



PI Asset Framework Drives Mill Analytics at WestRock

Presented by: Andre Perez



Agenda

WestRock's Mill Analytics Project

- Vision and Overview

WestRock's Progress

- Foundation
- Visualizations
- Analytics

Summary and Path Forward

- Project Goals
- Training and Support

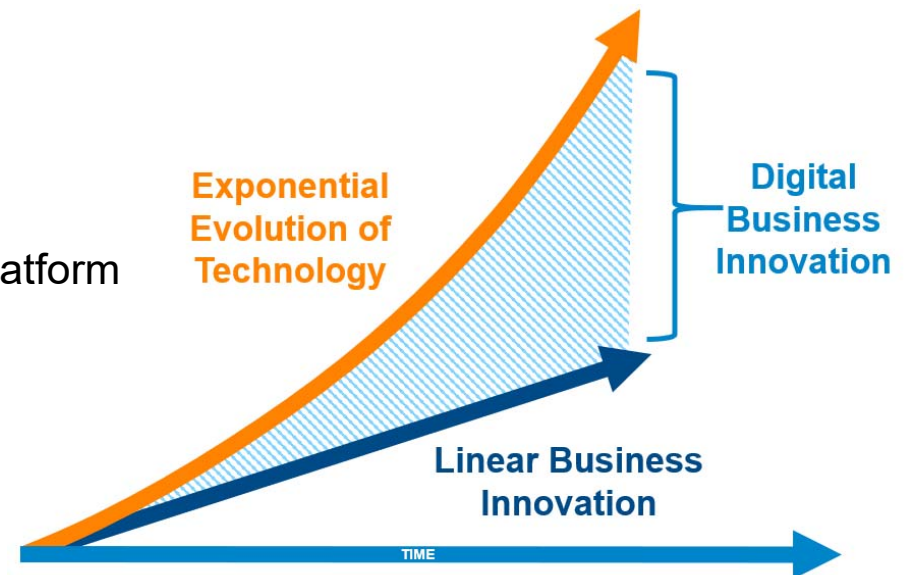
WestRock's Mill Analytics Project

Mill Analytics: Vision & Overview

In once sentence: Accelerating the time to actionable insights



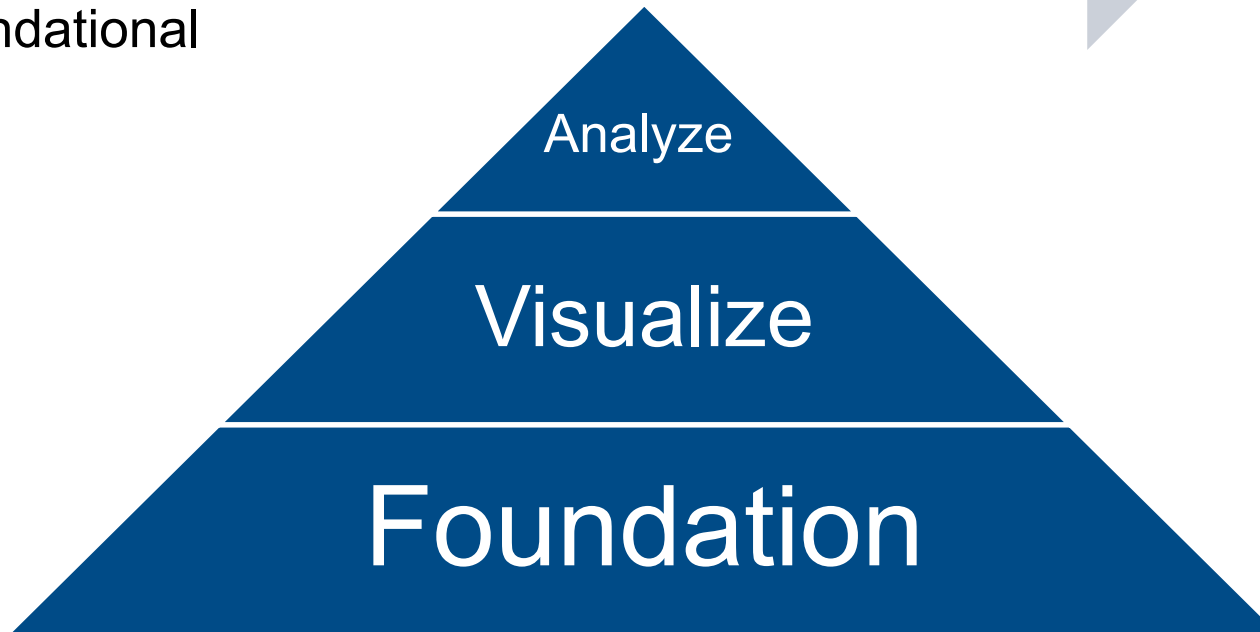
- Improving operational agility towards:
 - Variability reduction
 - Energy consumption
 - Margin expansion
- Improving knowledge capture with a standard platform
- Increasing access to disparate data systems
- Automating repetitive analyses and reporting
- Housing advanced analytics in one location



Mill Analytics: Vision & Overview



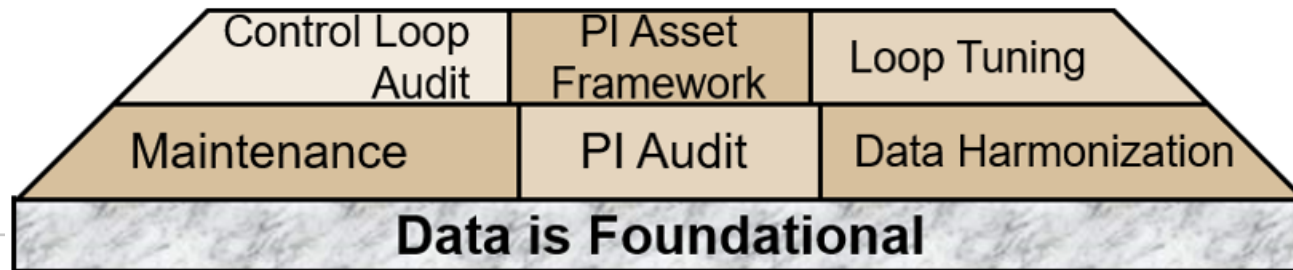
Data is foundational



Mill Analytics: Vision & Overview



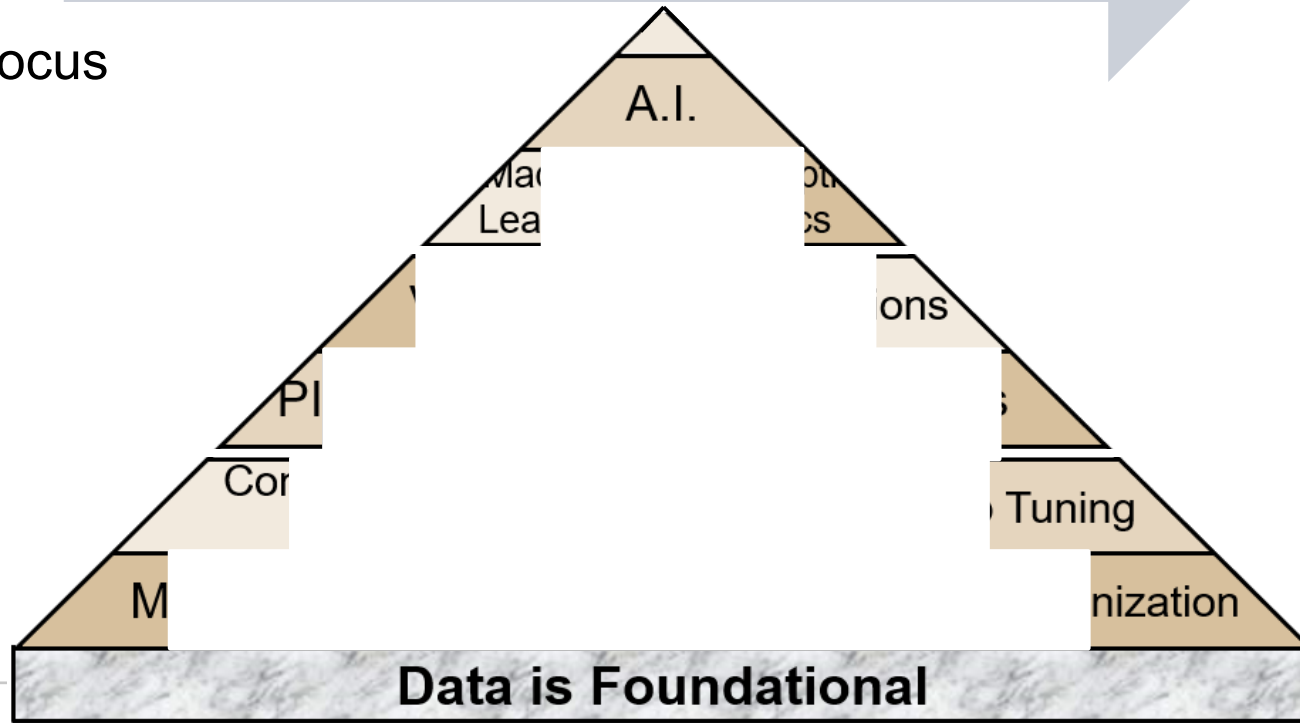
Our work is foundation focused



Mill Analytics: Vision & Overview



Top layer focus



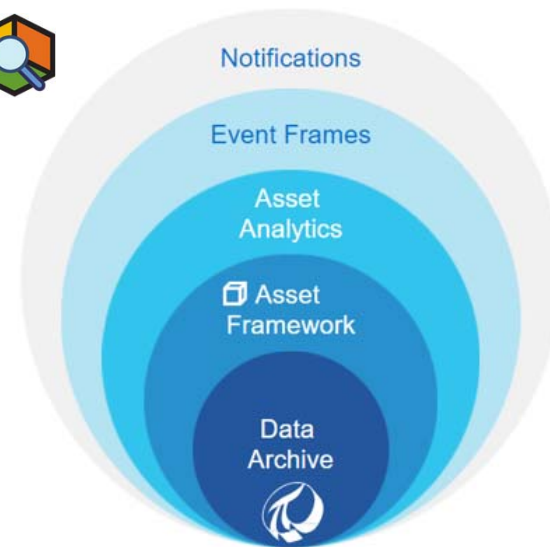
Mill Analytics: Vision & Overview



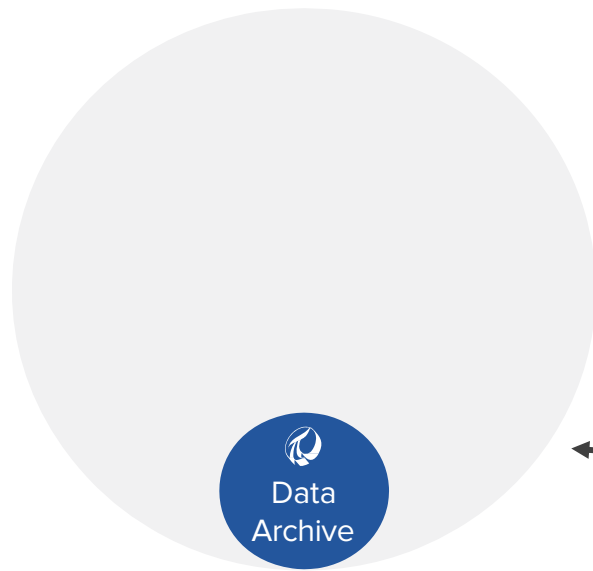
Honeywell



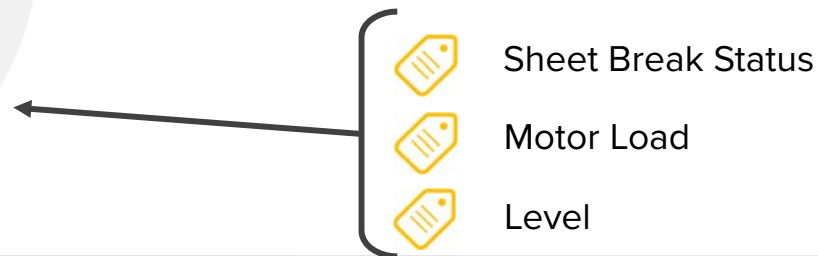
MAJIQ



Mill Analytics: Vision & Overview






Raw time-series data is stored in the **Data Archive**






Mill Analytics: Vision & Overview

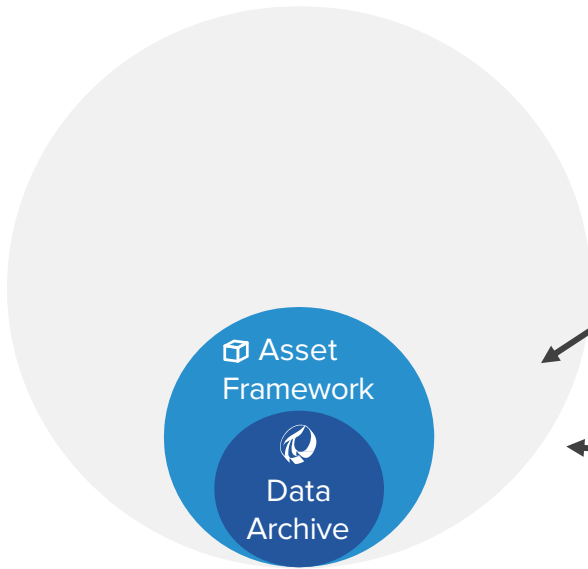


Meta-data stored in the **Asset Framework**

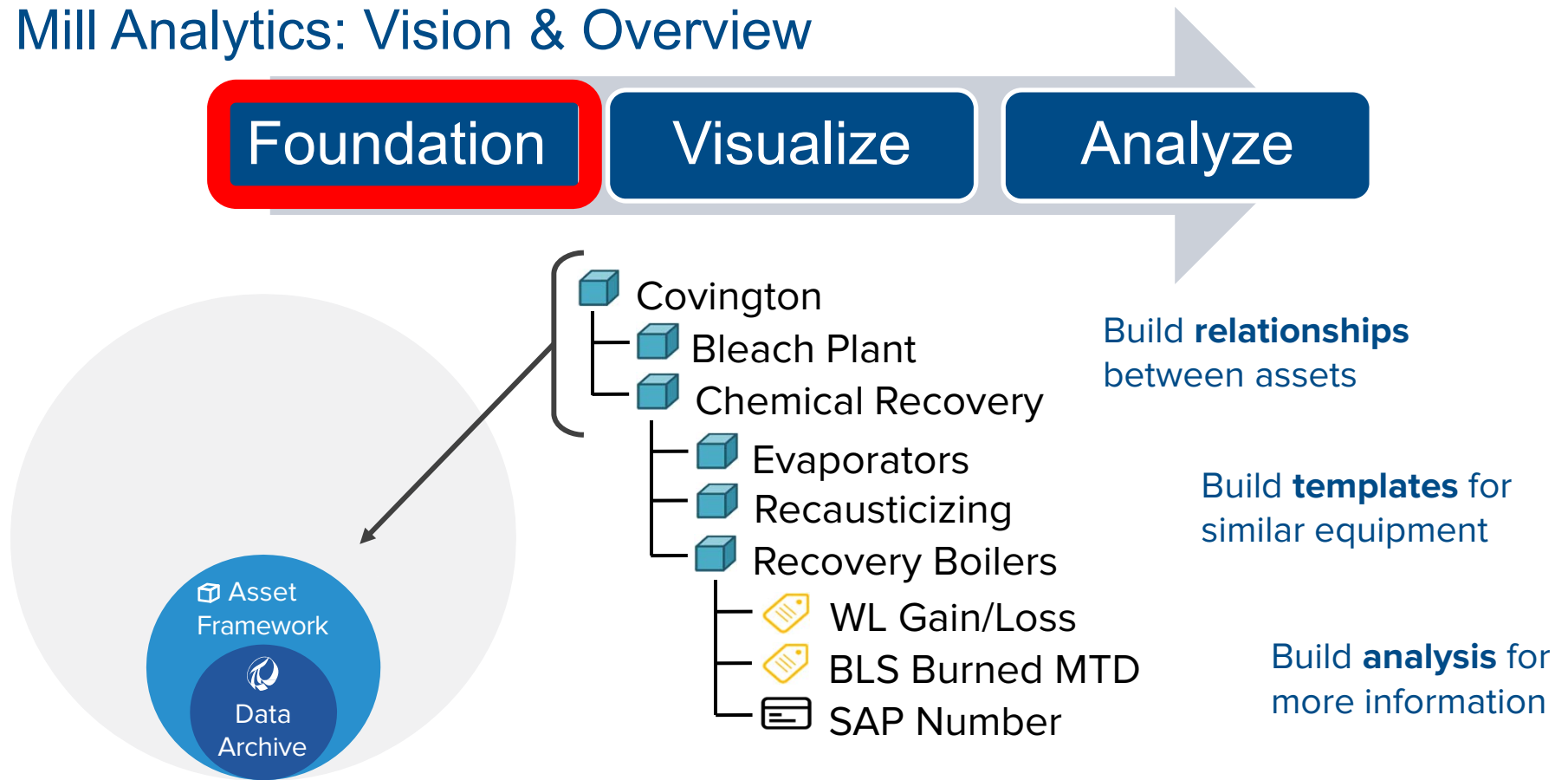
-  SAP Number
-  Upper & Lower Limits/Targets
-  Location

Raw time-series data is stored in the **Data Archive**

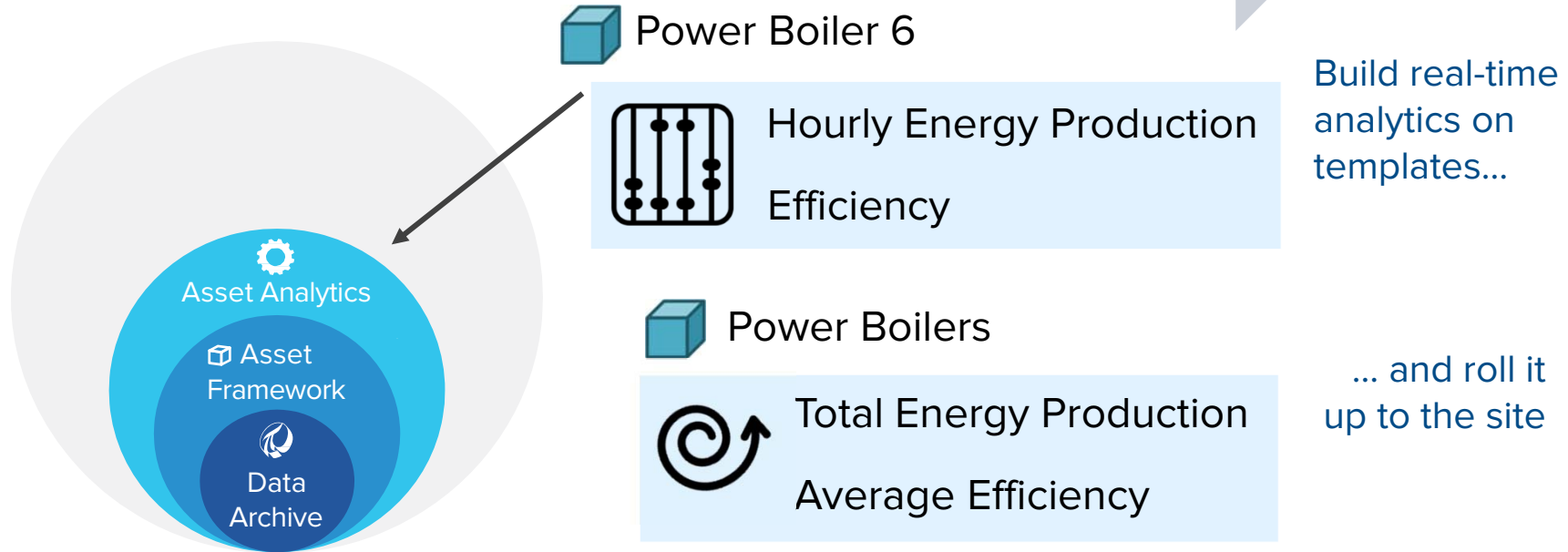
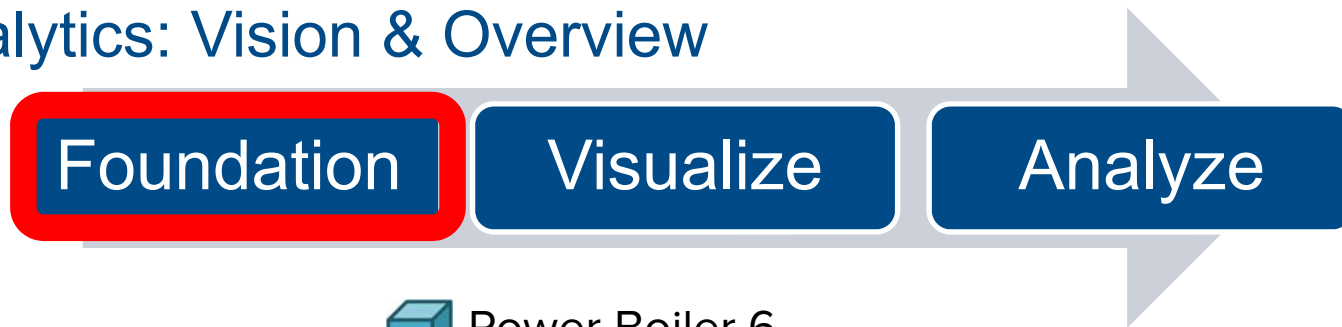
-  Sheet Break Status
-  Motor Load
-  Level



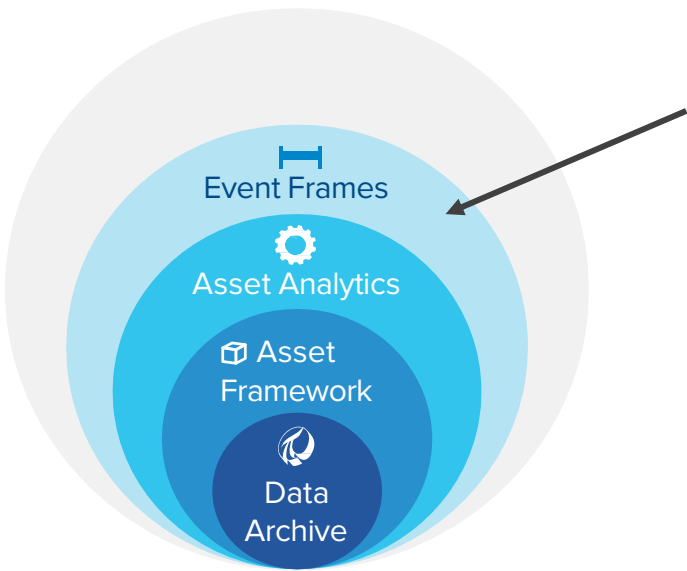
Mill Analytics: Vision & Overview



Mill Analytics: Vision & Overview



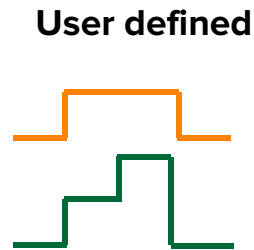
Mill Analytics: Vision & Overview



Batch Digesters

Downtime

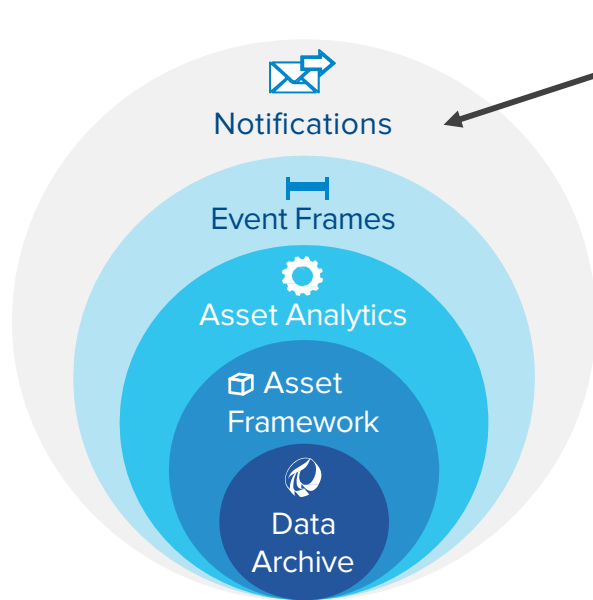
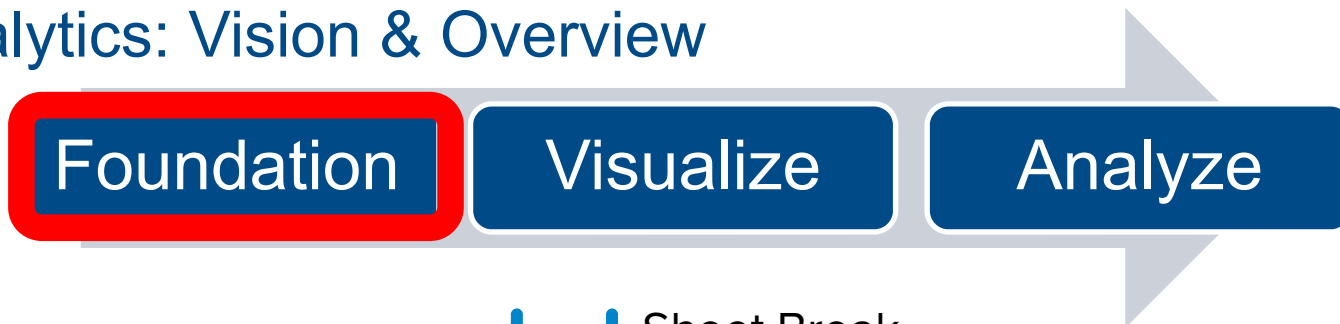
Triggers:



External Systems



Mill Analytics: Vision & Overview



Sheet Break

Notification

Subject: Paper Machine C1 is in a OFF REEL:Value At Send Time state as of

Attachments: +

Attention!

Paper Machine C1 is in an OFF REEL:Value At Send Time reel state as of Notification Rule:Send Time

Sent By: Covington PI Notifications System
Server: AF Server:Name

Test Send

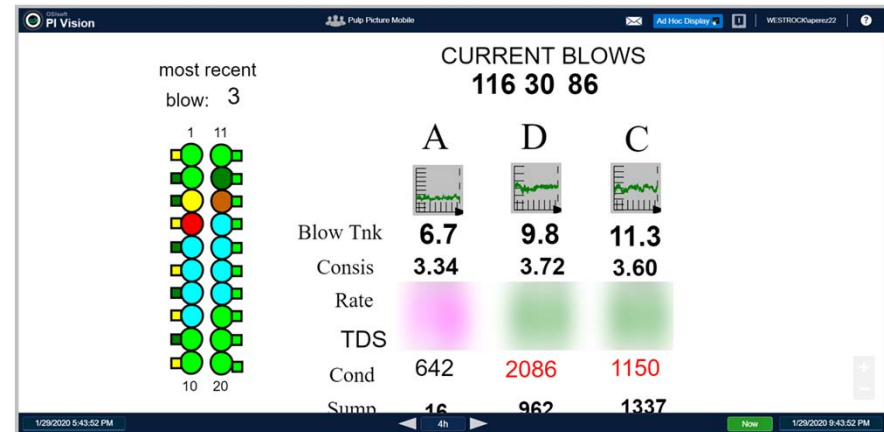
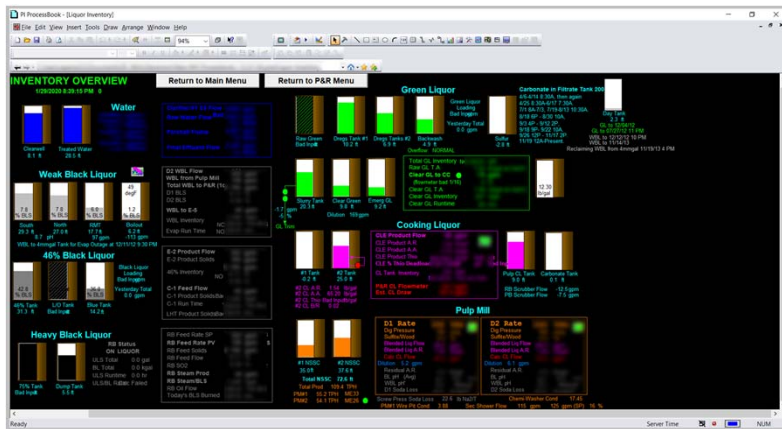
Mill Analytics: Vision & Overview



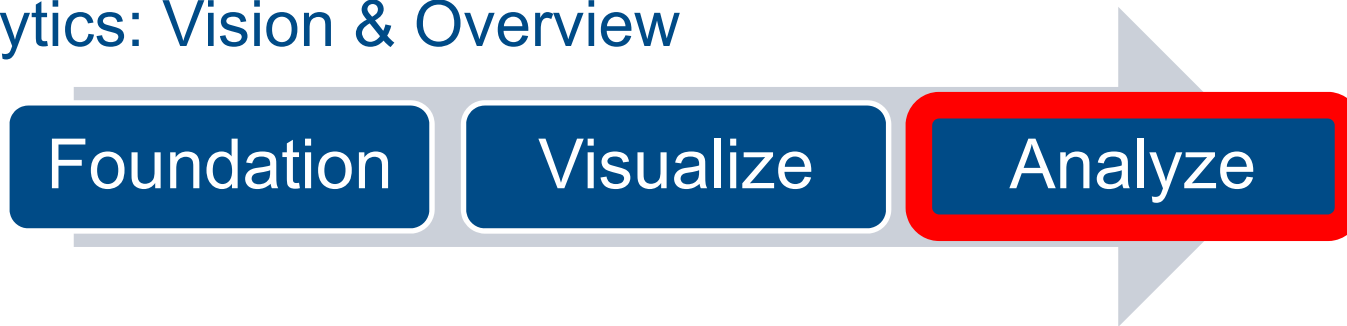
PI ProcessBook



PI Vision



Mill Analytics: Vision & Overview



Microsoft
Excel



ENVOY
Development



Sight Machine



Minitab

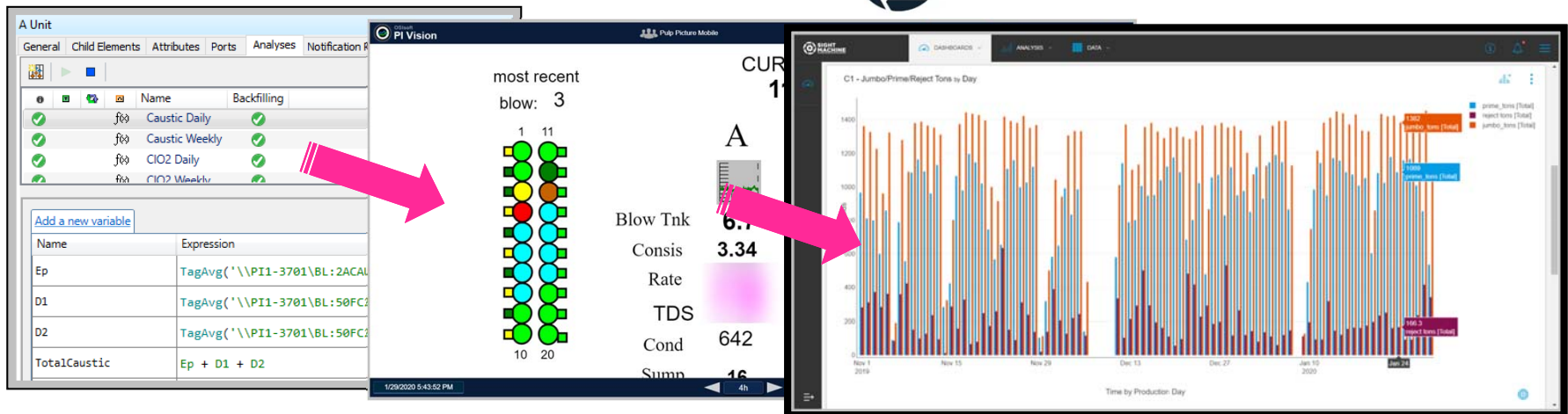


Mill Analytics: Vision & Overview

Foundation

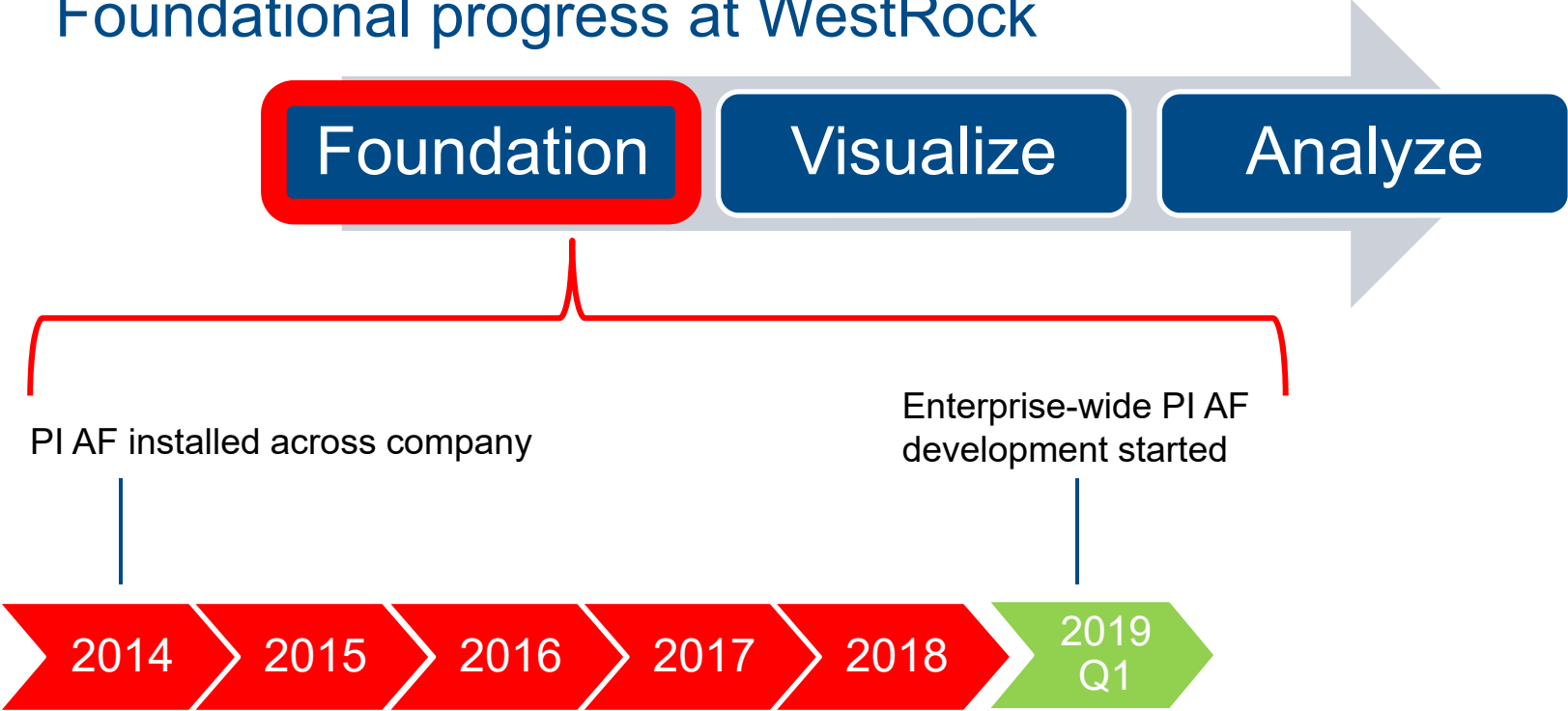
Visualize

Analyze

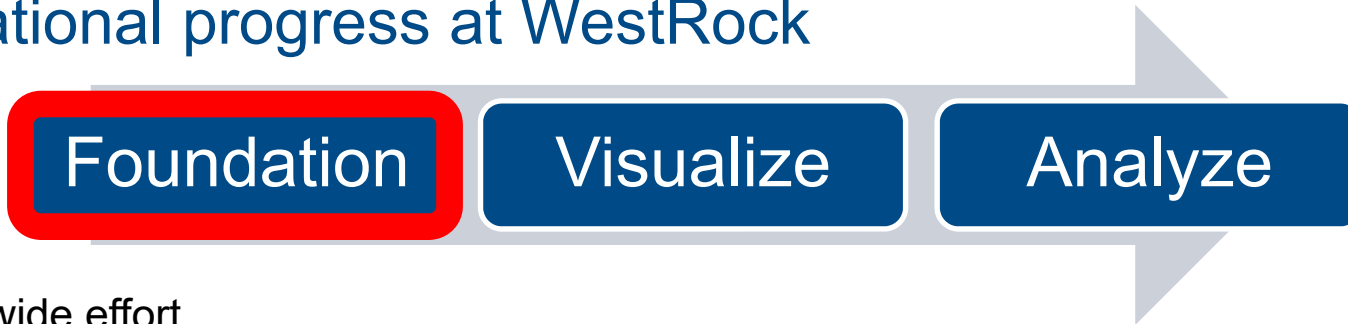


Foundational progress at WestRock

Foundational progress at WestRock



Foundational progress at WestRock

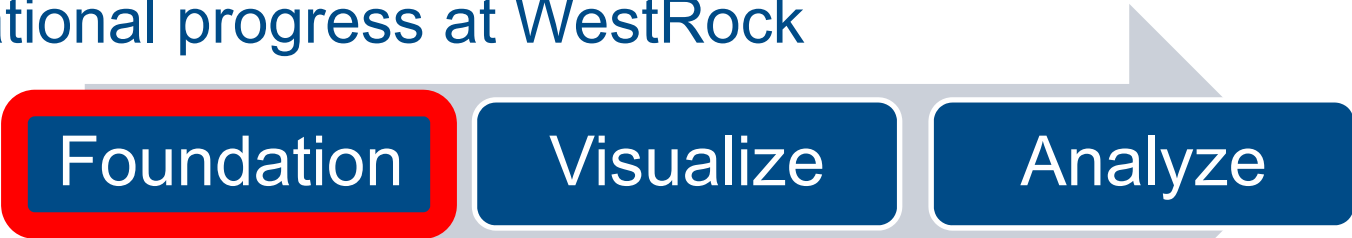


Enterprise-wide effort



- More than 250 manufacturing facilities, design centers, research labs and sales offices
- Located in 30 countries
- 39,000 employees around the world

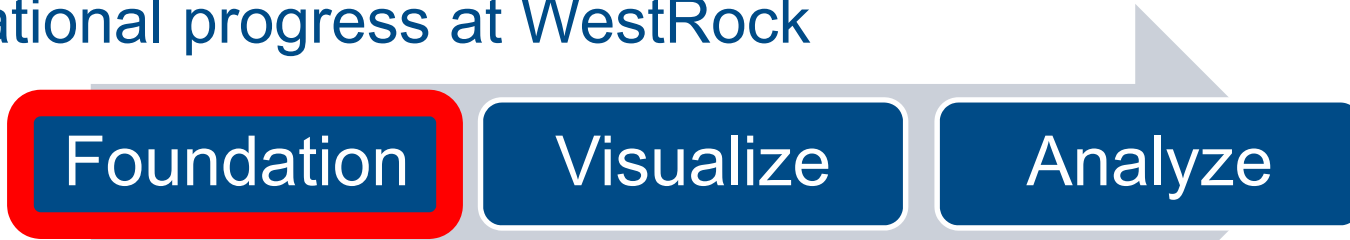
Foundational progress at WestRock



Enterprise-wide effort: starting at our production facilities = large undertaking



Foundational progress at WestRock



Enterprise-wide effort: starting at our production facilities = large undertaking

Solo remote effort



Facilitated onsite teamwork



Foundational progress at WestRock

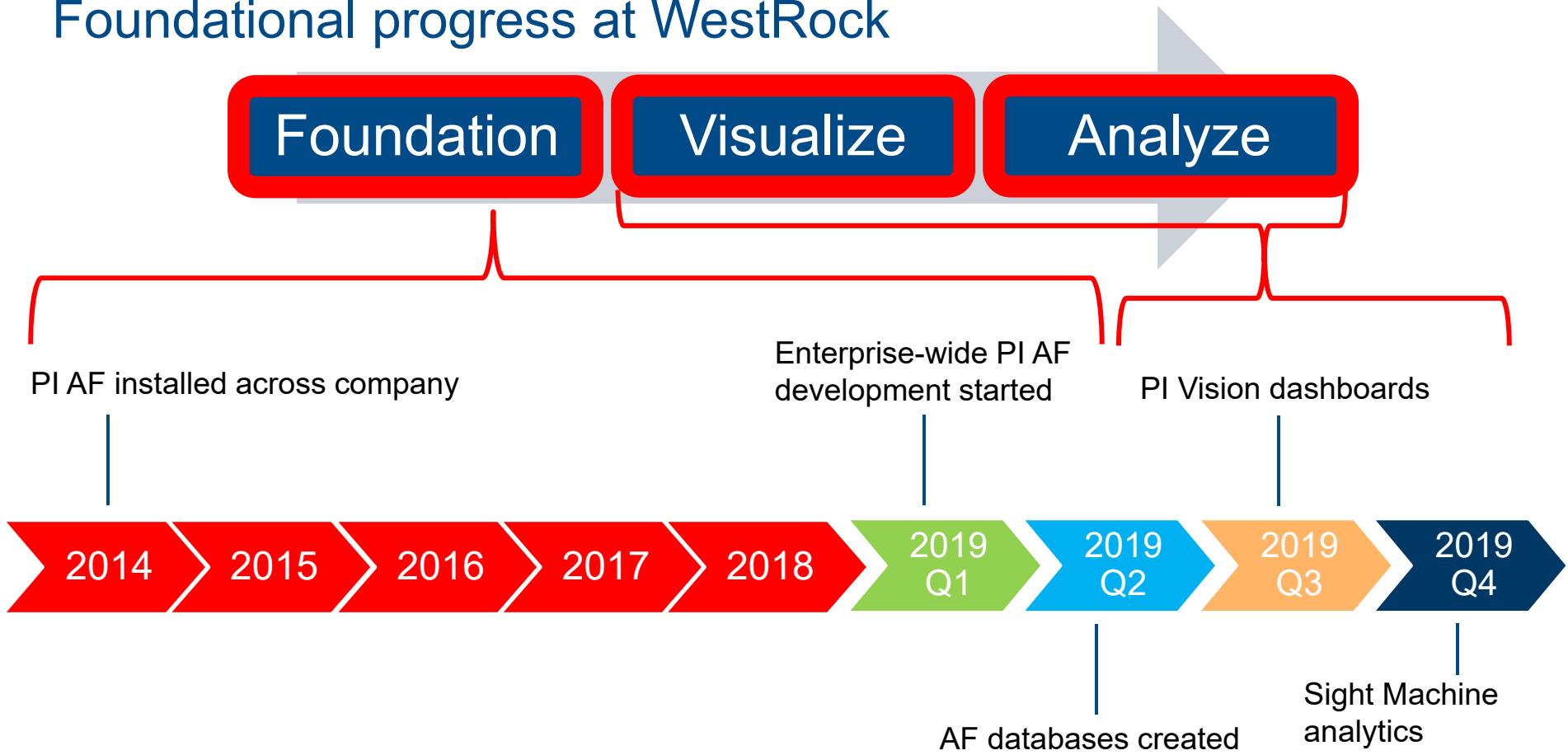


Reduce and distribute workload

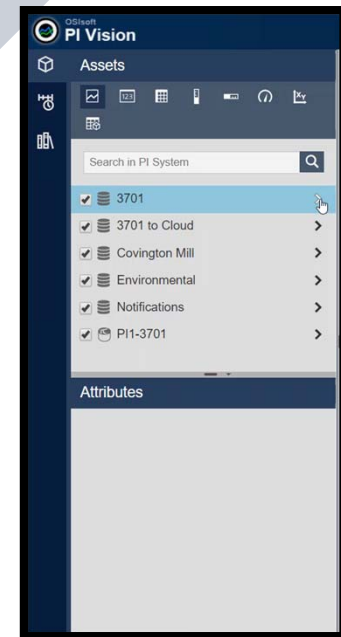
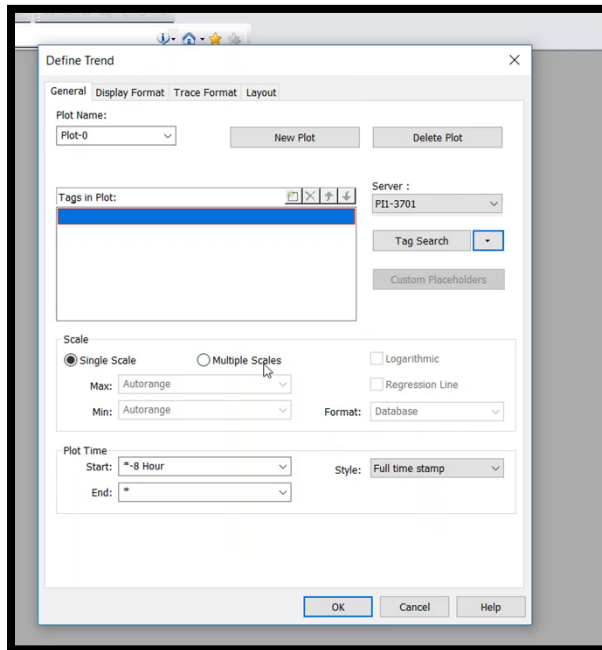
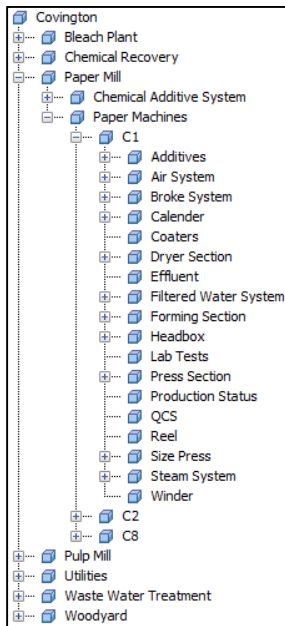
Automate tasks

Selected	Parent	Name	ObjectType	ReferenceType	Attribute	AttributeT	AttributeC	AttributeDefau	DefaultAt	Categories	Attribute\	Attribute\	Error
x	Hodge	Hodge	Element	Parent-Child									
x	Hodge\Pulp Mill	Pulp Mill	Element	Parent-Child									
x	Hodge\Pulp Mill\Blow Tanks	Blow Tanks	Element	Parent-Child									
x	Hodge\Pulp Mill\Blow Tanks\A/C Reclaim Tank Level	A/C Reclaim Tank Level	Element	Parent-Child									
x	Hodge\Pulp Mill\Blow Tanks\A/C Reclaim Tank Level	Gain	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\A/C Reclaim Tank Level	Integral	Attribute		\WT450 Single	PI Point	min						FALSE
x	Hodge\Pulp Mill\Blow Tanks	C Line Blow Tank Flow	Element	Parent-Child									
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Flow	C-Blow Tank Flow Output	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Flow	C-Blow Tank Flow	Attribute		\WT450 Single	PI Point	US gal/min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Flow	C-Blow Tank Flow Setpoint	Attribute		\WT450 Single	PI Point	US gal/min						FALSE
x	Hodge\Pulp Mill\Blow Tanks	C Line Blow Tank Bulk Dilution	Element	Parent-Child									
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	Gain	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	Integral	Attribute		\WT450 Single	PI Point	min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C BLOW TANK DIL valve output	Attribute		\WT450 Single	PI Point							FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C Blow Tank Dilution Process Value	Attribute		\WT450 Single	PI Point	US gal/min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C-Blow Trnk Dilution Flow Output	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C-Blow Trnk Dilution Flow	Attribute		\WT450 Single	PI Point	US gal/min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C-Blow Trnk Dilution Flow Setpoint	Attribute		\WT450 Single	PI Point	US gal/min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C Blow Tank Dilution Pump	Attribute		\WT450 Single	PI Point	%FLA						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C Line Blow Tank Bulk Dilution Flow OP	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C Line Blow Tank Bulk Dilution Flow PV	Attribute		\WT450 Single	PI Point	US gal/min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C-Blow Trnk Dilution Flow Gain	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C-Blow Trnk Dilution Flow Integral	Attribute		\WT450 Single	PI Point	min						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Dilution	C Line Blow Tank Dilution Pump Status	Attribute		\WT450 Single	PI Point							FALSE
x	Hodge\Pulp Mill\Blow Tanks	C Line Blow Tank Bulk Consistency	Element	Parent-Child									
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Consistency	Gain	Attribute		\WT450 Single	PI Point	%						FALSE
x	Hodge\Pulp Mill\Blow Tanks\C Line Blow Tank Bulk Consistency	Integral	Attribute		\WT450 Single	PI Point	min						FALSE
x	Hodge\Pulp Mill\Blow Tanks	C Line Blow Tank Bulk Level	Element	Parent-Child									

Foundational progress at WestRock



Foundational progress at WestRock



Visualization progress at WestRock



Visualization progress at WestRock



Increased visibility of pertinent data for the demineralizer plant

Power DI Regeneration Data

Asset	Mode	Inlet Flow	Totalized Flow	Total Gallons per Run	Total Gallons per ...	Regens Month to Date	Acid lb per kgal	Acid lb per kgal ...
#1 Cation	SERVICE	423.8	86,346.4	338.8	317.3	48.0	9.2	10.7
#2 Cation	SERVICE	493.3	350,828.7	508.7	571.2	34.0	6.4	5.9
#3 Cation	SERVICE	525.4	164,339.6	349.7	551.4	35.0	9.5	6.4
#4 Cation	STANDBY	0.0	29.3	584.3	571.6	36.0	5.7	6.6

Regens Month to Date Summary:

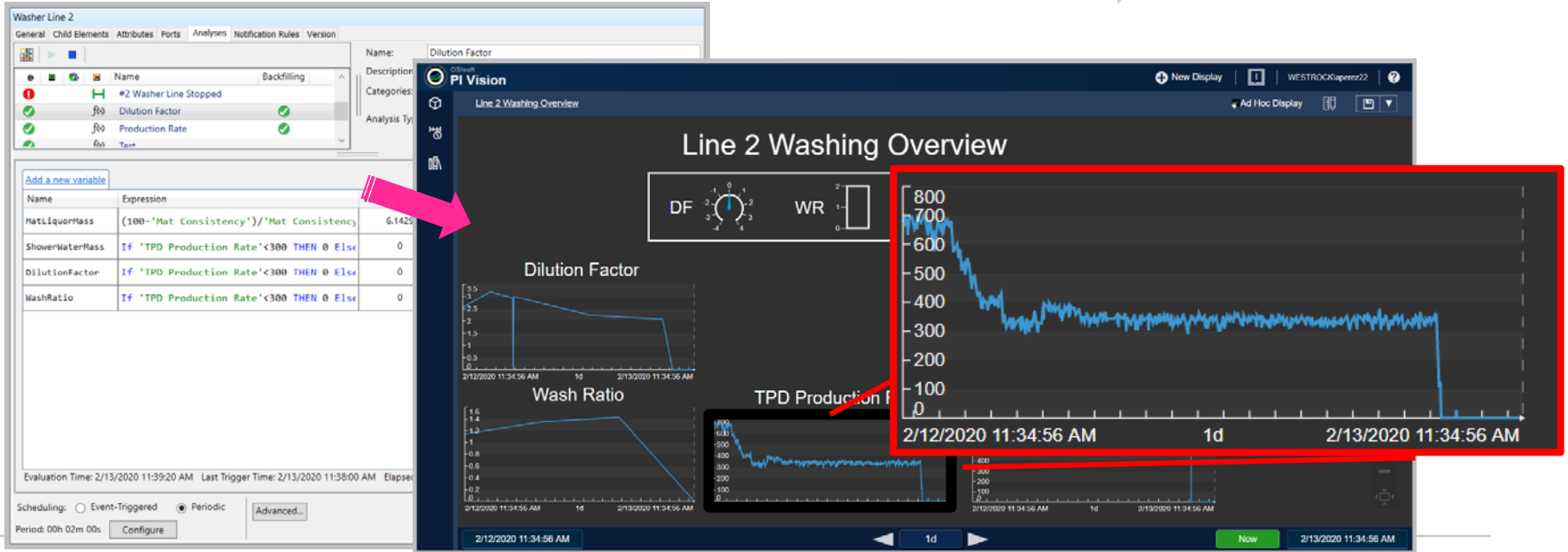
Asset	Regens Month to Date
#1 Cation	48.0
#2 Cation	34.0
#3 Cation	35.0
#4 Cation	36.0



Visualization progress at WestRock



Created new brown stock washer KPI's and dashboard





Visualization progress at WestRock



Quickly determine outliers in the batch digesters thanks to PI AF event frames





Visualization progress at WestRock



Logic to determine reason for blade changes, count and calculate life cycles

PM2 Coater Blade Life Cycles

Coater Blade #1 Current Run Time 19.0 Coater Blade #2 Current Run Time 18.9
Coater Blade #3 Current Run Time 18.9 Coater Blade #4 Current Run Time 0.0

Asset	Grade Change Avg Blade Life	Sheet Break Avg Blade Life	Quality Avg Blade Life
Blade 1	19	8	19
Blade 2	20	10	20
Blade 3	18	12	14
Blade 4	13	7	12

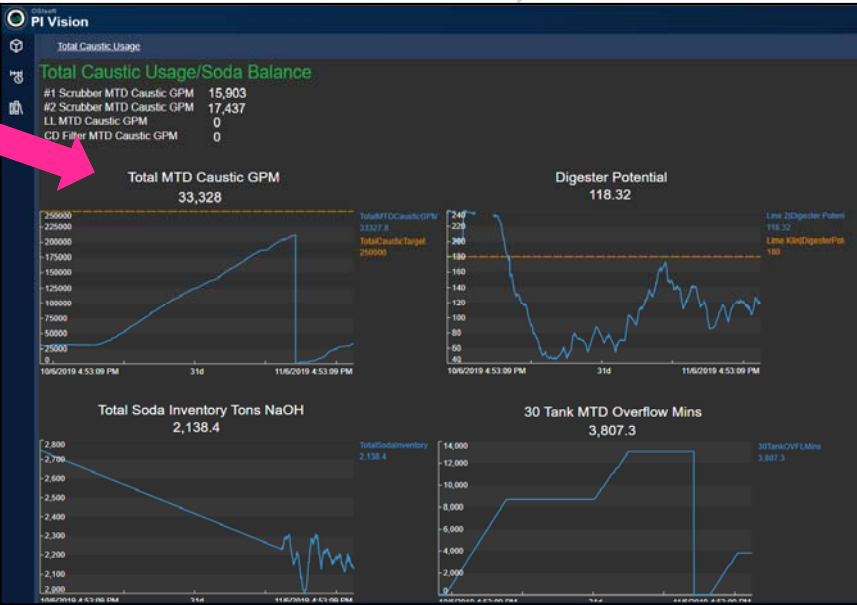


Visualization progress at WestRock



Soda balance calculations to indicate total inventory, digester potential, and chemical usages live

Name	Expression	Value at Evaluation
ScrubNaOHFlow2	IF "\\pkg-covi-picp1\\l2:fb861.1">18 OR "\\pkg-covi-picp1\\l2:fb861.1"<0.5 THEN ELSE "\\pkg-covi-	3.6047
ScrubNaOHFlow1	IF "\\pkg-covi-picp1\\l2:fb866.1">18 OR "\\pkg-covi-picp1\\l2:fb866.1"<0.5 THEN ELSE "\\pkg-covi-	2.9559
MTDScrubFlow	IF Row("**)=**" THEN @ else TagTot("ScrubNaOHFlow",Row("**),**")*1440	1.0172E+05
MTDScrubFlow	IF Row("**)=**" THEN @ else TagTot("ScrubNaOHFlow",Row("**),**")*1440	1.1202E+05
LLNaOHFlow	IF "\\pkg-covi-picp1\\l1:FC4839C.1"<0.5 THEN @ ELSE "\\pkg-covi-picp1\\l1:FC4839C.1"	0
MTDLLNaOHFlow	IF Row("**)=**" THEN @ else TagTot("LLNaOHFlow",Row("**),**")*1440	0
CDFILNaOHFlow	IF "\\pkg-covi-picp1\\l2:FC868.1">2 THEN @ ELSE "\\pkg-covi-picp1\\l2:FC868.1"	0
MTDCDFILNaOHFlow	IF Row("**)=**" THEN @ else TagTot("CDFILNaOHFlow",Row("**),**")*1440	34705
thirtyTankOverflowMTD	IF Row("**)=**" THEN @ else TimeGT("\\pkg-covi-picp1\\r2:30_TKL_PV", Row("**),**",99)/60	5433.6
FreshLine1Screw	IF BadVal("\\pkg-covi-picp1\\l2:SC135.2") = "TRUE" THEN @ ELSE "\\pkg-covi-picp1\\l2:SC135.2"/1000	0.09135
FreshLineLittleScrew	IF BadVal("\\pkg-covi-picp1\\l2:SC134.2") = "TRUE" THEN @ ELSE "\\pkg-covi-picp1\\l2:SC134.2"/1000	0
Line81A1	IF BadVal("\\pkg-covi-picp1\\l2:SC134.3") = "TRUE" THEN @ ELSE "\\pkg-covi-picp1\\l2:SC134.3"*2/24	0.13889
Line81A2	IF BadVal("\\pkg-covi-picp1\\l1:FPD_LINE_R002.1") = "TRUE" THEN @ ELSE "\\pkg-covi-picp1\\l1:FPD_L	0



Analytics progress at WestRock

Analytics progress at WestRock

Sight Machine Communication Structure



Analytics progress at WestRock

Sight Machine Communication Structure





Analytics progress at WestRock

Sight Machine Out of the Box Tools

The dashboard is organized into three main sections:

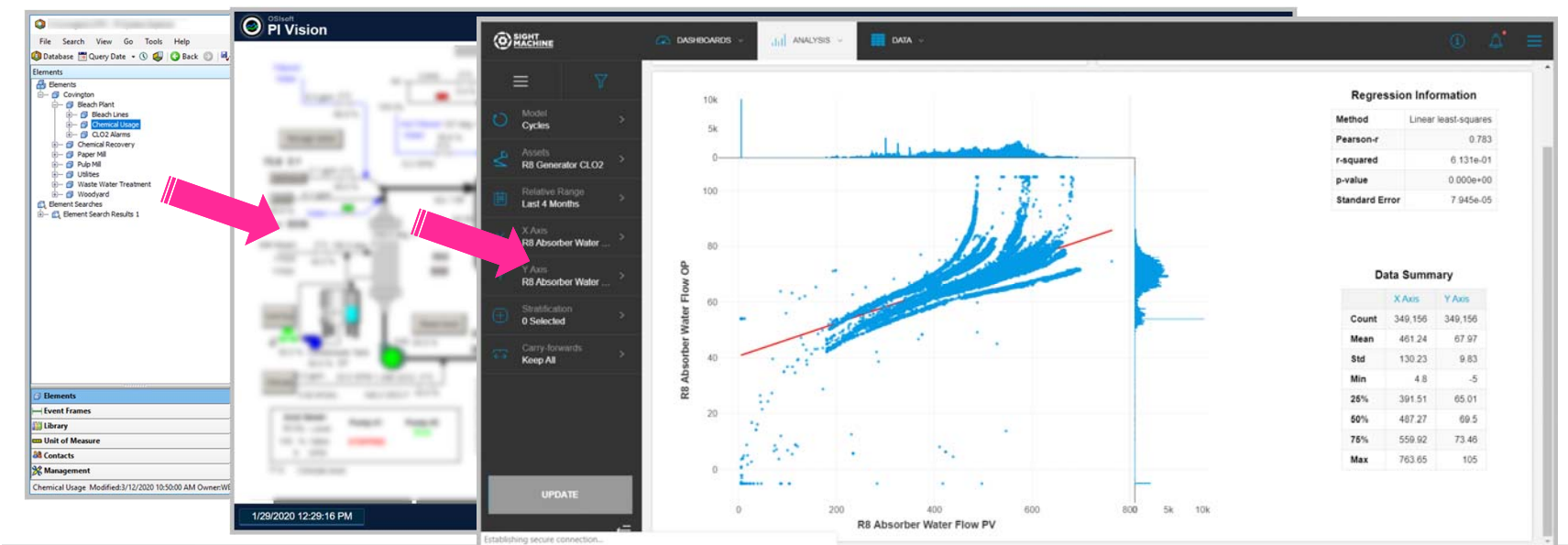
- DATA EXPLORATION**
 - Data Visualization**: Create robust visualizations leveraging contextualized data models.
 - Descriptive Statistics**: Perform in-depth analysis for a particular field.
 - Event Timeline**: Understand the duration and sequence of events over time, shown by category or type.
 - Timeline Analysis**: View the sequence of process data, downtimes, and defects over time.
- CORRELATION**
 - Correlation Heatmap**: Investigate pairwise relationships between multiple fields.
 - Curve Fit Analysis**: Gain an in-depth understanding of the relationship between a pair of fields.
 - Time-Series Correlation**: Understand which fields have the highest correlation to a field of interest.
- PROCESS VARIABILITY**
 - Statistical Process Control**: Monitor stability and initiate alerts when any parameters go out of control to ensure the quality and stability of your manufacturing process.
 - Variance Analysis**: Surface the fields with the highest variance.



Analytics progress at WestRock



Curve-fit diagram analyzing 4 months of flow vs. controller output, indicates failing pump





Analytics progress at WestRock



Variance analysis on paper machine highlights worst performing control loops

The dashboard displays a process flow tree on the left, two PI Vision charts for 'PM1 Additives' (Alum and Retention Aid), and a 'C1: Control Loop Monitoring - Last 24hrs' table. The table lists various control loops with their respective counts, means, standard deviations, and minimum values.

Top Varying Parameters	Count	Mean	Std	Min	25%
C1 Stock Approach: Brk Ref Consis (Super) OP	2,805	558 487	205 051	311 874	35
C1 Stock Approach: Thick Stock Flow OP	2,805	1,088 788	33 412	1,028 13	1.0
C1 Stock Approach: Red Dye Flow OP	2,805	33 194	16 984	0 098	2
C1 Stock Approach: Blend Chest pH OP	2,805	35 041	13 332	4 684	2
C1 Stock Approach: Fan Pump Speed OP	2,805	647 761	9 926	629 836	63
C1 Stock Approach: Tot Head/Fan Pump (Crit) OP	2,805	647 78	9 923	630 199	63
C1 Stock Approach: No. 1 Hw Refr Hpd/T (Sp To Prc) OP	2,805	61 628	9 62	47 034	5
C1 Stock Approach: Cons Dil Press Midrng OP	2,805	18 629	8 745	0 0	1
C1 Stock Approach: Spare Ref Hpd/T (Sp To Prc) OP	2,805	60 604	8 606	46 918	5
C1 Stock Approach: Pine Ref Consistency OP	2,805	1 534	7 467	0 0	

Top Varying Parameters	Count	Mean	Std	Min	25%
C1 Headbox: Total Flow (Slice Op)	2,804	32,899 599	660 299	31,906 7	32,047 475
C1 Headbox: Slice Flow (Slice Op)	2,804	1,315 984	26 412	1,276 28	1,281 9
C1 Headbox: Total Head (Critical) OP	2,804	647 778	0 027	630 356	636 428
C1 Headbox: Dilution Pressure Differential OP	2,804	95 718	1 53	93 085	93 979
C1 Headbox: Dilution Ratio OP	2,804	27 837	1 14	26 026	26 445
C1 Headbox: HB Pond Level OP	2,804	50 03	0 685	48 799	49 35
C1 Headbox: Jet Impingement OP	2,804	26 749	0 623	26 185	26 268
C1 Headbox: Edge Flow Volume DS OP	2,804	74 002	0 382	73 292	73 687
C1 Headbox: Edge Flow Volume TS OP	2,804	68 84	0 228	68 26	68 666
C1 Headbox: Dilution Recirc: Sio OP	2,804	23 466	0 163	23 058	23 368



Analytics progress at WestRock



Sheet Break tool performs variance analysis on 10-minute interval just before a recorded sheet break, surfacing possible cause of break

The screenshot displays the 'Sight Machine' software interface. On the left, a tree view under 'Elements' shows a hierarchy including 'Bleach Plant', 'Boilers', 'C1', 'C2', 'C8', and 'ON_REEL'. A pink arrow points from 'ON_REEL' to a 'Proficy Re' panel in the center, which lists various machine parameters like 'Machine', 'Grade', 'Speed, Ft/min', 'WEP', 'DEP', and '% Pine'. Another pink arrow points from 'WEP' to the 'Sheet Break Analysis Plot' on the right. The plot shows two line graphs: 'C8 Press Section: Smoothing Press Back' and 'C8 Press Section: Couch Torque Act'. The first graph shows a value of 0.238 before a sharp increase to 0.2646 at 02:00. The second graph shows a value of 771 before a sharp decrease to 769 at 02:00. To the right of the graphs are diagnostic tables.

Diagnostics	
Smoothing Press Back dropped due to constant values	
Couch Torque Act dropped due to constant values	
AKD Flow dropped due to constant values	

C8 Press Section: Smoothing Press Back	
Mean (Steady-state window)	0.238
Variance (Steady-state window)	0
Mean (Analysis window)	0.2646
Variance (Analysis window)	0.0004285
Difference in Variance (in Standard Deviations)	inf

C8 Press Section: Couch Torque Act	
Mean (Steady-state window)	771
Variance (Steady-state window)	0
Mean (Analysis window)	771
Variance (Analysis window)	5e-08
Difference in Variance (in Standard Deviations)	inf



Analytics progress at WestRock



Time-series correlation can identify unknown relationships and root causes

C2 Coaters: CT4 Time on Current Blade

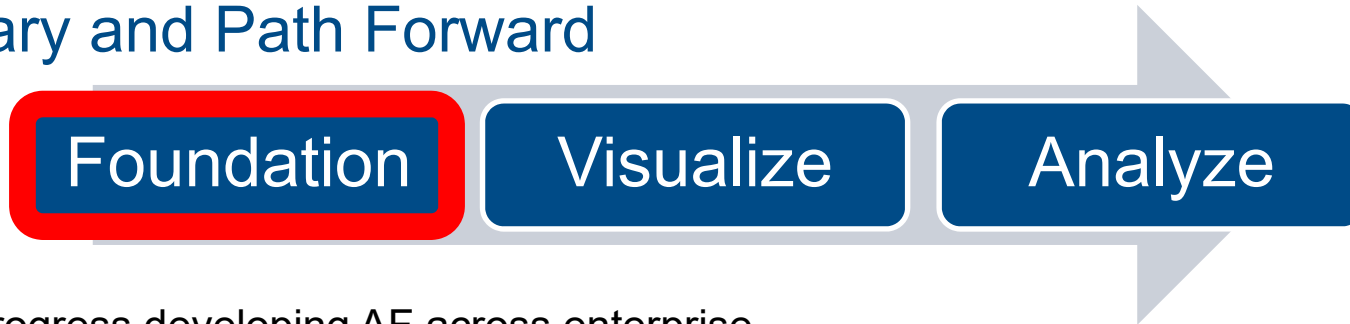
Correlation Strength	Strong
Correlation Coef	0.79
Count of Values	4,636
Mean	4.45
Std Dev	3.86
Min	0.00
25%	1.47
50%	3.44
75%	7.14
Max	14.12

C2 Coaters: CT1 Time on Current Blade

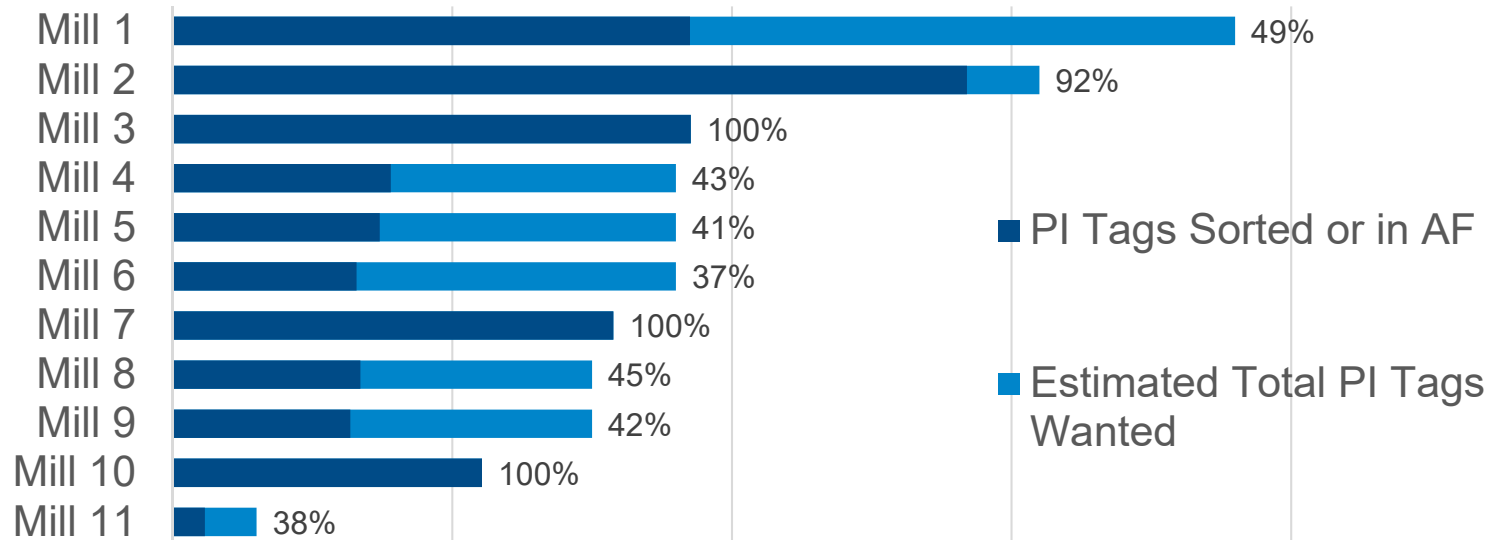
Correlation Strength	Strong
Correlation Coef	0.74
Count of Values	4,636
Mean	6.14
Std Dev	4.95
Min	0.00
25%	0.95
50%	5.70

Summary and Path Forward

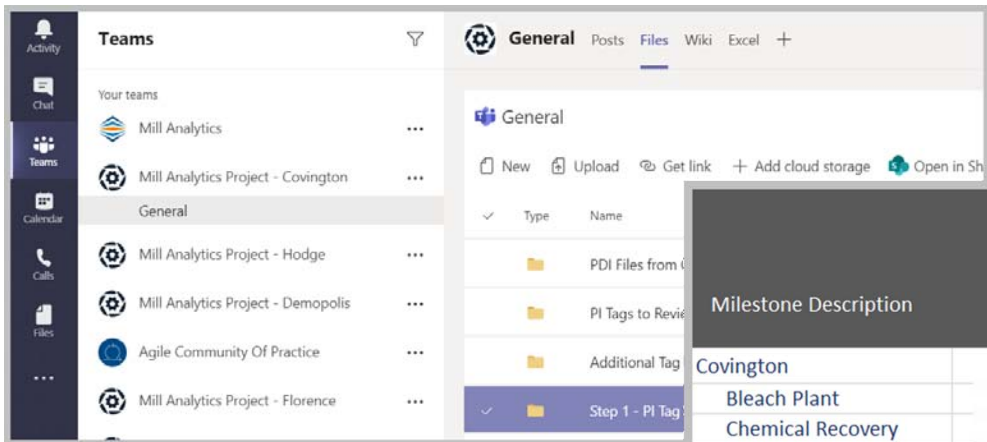
Summary and Path Forward



Ongoing progress developing AF across enterprise



Summary and Path Forward



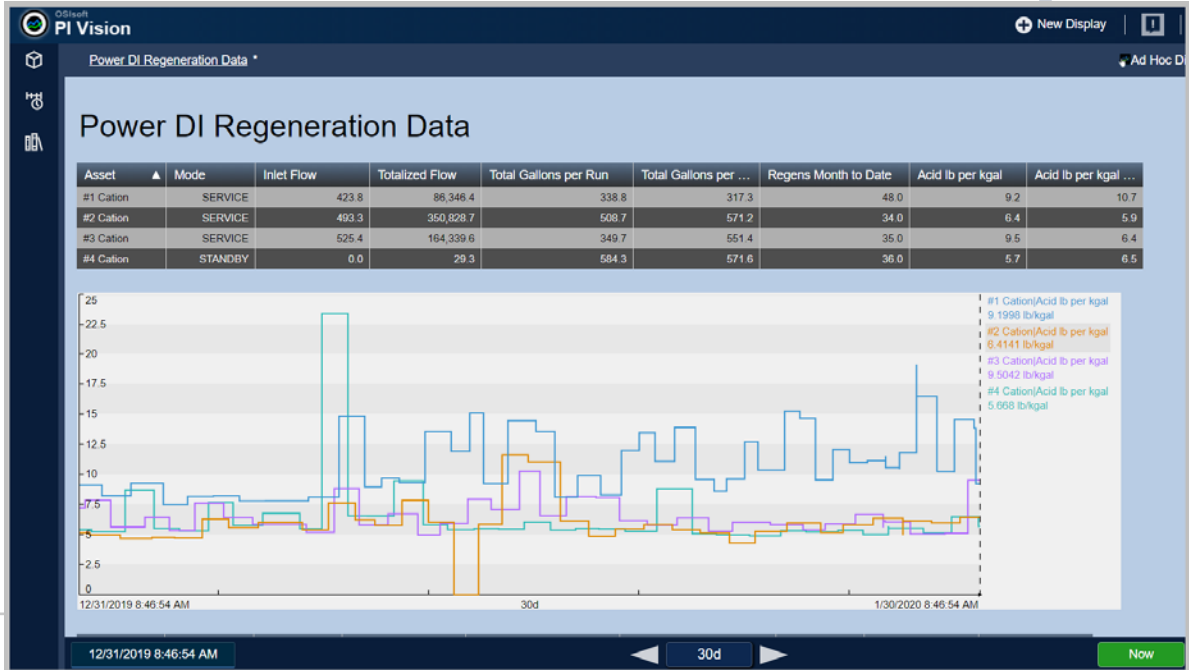
PI Asset Framework				
Milestone Description	Assigned To	Progress	PI Sort Start	PI Sort Complete
Covington			21-Jan	30-May
Bleach Plant		100%		
Chemical Recovery		100%		
Paper Mill		100%		
Pulp Mill		100%		
Utilities		100%		
Woodyard		100%		
WTP		100%		



Summary and Path Forward



Continue to standardize visualizations

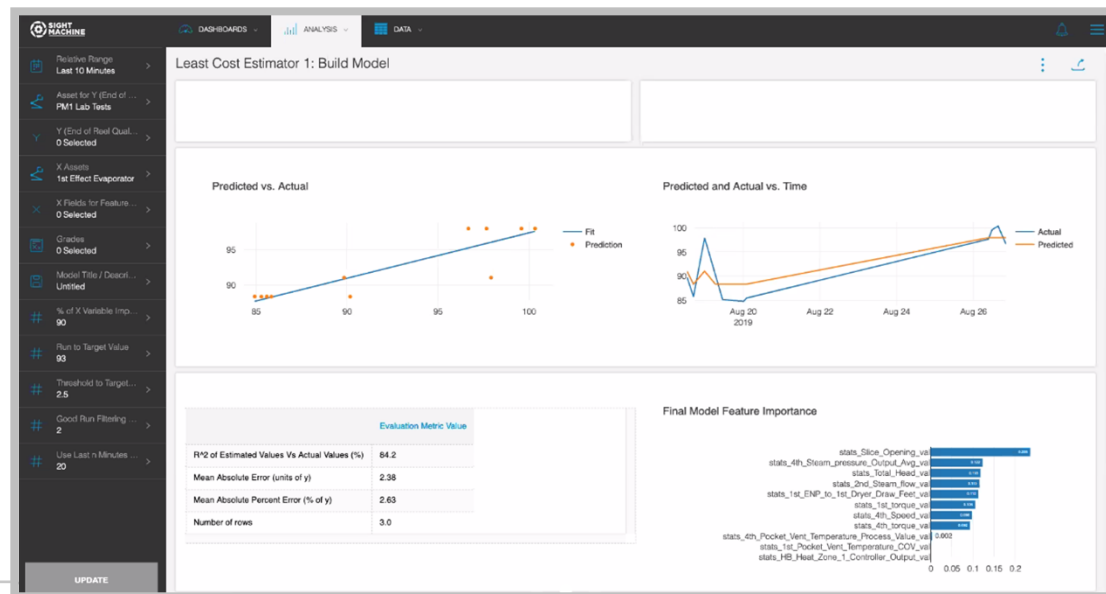




Summary and Path Forward



Continue to develop new analytics and custom tools



Mill Analytics



CHALLENGES

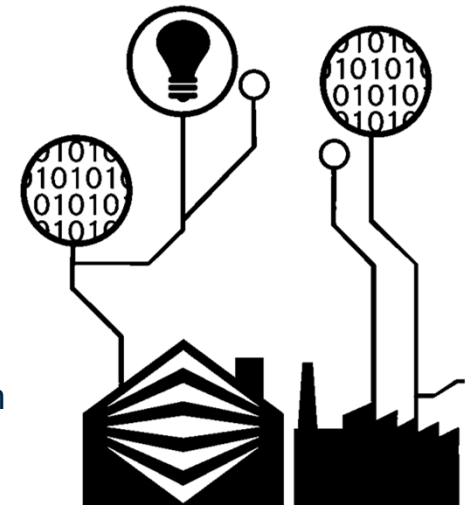
- Too much time spent analyzing data
- Disparate data systems
- Pertinent decision-making data not easily available

SOLUTION

Using PI AF and Sight Machine, we have mapped over 200k PI tags across the enterprise and streamed it to a single analytical platform

BENEFITS

- Slow and repetitive Excel analyses streamlined in PI AF
- Actionable insights provided through standardized dashboards
- 500+ manhours/month saved per facility



Our focus was to standardize our data across multiple core mill systems to create a common set of tools that we could scale across our enterprise mill network to drive immediate visibility to actionable data, rapid root cause problem analysis and predictive insights that were not previously available.



- Mark Miller, VP IT Transformation & Mills, WestRock

Speaker Information



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Questions?

Please wait for
the **microphone**



State your
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