Maintenance and Reliability

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Systems Engineer

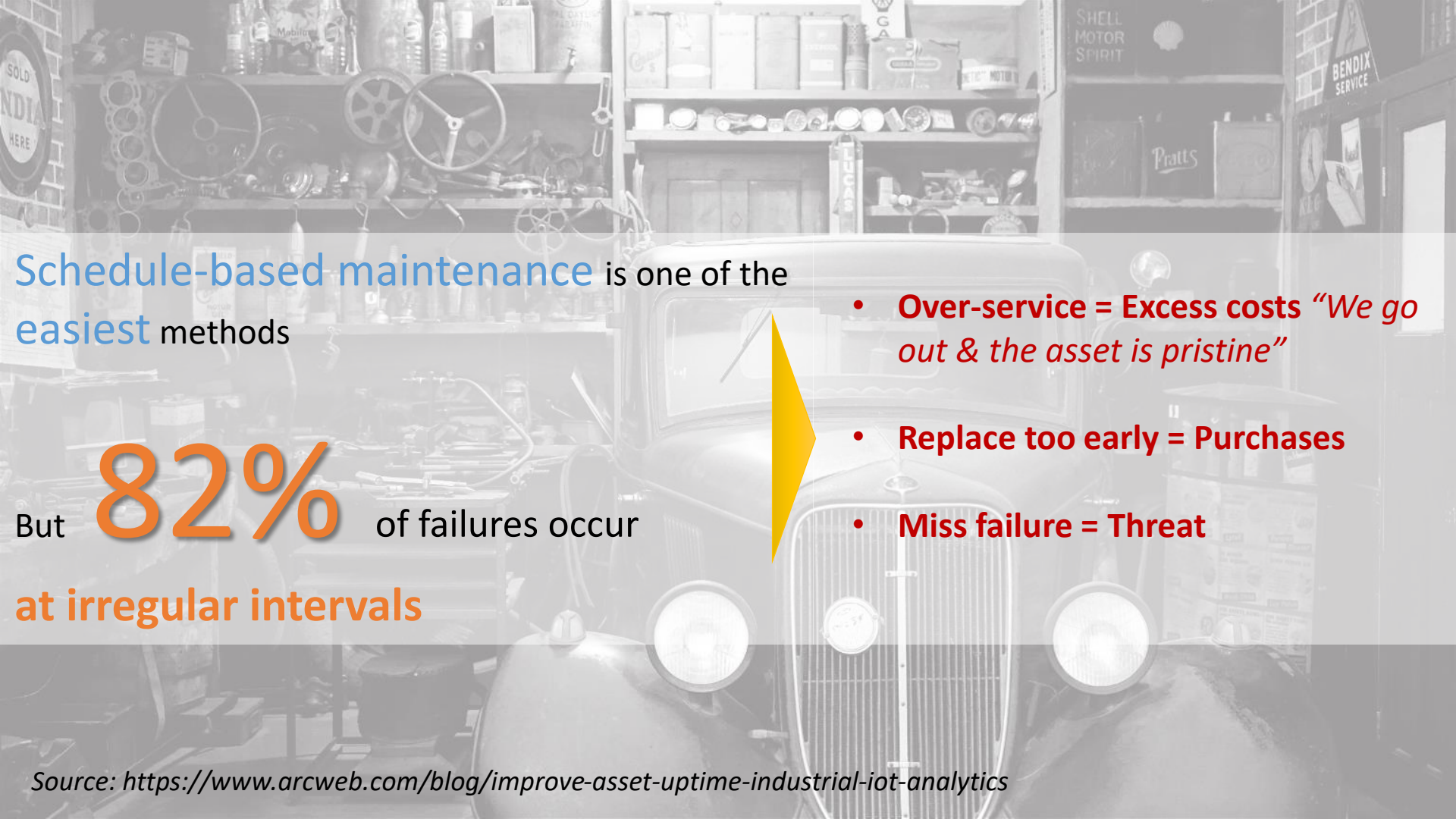
OSIsoft®

Schedule-based maintenance is one of the easiest methods

But 82% of failures occur

at irregular intervals

Source: https://www.arcweb.com/blog/improve-asset-uptime-industrial-iot-analytics



Schedule-based maintenance is one of the easiest methods

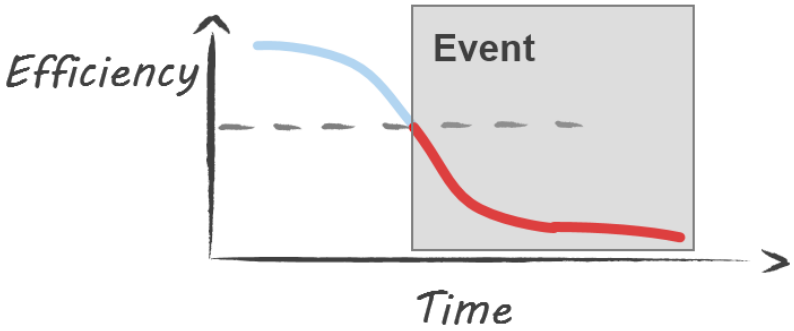
But 82% of failures occur at irregular intervals

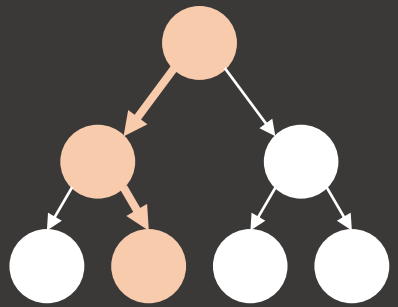
- **Over-service = Excess costs** *"We go out & the asset is pristine"*
- **Replace too early = Purchases**
- **Miss failure = Threat**

Source: https://www.arcweb.com/blog/improve-asset-uptime-industrial-iot-analytics

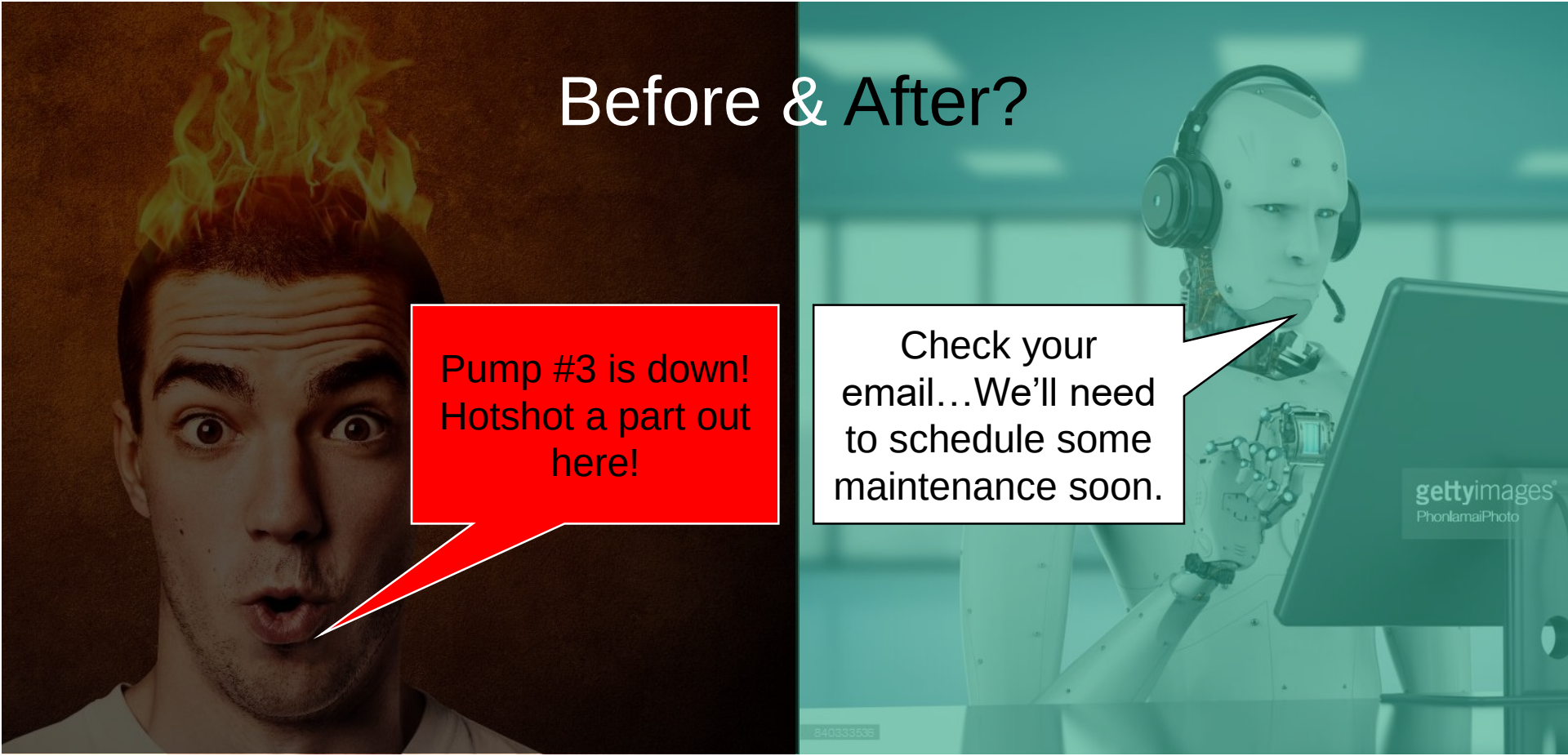
“Maintenance” offer many choices…

Asset Efficiency < 75%



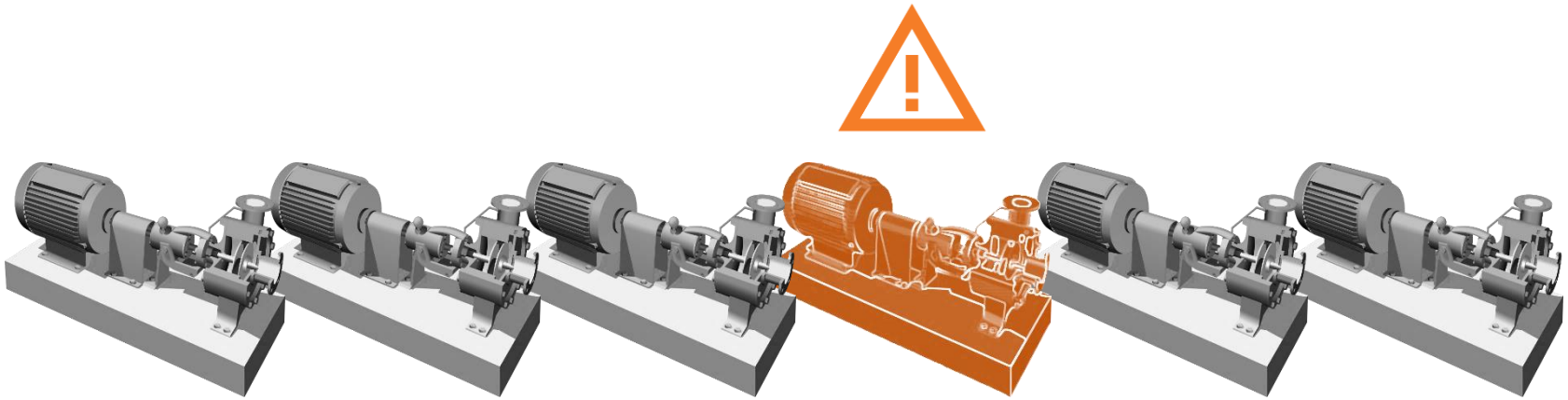


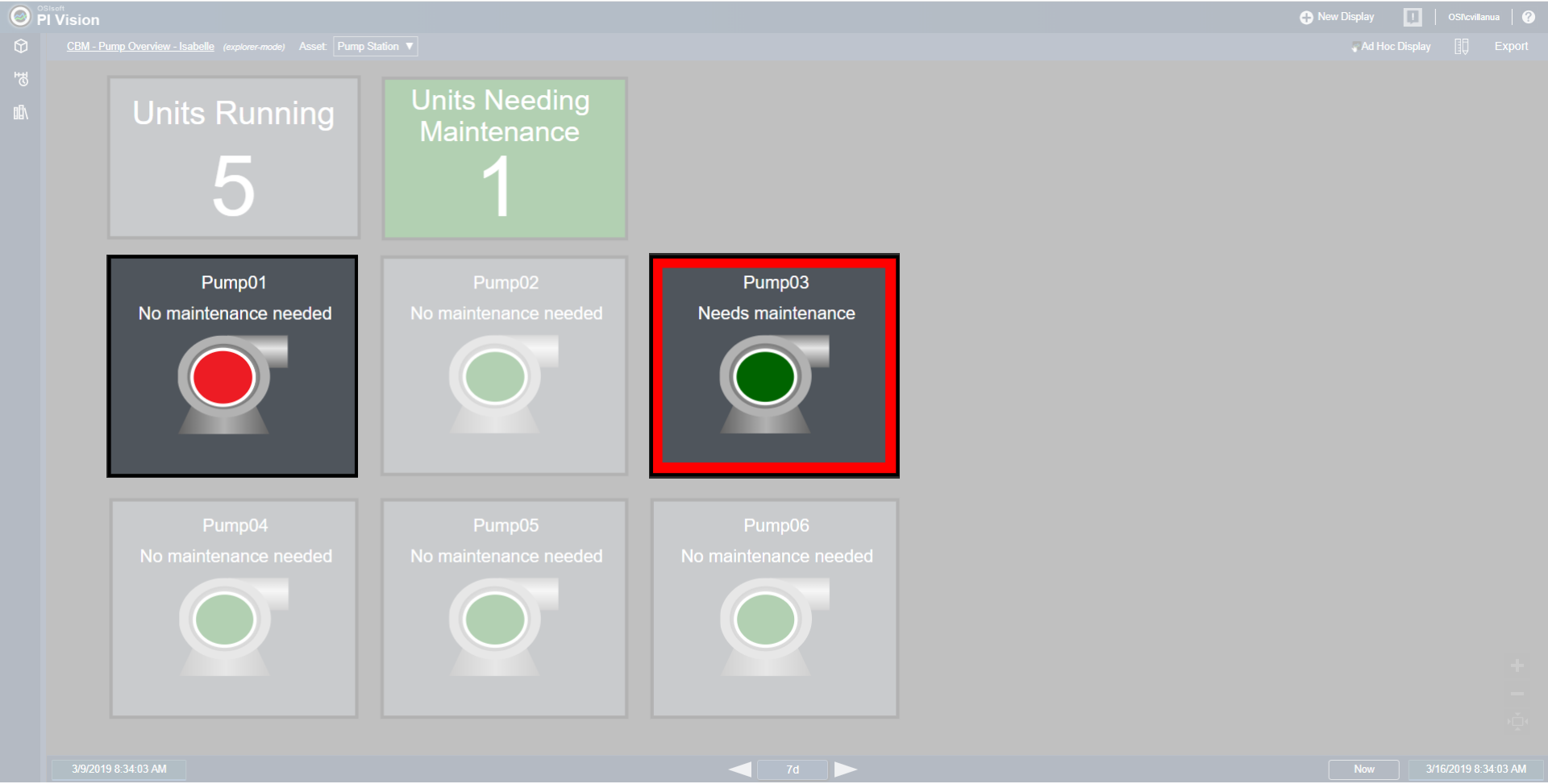
Before & After?



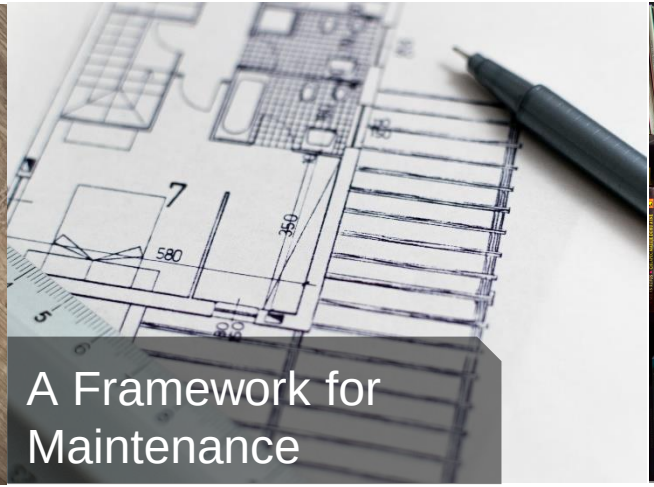
Where do I start?
or
Where are the quick wins?

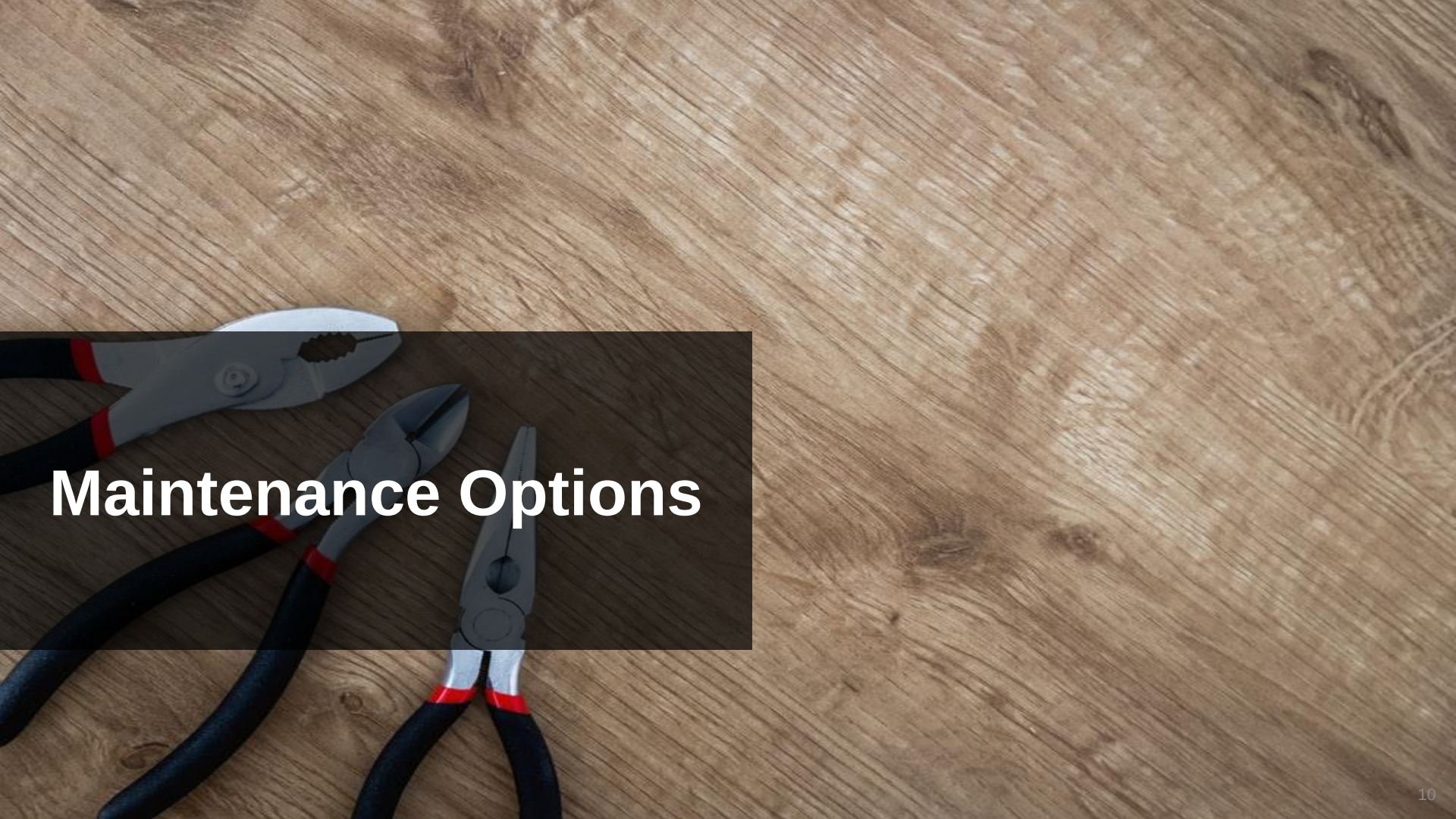
Are all of my pumps healthy today?





Sections We'll Cover



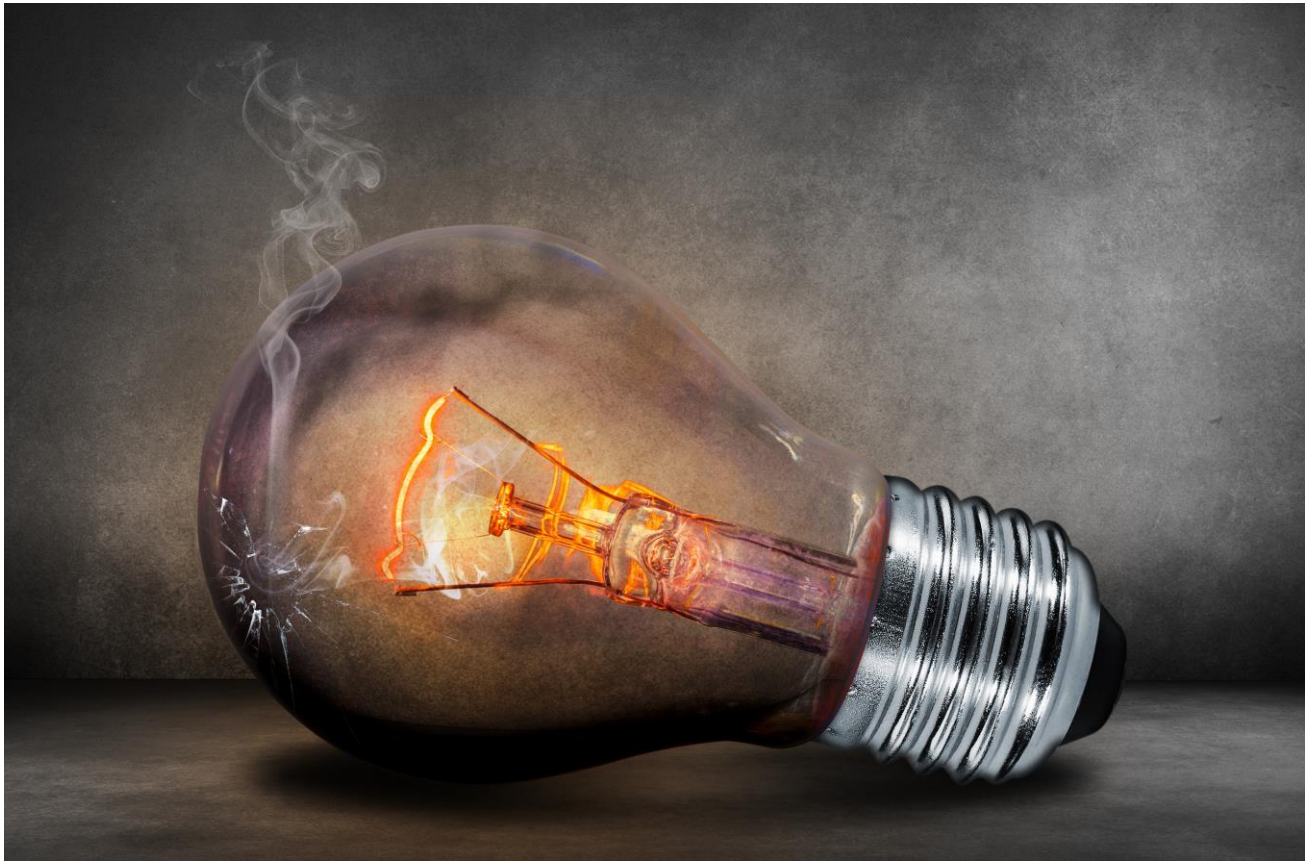


Maintenance Options

Many words for similar goal: Keep assets healthy

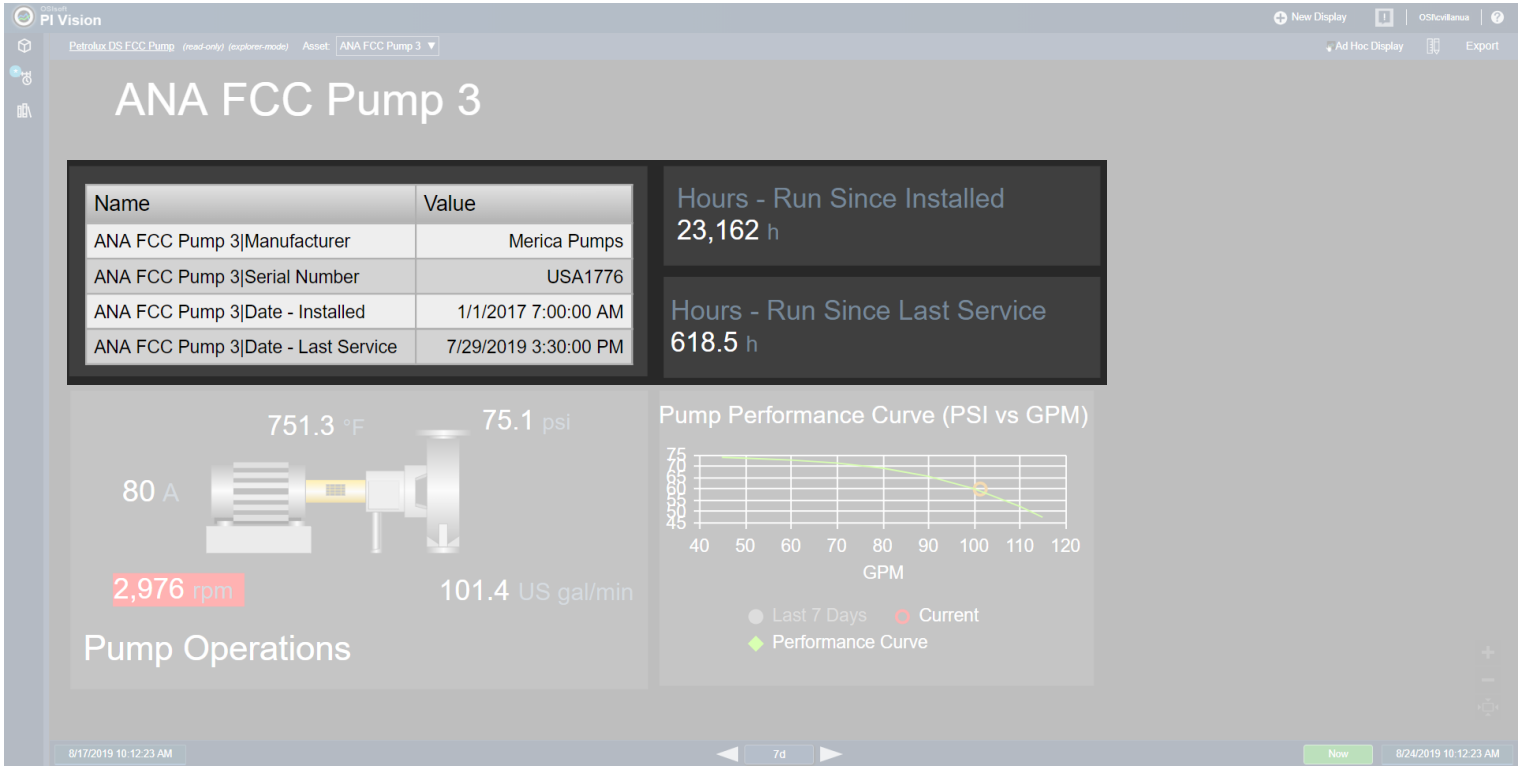
…In a cost effective way

Reactive Maintenance



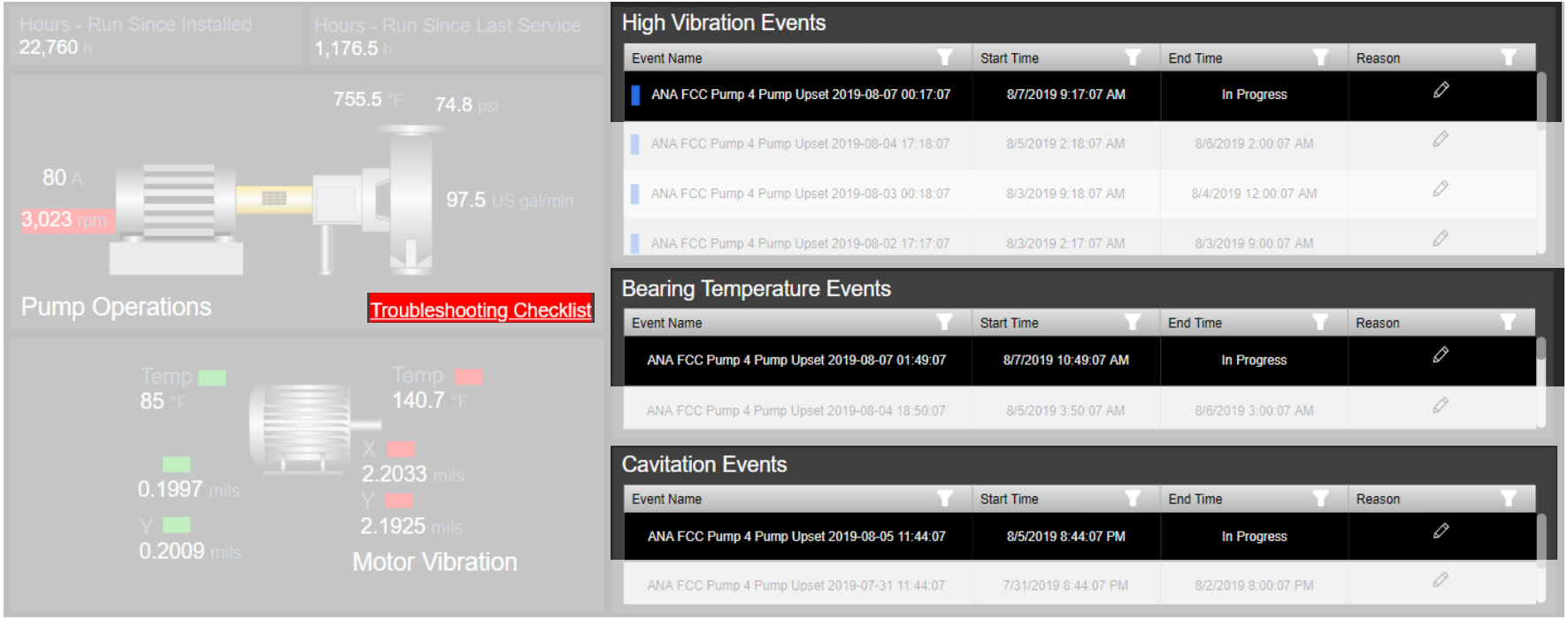
Usage Based Maintenance

- Pump Run-hours
- Pump starts/stops



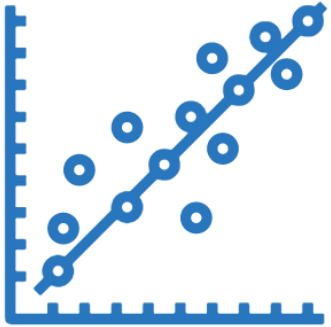
Condition Based Maintenance

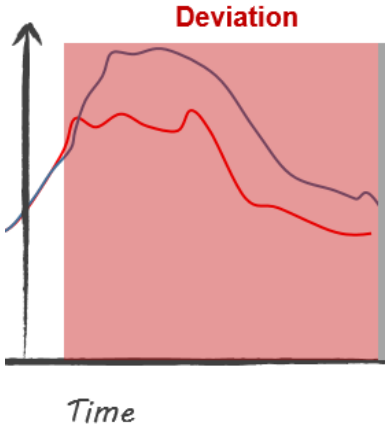
- Cavitation Events
- High bearing temperature
- High vibration



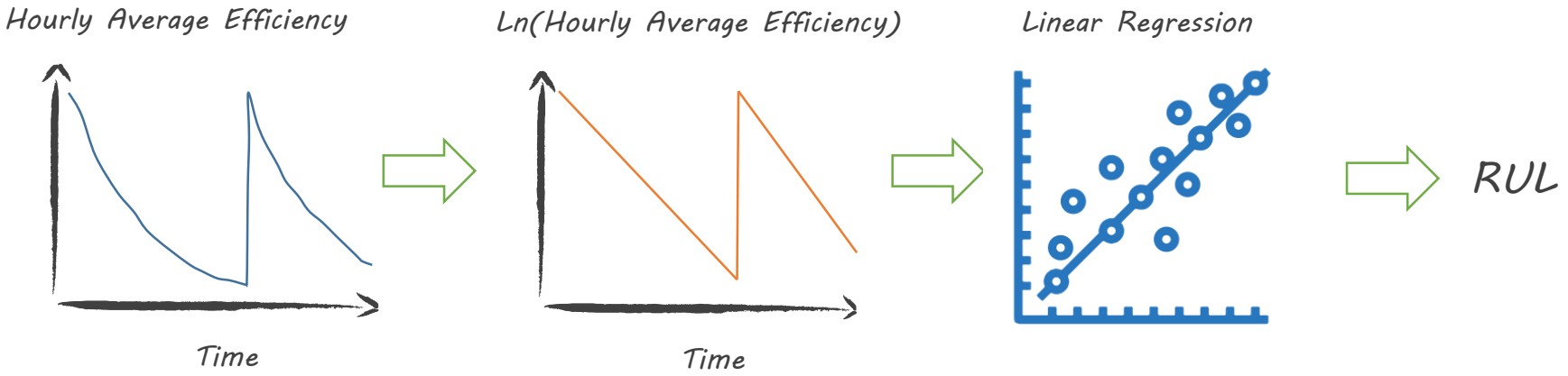
Predictive Based Maintenance

- Pulverizer – early fault detection
- Predict engine failure
- Anomaly detection (HVAC - Air Handler)

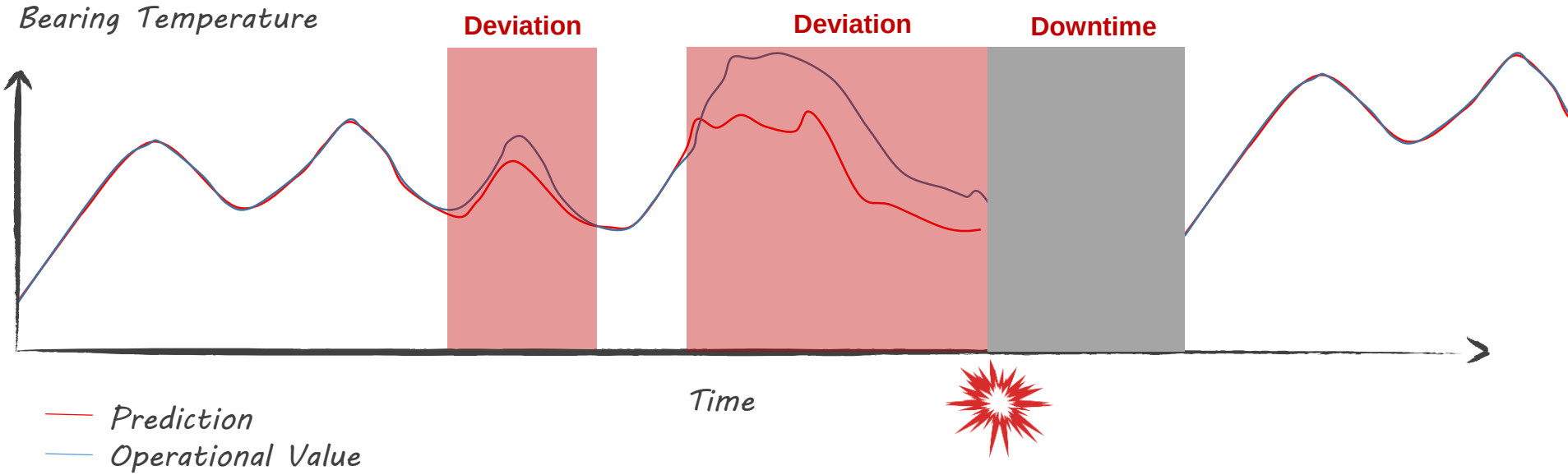




Predictive – RUL (remaining useful life)
RUL for a Pump



Predictive – APR (advanced pattern recognition)



What are our maintenance options?

Reactive

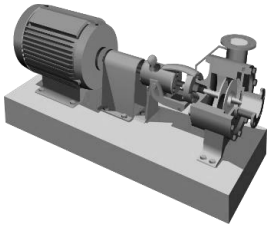
"Break-Fix"
Run to failure

Used Based

Repair based on usage

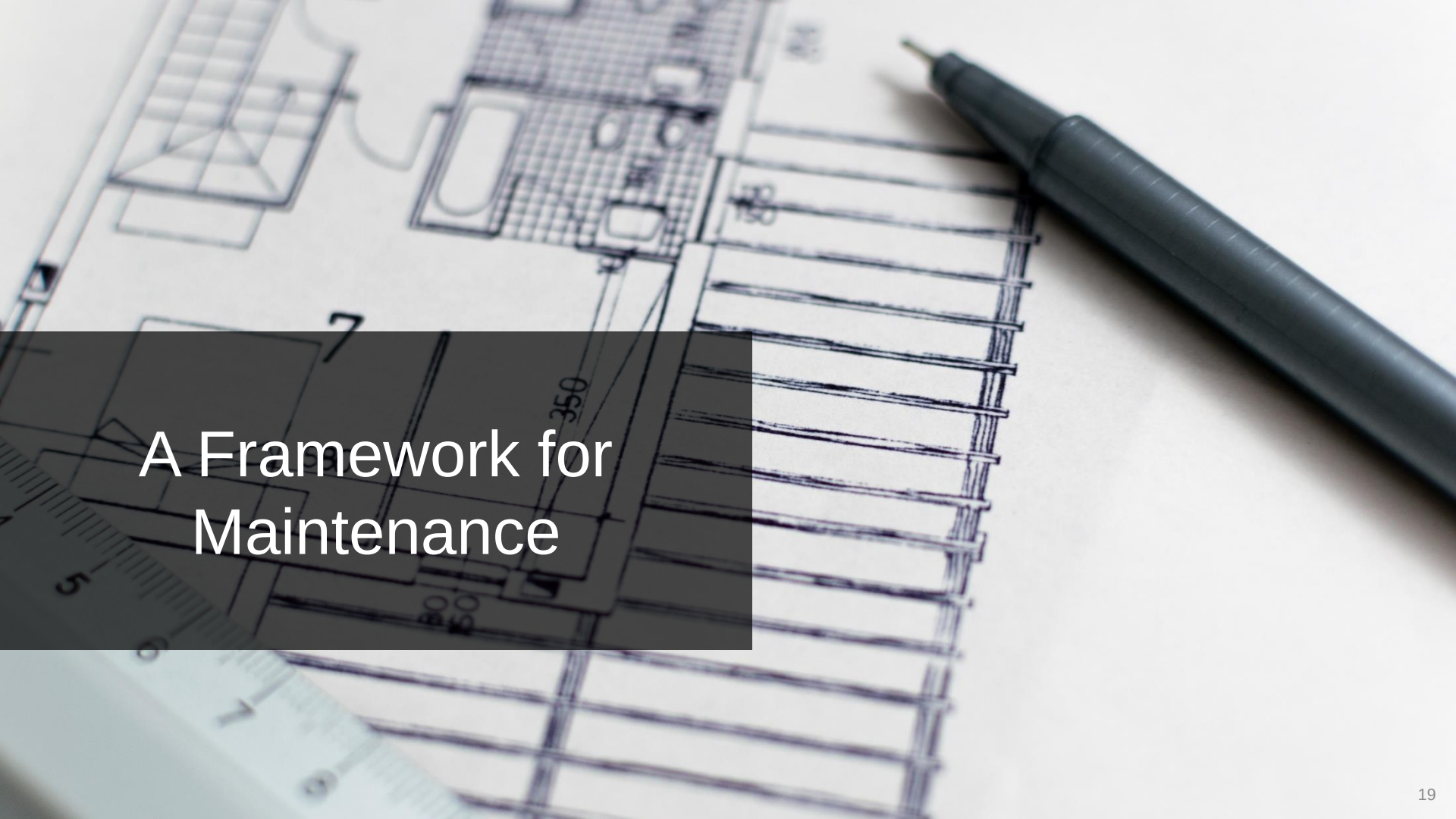
Condition Based

Repair based on insight



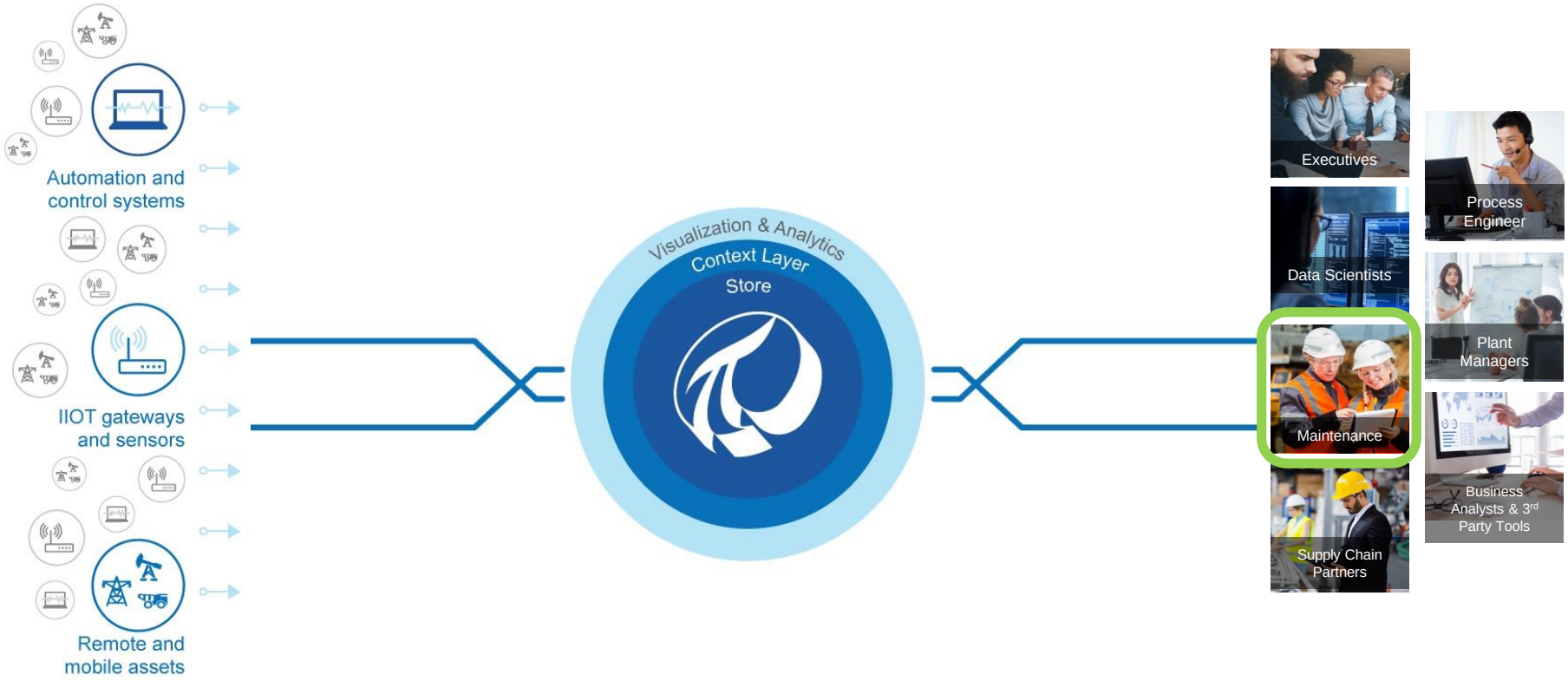
Predictive

Advanced Pattern Recognition

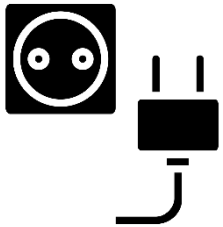


A Framework for Maintenance

OSIsoft – PI System Data Infrastructure



5 Steps of Maintenance



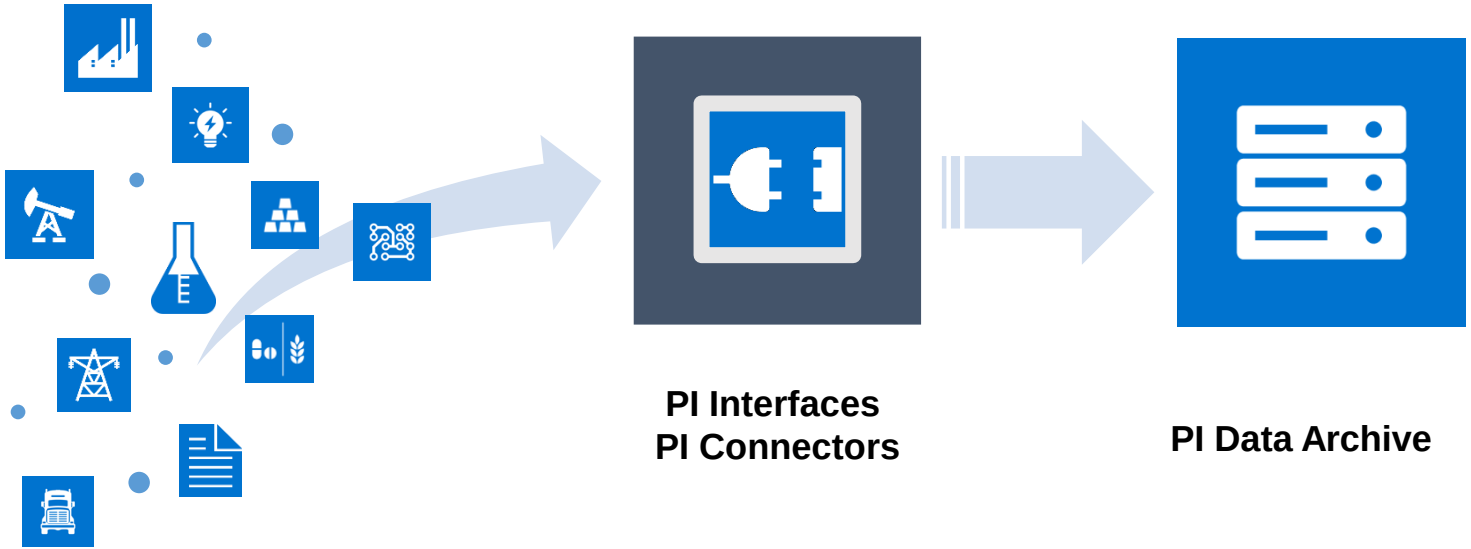
Connect
Collect & Store

Assign Context

Execute
Condition Logic

Alert and Notify

Visualize



PI Interfaces
PI Connectors

PI Data Archive

OPERATIONS

Temperature
Pressure
Voltage
…

UNIFIED DATA

Smarter operation
Improved KPIs
In-context decisions

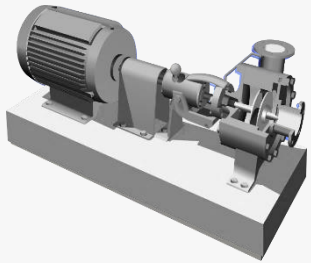
MAINTENANCE

Date of Last Service
Motor Horse Power
Vibration Analysis
…

Building a Digital Model – Start Small

Element Template

Pump



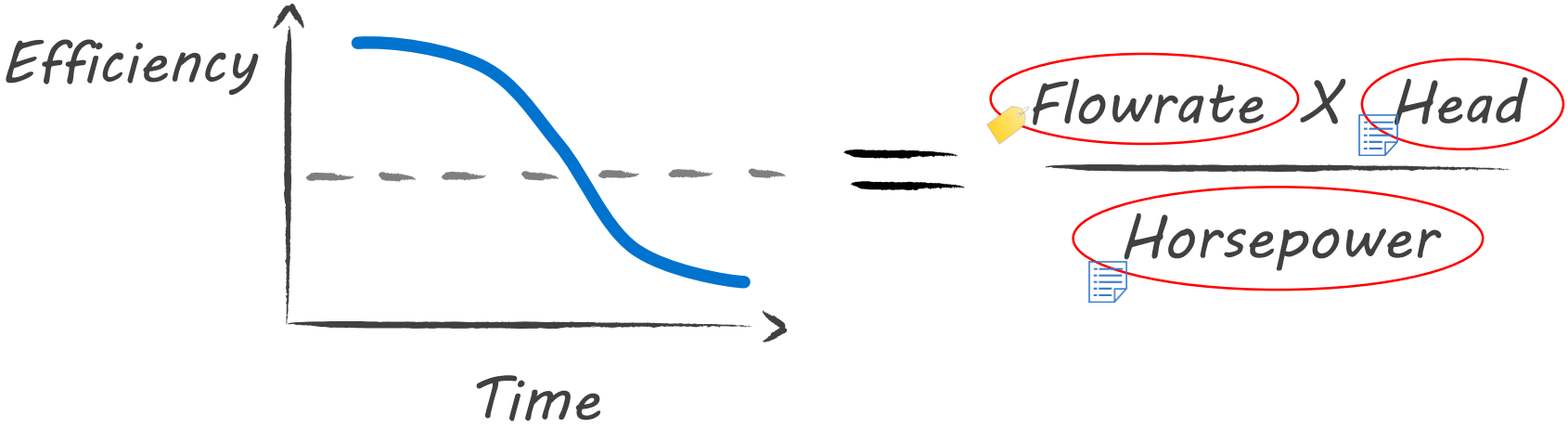
Attributes

- Pump Status
- Discharge Flow Rate
- Horsepower
- Total Head

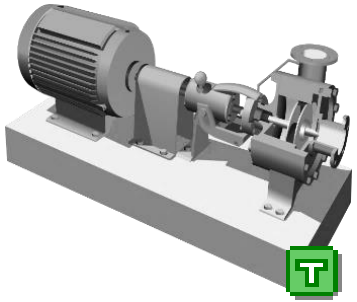
Calculations with Asset Analytics

- Pump Runtime
- Efficiency

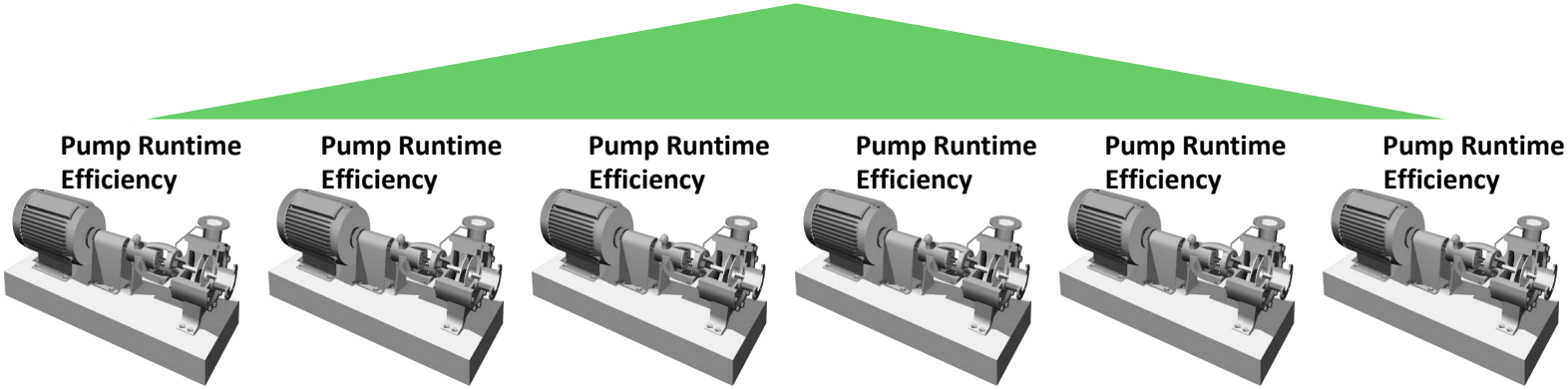
Building a Digital Model – Start Small



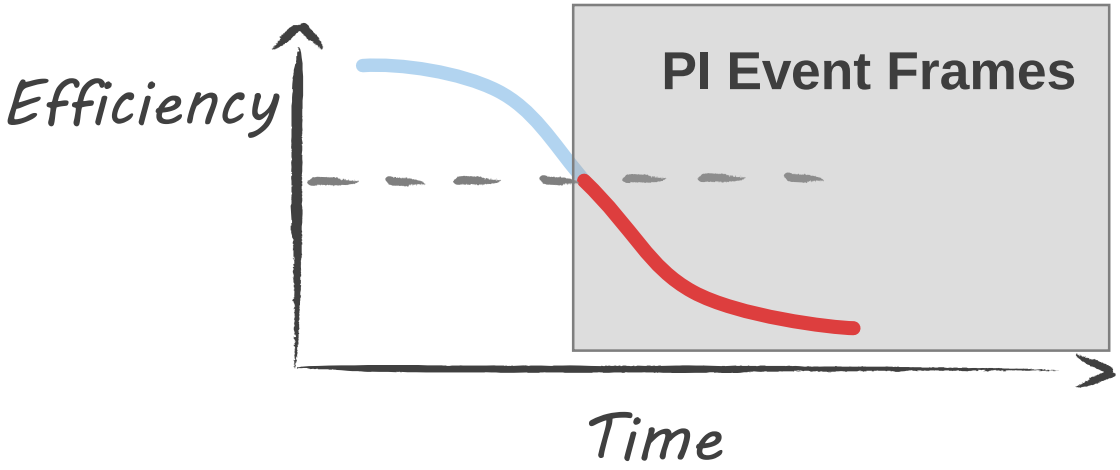
Reuse Your Template



Pump Runtime Efficiency



Pump Efficiency < **75%**



Writing Logic is Simple

x

Elements

Pump01

Attributes

Pump Status

Flow Rate

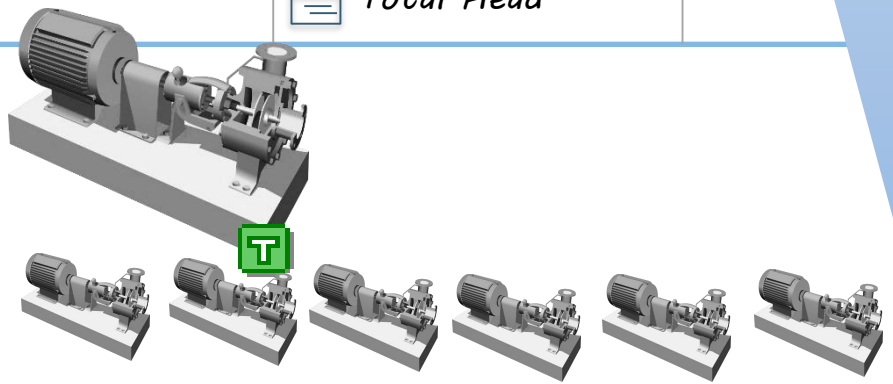
Horsepower

Total Head

Analytics

Run Hours

Pump Efficiency



Maintenance event

Template: Pump maintenance

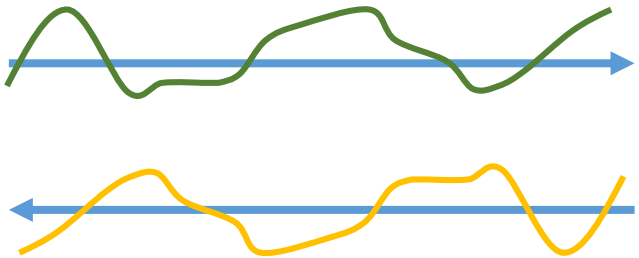
Expression

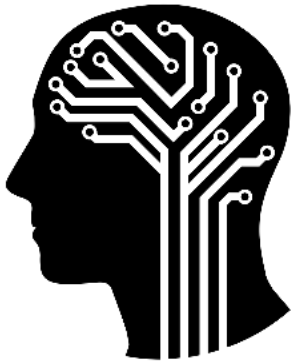
`'Pump Efficiency' < '75'`

True for

`10 min`

Integrate with other systems





Send data in a bi-directional manner

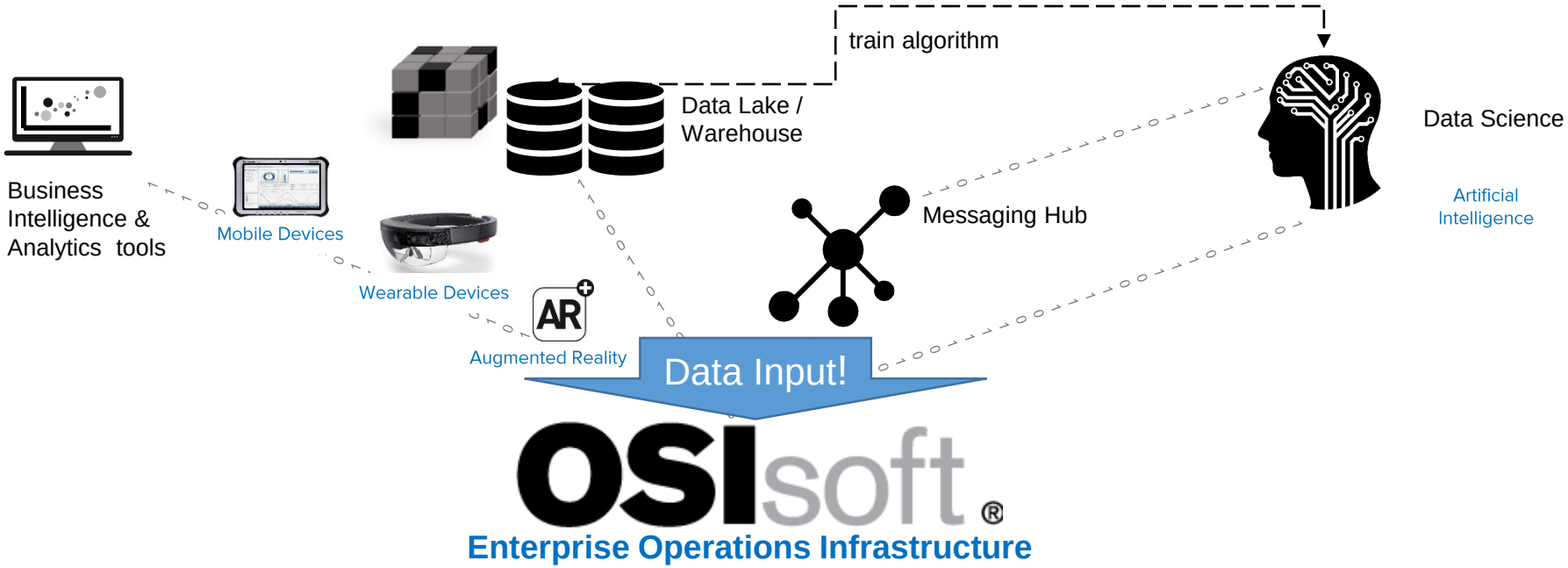
Connect
Collect & Store

Assign Context

Execute
Condition Logic

Alert and Notify

Visualize



Connect
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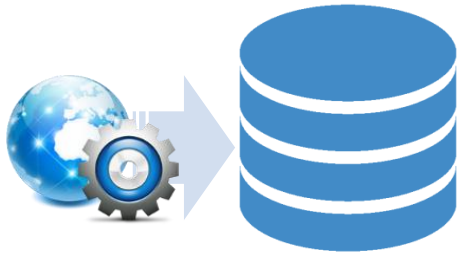
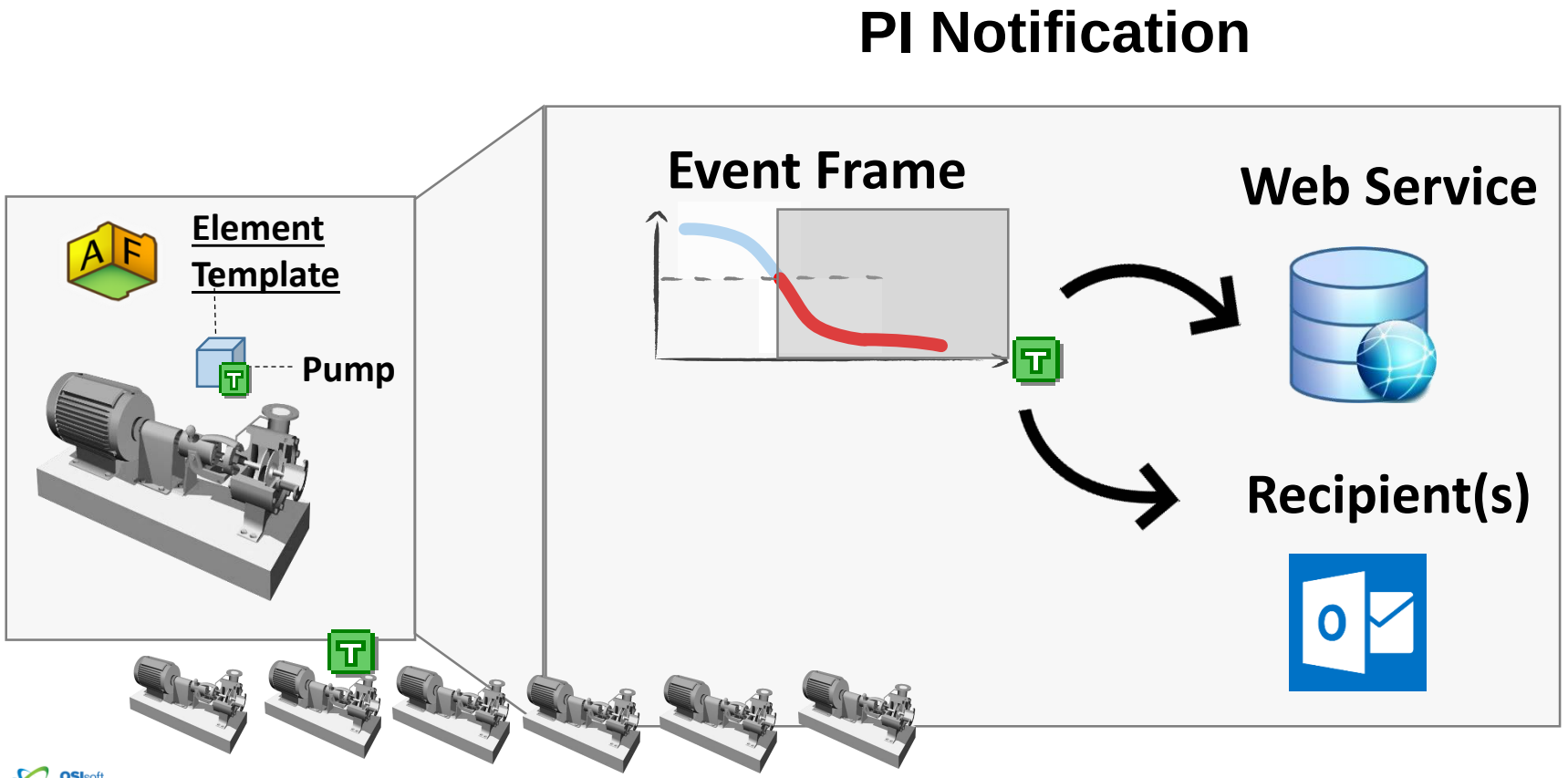
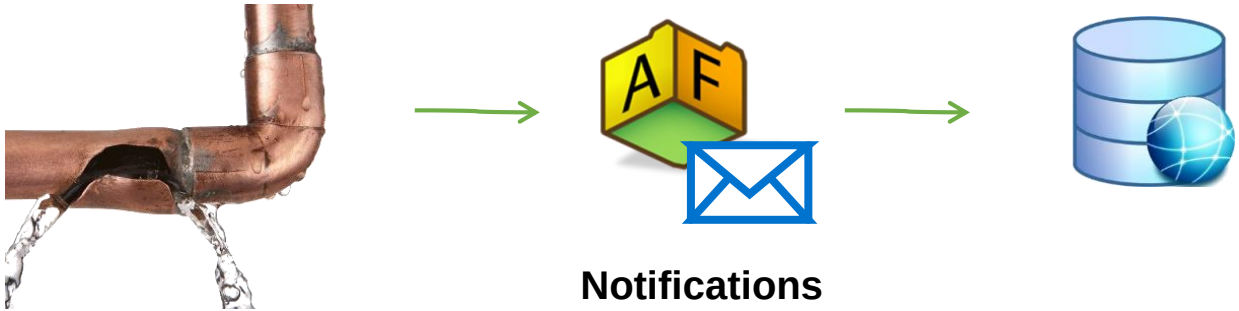


Alert and Notify



Beyond basics: Notifications to a CMMS

(Computerized Maintenance Management System)



Connect
Collect & Store

Assign Context

Execute
Condition Logic

Alert and Notify

Visualize

PI Vision

PI DataLink

Petrolux Refining

Petrolux Downstream FCC Equipment Summary

Refinery
FCC Rollup
Dashboard
PFD Overview
Key Metrics
Feed Quality
IOW
Equipment
Pumps
Exchangers

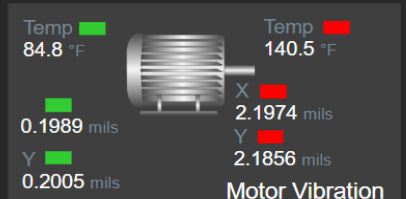
	Pumps				Air Blowers	Heat Exchangers	Wet Gas Compressors
Anacortes	1,991 rpm ANA FCC Pump 1	3,034 rpm ANA FCC Pump 2	1,976 rpm ANA FCC Pump 3	2,022 rpm ANA FCC Pump 4	2,012 rpm ANA FCC Blower 1	Overall U 196.51 Btu/h/ft2/F Heat Exchanger-013	1,984 rpm ANA FCC Wet Gas Compressor 1
Baton Rouge	2,962 rpm BAT FCC Pump 1	2,022 rpm BAT FCC Pump 2	1,996 rpm BAT FCC Pump 3	1,986 rpm BAT FCC Pump 4	1,994 rpm BAT FCC Blower 1	Overall U 203 Btu/h/ft2/F Heat Exchanger-014	1,992 rpm BAT FCC Wet Gas Compressor 1
Houston	1,997 rpm HOU FCC Pump 1	2,004 rpm HOU FCC Pump 2	1,973 rpm HOU FCC Pump 3	1,971 rpm HOU FCC Pump 4	1,977 rpm HOU FCC Blower 1	Overall U 196 Btu/h/ft2/F Heat Exchanger-015	1,983 rpm HOU FCC Wet Gas Compressor 1
Martinez	1,980 rpm MAR FCC Pump 1	1,992 rpm MAR FCC Pump 2	3,023 rpm MAR FCC Pump 3	2,013 rpm MAR FCC Pump 4	1,976 rpm MAR FCC Blower 1	Overall U 196.51 Btu/h/ft2/F Heat Exchanger-013	2,022 rpm MAR FCC Wet Gas Compressor 1
Sarnia	1,994 rpm SAR FCC Pump 1	2,971 rpm SAR FCC Pump 2	2,005 rpm SAR FCC Pump 3	2,013 rpm SAR FCC Pump 4	2,010 rpm SAR FCC Blower 1	Overall U 203 Btu/h/ft2/F Heat Exchanger-014	1,988 rpm SAR FCC Wet Gas Compressor 1

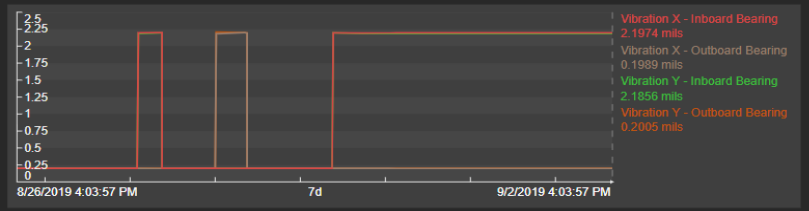
Petrolux Refining

Refinery
FCC Rollup
Dashboard
PFD Overview
Key Metrics
Feed Quality
IOW
Equipment
Pumps
Exchangers
Analysis

BAT FCC Pump 1

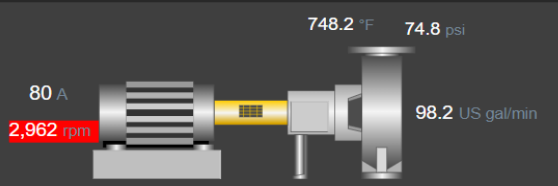
Name	Value
BAT FCC Pump 1|Manufacturer	Imperial Pumps
BAT FCC Pump 1|Serial Number	K2SE
BAT FCC Pump 1|Asset	BAT FCC Pump 1
BAT FCC Pump 1|FCC	BAT FCC 1
BAT FCC Pump 1|Refinery	Baton Rouge Refinery
BAT FCC Pump 1|Date - Installed	1/1/2017 7:00:00 AM
BAT FCC Pump 1|Date - Last Service	8/18/2019 3:30:00 PM





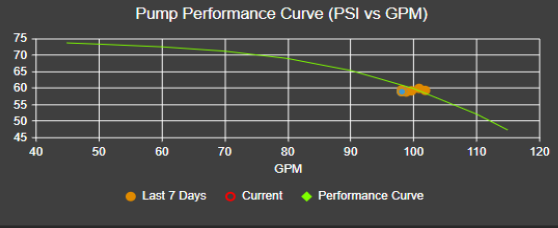
Hours - Run Since Installed
23,323 h

Hours - Run Since Last Service
299.5 h



Pump Operations

Troubleshooting Checklist



High Vibration Events

Event Name	Start Time	End Time	Reason	Acknowledged By
BAT FCC Pump 1 Pump Upset 2019-08-30 00:17:07	8/30/2019 9:17:07 AM	In Progress		
BAT FCC Pump 1 Pump Upset 2019-08-28 15:17:07	8/29/2019 12:17:07 AM	8/29/2019 9:00:07 AM		
BAT FCC Pump 1 Pump Upset 2019-08-27 17:18:07	8/28/2019 2:18:07 AM	8/28/2019 9:00:07 AM		

Bearing Temperature Events

Event Name	Start Time	End Time	Reason	Acknowledged By
BAT FCC Pump 1 Pump Upset 2019-08-30 01:52:07	8/30/2019 10:52:07 AM	In Progress		
BAT FCC Pump 1 Pump Upset 2019-08-28 16:49:07	8/29/2019 1:49:07 AM	8/29/2019 10:00:07 AM		

Cavitation Events

Event Name	Start Time	End Time	Reason	Acknowledged By
BAT FCC Pump 1 Pump Upset 2019-08-30 11:47:07	8/30/2019 8:47:07 PM	In Progress		
BAT FCC Pump 1 Pump Upset 2019-08-30 11:43:07	8/30/2019 8:43:07 PM	8/30/2019 8:46:07 PM		

CSU Raw Water Pump Diagnostics - DCH.xlsx - Excel

File | Home | Insert | Page Layout | Formulas | Data | Review | View | ACROBAT | Tell me what you want to do... | Keith Pierce | Share

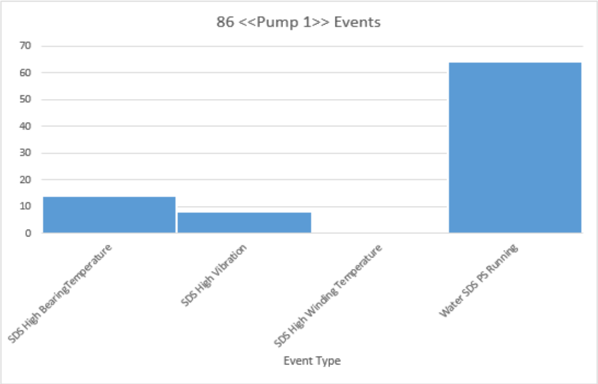
L23

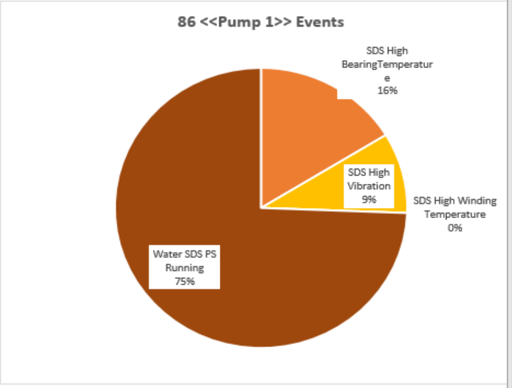
Row	C	D	E	F	G	H	I	J	K	L	M	N
1			Pump Station	**SD Juniper (Raw)**		**Performance Data**		**Forcasting Dates**			Current Values	
2	***-90d**					Run Rate	3	**Cicuit Breaker Test Forecast**		#NAME?	**Monthly Total Starts**	#NAME?
3	***-1d**		Pump Name	**Pump 1**		Runhours Last 30 Days	45	**Cooling Fan Check Forecast**		#NAME?	**Yearly Total Starts**	#NAME?
4						Runhours Last 90 Days	240	**Thermography Maint Forecast**		#NAME?		
5						7 Day Avg kwH per MG	0.00					
6						kwH per MG	1450.20					

Row	C	D	E	F	G	H	I	J	K	L	M
11	VIBRATION DATA					BEARING TEMPERATURES				Motor	
12	Bottom X Axis Vib	Bottom Y Axis Vib	Top X Axis Vib	Top Y Axis Vib	Top Z Axis Vib	Lower Bearing Temperature	Thrust Bearing Temperature 1	Thrust Bearing Temperature 2	Upper Bearing Temperature	PhaseA Winding Temperature 1	
13	in/s^2	in/s^2	in/s^2	in/s^2	in/s^2	°F	°F	°F	°F	°F	UOM
14	0.001342814	0.00	0.00	0.01	0.00	74.98583221	80.75234985	79.92961121	79.80238342	82.43	Value at Start: 18-Nov-16 14:18:15
15	0.000885037	0.00	0.00	0.00	0.00	72.78	75.16	74.33	74.33	76.57	Value at End: 15-Feb-17 14:15:59
16	0	0.00	0.00	0.00	0.00	64.87	68.89	67.62	67.92	69.69	Minimum
17	0.00	0.00	0.01	0.01	0.00	72.95	80.77	78.59	79.30	82.46	Average
18	0.09	0.07	0.16	0.11	0.03	96.66	126.82	113.47	121.66	132.30	Maximum
19	0.01	0.01	0.01	0.01	0.00	6.04	15.57	12.09	14.28	15.90	StDev

Row	C	D	E	F	G	H
22	**EF NAME**		**EVENT CATEGORY**			**EVENT TEMPLATE**
23	*		*			*
25		Minimum	0 0:00:03		Minimum	0.0
26		Average	0 13:05:10		Average	87.5
27		StdDev	0 5:56:29		StdDev	274.1
28		Maximum	1 0:00:20		Maximum	1440.3

Row	Start time	End time	Duration	Event template	Duration Minutes
31	19-Nov-16 22:06:23	20-Nov-16 13:10:45	0 15:04:22	Water SDS PS Running	904.4
32	19-Nov-16 23:00:00	20-Nov-16 13:20:00	0 14:20:00	SDS High BearingTempe	860.0
33	20-Nov-16 22:06:23	21-Nov-16 15:00:46	0 16:54:23	Water SDS PS Running	1014.4
34	20-Nov-16 22:30:00	21-Nov-16 15:10:00	0 16:40:00	SDS High BearingTempe	1000.0
35	21-Nov-16 22:06:25	22-Nov-16 13:29:13	0 15:22:49	Water SDS PS Running	922.8
36	21-Nov-16 22:50:00	22-Nov-16 13:30:00	0 14:40:00	SDS High BearingTempe	880.0
37	24-Nov-16 22:06:22	25-Nov-16 15:00:41	0 16:54:19	Water SDS PS Running	1014.3
38	24-Nov-16 22:06:22	25-Nov-16 15:01:30	0 16:55:07	Water SDS PS Running	1015.1
39	24-Nov-16 22:06:24	25-Nov-16 15:00:45	0 16:54:21	Water SDS PS Running	1014.4
40	24-Nov-16 22:40:00	25-Nov-16 15:10:00	0 16:30:00	SDS High BearingTempe	990.0
41	24-Nov-16 23:00:00	25-Nov-16 15:10:00	0 16:10:00	SDS High BearingTempe	970.0
42	25-Nov-16 22:06:23	26-Nov-16 12:38:39	0 14:32:16	Water SDS PS Running	872.3
43	26-Nov-16 22:06:22	27-Nov-16 15:00:42	0 16:54:19	Water SDS PS Running	1014.3
44	27-Nov-16 22:06:24	28-Nov-16 15:00:42	0 16:54:17	Water SDS PS Running	1014.3
45	28-Nov-16 22:06:24	29-Nov-16 14:12:00	0 16:05:37	Water SDS PS Running	965.6
46	28-Nov-16 22:06:24	29-Nov-16 14:12:48	0 16:06:24	Water SDS PS Running	966.4
47	28-Nov-16 23:10:00	29-Nov-16 14:20:00	0 15:10:00	SDS High BearingTempe	910.0
48	29-Nov-16 14:12:27	29-Nov-16 14:12:30	0 0:00:03	SDS High Vibration	0.1
49	29-Nov-16 22:06:22	30-Nov-16 15:00:45	0 16:54:22	Water SDS PS Running	1014.4
50	29-Nov-16 22:06:23	30-Nov-16 15:00:40	0 16:54:18	Water SDS PS Running	1014.3





Pump Diagnostics | Runtime and Energy Analysis

Ready Calculate 70%

***PI Integrators speed the process** that **brings trustworthy data** to many unique analytics tools*

SAP HANA

Amazon Web Services

5 Steps of Maintenance

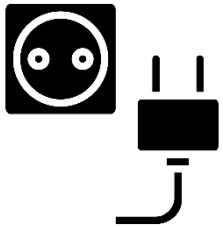
Connect
Collect & Store

Assign Context

Execute
Condition Logic

Alert and Notify

Visualize



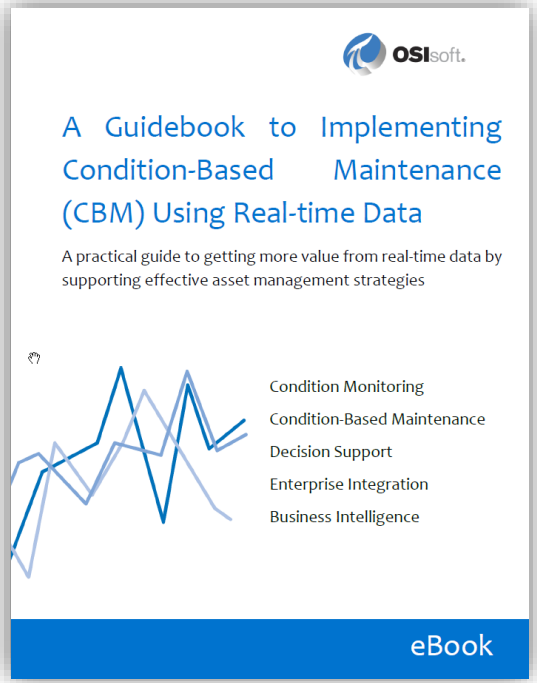

Resources to Help you Succeed

PI Square

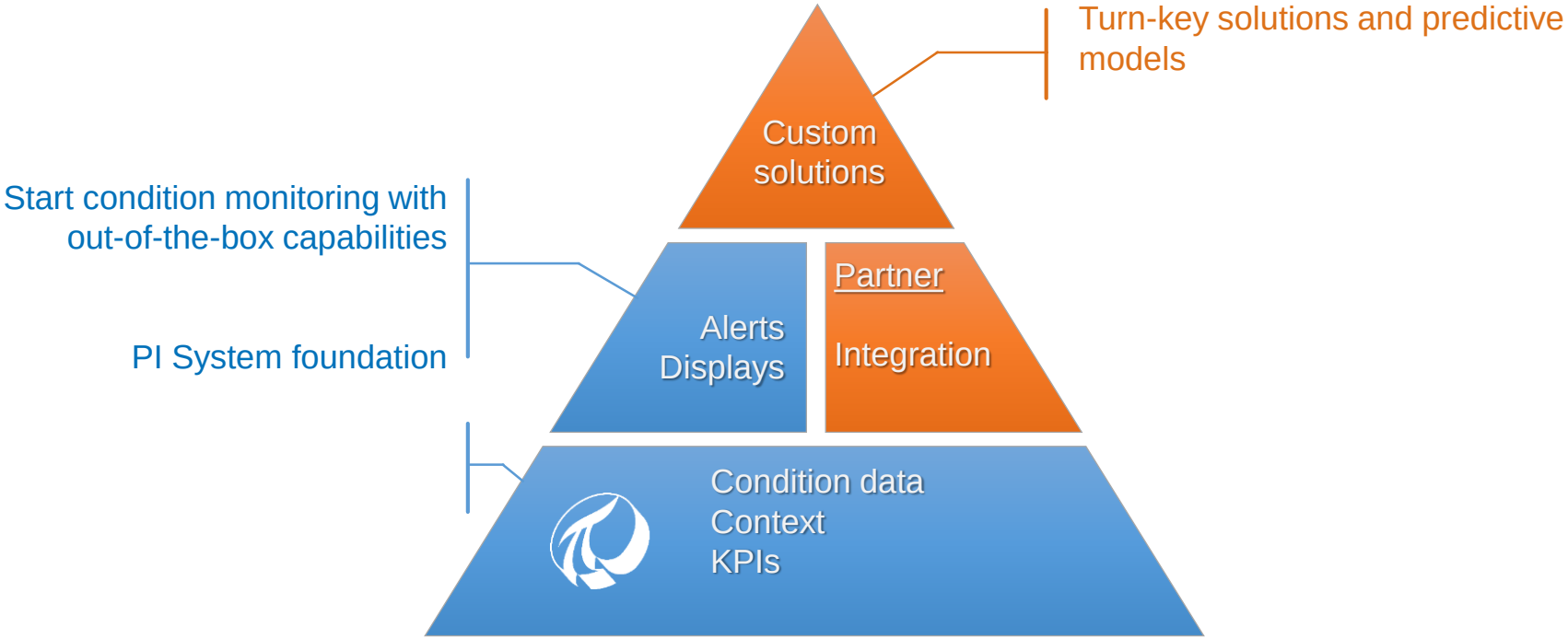
The OSIsoft Community

All Places > All Things PI - Ask, Discuss, Connect

Asset Based PI Example Kits

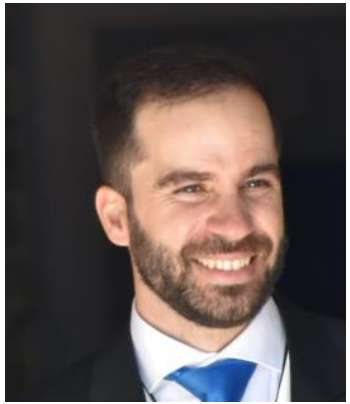


Partners Are Here to Help



Source: https://www.arcweb.com/blog/improve-asset-uptime-industrial-iot-analytics

Contact us for more information…



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OSIsoft, LLC

Questions?

Please wait for the **microphone**

State your **name & company**

Please remember to…

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