- Process components and properties are tracked through the flowsheet
- Ability to define process costs, profit, targets, high/low limits, rate limits, smoothing factors, etc.



Co-pilot for your mill- 24/7



Mill-Wide Optimization

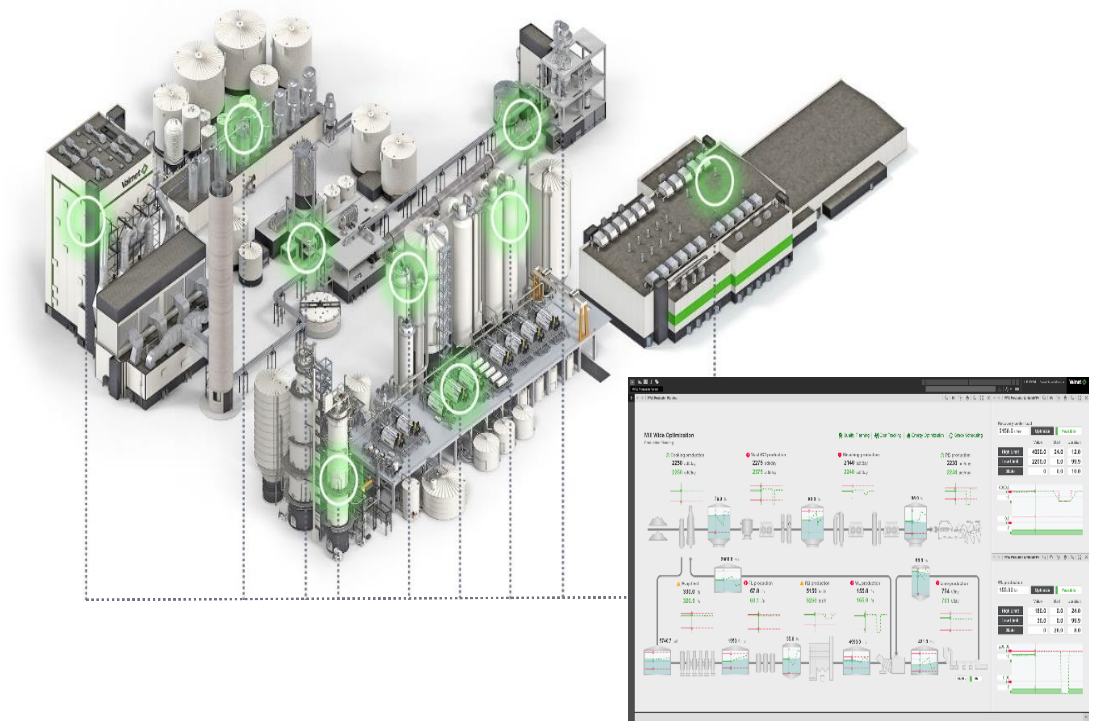
Application Areas

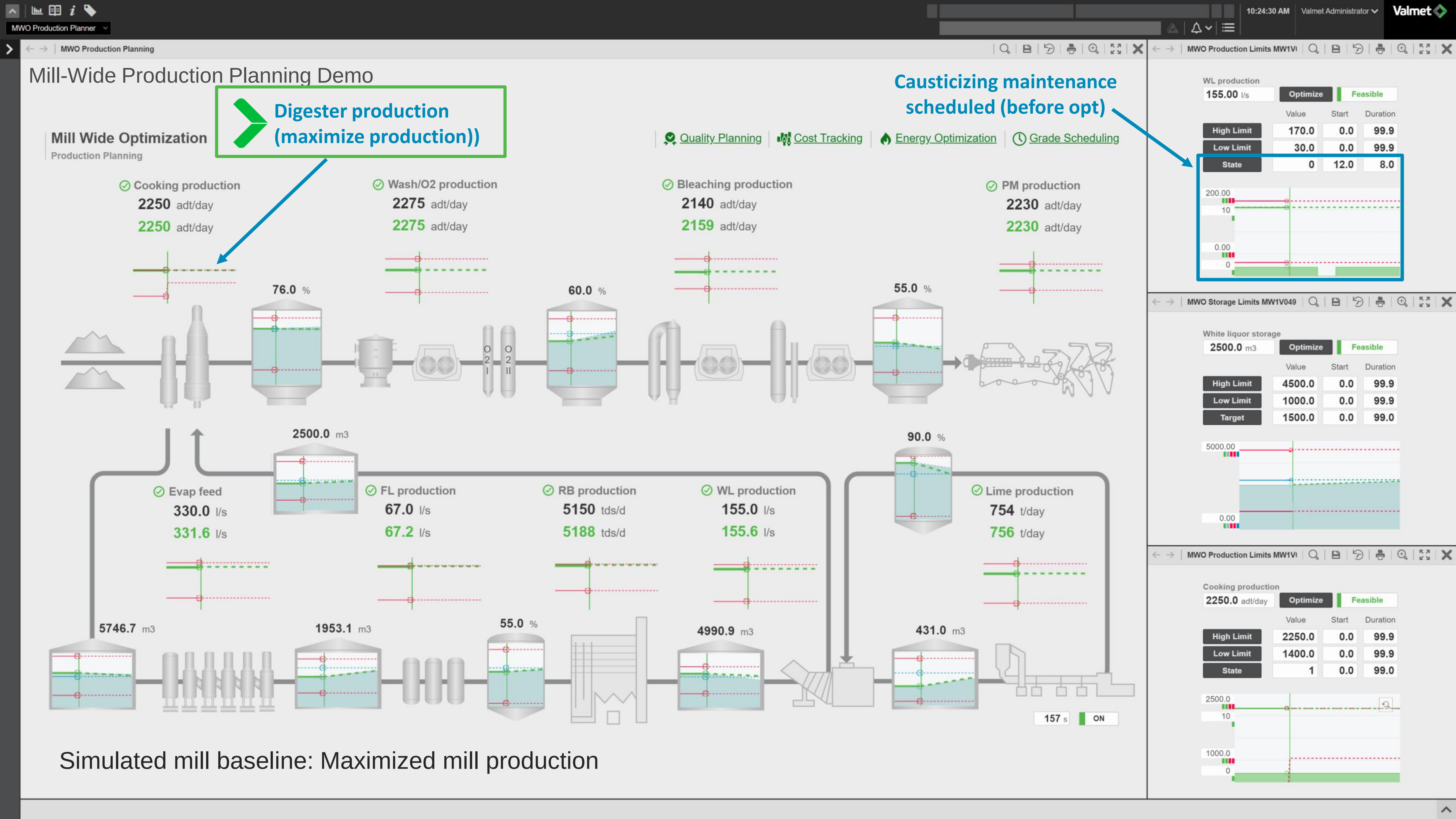
Mill Wide Production Planning	Coordinate and balance pulp and liquor production
Mill Wide Quality Planning	Set quality targets from feed to final product
Mill Wide Energy Planning	Optimize the energy production and energy balance
Quality Tracking	Track quality through mill
Cost Tracking	Track pulp and liquor costs through mill
Grade Scheduling	Achieve production plan at maximum profit
Process data validation	Improve data reliability and detect errors

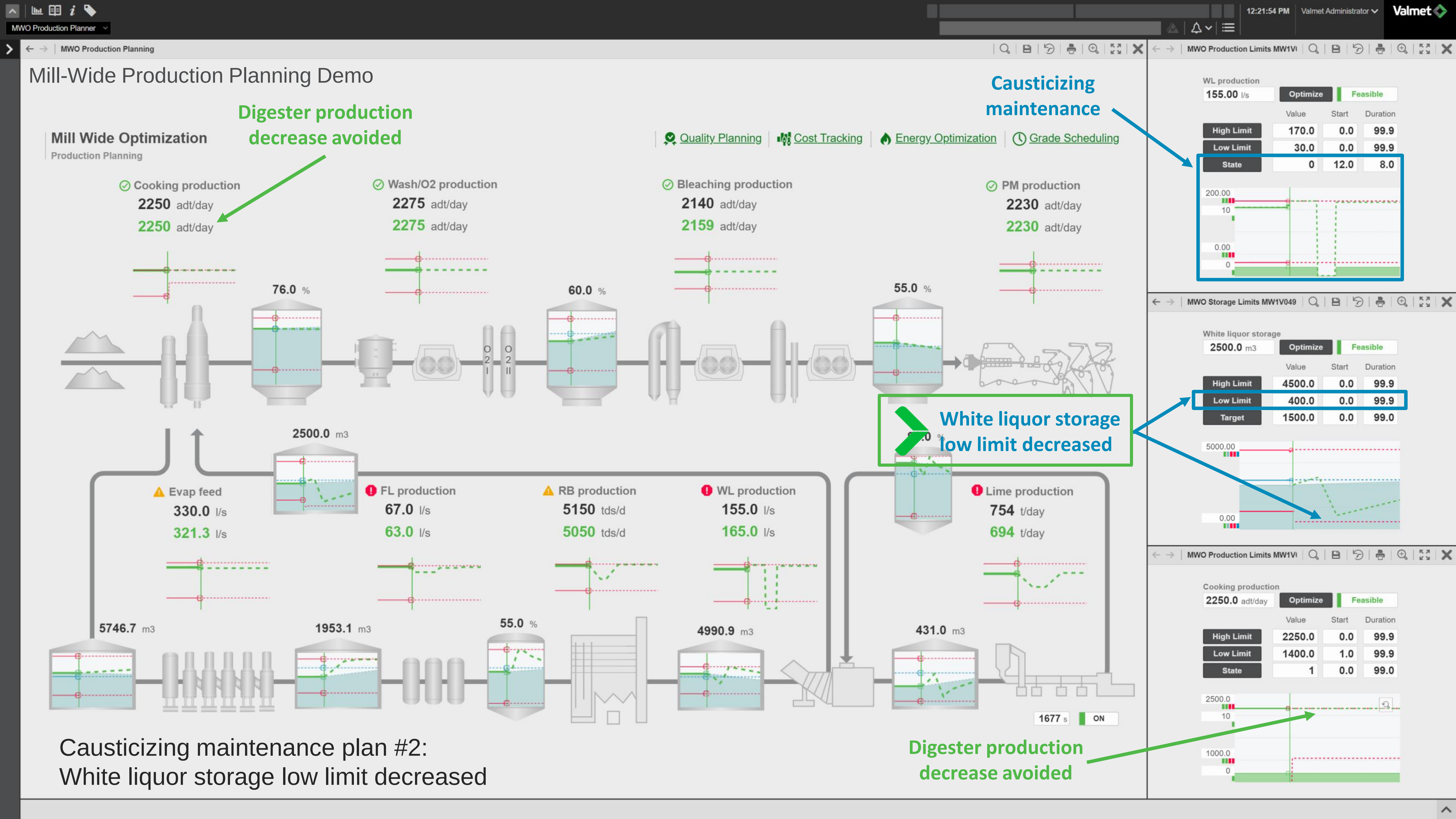
Mill-Wide Optimization

Application Areas

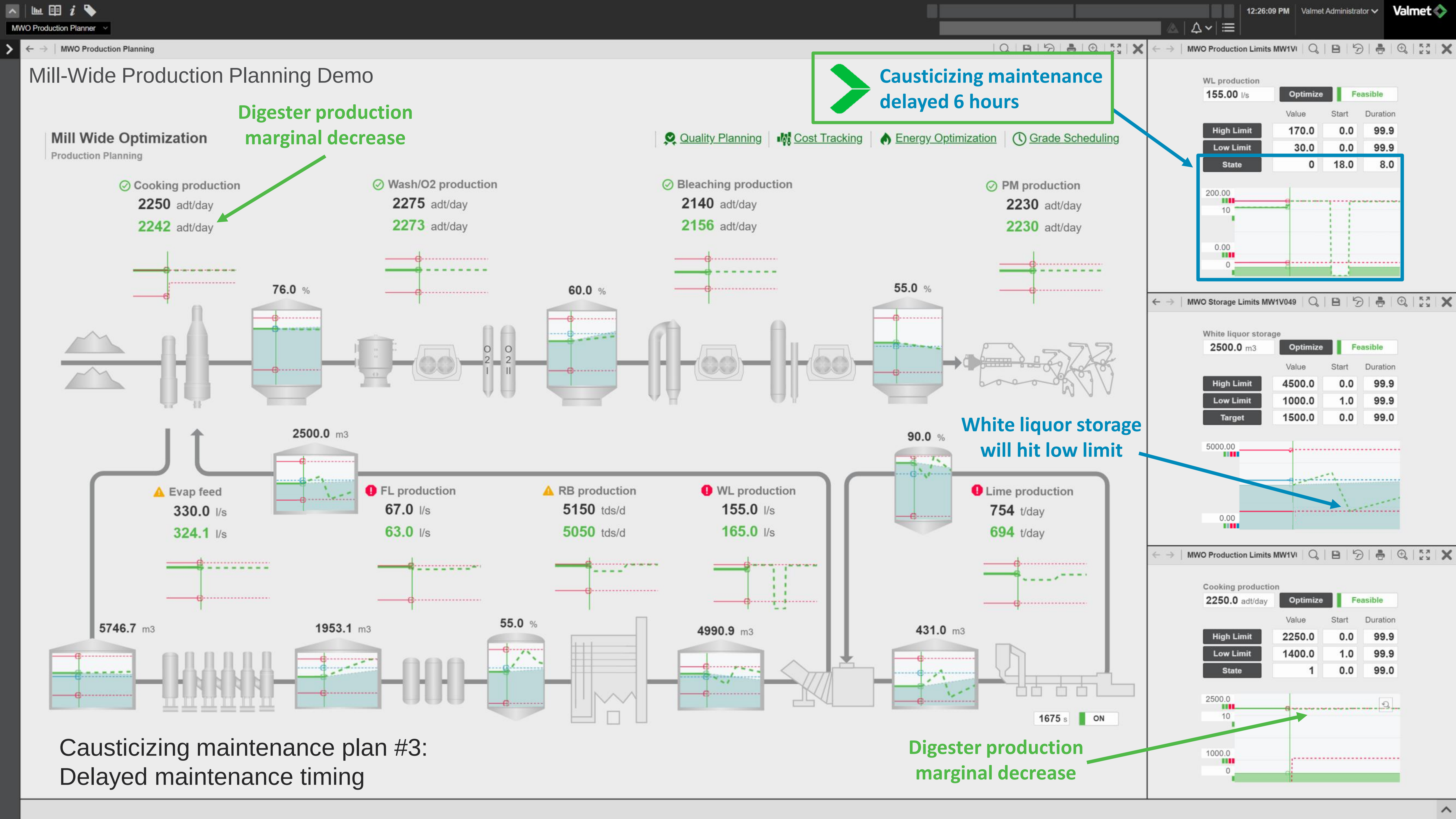
- Process areas are optimized together
- Operating decisions are made based on the total mill balance and forecast
- Visualization of the current and future state of the whole mill




MWO Production Planner
MWO Production Planning
10:24:30 AM
Valmet Administrator
Valmet
Mill-Wide Production Planning Demo
Digester production (maximize production))
Causticizing maintenance scheduled (before opt)
Mill Wide Optimization
Production Planning
Quality Planning
Cost Tracking
Energy Optimization
Grade Scheduling
Cooking production
2250 adt/day
2250 adt/day
Wash/O2 production
2275 adt/day
2275 adt/day
Bleaching production
2140 adt/day
2159 adt/day
PM production
2230 adt/day
2230 adt/day
76.0 %
60.0 %
55.0 %
2500.0 m3
90.0 %
Evap feed
330.0 l/s
331.6 l/s
FL production
67.0 l/s
67.2 l/s
RB production
5150 tds/d
5188 tds/d
WL production
155.0 l/s
155.6 l/s
Lime production
754 t/day
756 t/day
5746.7 m3
1953.1 m3
55.0 %
4990.9 m3
431.0 m3
157 s
ON
MWO Production Limits MW1V
WL production
155.00 l/s
Optimize
Feasible
Value
Start
Duration
High Limit 170.0 0.0 99.9
Low Limit 30.0 0.0 99.9
State 0 12.0 8.0
MWO Storage Limits MW1V049
White liquor storage
2500.0 m3
Optimize
Feasible
Value
Start
Duration
High Limit 4500.0 0.0 99.9
Low Limit 1000.0 0.0 99.9
Target 1500.0 0.0 99.0
MWO Production Limits MW1V
Cooking production
2250.0 adt/day
Optimize
Feasible
Value
Start
Duration
High Limit 2250.0 0.0 99.9
Low Limit 1400.0 0.0 99.9
State 1 0.0 99.0
Simulated mill baseline: Maximized mill production



MWO Production Planner
12:21:54 PM
Valmet Administrator
Valmet
MWO Production Planning
Mill-Wide Production Planning Demo
Digester production decrease avoided
Causticizing maintenance
Mill Wide Optimization
Production Planning
Quality Planning
Cost Tracking
Energy Optimization
Grade Scheduling
Cooking production
2250 adt/day
2250 adt/day
Wash/O2 production
2275 adt/day
2275 adt/day
Bleaching production
2140 adt/day
2159 adt/day
PM production
2230 adt/day
2230 adt/day
76.0 %
60.0 %
55.0 %
2500.0 m3
White liquor storage low limit decreased
Evap feed
330.0 l/s
321.3 l/s
FL production
67.0 l/s
63.0 l/s
RB production
5150 tds/d
5050 tds/d
WL production
155.0 l/s
165.0 l/s
Lime production
754 t/day
694 t/day
5746.7 m3
1953.1 m3
55.0 %
4990.9 m3
431.0 m3
1677 s
ON
Causticizing maintenance plan #2:
White liquor storage low limit decreased
Digester production decrease avoided
MWO Production Limits MW1V
WL production
155.00 l/s
Optimize
Feasible
Value
Start
Duration
High Limit 170.0 0.0 99.9
Low Limit 30.0 0.0 99.9
State 0 12.0 8.0
MWO Storage Limits MW1V049
White liquor storage
2500.0 m3
Optimize
Feasible
Value
Start
Duration
High Limit 4500.0 0.0 99.9
Low Limit 400.0 0.0 99.9
Target 1500.0 0.0 99.0
MWO Production Limits MW1V
Cooking production
2250.0 adt/day
Optimize
Feasible
Value
Start
Duration
High Limit 2250.0 0.0 99.9
Low Limit 1400.0 1.0 99.9
State 1 0.0 99.0


MWO Production Planner
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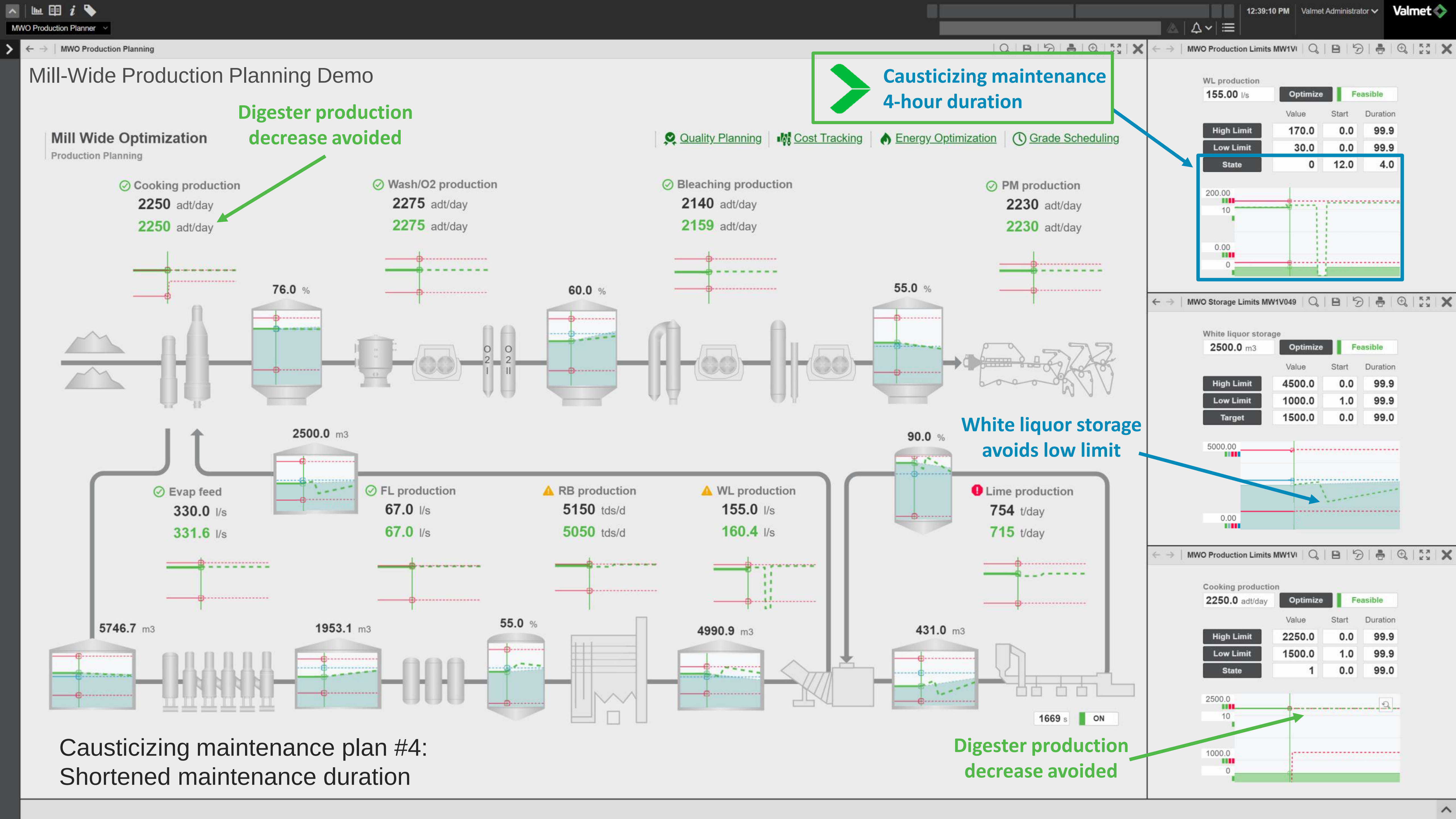
Valmet Administrator
Valmet
MWO Production Planning
Mill-Wide Production Planning Demo
Digester production marginal decrease
Causticizing maintenance delayed 6 hours
Mill Wide Optimization
Production Planning
Quality Planning
Cost Tracking
Energy Optimization
Grade Scheduling
Cooking production
2250 adt/day
2242 adt/day
Wash/O2 production
2275 adt/day
2273 adt/day
Bleaching production
2140 adt/day
2156 adt/day
PM production
2230 adt/day
2230 adt/day
76.0 %
60.0 %
55.0 %
2500.0 m3
90.0 %
Evap feed
330.0 l/s
324.1 l/s
FL production
67.0 l/s
63.0 l/s
RB production
5150 tds/d
5050 tds/d
WL production
155.0 l/s
165.0 l/s
Lime production
754 t/day
694 t/day
5746.7 m3
1953.1 m3
55.0 %
4990.9 m3
431.0 m3
1675 s
ON
Causticizing maintenance plan #3:
Delayed maintenance timing
Digester production marginal decrease
White liquor storage will hit low limit
MWO Production Limits MW1V
WL production
155.00 l/s
Optimize
Feasible
Value Start Duration
High Limit 170.0 0.0 99.9
Low Limit 30.0 0.0 99.9
State 0 18.0 8.0
MWO Storage Limits MW1V049
White liquor storage
2500.0 m3
Optimize
Feasible
Value Start Duration
High Limit 4500.0 0.0 99.9
Low Limit 1000.0 1.0 99.9
Target 1500.0 0.0 99.0
MWO Production Limits MW1V
Cooking production
2250.0 adt/day
Optimize
Feasible
Value Start Duration
High Limit 2250.0 0.0 99.9
Low Limit 1400.0 1.0 99.9
State 1 0.0 99.0


MWO Production Planner
MWO Production Planning
12:39:10 PM
Valmet Administrator
Valmet
Mill-Wide Production Planning Demo
Digester production decrease avoided
Causticizing maintenance 4-hour duration
Mill Wide Optimization
Production Planning
Quality Planning
Cost Tracking
Energy Optimization
Grade Scheduling
Cooking production 2250 adt/day 2250 adt/day
Wash/O2 production 2275 adt/day 2275 adt/day
Bleaching production 2140 adt/day 2159 adt/day
PM production 2230 adt/day 2230 adt/day
76.0 %
60.0 %
55.0 %
2500.0 m3
90.0 %
Evap feed 330.0 l/s 331.6 l/s
FL production 67.0 l/s 67.0 l/s
RB production 5150 tds/d 5050 tds/d
WL production 155.0 l/s 160.4 l/s
Lime production 754 t/day 715 t/day
White liquor storage avoids low limit
5746.7 m3
1953.1 m3
55.0 %
4990.9 m3
431.0 m3
1669 s
ON
Causticizing maintenance plan #4:
Shortened maintenance duration
MWO Production Limits MW1V(
WL production
155.00 l/s
Optimize
Feasible
Value Start Duration
High Limit 170.0 0.0 99.9
Low Limit 30.0 0.0 99.9
State 0 12.0 4.0
MWO Storage Limits MW1V049
White liquor storage
2500.0 m3
Optimize
Feasible
Value Start Duration
High Limit 4500.0 0.0 99.9
Low Limit 1000.0 1.0 99.9
Target 1500.0 0.0 99.0
MWO Production Limits MW1V(
Cooking production
2250.0 adt/day
Optimize
Feasible
Value Start Duration
High Limit 2250.0 0.0 99.9
Low Limit 1500.0 1.0 99.9
State 1 0.0 99.0
Digester production decrease avoided

Mill-Wide Production Planning

Reference Site – European Market Pulp Mill

Project Goals

- Estimate production increase potential via “Re-optimize the Past” audit
- Demonstrate production increase potential
- Realize production increase

Our solution

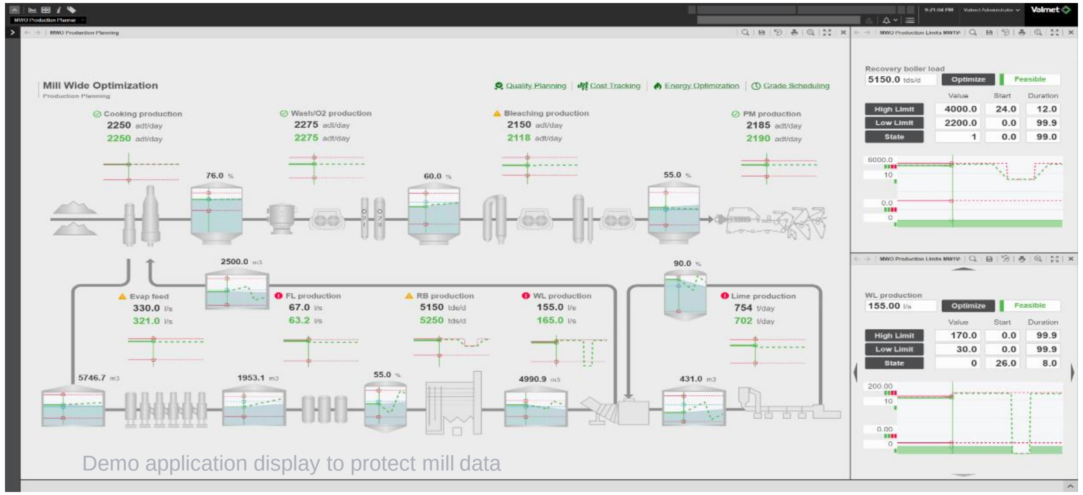
- Online advisory system with “What-if” capability
- Maximizes production towards mill bottlenecks, smooths production, and balances the pulp and liquor inventories
- User interface for visualizing future state of the mill
- Continuous improvement program

Mill-Wide Production Planning

...cont..Reference Site – European Market Pulp Mill

Benefits

- 5.2% digester production increase during first 8 months
- 2 record production months
- Consistently higher digester production target
- Improved unit stop and slowdown planning



ONLINE AND DYNAMIC PRODUCTION PLANNING SYSTEM THAT ALLOWS THE USER TO VISUALIZE AND OPTIMIZE THE FUTURE MILL STATE

Mill-Wide Production Planning

Reference Site – European Market Pulp Mill

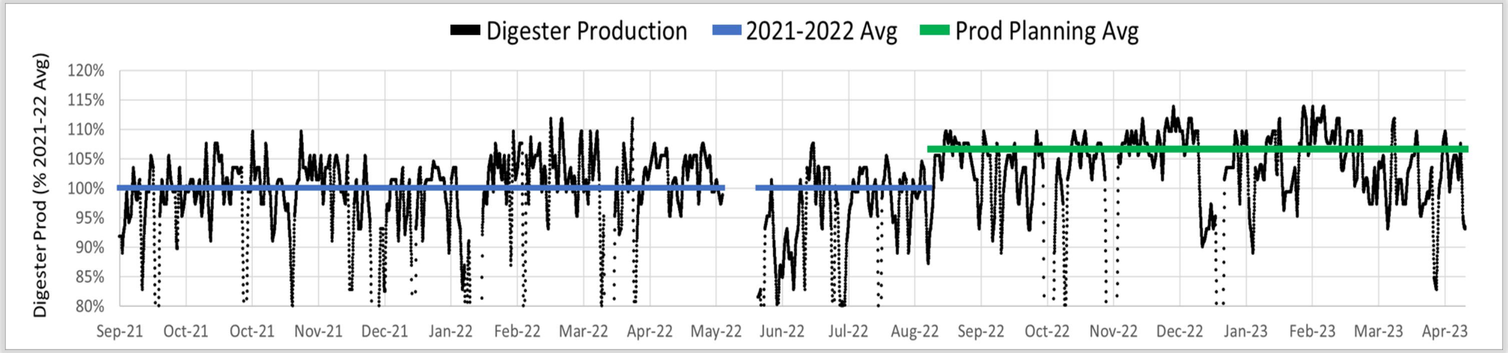
"Re-optimize the Past" Estimated Benefits

	Prodn. Increase	Bottle neck
Cooking	**4.5%**	4.1%
Washing	4.3%	1.5%
Bleaching	3.4%	6.8%
Pulp Dryer	4.5%	0.6%
Evaps	4.4%	**30.9%**
Rec Boiler	4.6%	11.1%
Caust	4.9%	**42.2%**
Kiln	2.9%	2.4%

4.5%

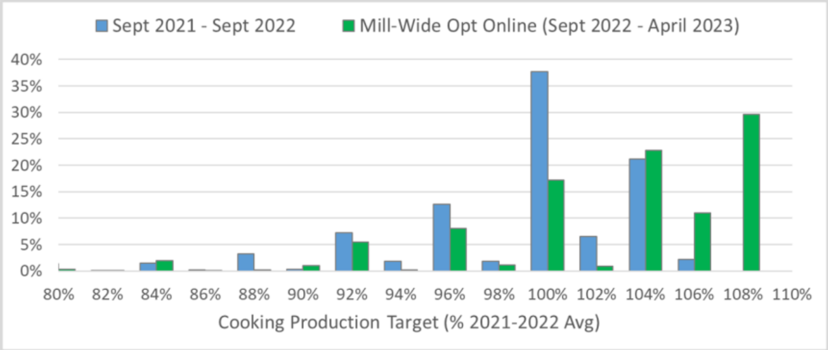
Estimated production increase

Production Planning Trial Realized Benefits



5.2%

Realized production increase



Cooking Production Target

Process Area	Average	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23
Cooking	66.6%	63.7%	84.7%	92.3%	94.5%	60.9%	75.3%	48.4%	12.8%
Washing - O2 Delig	0.5%	0.2%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	3.1%
ClO2 Prod	0.9%	0.3%	2.5%	0.0%	1.0%	1.6%	0.3%	0.3%	1.0%
Bleaching	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.3%	0.0%	0.3%
Pulp Dryer	10.9%	0.0%	0.0%	0.7%	0.3%	0.0%	40.8%	28.6%	16.6%
Evap Set 1	12.4%	15.3%	12.2%	6.4%	5.5%	5.3%	0.5%	12.1%	42.4%
Evap Set 2	6.8%	37.1%	4.5%	0.1%	0.0%	0.0%	10.1%	1.9%	0.8%
Evap Set 3	5.7%	6.6%	15.6%	2.8%	0.8%	0.3%	2.6%	2.3%	14.4%
Rec Boiler Feed	19.0%	3.4%	17.6%	40.9%	17.6%	37.3%	22.2%	9.4%	3.9%
Rec Boiler Sec Air	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rec Boiler SH Steam	1.8%	13.8%	0.3%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%
Causticizing	27.0%	4.2%	1.4%	3.3%	4.7%	26.6%	49.0%	46.7%	80.1%
Lime Kiln	7.3%	20.4%	0.1%	5.5%	0.4%	7.7%	3.7%	3.2%	17.2%

Optimization bottlenecks

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FORWARD