

# ASSET PERFORMANCE (CNC) MACHINES INSIGHTS

1

**SPINDLE DATA  
ANALYTICS**

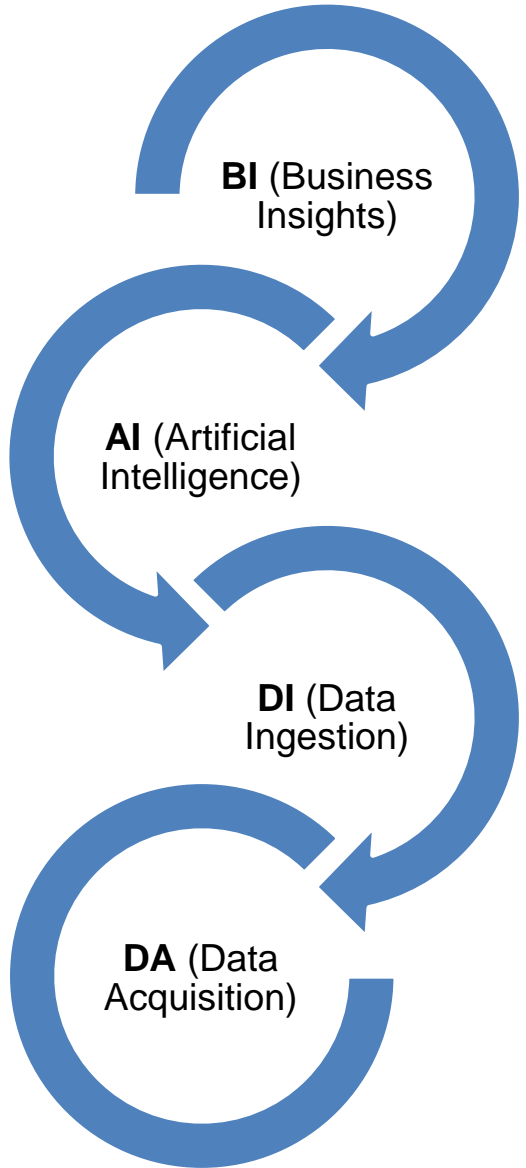
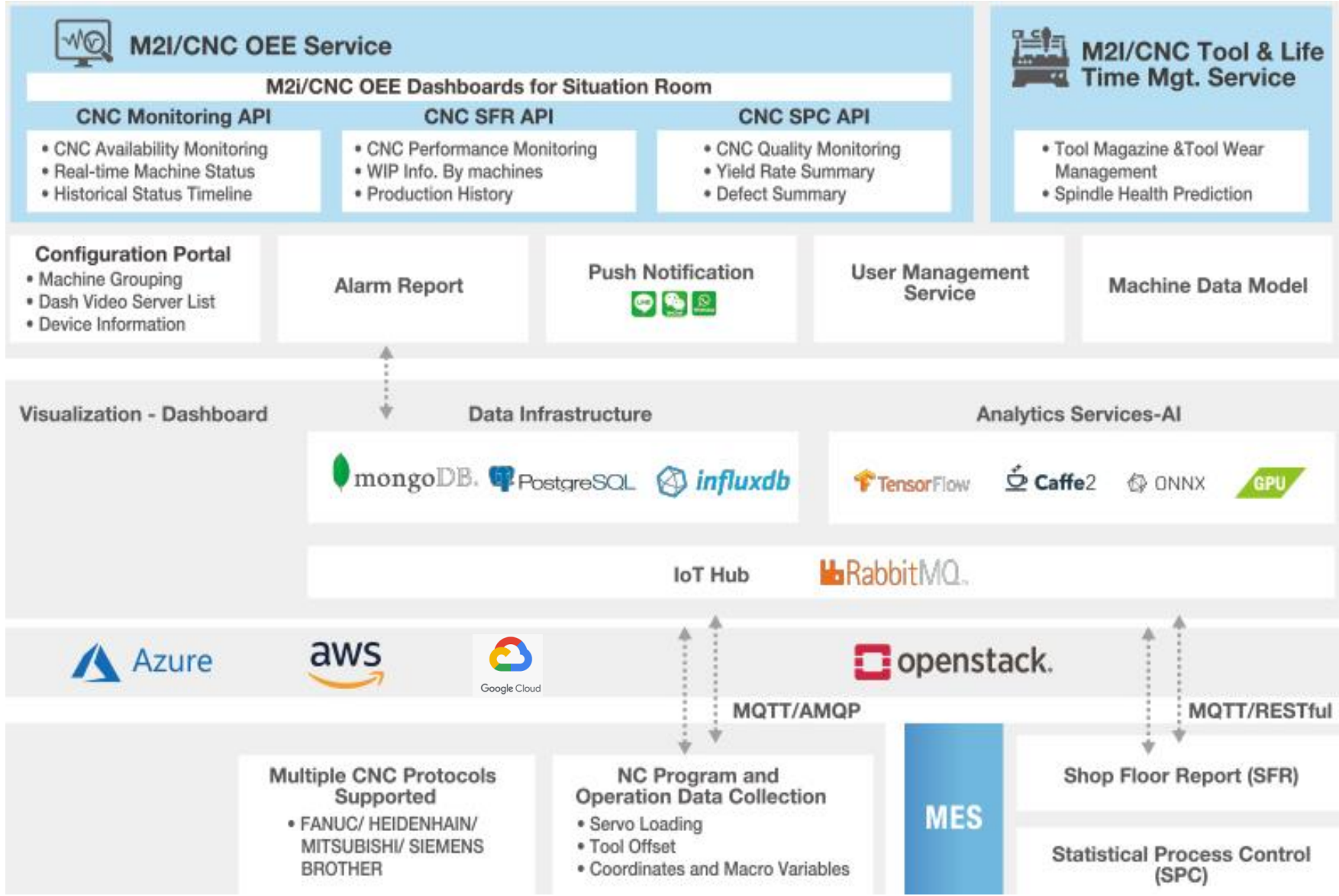
2

**TOOL CONDITION  
PREDICTION**

3

**MACHINE  
PERFORMANCE  
ANALYSIS**

# CNC MACHINE INSIGHTS AS A SERVICE



# CNC DATA MODEL

## X-axis

- X1\_ActualPosition: actual x position of part (mm)
- X1\_ActualVelocity: actual x velocity of part (mm/s)
- X1\_ActualAcceleration: actual x acceleration of part (mm/s/s)
- X1\_CommandPosition: reference x position of part (mm)
- X1\_CommandVelocity: reference x velocity of part (mm/s)
- X1\_CommandAcceleration: reference x acceleration of part (mm/s/s)
- X1\_CurrentFeedback: current (A)
- X1\_DCBusVoltage: voltage (V)
- X1\_OutputCurrent: current (A)
- X1\_OutputVoltage: voltage (V)
- X1\_OutputPower: power (kW)

## Y-axis

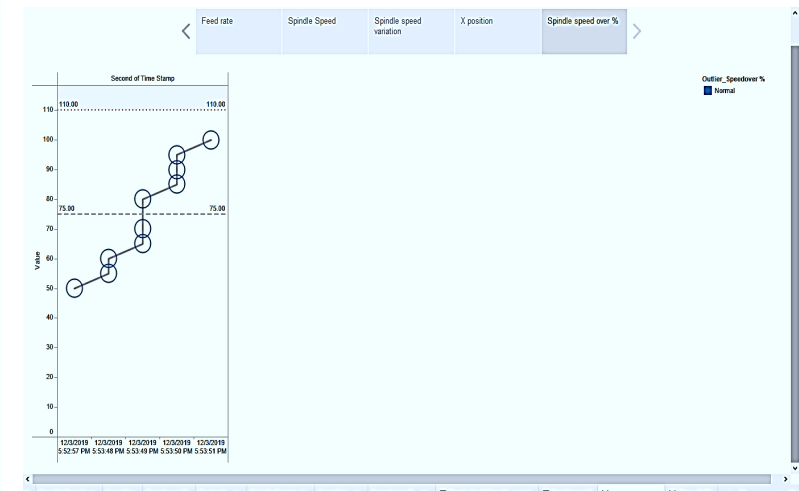
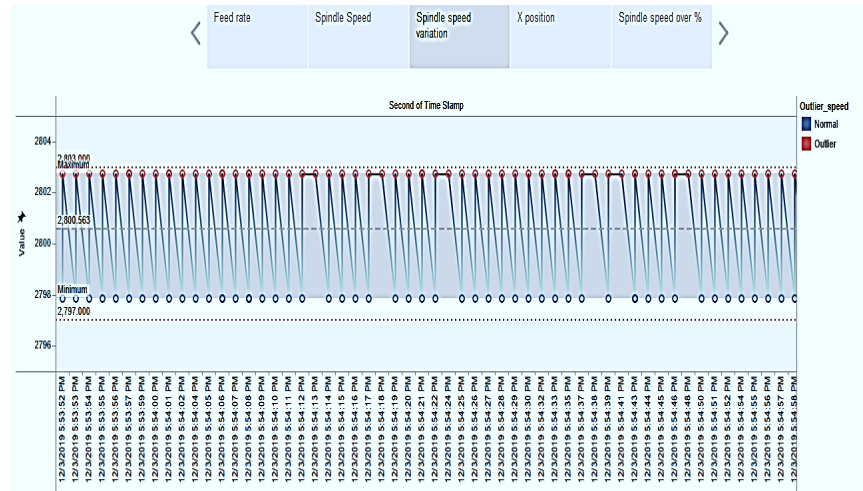
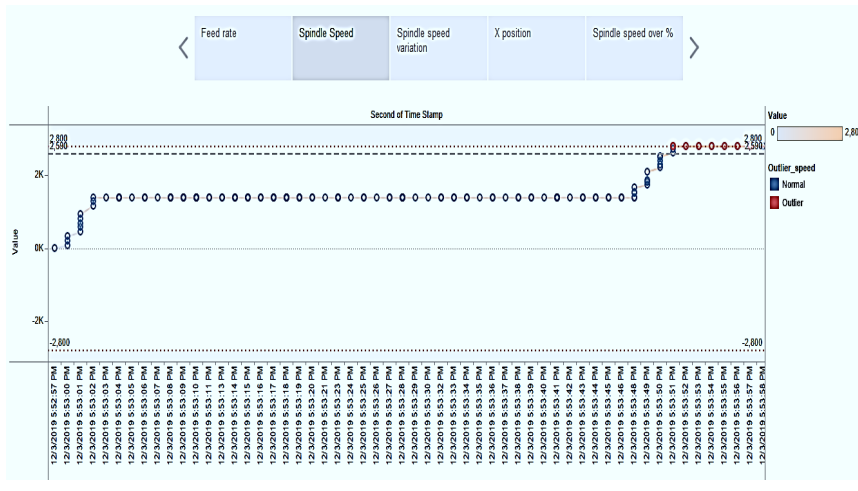
- Y1\_ActualPosition: actual y position of part (mm)
- Y1\_ActualVelocity: actual y velocity of part (mm/s)
- Y1\_ActualAcceleration: actual y acceleration of part (mm/s/s)
- Y1\_CommandPosition: reference y position of part (mm)
- Y1\_CommandVelocity: reference y velocity of part (mm/s)
- Y1\_CommandAcceleration: reference y acceleration of part (mm/s/s)
- Y1\_CurrentFeedback: current (A)
- Y1\_DCBusVoltage: voltage (V)
- Y1\_OutputCurrent: current (A)
- Y1\_OutputVoltage: voltage (V)
- Y1\_OutputPower: power (kW)

## Z-axis

- Z1\_ActualPosition: actual z position of part (mm)
- Z1\_ActualVelocity: actual z velocity of part (mm/s)
- Z1\_ActualAcceleration: actual z acceleration of part (mm/s/s)
- Z1\_CommandPosition: reference z position of part (mm)
- Z1\_CommandVelocity: reference z velocity of part (mm/s)
- Z1\_CommandAcceleration: reference z acceleration of part (mm/s/s)
- Z1\_CurrentFeedback: current (A)
- Z1\_DCBusVoltage: voltage (V)
- Z1\_OutputCurrent: current (A)
- Z1\_OutputVoltage: voltage (V)

## Spindle

- S1\_ActualPosition: actual position of spindle (mm)
- S1\_ActualVelocity: actual velocity of spindle (mm/s)
- S1\_ActualAcceleration: actual acceleration of spindle (mm/s/s)
- S1\_CommandPosition: reference position of spindle (mm)
- S1\_CommandVelocity: reference velocity of spindle (mm/s)
- S1\_CommandAcceleration: reference acceleration of spindle (mm/s/s)
- S1\_CurrentFeedback: current (A)
- S1\_DCBusVoltage: voltage (V)
- S1\_OutputCurrent: current (A)
- S1\_OutputVoltage: voltage (V)
- S1\_OutputPower: current (A)
- S1\_SystemInertia: torque inertia (kg\*m<sup>2</sup>)

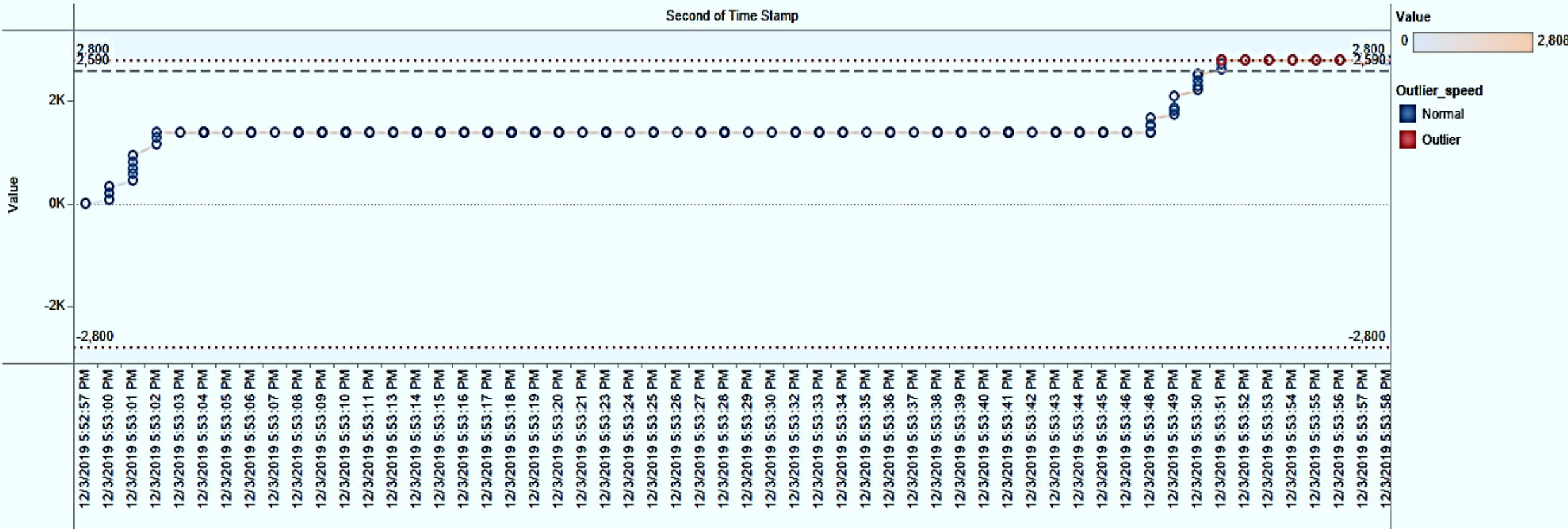


# PRODUCTIVITY - CNC MACHINE'S PERFORMANCE METRICS

- Spindle, Hydraulic, and Lubrication Analysis are showcased as part of the machine performance monitoring dashboard
- CNC Machine Failure Prediction with What-If Models; A&Es (Alerts & Events) Analysis for shutdowns
- Support for Energy losses analytics

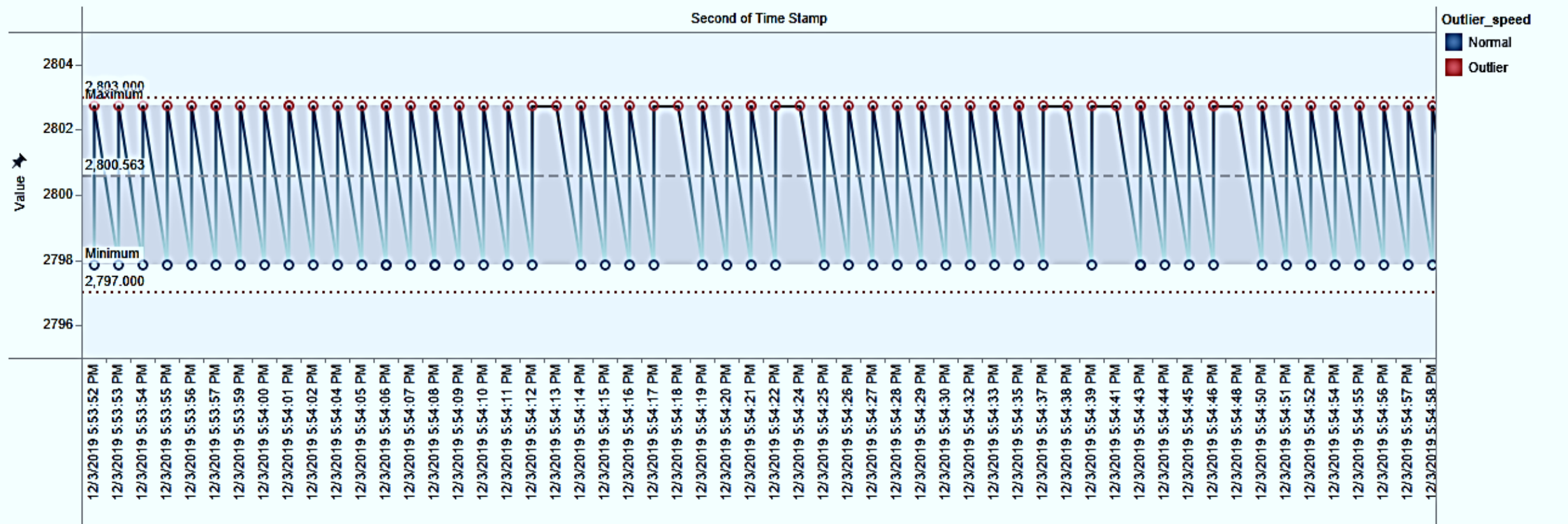
# SPINDLE SPEED ANALYSIS 1

Navigation tabs: Feed rate, Spindle Speed, Spindle speed variation, X position, Spindle speed over %



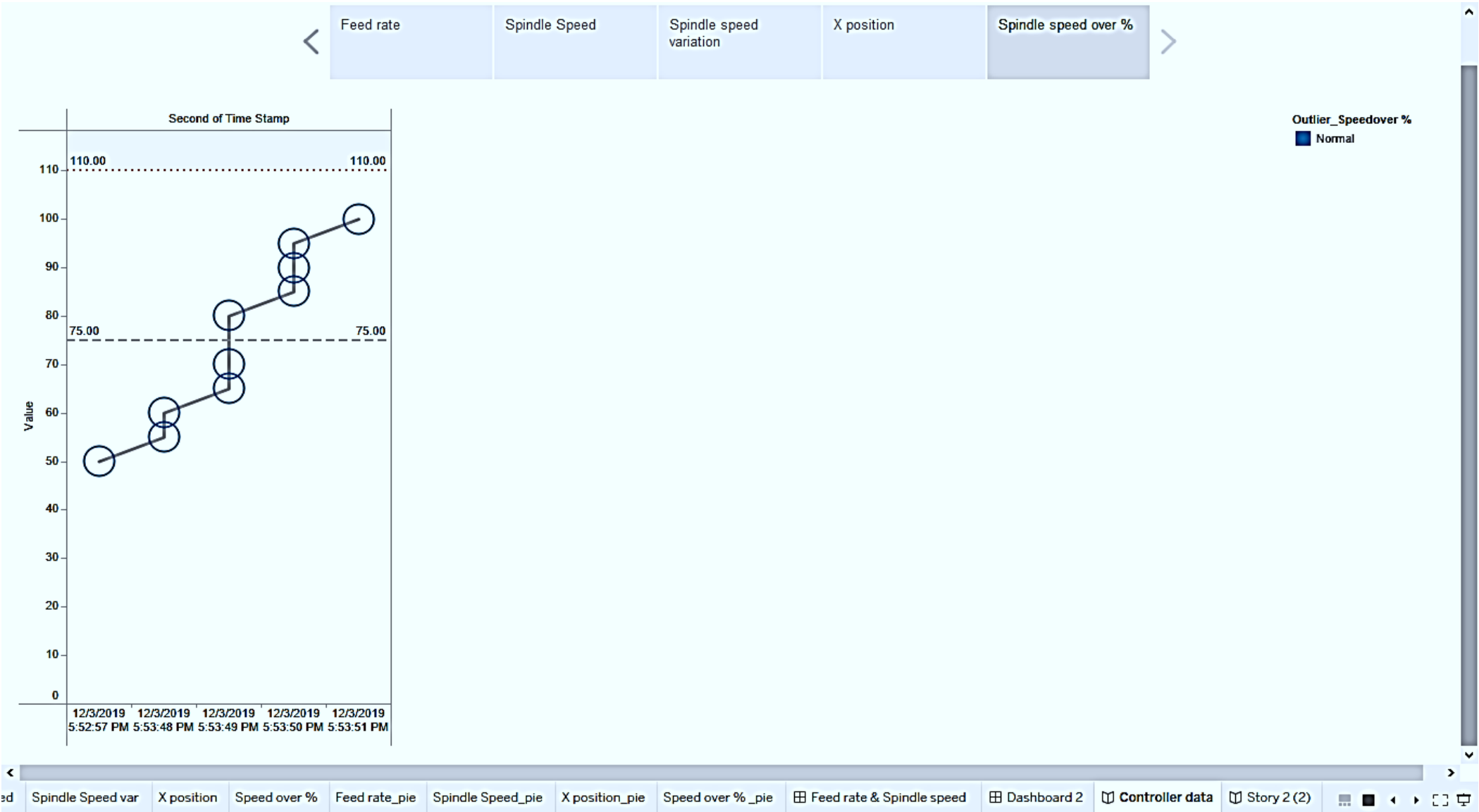
# SPINDLE SPEED VARIATION ANALYSIS

Navigation tabs: Feed rate, Spindle Speed, Spindle speed variation (selected), X position, Spindle speed over %



# SPINDLE SPEED OVER % ANALYSIS

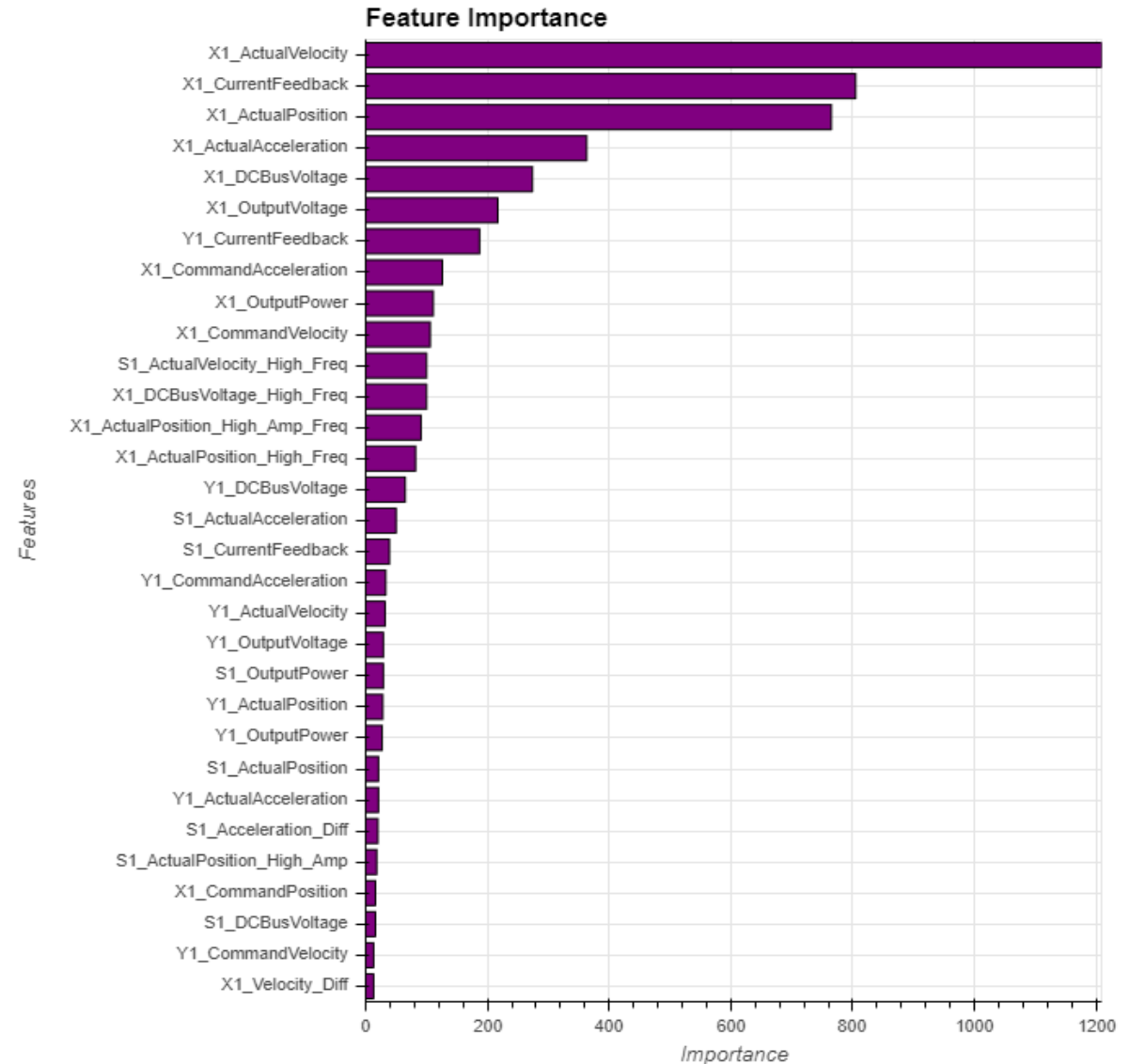
1



# FEATURES FOR TOOL CONDITION

2

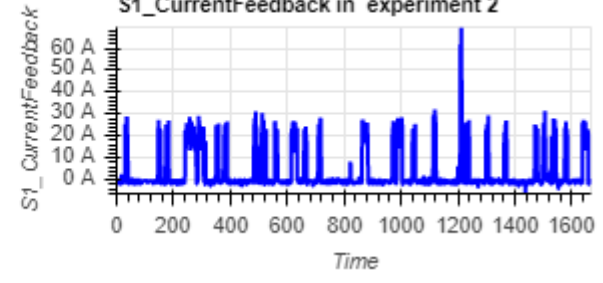
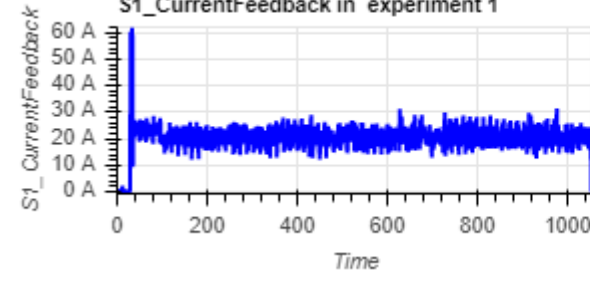
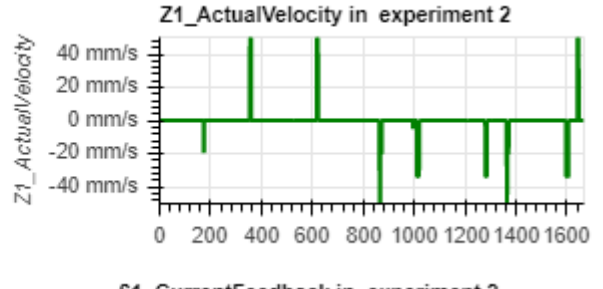
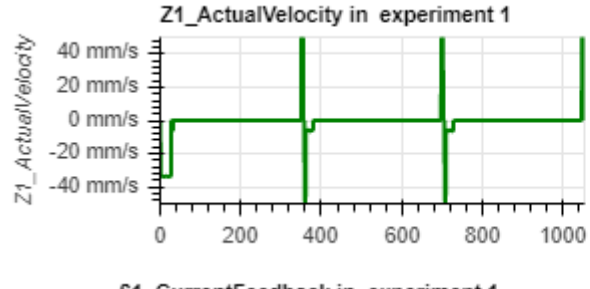
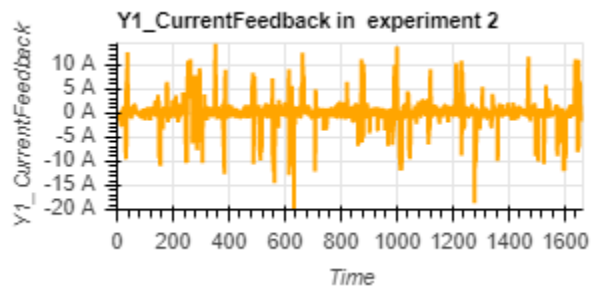
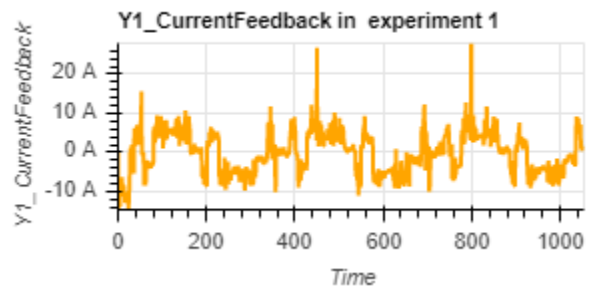
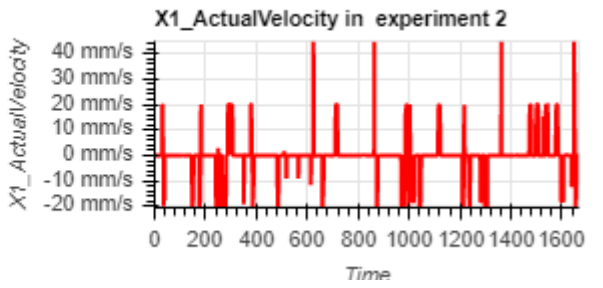
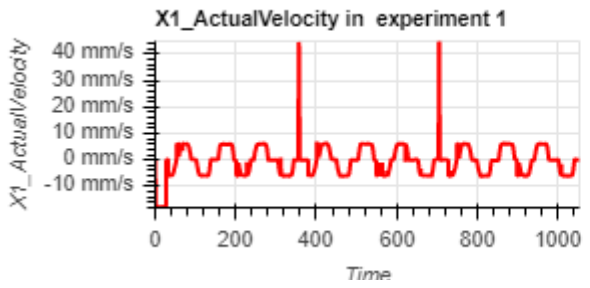
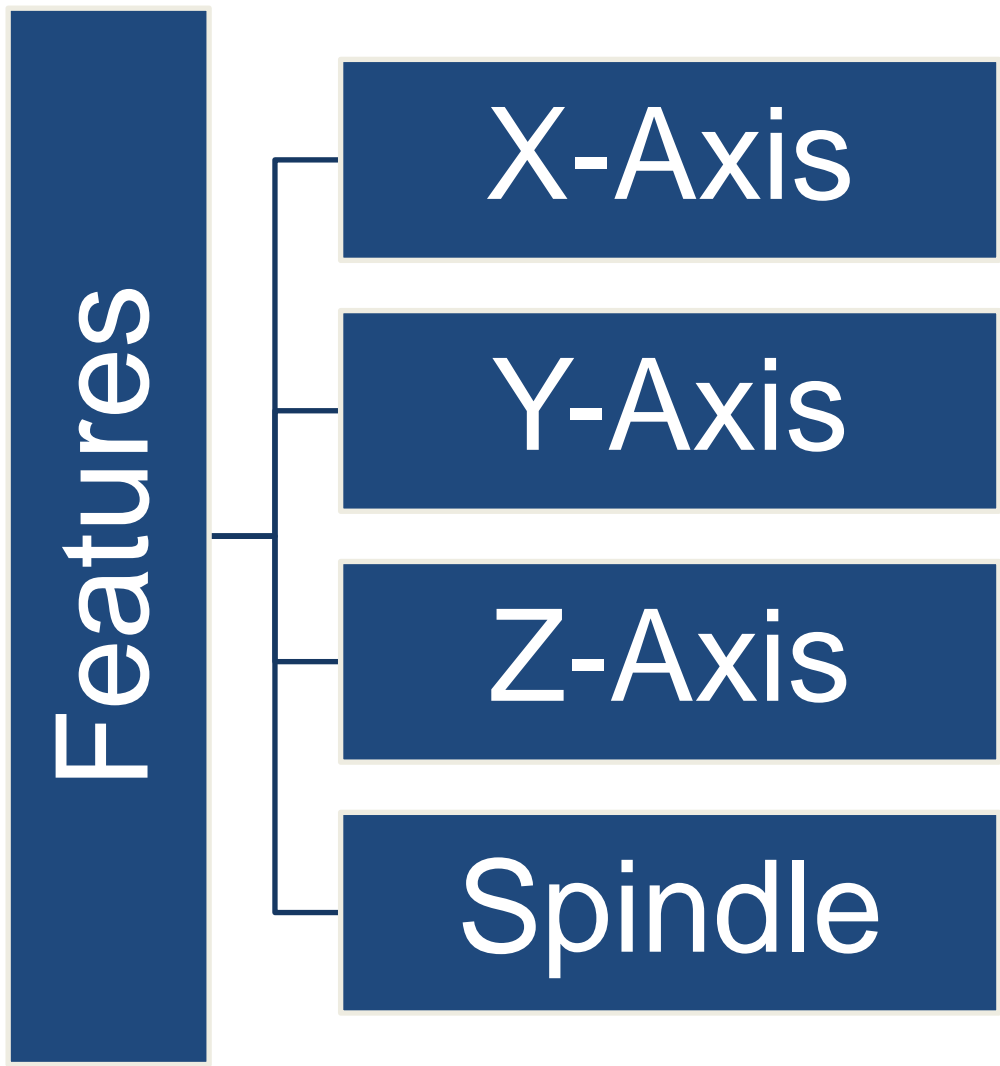
1. Speeds (RPMs, rotary velocity, spindle speed)
2. Feed rate
3. Loads & positions of tools on each individual axis
4. Machine status (active, inactive) and part count increments
5. Other control metrics that come off a machine that must be there anyway for the machine to run



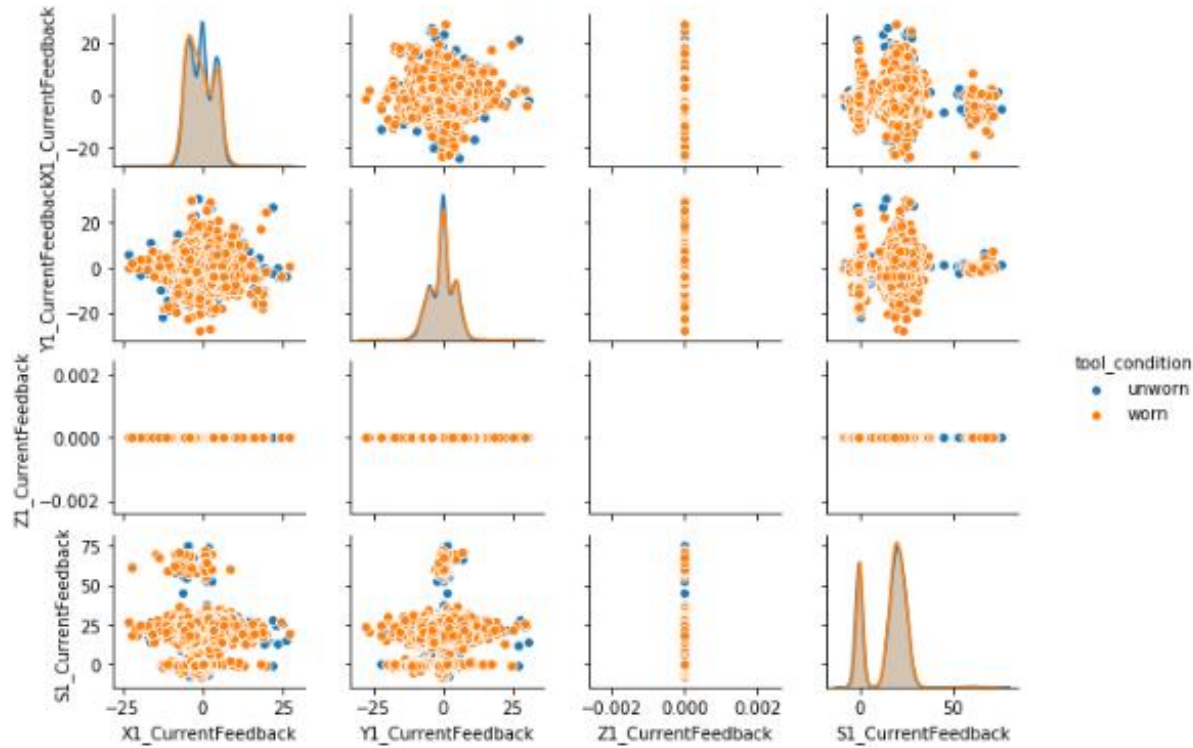


# PREDICT TOOL CONDITION

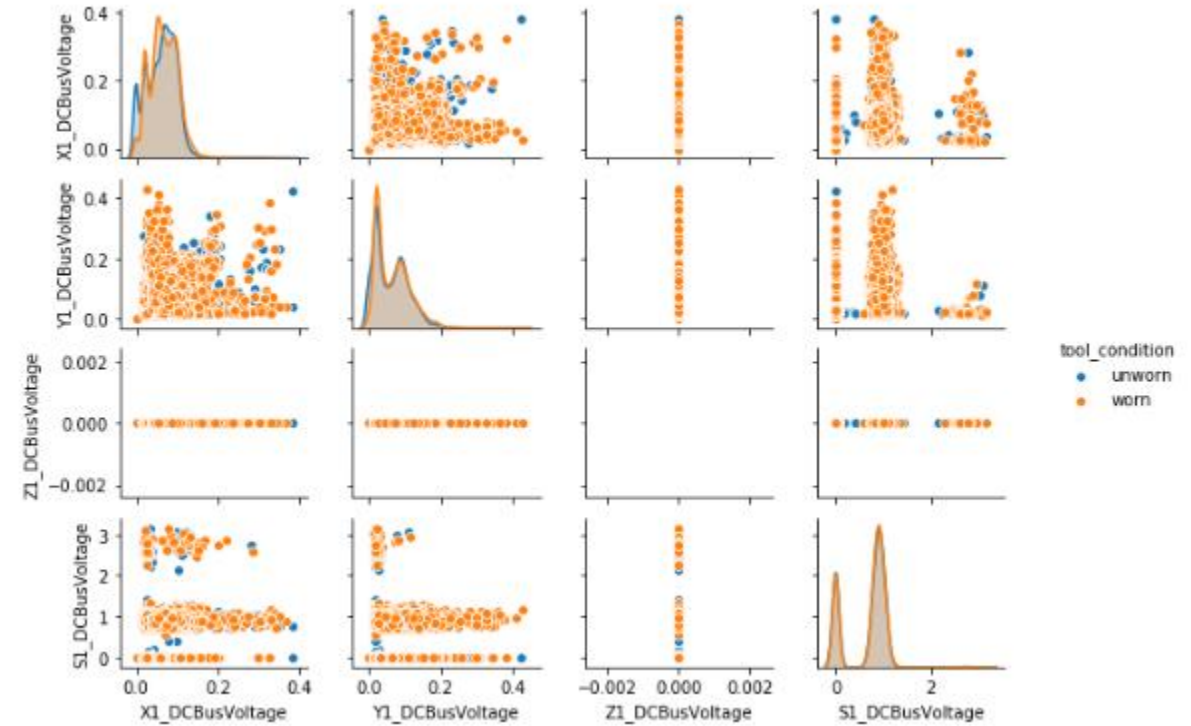
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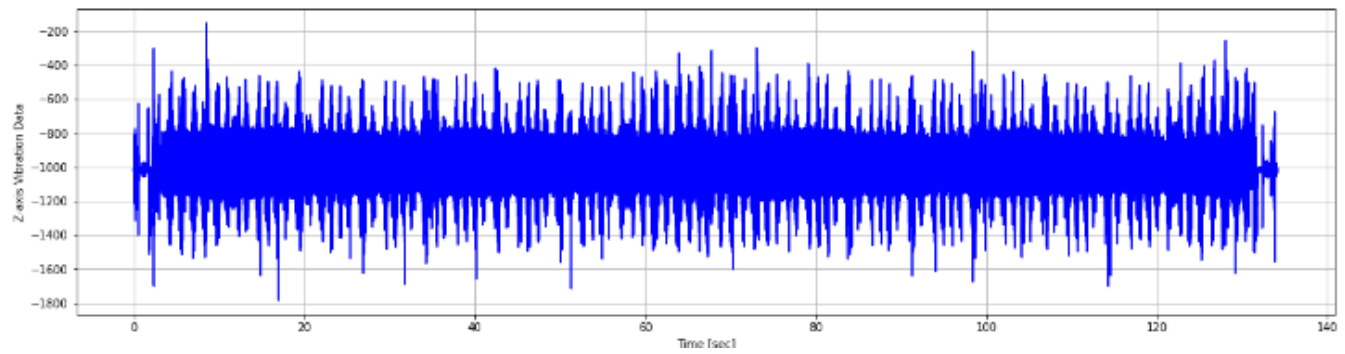
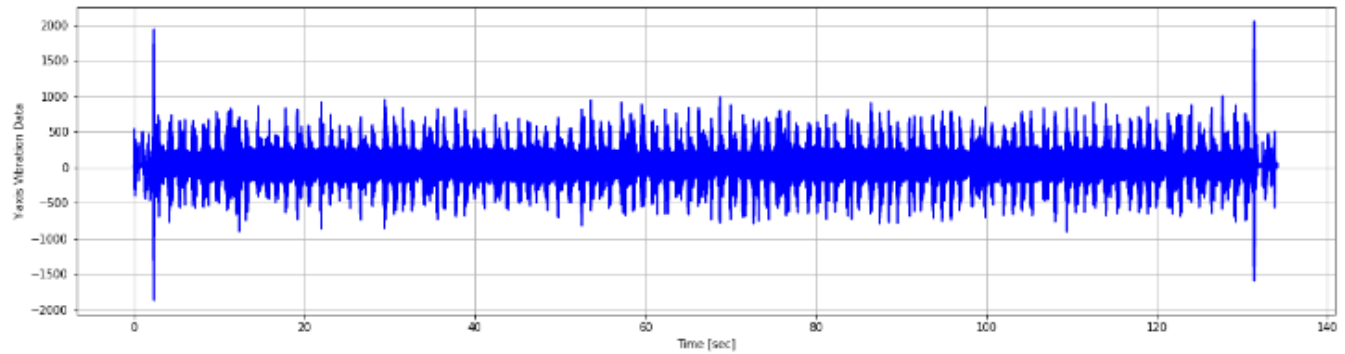
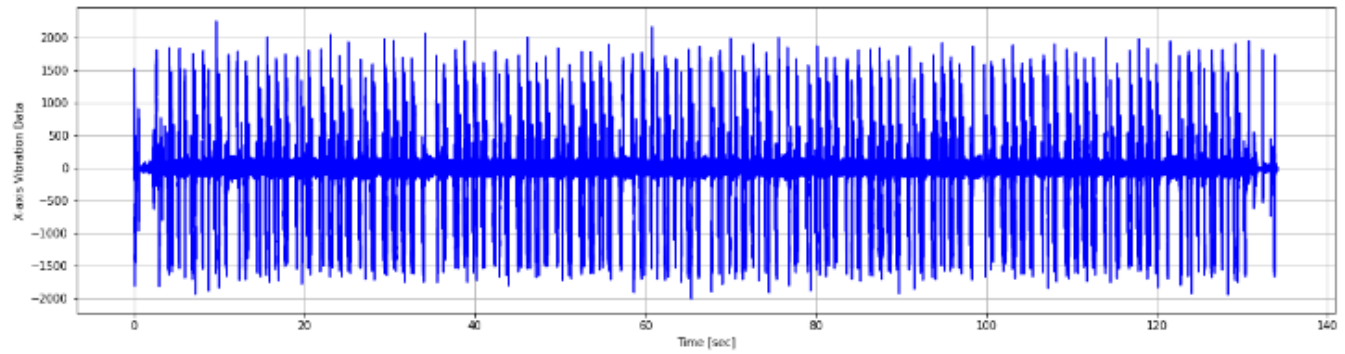
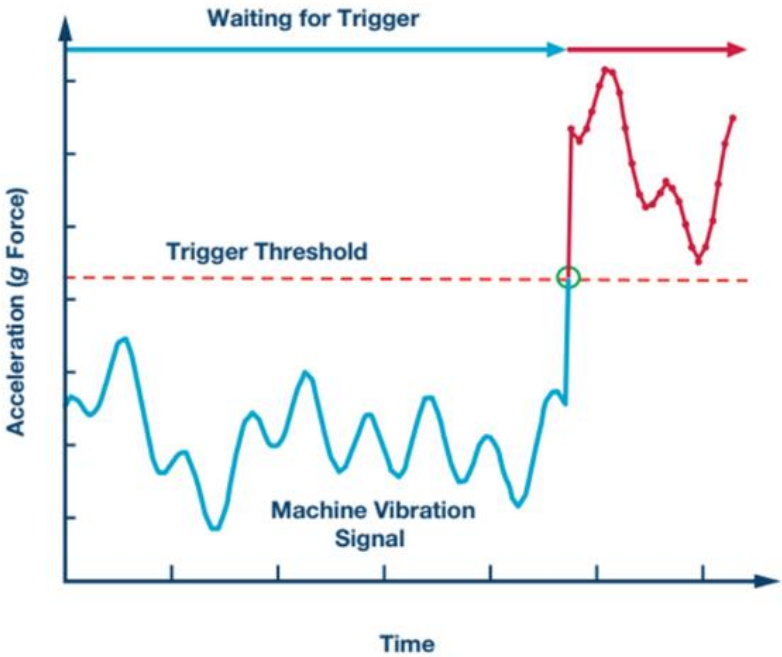
## TOOL CONDITION - CURRENT



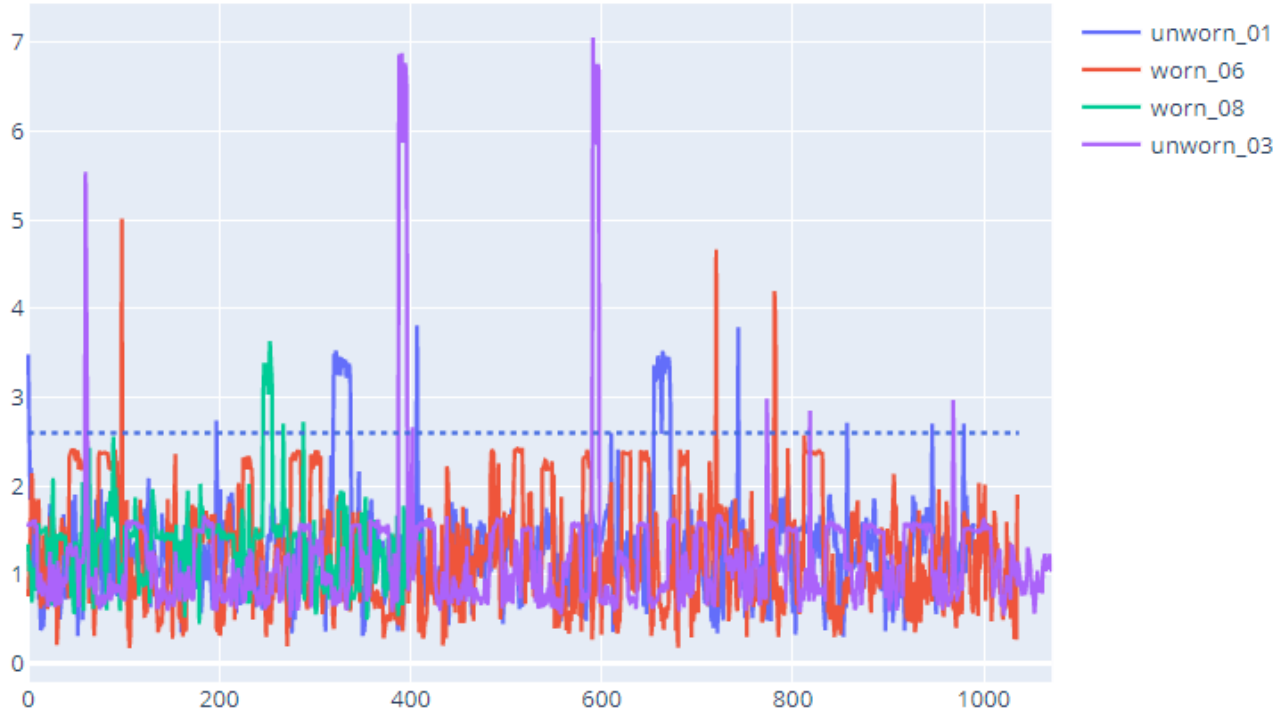
## TOOL CONDITION - VOLTAGE



# PERFORMANCE - VIBRATION ANALYSIS



# PERFORMANCE - OUTLIER DETECTION



## ASSET PERFORMANCE (PUMP) MACHINE INSIGHTS

1

PUMP FAILURES  
PREDICTION

2

PUMP DIAGNOSIS  
INSIGHTS

3

PUMP PERFORMANCE  
ANALYSIS

# PUMP DATA MODEL (e.g., Electrical Submersible Pump)

## Pump Data Model

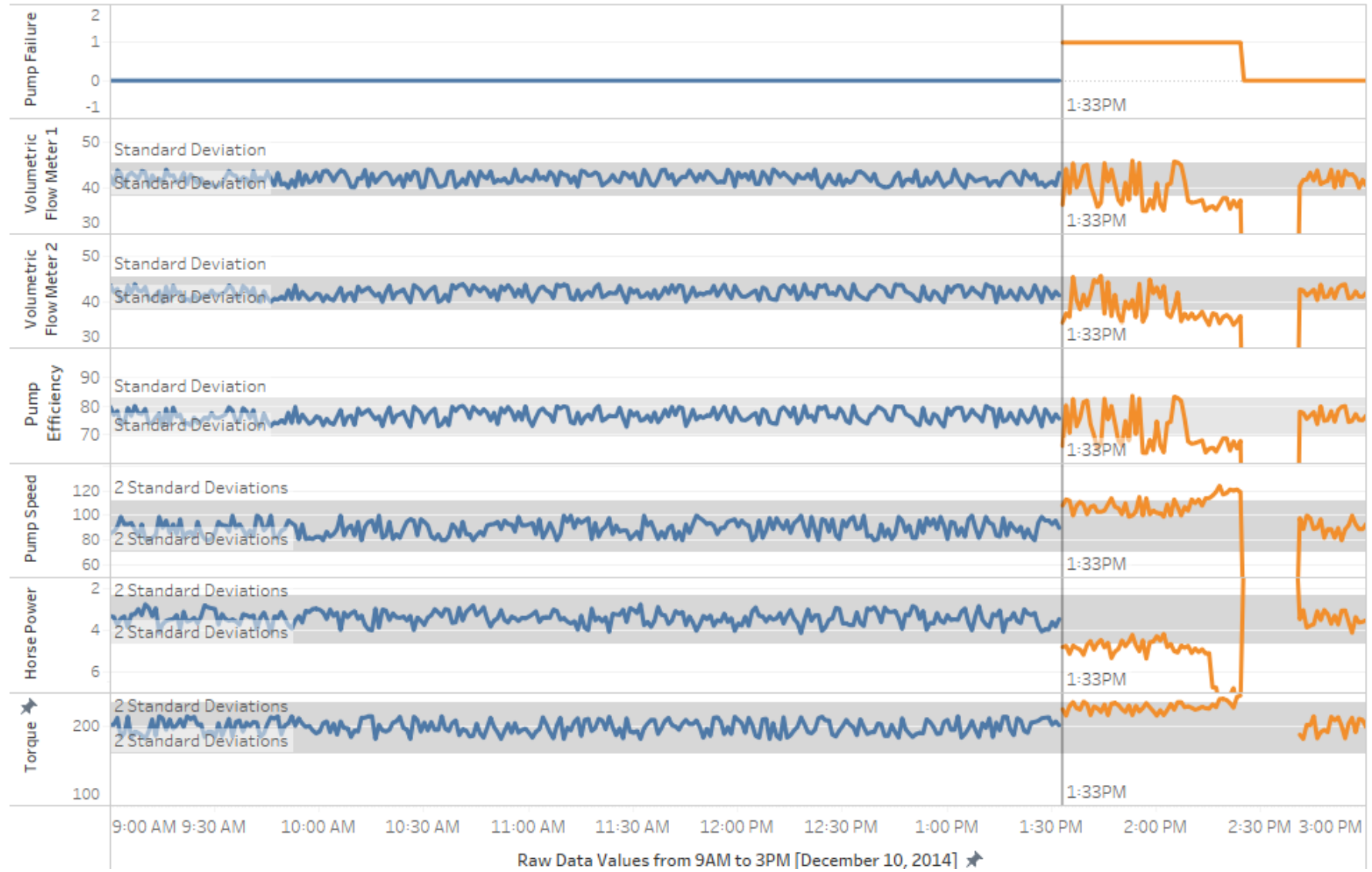
- - CURRENT(Amperes)
- PRESS\_DESC: Discharge Pressure (Psi)
- FREQUENCY(Hz)
- PRES\_INT: Intake Pressure (Psi)
- TEMP\_INT: Intake Temperature (°F)
- TEMP\_MOT: Engine temperature (°F)
- OUT\_VOLT: Output Voltage (V)
- PRES\_INTK: Intake Pressure (Psi)
- TEMP\_INTK: Intake Temperature (°F)
- Vibration: Normal Range Values lie between 0 - 0.8

## Production Data Model

- - BFPD: Barrels of Fluid per Day
- BOPD: Barrels of Oil per Day
- BWPD: Barrels of Water per Day
- MSCF: Million of Standard Cubic Feet
- BSW: Basic sediment and water (%)
- GOR(MSFC/BPPD): Gas-oil Relation
- GLR(SCF/BFPD): Gas-liquid Relation
- API: Oil API Gravity
- FREC(Hz): Frequency
- PIP(PSI): Pump intake pressure
- PROF\_INTAKE(ft): Intake Depth
- AMPERAGE: Current
- PUMP: Pump name
- PSI\_CAB: Wellhead Pressure

# METRICS FOR PUMP FAILURE

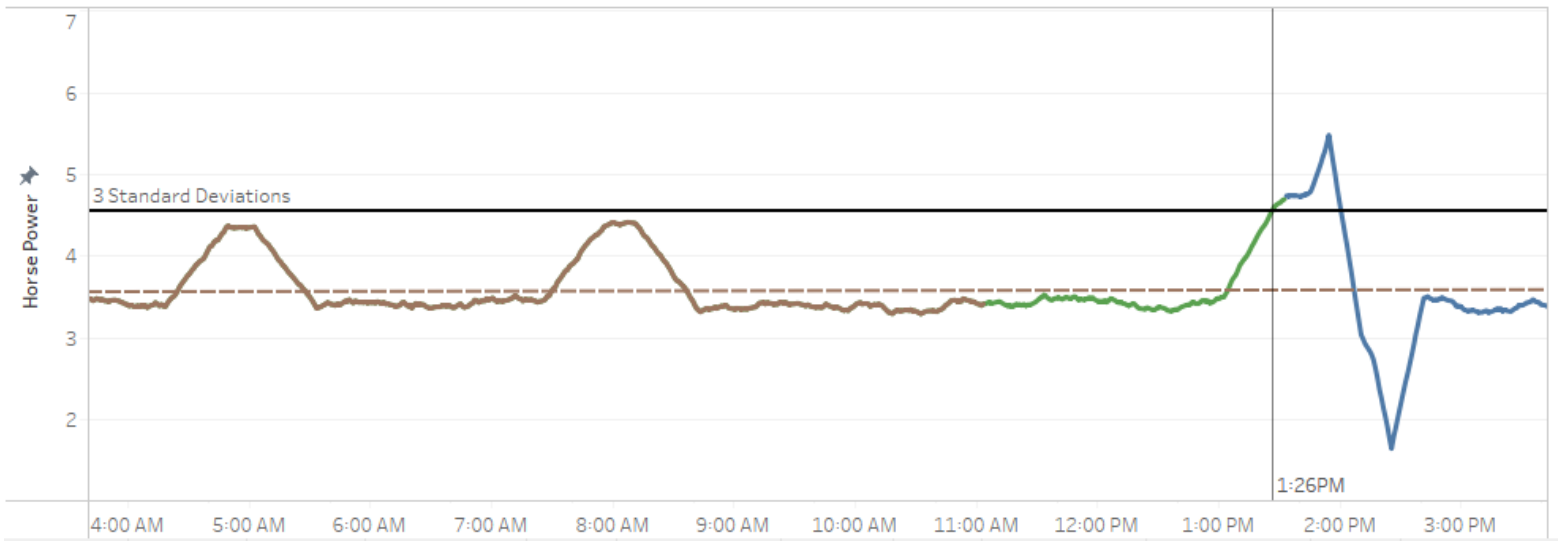
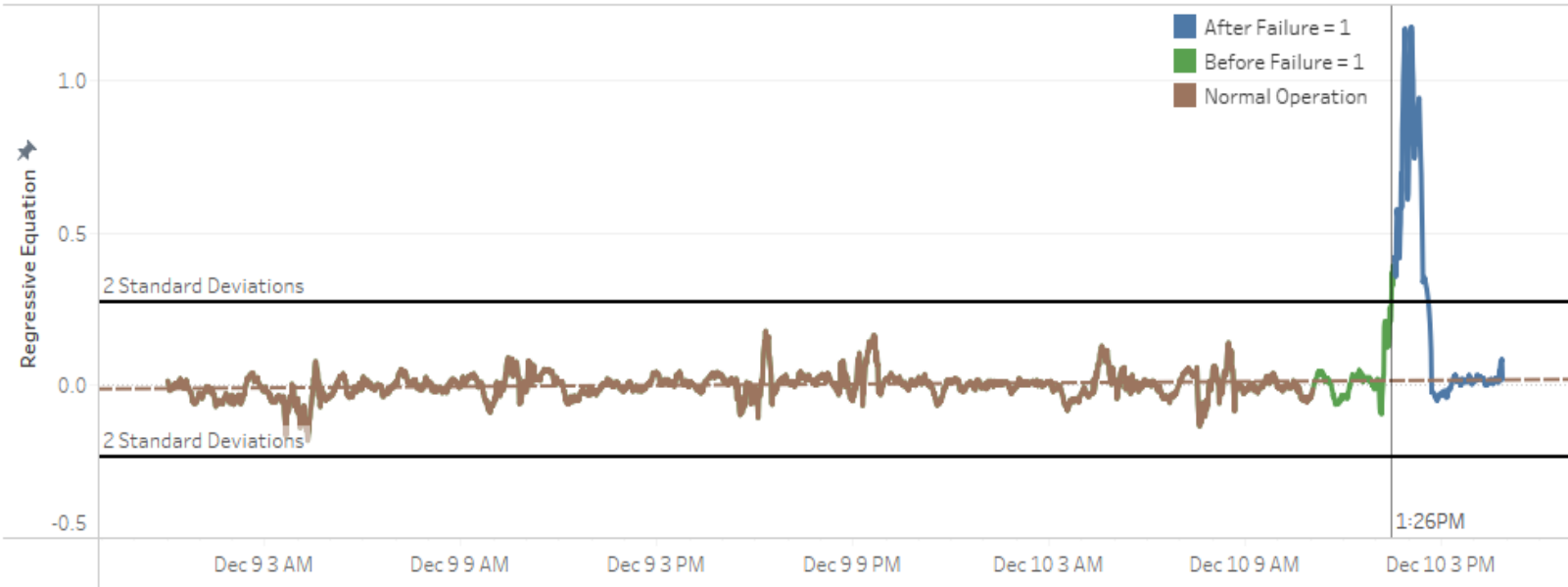
1



Post Failure    Pre Failure

# FORECASTING PUMP FAILURES

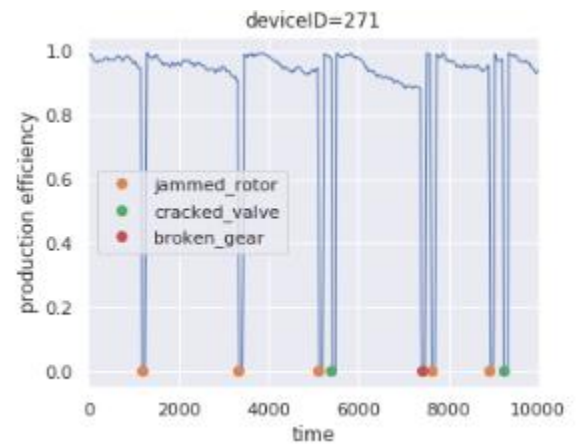
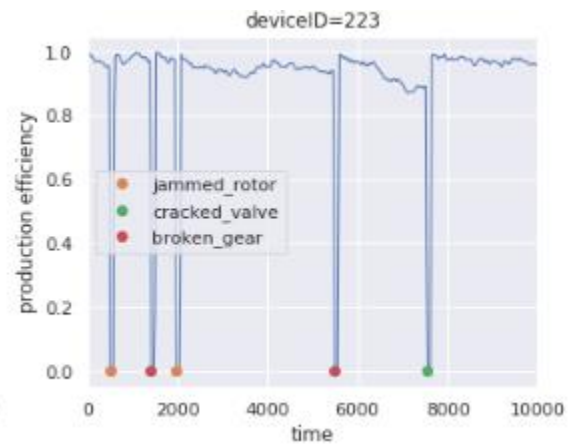
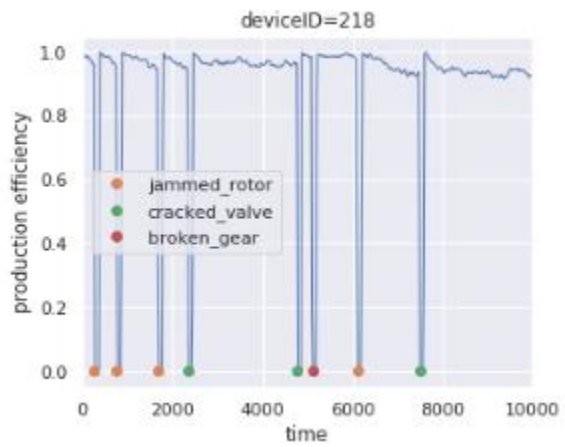
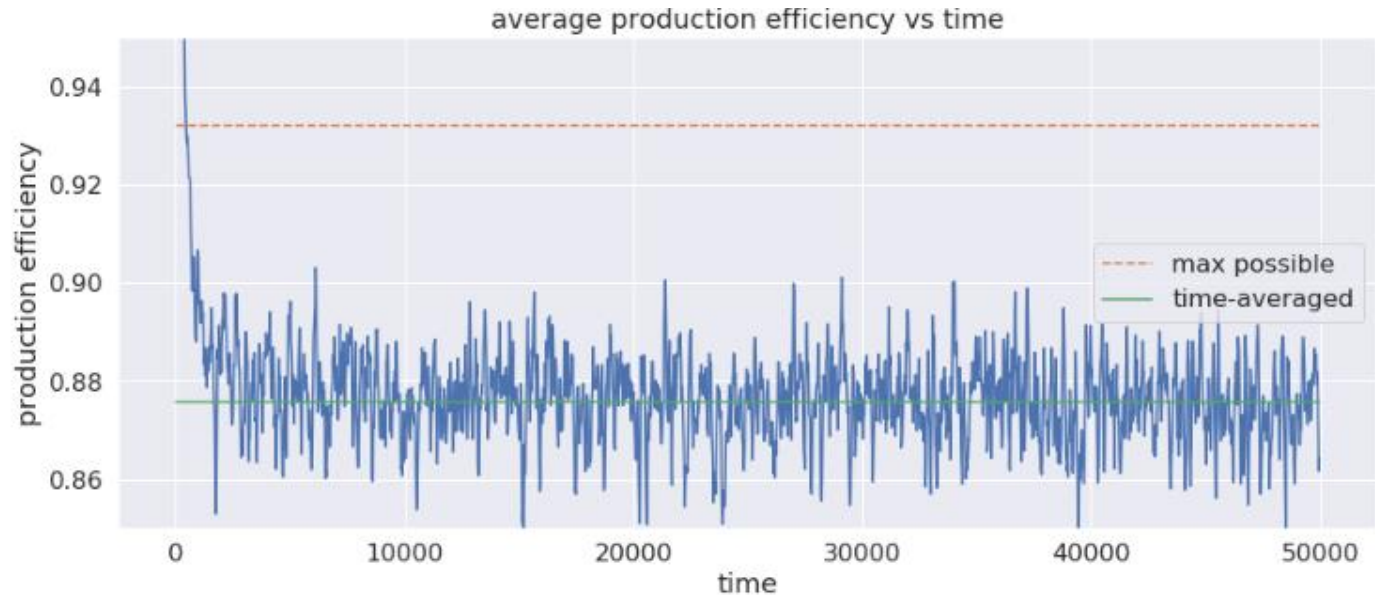
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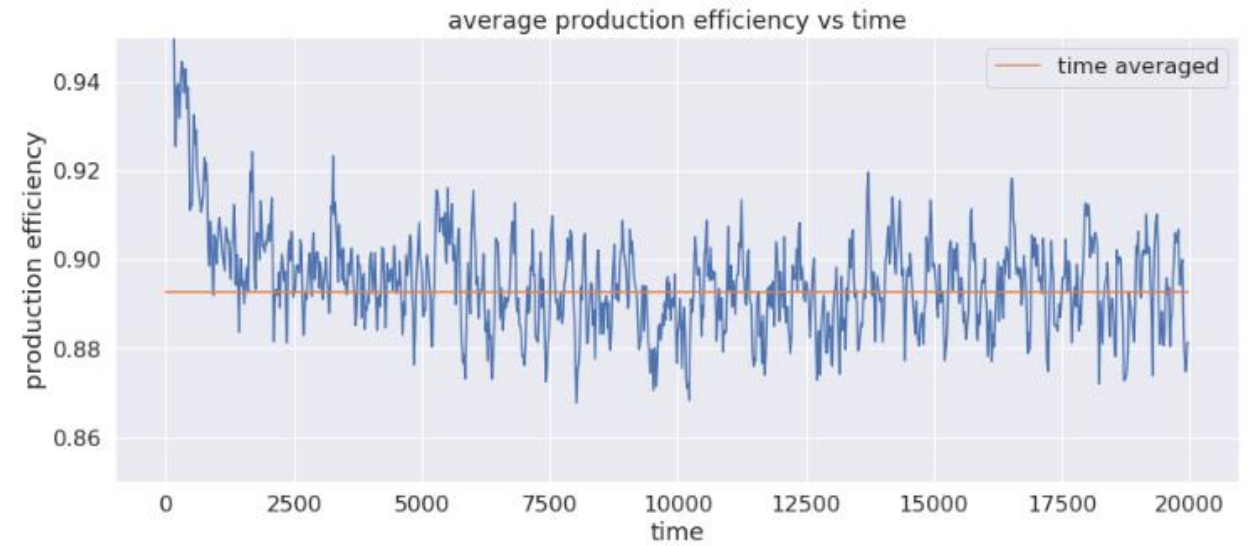
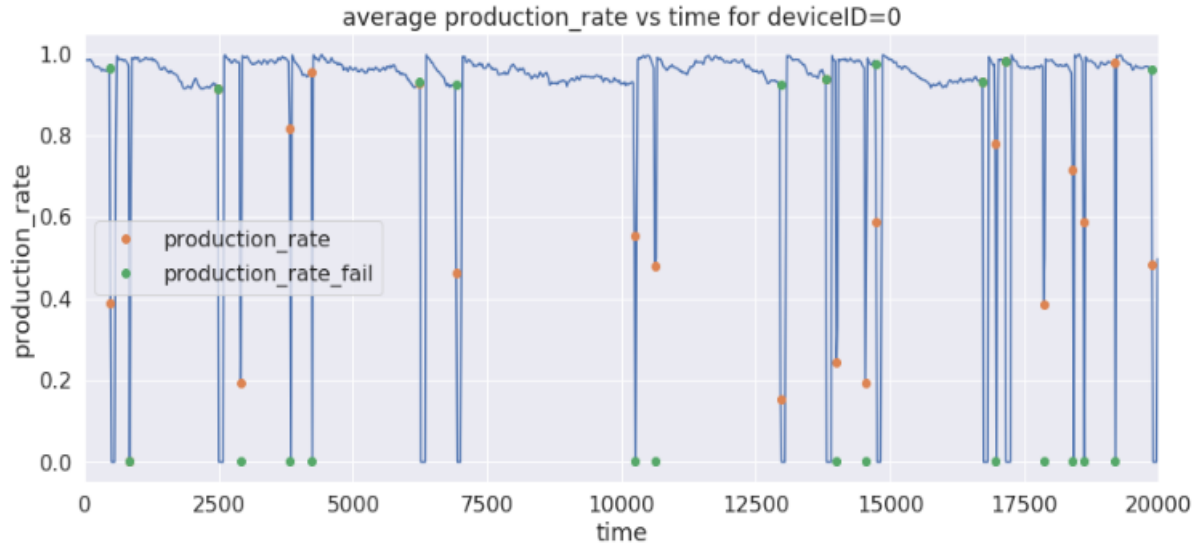


# DIAGNOSTICS OF ROD & BOREHOLE PUMPS

2



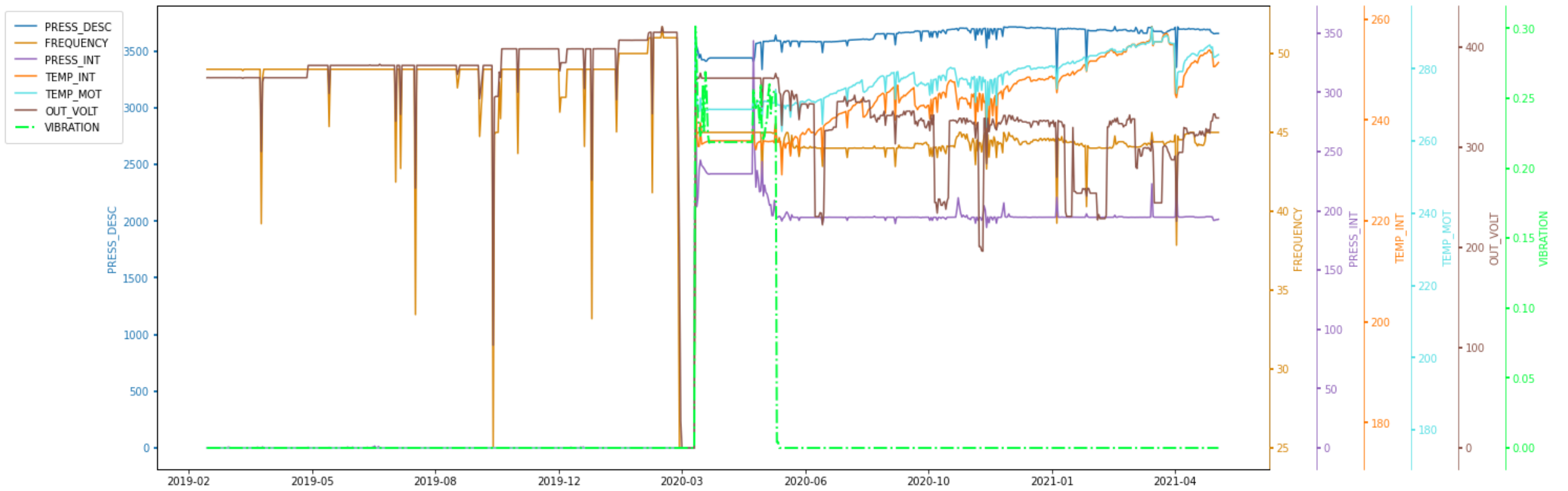
# DIAGNOSTICS OF ROD & BOREHOLE PUMPS 2



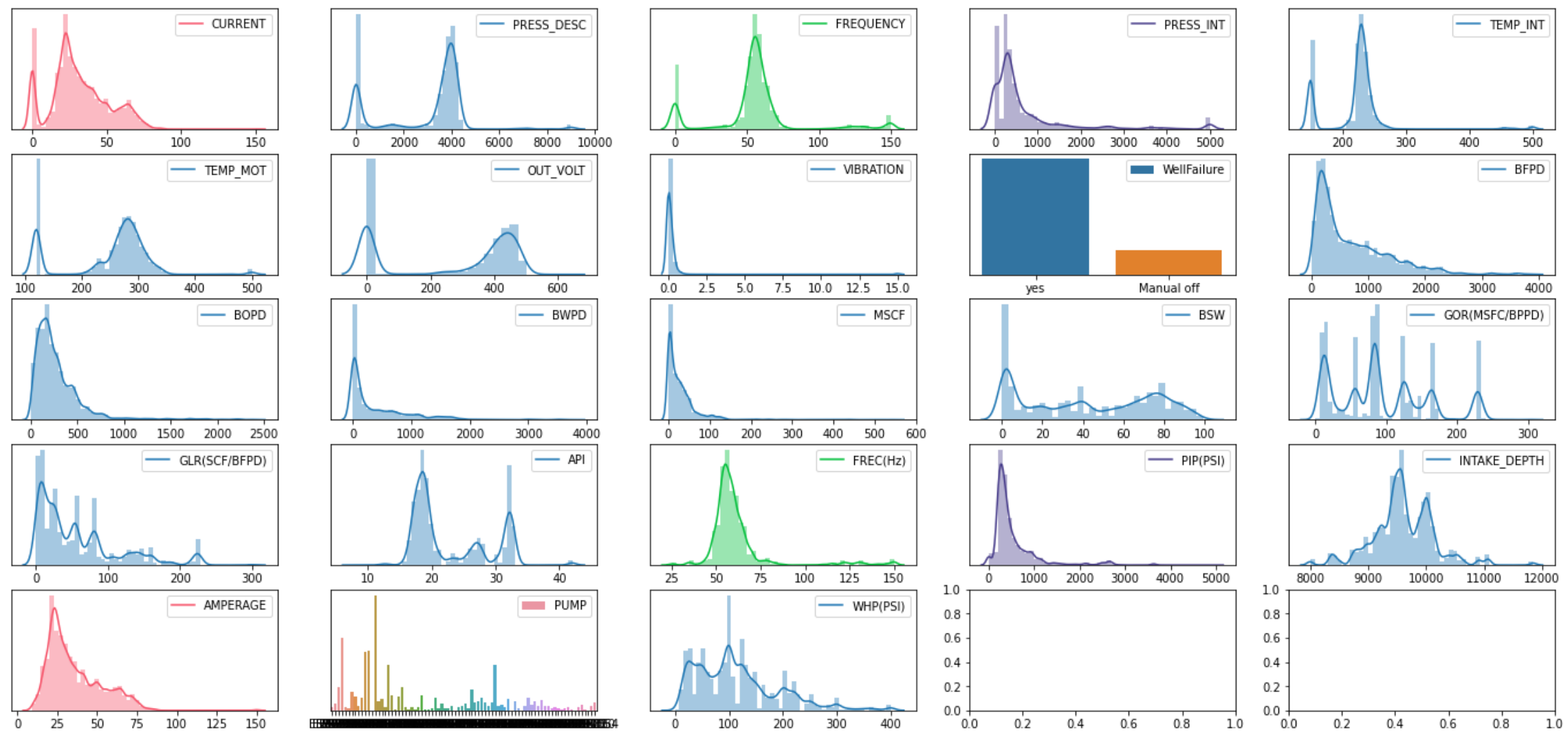
# DIAGNOSTICS OF ESPs\*

2

\* *Electrical Submersible Pumps*



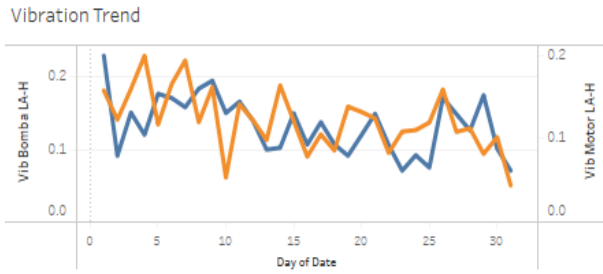
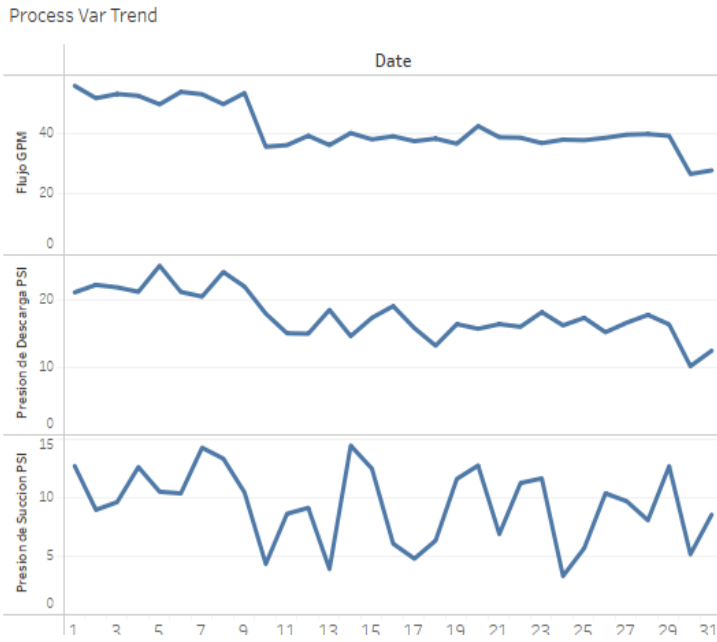
# PERFORMANCE - ESPs KPIs 3



# PERFORMANCE -

# VIBRATION ANALYSIS

3



■ Vib Bomba LA-H ■ Vib Motor LA-H

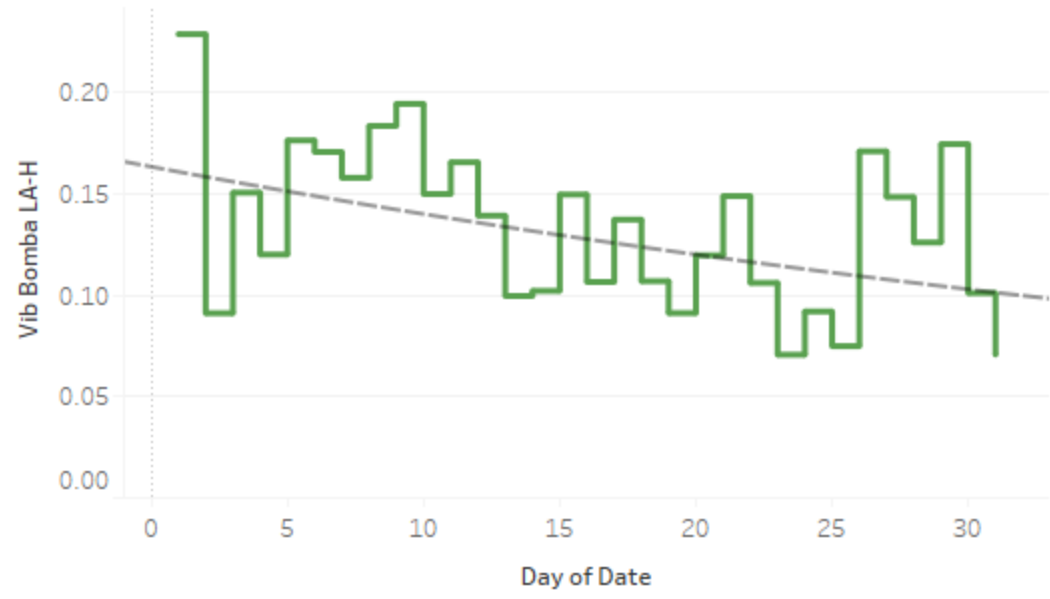
Failure Type



Tipo

■ Electrica ■ Mecanica

Vibration Forecats



# PROCESS COMPLIANCE

## PROCESS INSIGHTS

1

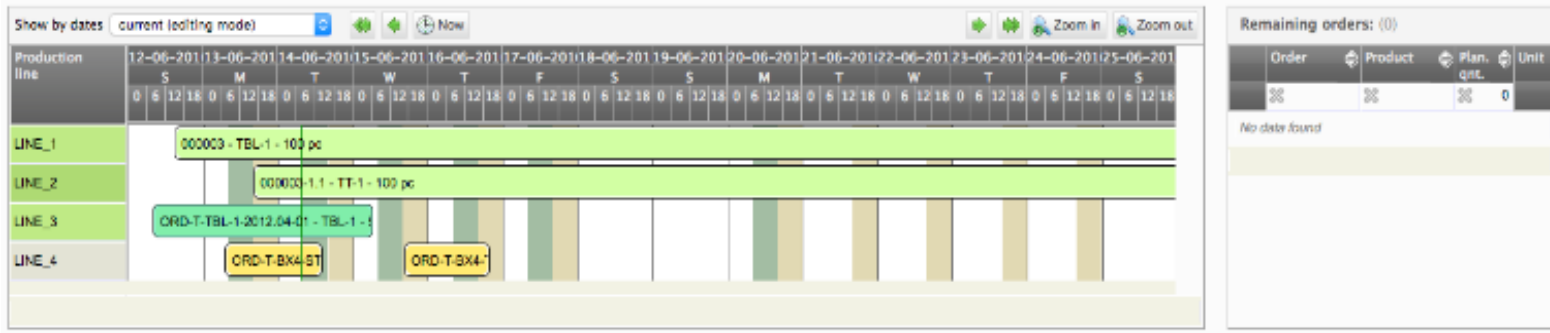
**PRODUCTION  
FORECASTING**

2

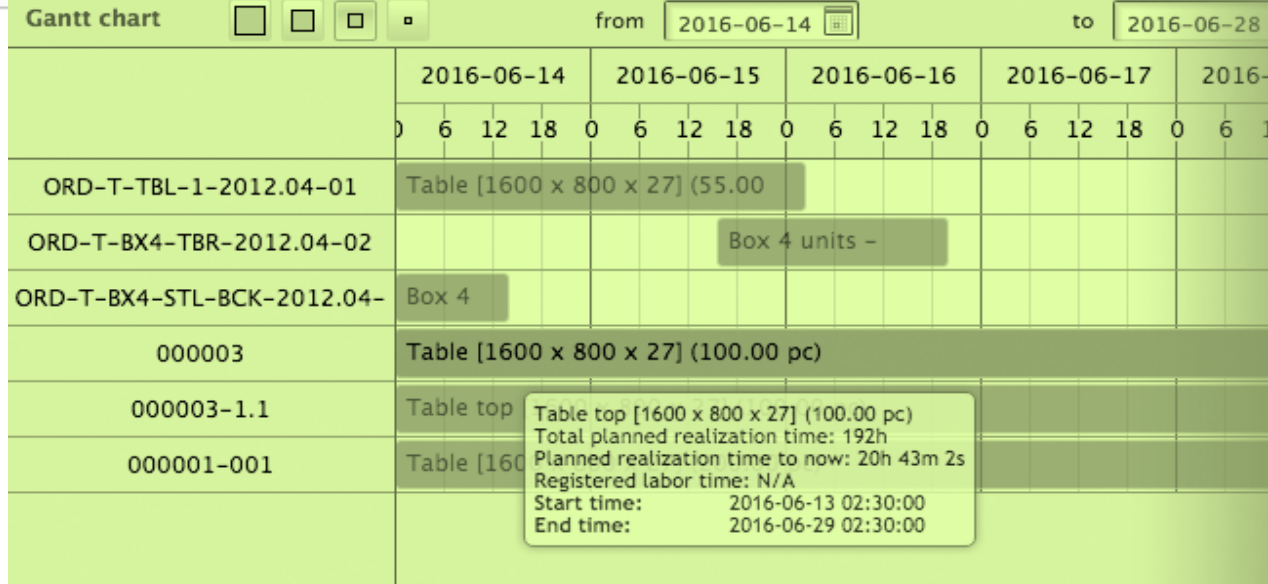
**INVENTORY &  
VENDORS  
MONITORING**

3

**REMOTE  
INSPECTIONS**

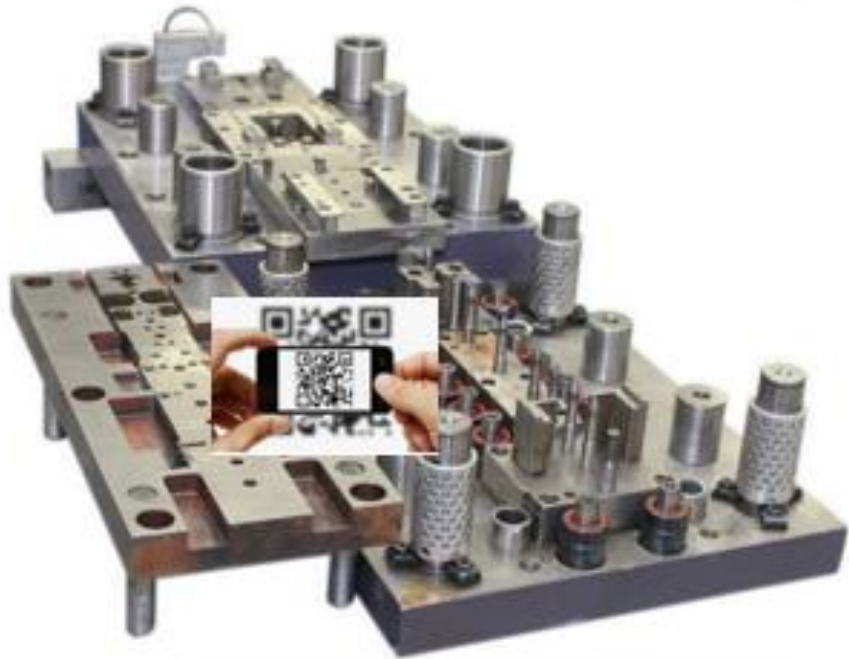


Start Planned: 2016-05-15 12:45:00  
 Corrected:   
 Effective: 2016-06-12 07:15:00  
 Cause of planned start date correction:   
 Types:   
 Comment:   
 End Planned: 2016-05-16 23:00:00  
 Corrected: 2016-06-15 06:15:00  
 Effective:   
 Cause of planned end date correction:   
 Types: Faulty materials  
 Comment: The wood was not good enough  
 State: In Progress  
 Deadline: 2016-05-16 23:05:00  
 Technology: Tech. Table [1600 x 800 x 27] (TBL-1)  
 Production per shift  
 Product Quantities



# MES - PRODUCTION SCHEDULING & FORECASTING 1

- Easily arrange orders on production lines & plan considering of shifts, resources, assumed capacity of machines and retooling operations
- Batch planning for master orders with real-time progress tracking
- Graphical scheduler with progress monitoring through Gantt charts



### Inventory Manager

🔍
Add Part
Start Scanner

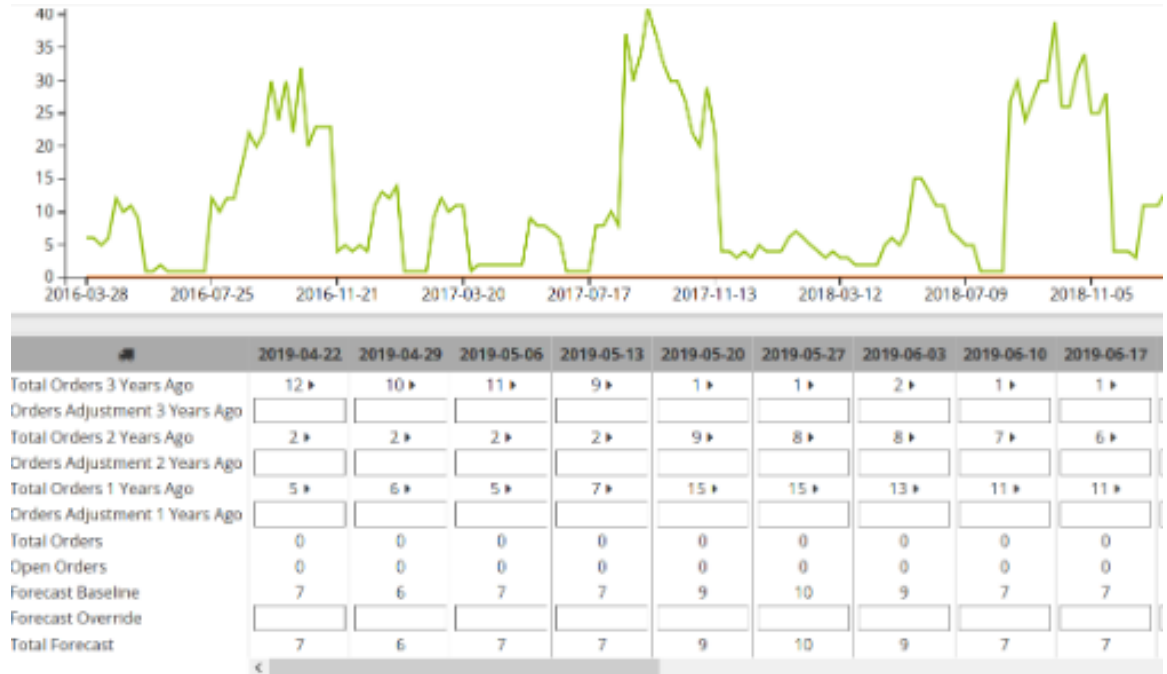
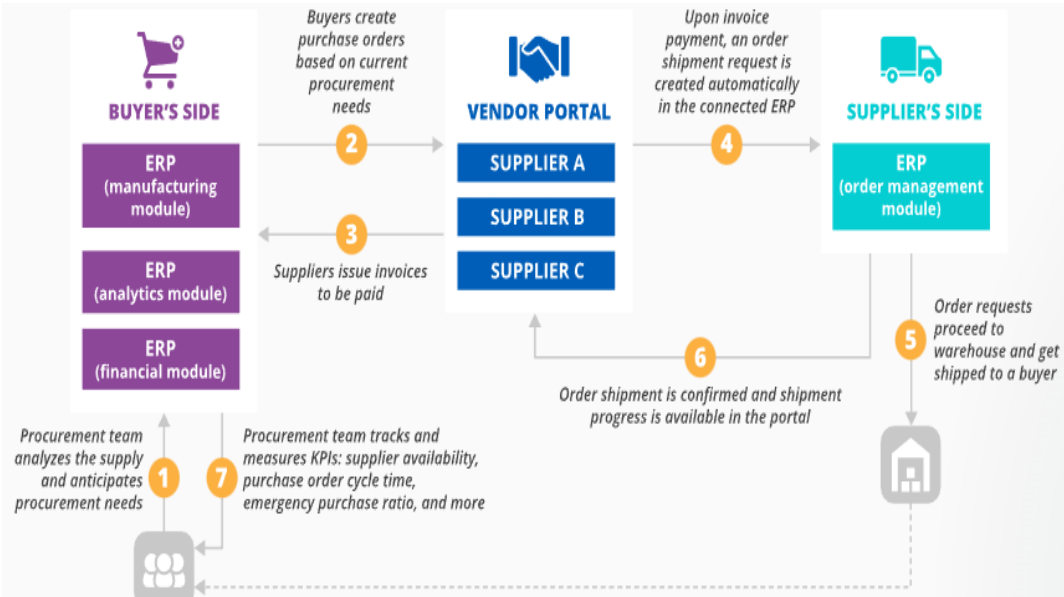
Code	Name	Type	Value	Size	Quantity	Location
8248070218458086155	OJ-SS-112LMH2	Relay			100	
4182997901177315050	R0402_120R	R	120R	0402	9997	
545967829376700775		Crystal	32.768k		9	B5
2733507424624619367	AT24C64D	EEPROM	64kbit	TSSOP8	10	
3095430749462342794	Orange Pi Zero 512M	SBC			1	Martin
7313869313628642229	TIP141	NPN	TIP141	TO218	38	
460240042213056664	R0603_100k	R	100k	0603	4900	RL
	Brain LEDs	PCB			9	B6
3144398906828399201	C0603_330nF/50V	C	330nF/50V	0603	498	B3
857111838327459340	R0402_100R	R	100R	0402	9900	RL

# INVENTORY - QR

## ENABLED 2

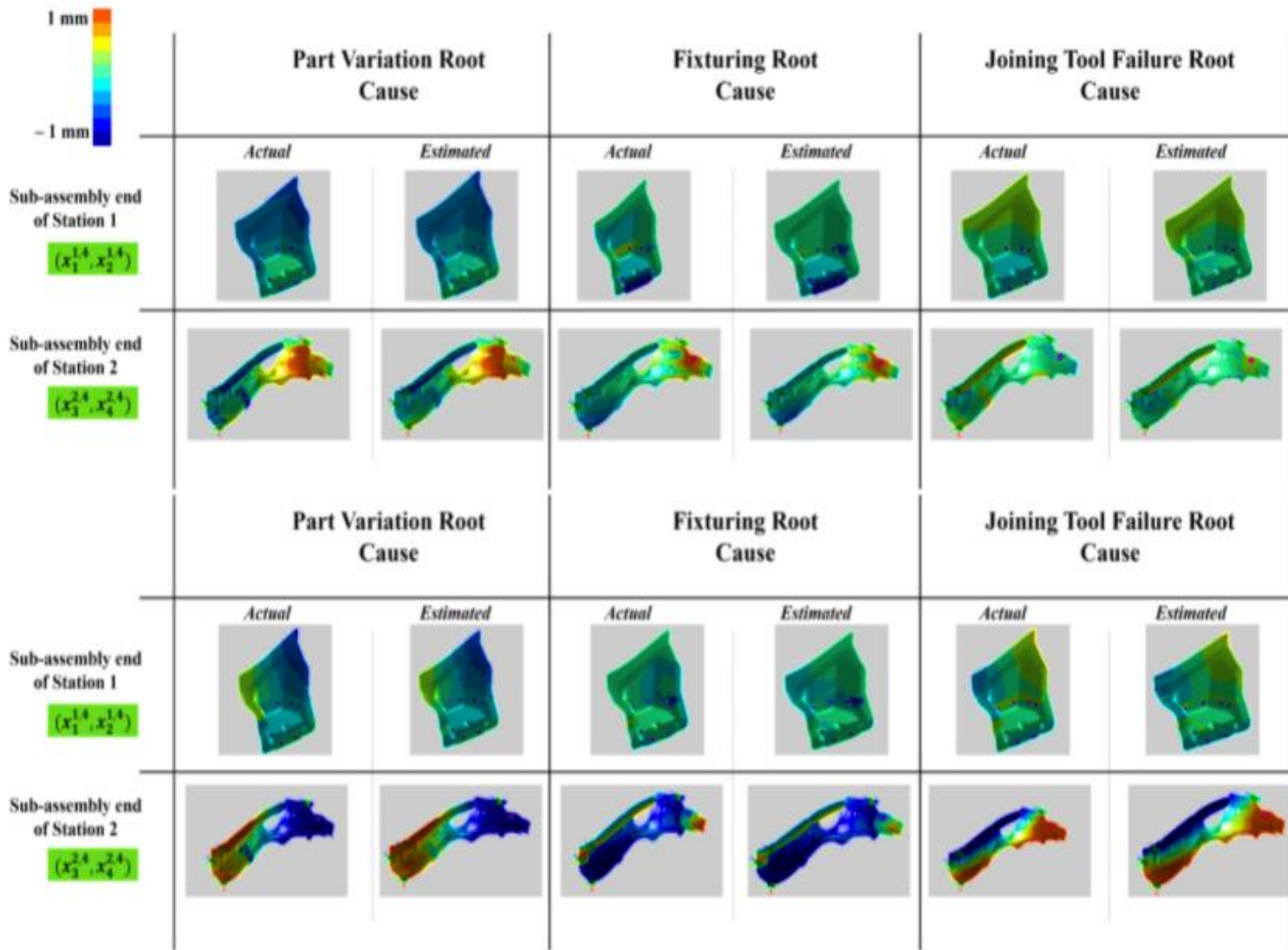
- QR based inventory management system improves the accuracy & reduce waiting time during production cycles
- Solution fulfills the demand for a parallel physical inventory
- This can stay as a standalone system or integrated with the ERP system





# SUPPLY CHAIN - VENDOR PROCUREMENT 2

- In future, visibility of the product/procurement activities pertaining to various vendors/sub-vendors
- Enable smooth finalization of non-performance deductions, if any, without any contention
- Monitor Project/Contract performance visualization with SLAs exceptions in real-time



# SUPPLY CHAIN - REMOTE INSPECTIONS

3

- Defects detection using CNN (Convolution Neural Networks)
- App-based streaming on inspected items is shared in real-time to the QC team at production site
- Solution also supports for 3D and AR (Augmented Reality) models

# PRODUCTION OPTIMIZATION LINE PERFORMANCE

1

**PREDICT JOB  
PERFORMANCE**

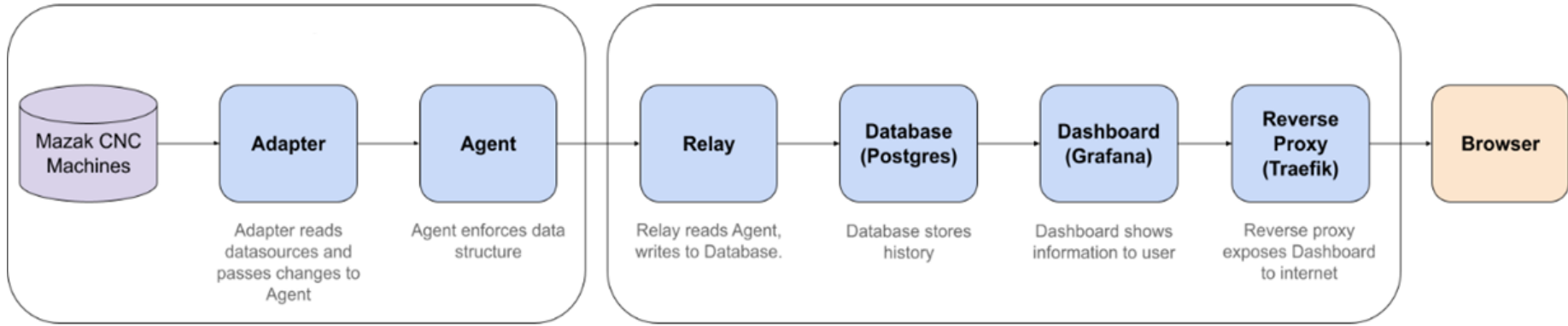
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**MACHINE'S OEE  
INSIGHTS**

3

**PRODUCTION  
KPIs**

# REAL-TIME JOB MONITORING 1

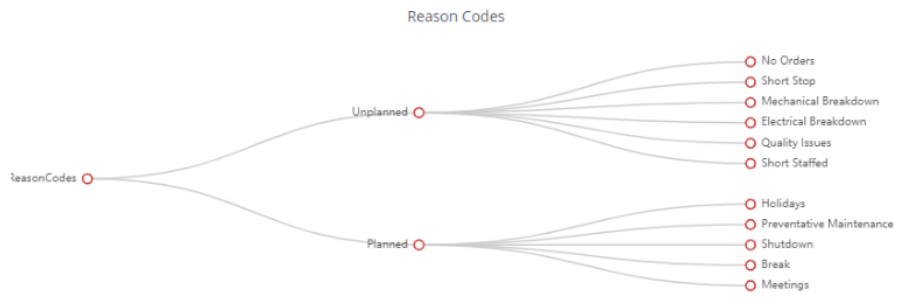
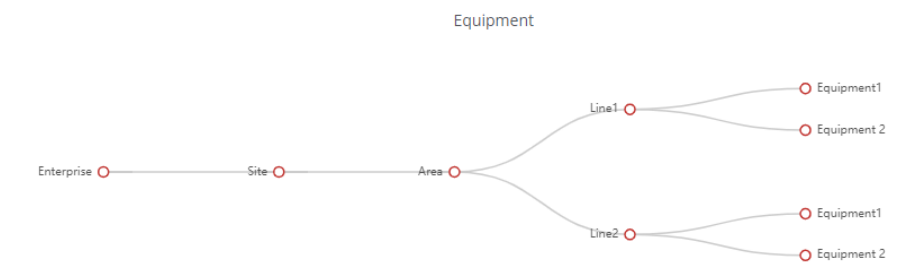


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    </Adapters>
  </Components>
</MTConnectDevices>
```



# LINE PERFORMANCE MONITORING

1



SmartFactory > Line Performance

📊 🌟 📄 ⚙️ 💬
🕒 Last 7 days
🔍
🔄 10s

Site Site
Area Area
Line Line1
Annotations & Alerts 
Links

Current Running Order

Time	Production Line	Order ID	Product ID	Product Description	Order State	Scheduled Start Time	Actual Start Time	Setpoint Rate	Order Qty	Issued Qty	Remaining Qty	Remaining Time
1969-12-31 19:00:00	Site   Area   Line1	100033	1	Chicken Pizza	running	2020-08-20 10:22:07.007	2020-08-20 10:00:01	100.00	100000	-	-	-
1969-12-31 19:00:00	Site   Area   Line1	100034	1	Chicken Pizza	next	2020-08-21 03:02:57.007	-	0	10000	-	-	-

Planned Production

16787

Actual Production

3530

Held Time

1.83 day

Running Time

2.61 day

Availability

58.79%

Performance

34.97%

Current Rate

65

Line Performance

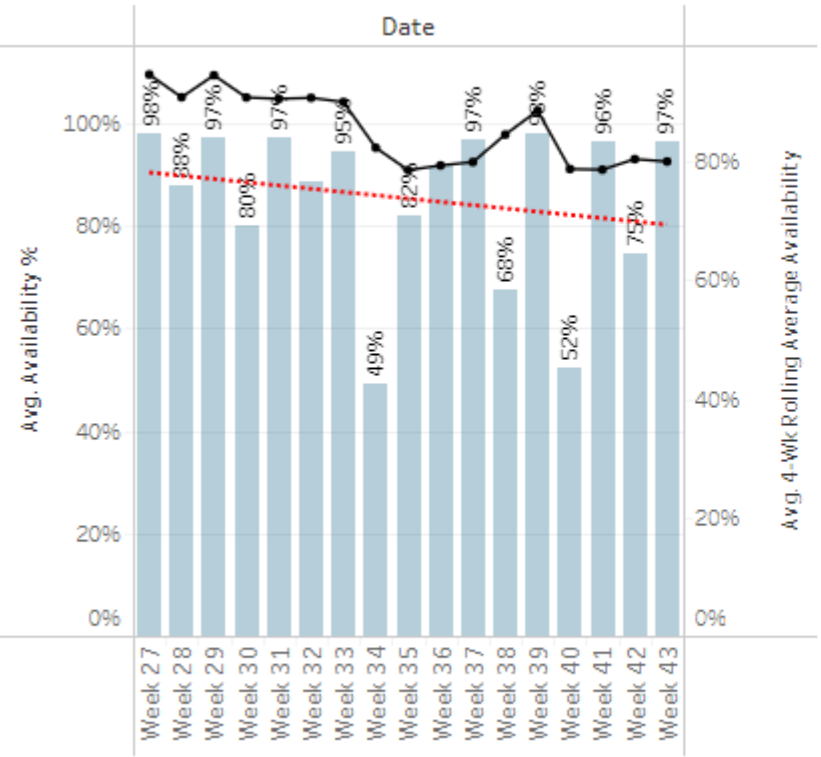
Downtime Editor Table

Time	duration	status	category	reason	equipment
2020-08-19 19:04:07.402	16:48:29.500	held	Unplanned	Electrical Breakdown	
2020-08-19 11:24:34.801	07:39:32.601	held	Unplanned	No Orders	
2020-08-19 03:11:29.653	08:13:05.148	held	Unplanned	Short Staffed	
2020-08-19 00:08:28.179	03:03:01.474	held	Planned	Holidays	
2020-08-18 13:00:32.920	11:07:55.259	held	Unplanned	Short Staffed	
2020-08-17 01:32:15.575	35:28:17.345	held	Planned	Holidays	

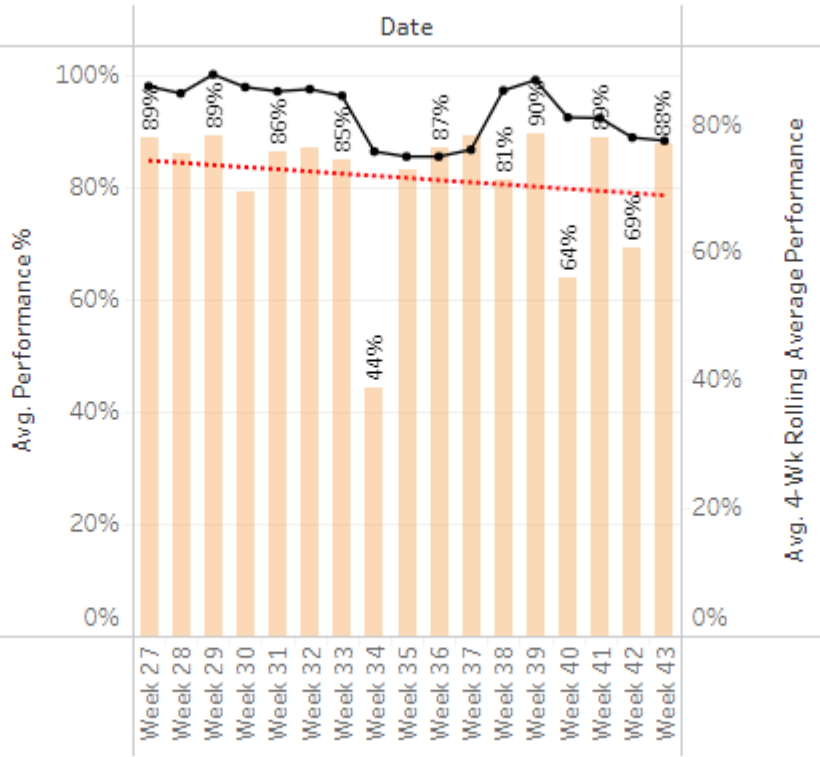
# LINE PERFORMANCE MONITORING

## OEE BY PLANT/MACHINE

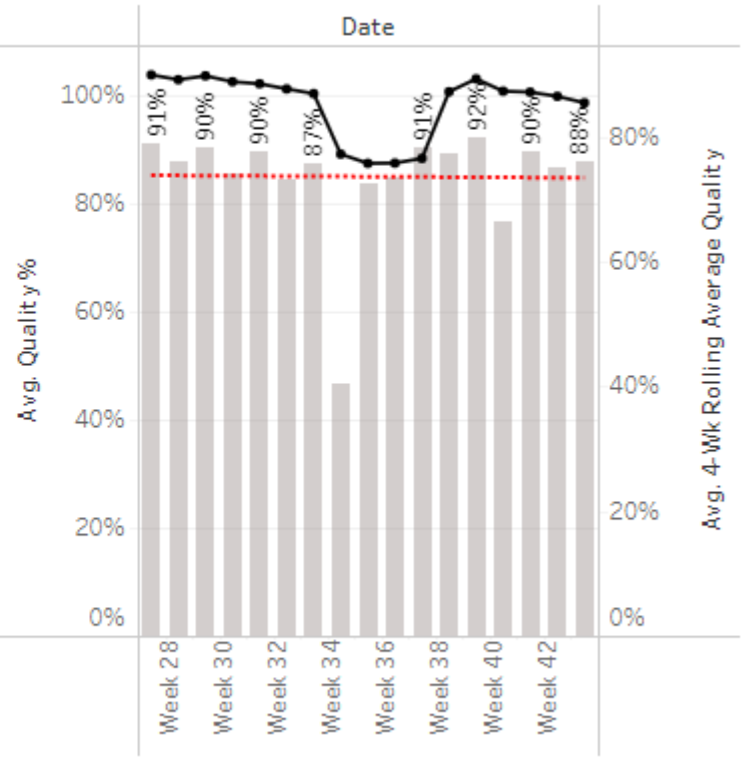
Availability %

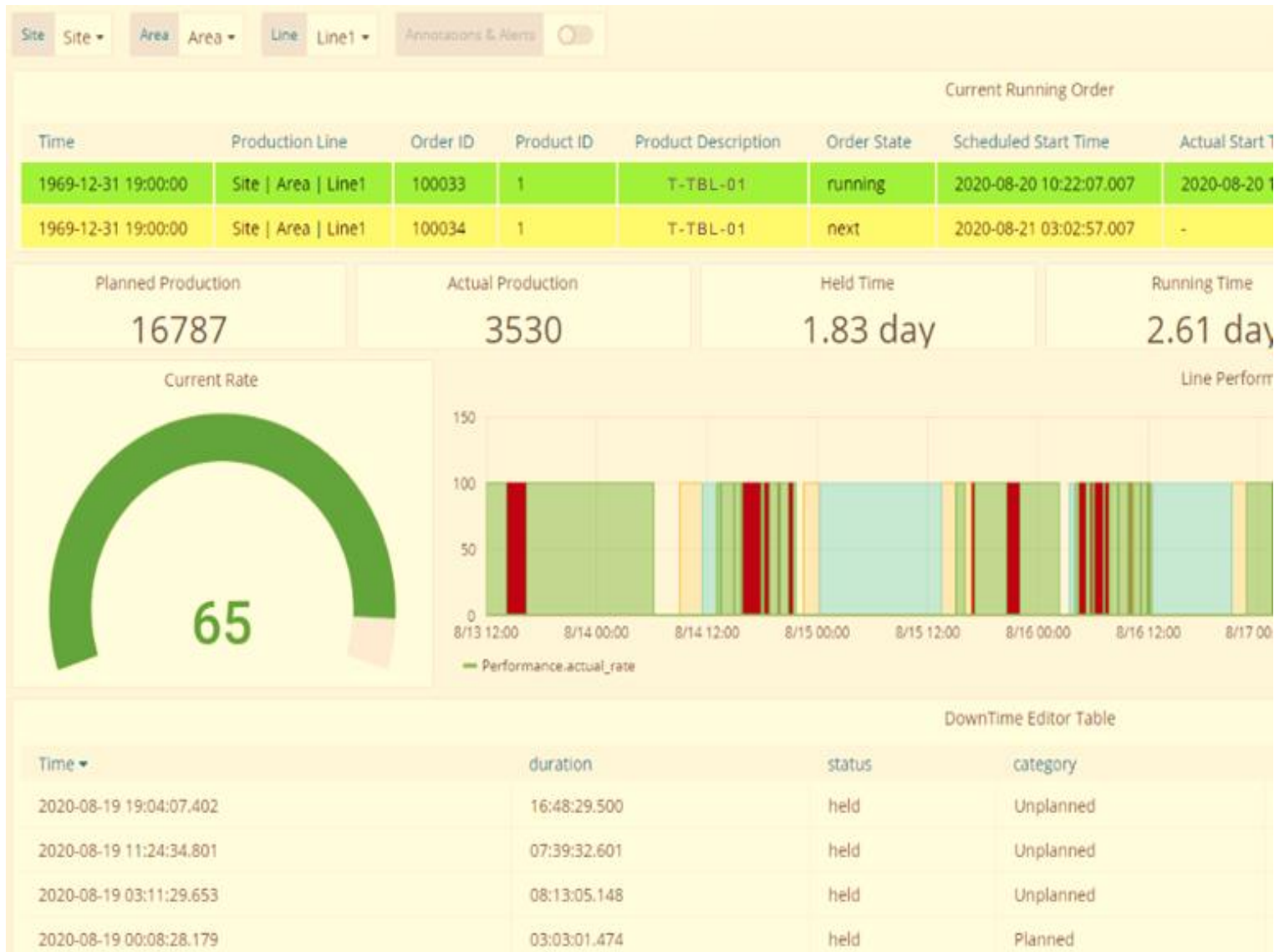


Performance %



Quality %





# MES - PRODUCTION KPIs 3

- Integrated Production KPIs is showcased as part of the KPI dashboard
- Solution supports for Production Forecasting with What-If Models
- Production KPIs are well guarded, so manufacturers need a flexibility – on cloud, on premise or hybrid