

AVEVA PI WORLD

OPE (Overall Process Effectiveness) analytics for better performance intelligence

Optional Subtitle

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OPE (Overall Process Effectiveness) analytics for better performance intelligence

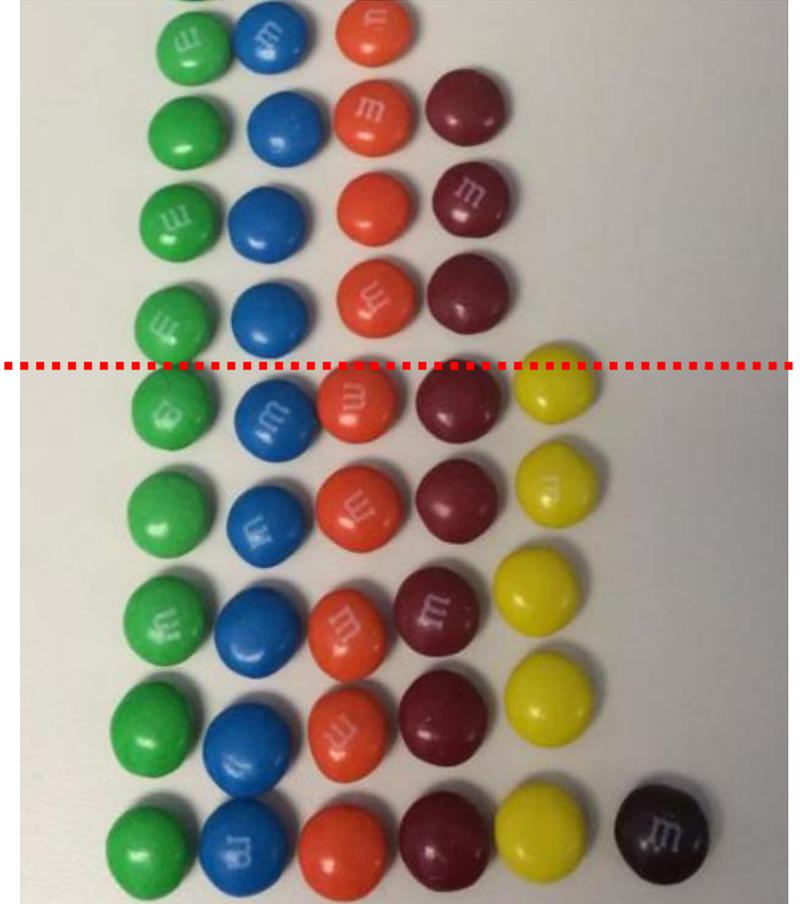
The Ecolab Clearing Plant outside Chicago, IL had plenty of sensor data but they were not structured for OPE (overall process effectiveness) or OEE (overall equipment effectiveness) analysis.

Join us for this session as we walk through how we used the PI System's function primitives and other AF/EF capabilities for data modeling and then applied the manufacturing context to raw sensor (time-series) measurements and lab quality data to prepare for OPE diagnostics. This upfront data engineering also proved to be critical for PI Vision and BI (business intelligence) displays for visual analytics.

Lastly, we will discuss the insights and business benefits we have seen so far, including the next phase in this ongoing work to incorporate machine learning (ML) for additional analytics.

Problem Statement

Munchies for the band (Van Halen) in their dressing room...



IT vis-à-vis Process Engineer

IT

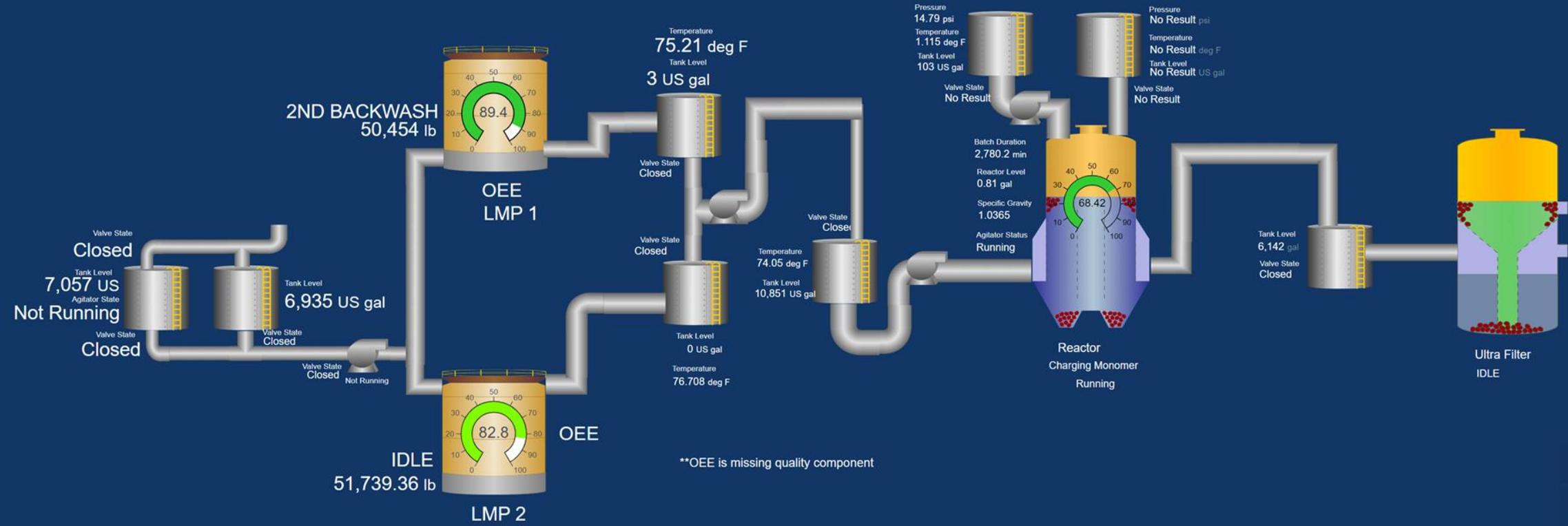
... Just give me all the data, let's put it in a data lake and we'll figure it out...

Process Engineer

... Let's decompose the problem into smaller chunks – do a first-cut analysis with tools and resources we already have...

PI World * Asset: [Asset Name]

[Navigation Icons: Home, Refresh, Copy, Paste, Delete, Zoom, Pan, Text, Help]



**OEE is missing quality component

8/14/2021 11:33:24 AM



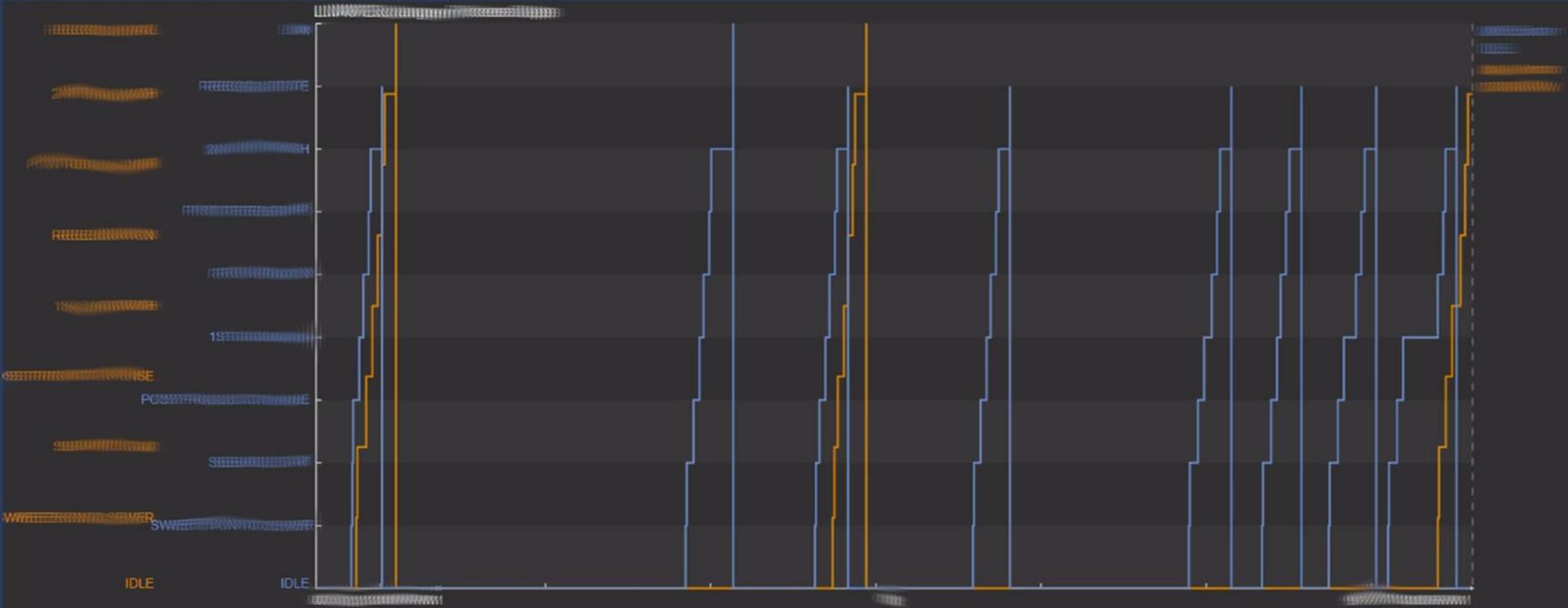
1d

Now

8/15/2021 11:33:24 AM



Asset: [Dropdown menu]



Now

9/1/2021 2:40:06 PM



PI System Explorer

File Search View Go Tools Help

Database Query Date Back Check In Refresh New Element

Elements

- Elements
 - CCIX
 - Ecolab Supply Chain
 - Production Data
 - Reactor
 - Reactor
 - Reactor
 - Reactors
 - Ultrafilter
 - Ultrafilter
 - Ultrafilter
 - Ultrafilters
 - zzz.GlobalConfiguration
- Element Searches

Elements

Search

Name	Description
Ecolab Supply Chain	
zzz.GlobalConfiguration	

File Search View Go Tools Help

Database Query Date Back Check In Refresh New Element New Attribute Search Elements

Elements

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UF7

General Child Elements Attributes Ports Analyses Notification Rules Version

Excluded attributes are hidden.

Filter

Name	Value
Idle Trigger: Between Batches_IdleTrigger	1
Lowest Output Last 7 Days	34554 kg
MIN	Scan Off
Naming Prefix	BP.NAG.Grow.UF7.UF7.
OEE	5.4198 %
OPE	100 %
Permeability	0
Permeate Specific Gravity	1
Pressure: Before Bag Filter	psig
Pressure: UF Inlet	psig
Pressure: UF Outlet	psig
Process Step	Idle
Pump: UF	Not Running
Retentate Specific Gravity	1
Run Time (Control Screen)	0

Group by: Category Template

Name: AVG Cycle time loss Per Batch (

Description:

Properties: <None>

Categories: Work in Progress

Default UOM: minute

Value Type: Single

Value: 96.113 min

Display Digits: -5

Data Reference: PI Point

Settings...

Limits Forecasts

Filter

Name	[49.08:00:30.6...	Duration	Start Time	End ...	Descri...	Categ...	Severity	Template
Reactor Producing			8/30/2021 4:29:35.063 PM	8/30...			None	Downtime Loss Event
Reactor Hold Time 8/30/2021 10:14:32 PM			8/30/2021 5:14:32.061 PM	8/30...			None	Process Step Duration
Reactor Grow Template 8/30/2021 10:14:34 PM			8/30/2021 5:14:34.061 PM	8/30...			None	Process Step Duration
Reactor Ready to Pump Out Batch 8/30/2021 11:16:54 PM			8/30/2021 6:16:54.075 PM	8/30...			None	Process Step Duration
Reactor 8/30/2021 11:18:23 PM			8/30/2021 6:18:23.075 PM	8/30...			None	Process Step Duration
Reactor Idle 8/30/2021 11:20:52 PM			8/30/2021 6:20:52.075 PM				None	Process Step Duration
Reactor Not Identified: Midprocess		0:04:37.997	8/30/2021 6:20:52.075 PM	8/30...			None	Downtime Loss Event
Reactor Not Identified: Between Batches		1:13:46:34.332	8/30/2021 6:25:30.072 PM	9/1/...			None	Downtime Loss Event
Daily Aggregated Values of Performance 2021-08-31 00:00:00.000			8/30/2021 7:00:00 PM	8/31...	This E...		None	Daily Aggregated Values o...
Reactor			8/30/2021 7:00:00 PM	8/31...	Daily ...		None	Daily Aggregated values o...
Reactor Waiting Loss: Tank is Empty		0:07:42	9/1/2021 8:12:04.404 AM	9/1/...			None	Downtime Loss Event
Reactor Not Identified: Between Batches		0:00:03	9/1/2021 8:19:46.404 AM	9/1/...			None	Downtime Loss Event
Reactor Waiting Loss: Tank is Empty		0:01:41	9/1/2021 8:19:49.404 AM	9/1/...			None	Downtime Loss Event
Reactor Not Identified: Between Batches		0:00:15	9/1/2021 8:21:30.404 AM	9/1/...			None	Downtime Loss Event
Reactor Waiting Loss: Tank is Empty		0:00:37	9/1/2021 8:21:45.404 AM	9/1/...			None	Downtime Loss Event
Reactor Not Identified: Between Batches		6:03:02.075	9/1/2021 8:22:22.404 AM				None	Downtime Loss Event

Filter

Name	[10.21:48:37.4...	Duration	Start Time	- End ...	Descri...	Categ...	Severity	Template	Primary EK
Not Identified Midprocess		0:00:11	9/1/2021 1:16:31.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:03:54	9/1/2021 1:16:42.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:03	9/1/2021 1:20:36.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:00:32	9/1/2021 1:20:39.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:03	9/1/2021 1:21:11.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:03:40	9/1/2021 1:21:14.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:05	9/1/2021 1:24:54.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:06:50	9/1/2021 1:24:59.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:12	9/1/2021 1:31:49.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:00:44	9/1/2021 1:32:01.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:09	9/1/2021 1:32:45.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:00:30	9/1/2021 1:32:54.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:30	9/1/2021 1:33:24.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:14:33.999	9/1/2021 1:33:54.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:09	9/1/2021 1:48:28.033 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:06:56	9/1/2021 1:48:37.033 PM	9/1/...			None	Downtime Loss Event	

File Search View Go Tools Help

Database Query Date Back Check In Refresh New Element Search Elements

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UF7

General Child Elements Attributes Ports Analyses Notification Rules Version

Name: Average and Time Based Calculation

Description: This is used to calculate Averages and ___ day based calculations, such as av

Categories:

Analysis Type: Expression Rollup Event Frame Generation SQC

Name	Expression	Output Attribute
OEEArray	RecordedValues('OEE', '-3d')	Map
AVGOEE_LAST_3_DAYS	Total(OEE_Array)/ArrayLeng	AVG OEE Last 3 Days
OPEArray	RecordedValues('OPE', '-3d')	Map
AVGOPE_LAST_3_DAYS	Total(OPE_Array)/ArrayLeng	AVG OPE Last 3 Days
Arrayof_output_3days	RecordedValues('UF Concent	Map
TotalOutput_3Days	Total(Array_of_output_3day	Total Output Last 3 Days
LowesetOuput_7Days	TagMin('UF Concentration_F	Lowest Output Last 7 Days
CTLArray	RecordedValues('Ultrafilte	Map
AVGCTL_Last_3_DAYS	Total(CTLArray)/ArrayLengt	AVG Cycle time loss Per Batch (Last 7 Days)
Variable1	//recor	Map

Scheduling: Event-Triggered Periodic

Run every day at 5:05 AM

Connected to the PI Analysis Service.



LINKS



EXECUTIVES

PLANT ENGG

OPERATORS

GENERAL

All Unit Operations

All Unit Operations

All Unit Operation Visibility

UO Display - Control Room



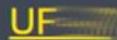
> DOWNTIME



> CYCLE TIME

> DOWNTIME

> OUTPUT



> CYCLE TIME

> OUTPUT



Information



8/1/2021 2:33:21 PM



31d



Now

9/1/2021 2:33:21 PM

Reactor Operator Asset: [Progress Bar]

REACTOR

BREAKDOWN OF PUMPS

- Recycle Pump Breakdown - Func
- Cofeed Pump Breakdown - Func
- Overflow Pump Breakdown - Func

REACTOR DOWNTIME EVENTS

Event Name	Start Time
Reactor Not Identified: Between Batches	9/1/2021 8:22:2
Reactor Waiting Loss: Tank 350 is Empty	9/1/2021 8:21:4
Reactor Not Identified: Between Batches	9/1/2021 8:21:3
Reactor Waiting Loss: Tank 350 is Empty	9/1/2021 8:19:4
Reactor Not Identified: Between Batches	9/1/2021 8:19:4
Reactor Waiting Loss: Tank 350 is Empty	9/1/2021 8:12:04 AM

Reason Code Editor

Reactor Not Identified: Midprocess

- Breakdown - Pipe
- Breakdown - Valve
- Lack of Personnel - Meeting/Training
- Lack of Personnel - Other
- Lack of Personnel - Shift Change/Break
- Lack of Personnel - Vacation/Holiday/Illness
- Planned Downtime - Holiday
- Planned Downtime - No Orders
- Planned Maintenance
- Set up Time - Raw Materials
- Waiting Loss - QA
- Waiting Loss - Raw Materials from Supplier
- Waiting Loss - Supervisor/Engineering
- Waiting Loss - Utilities
- Waiting Loss - Weather

Clear Apply Cancel

7
352

Cycle Time Batch Duration
min

Retentate Specific Gravity
1.0000



Not Identified Loss
519
hrs

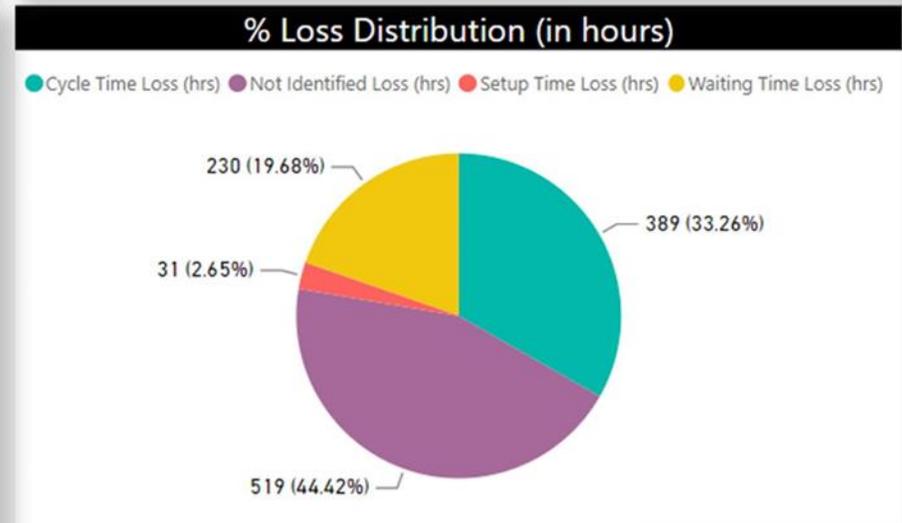
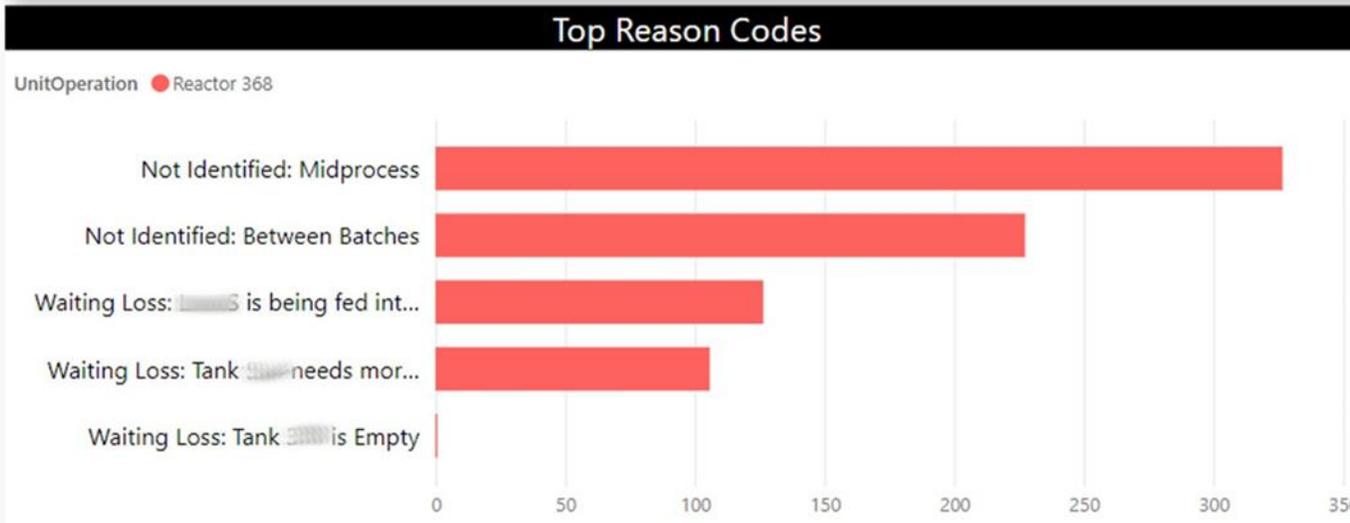
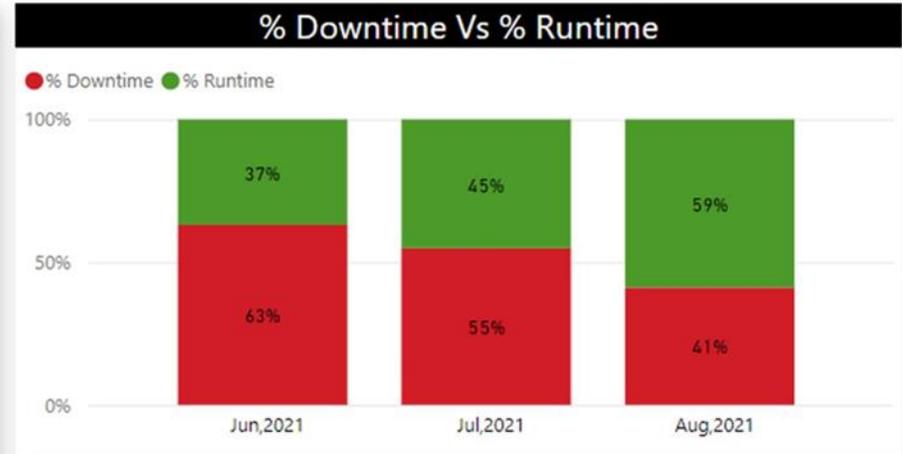
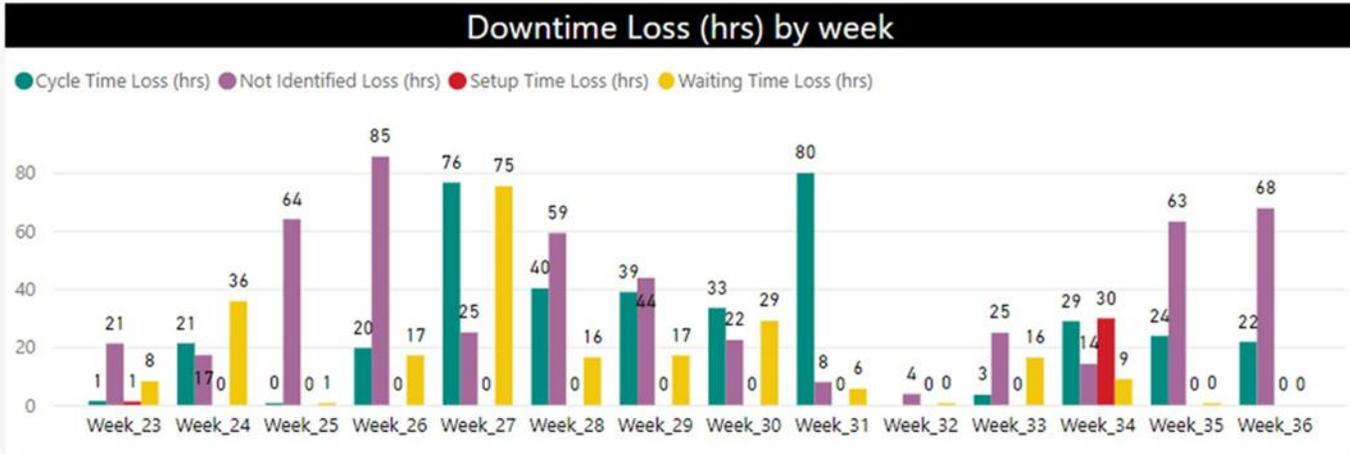
Waiting Loss
230
hrs

Set Up Time Loss
31
hrs

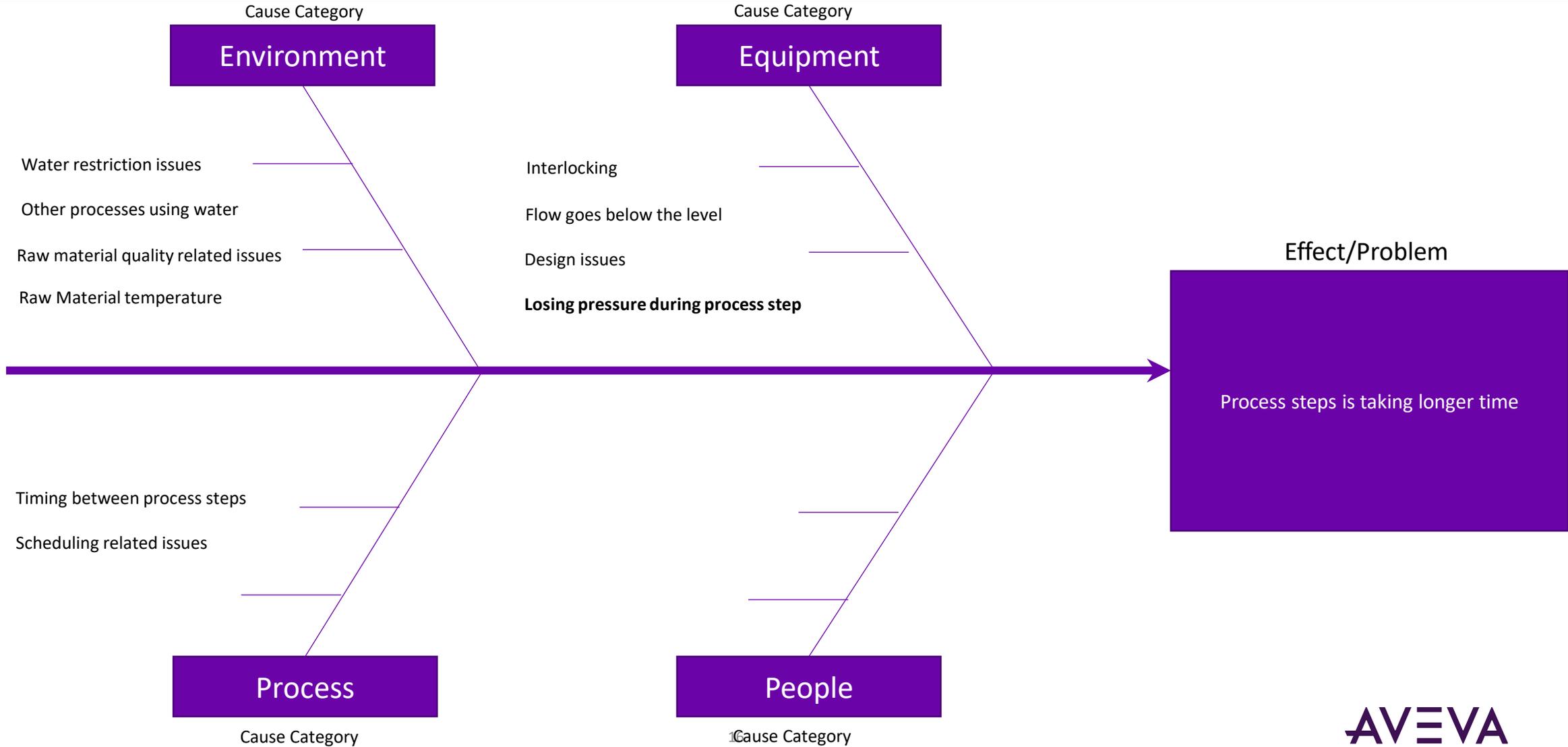
Cycle Time Loss
389
hrs

Unit Operation
Reactor 368

Last 3 Months (...)
6/1/2021 - 8/31/2021



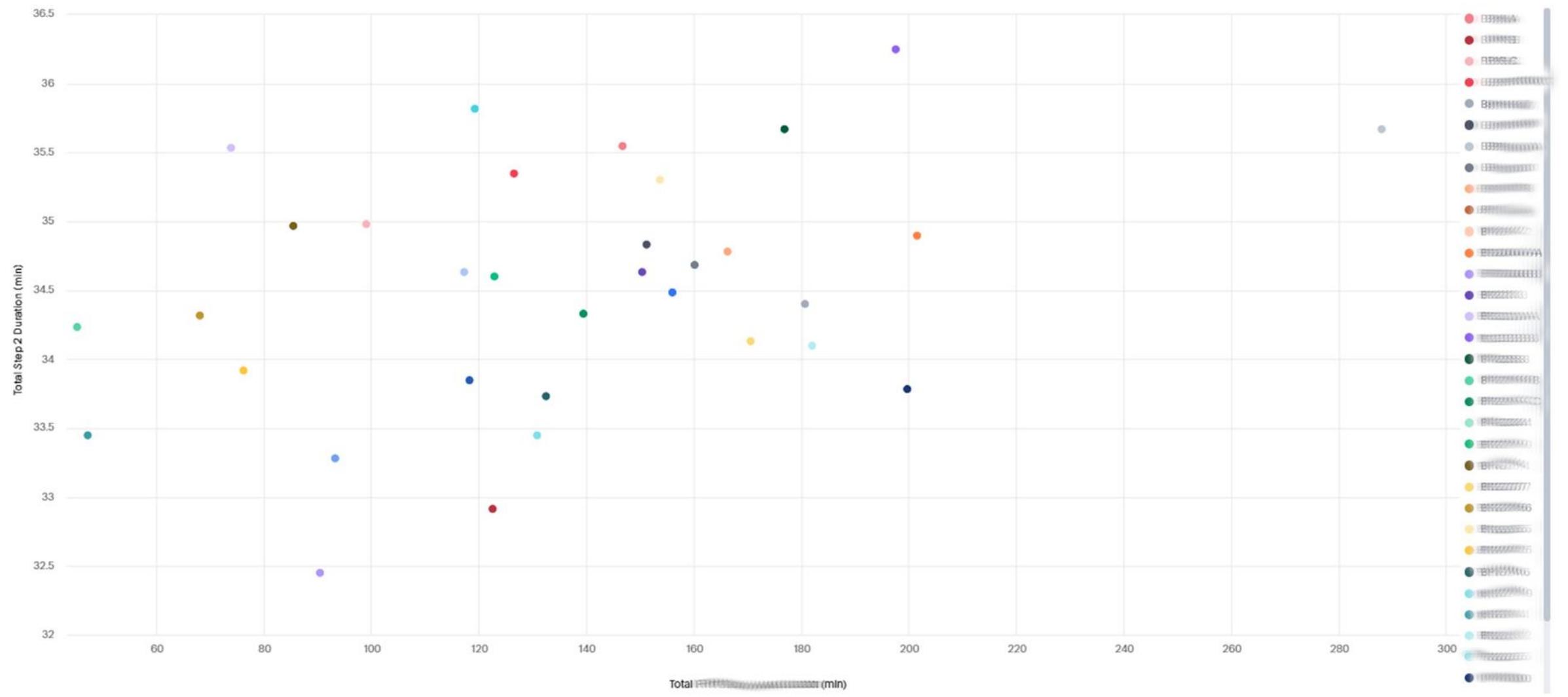
Cause and Effect



Total Step 2 Duration (min) by (min) and Batch ID



mm... > 41



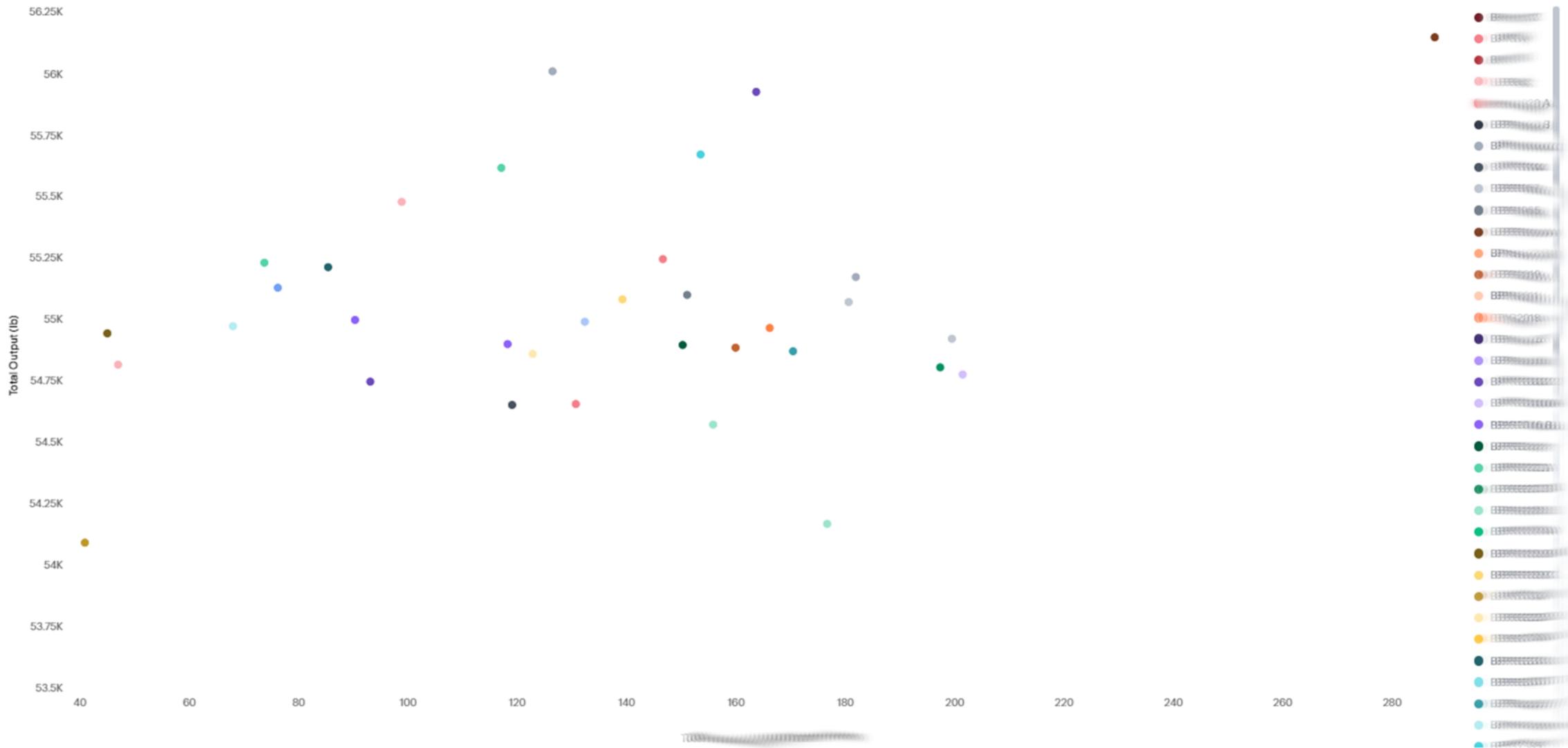


wash dura

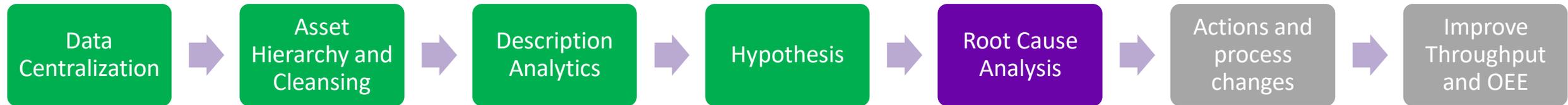
batch id

output (lb)

Total Output (lb) by Total (min) and Batch ID



Our Journey



Takeaways

- Fit-for-Purpose analytics - Engineered vis-à-vis AI/ML
- Ratio : Count of Engineered analytics to AI/ML analytics
- [PI Dev Club FAQ](#) (PI sandbox environment)

Other Resources

[lessons-of-simplicity-in-iiot-analytics-for-operations-and-maintenance-om](#) (blog – 10-minute read)

[Analytics for industrial sensor data in the PI System](#) (3-part series, recording and slides)

[Layered approach to maintenance/reliability](#) (blog + workshop intro)

[Industrial IoT time-series data engineering - a layered approach to data quality](#) (blog + workshop intro + recording)

[PI System 101](#) (webinar recording – 1 hour)

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AVEVA, a global leader in industrial software, drives digital transformation for industrial organizations managing complex operational processes. Through Performance Intelligence, AVEVA connects the power of information and artificial intelligence (AI) with human insight, to enable faster and more precise decision making, helping industries to boost operational delivery and sustainability. Our cloud-enabled data platform, combined with software that spans design, engineering and operations, asset performance, monitoring and control solutions delivers proven business value and outcomes to over 20,000 customers worldwide, supported by the largest industrial software ecosystem, including 5,500 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 6,000 employees at 90 locations in more than 40 countries. For more details visit: www.aveva.com