

NOV 16, 2022

Scaling AI & ML Globally

Albemarle Intelligence

The Intelligence may be Artificial, but the Success is Real -
The Albemarle Intelligence story

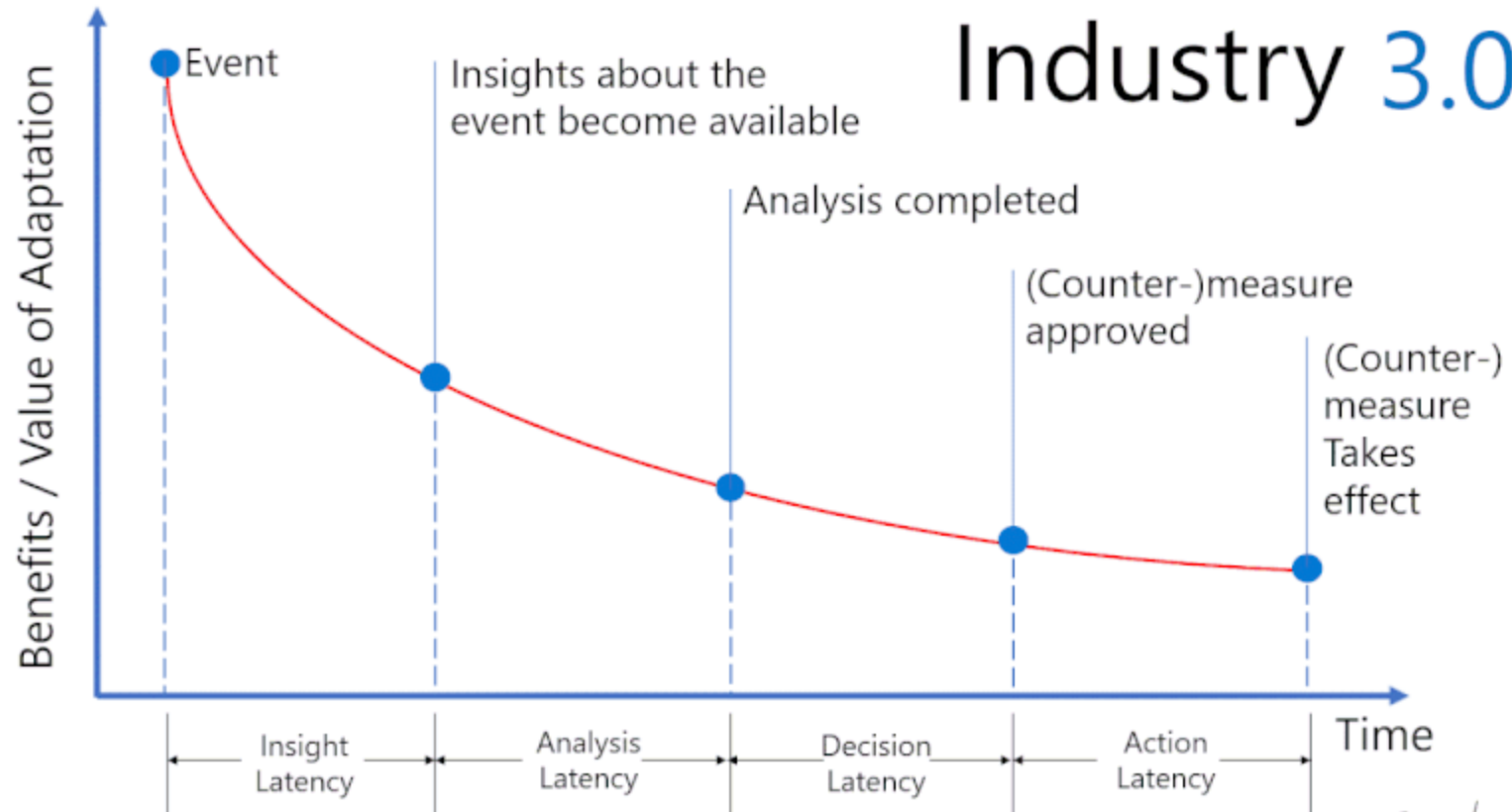
Presented By: Jonathan Alexander

AVEVA

25,000
minutes
annually



Industry 3.0



Source: Acatech's Industrie 4.0 Maturity Index

Jeff Winter

Data

Insights

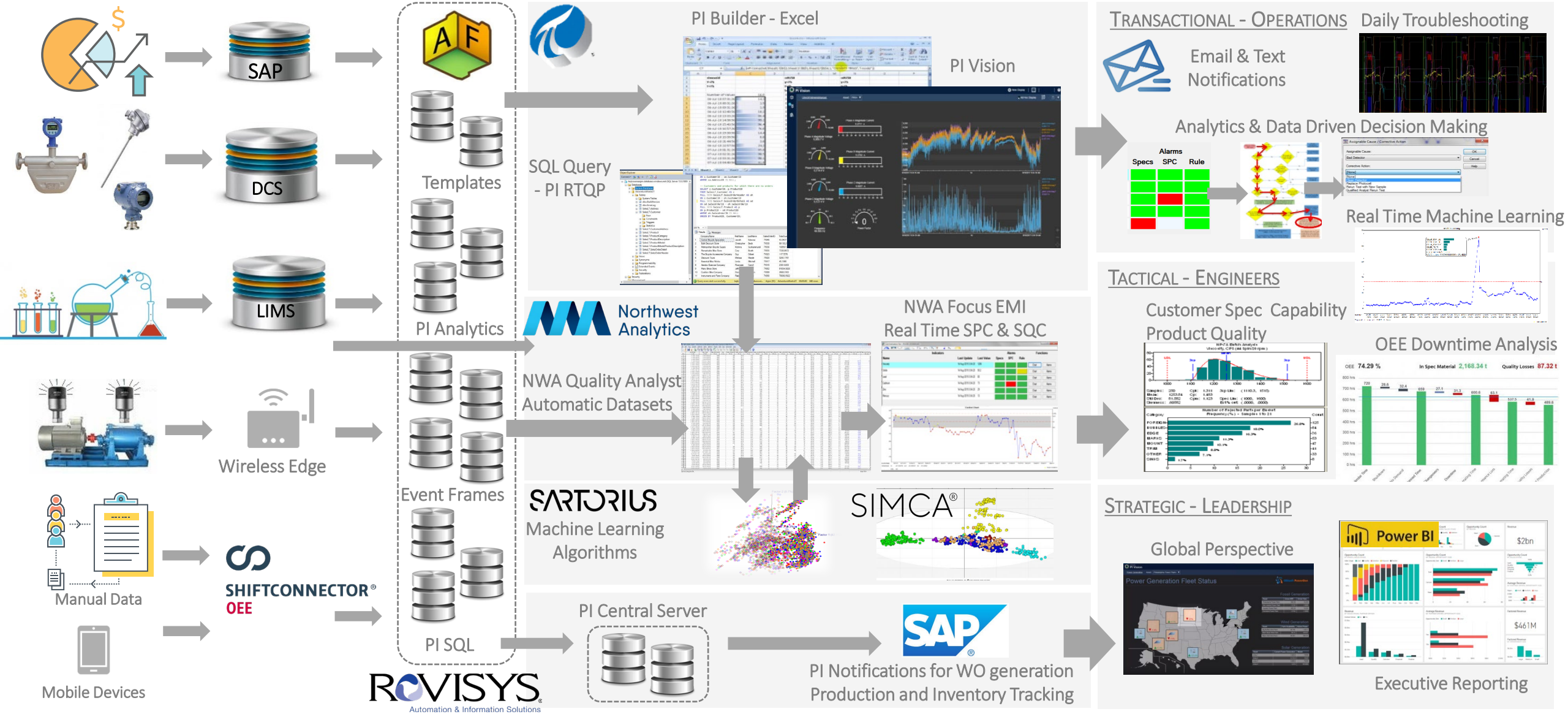


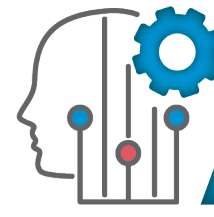
DATA SOURCES

AVEVA PI SYSTEM ASSET FRAMEWORK

DATA ANALYTICS SUITE

USER ROLES

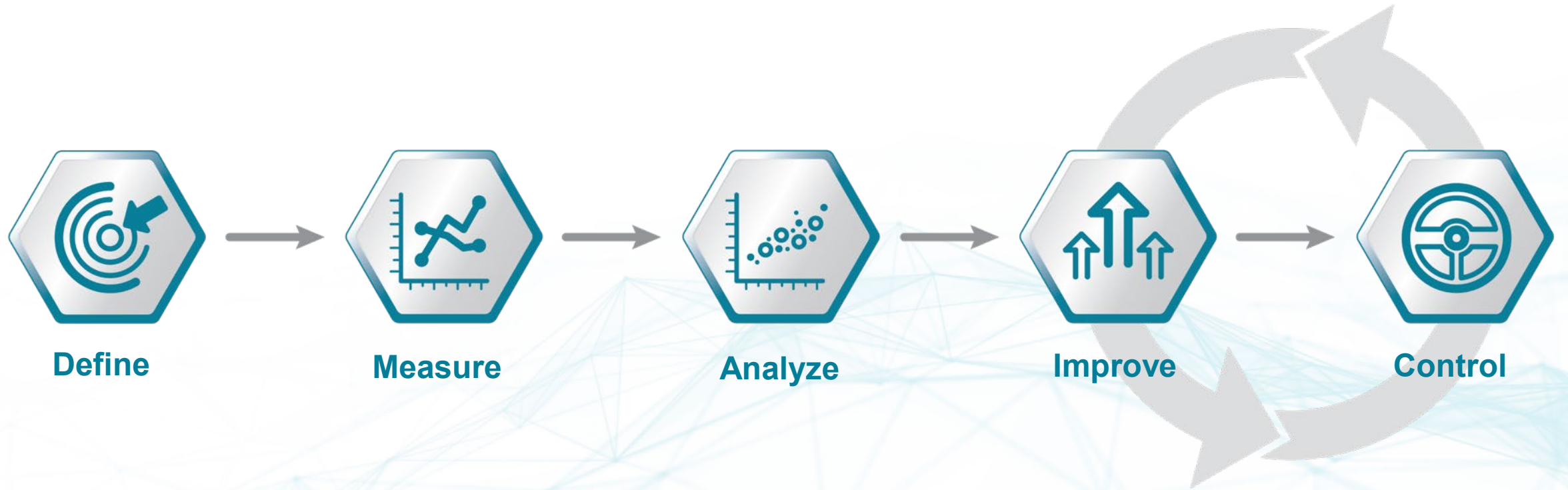




ALBEMARLE INTELLIGENCE



Six Sigma: Manual Version



Six Sigma: Automated



Define



Measure



Analyze

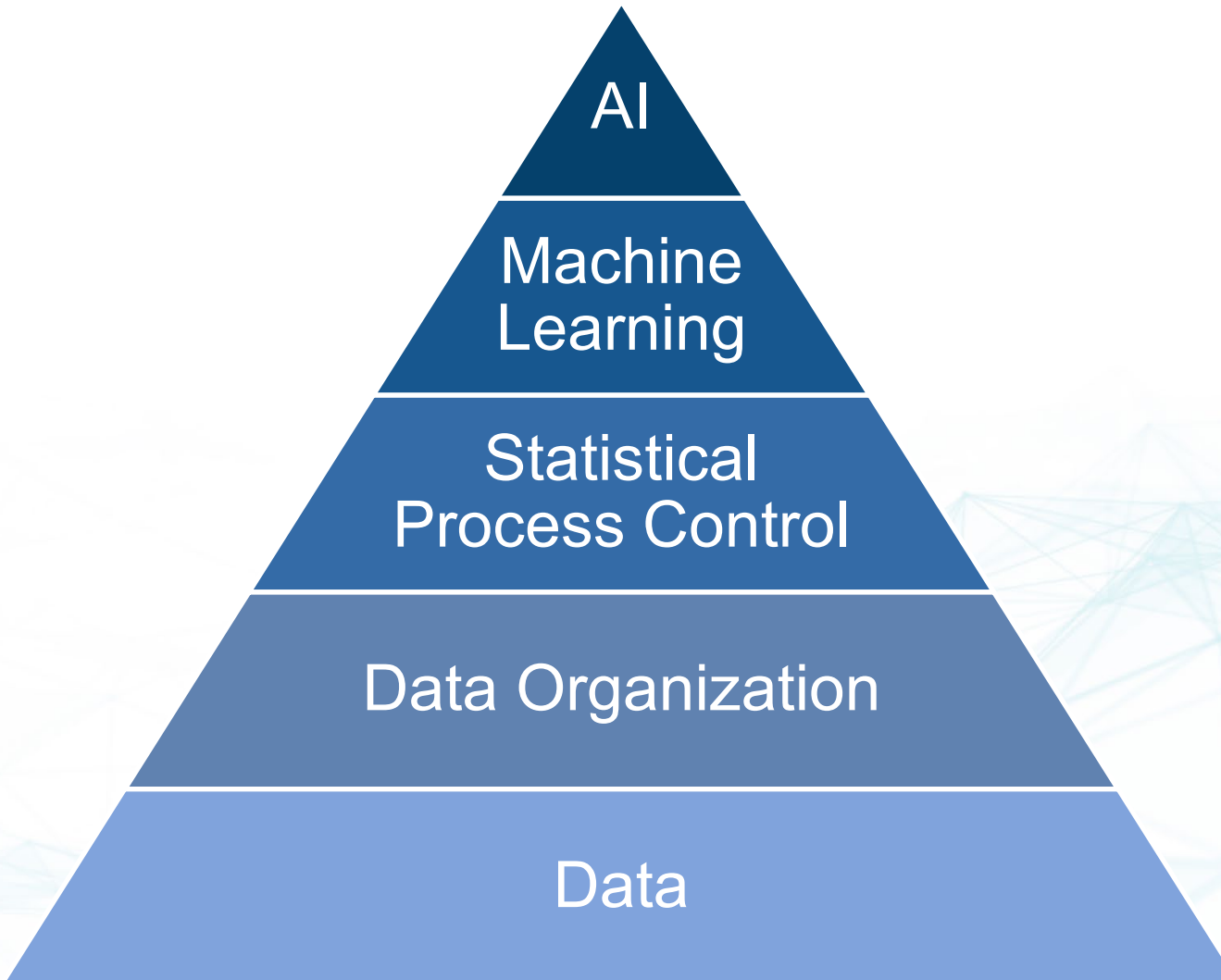


Improve



Control

AI Strategy



Automation

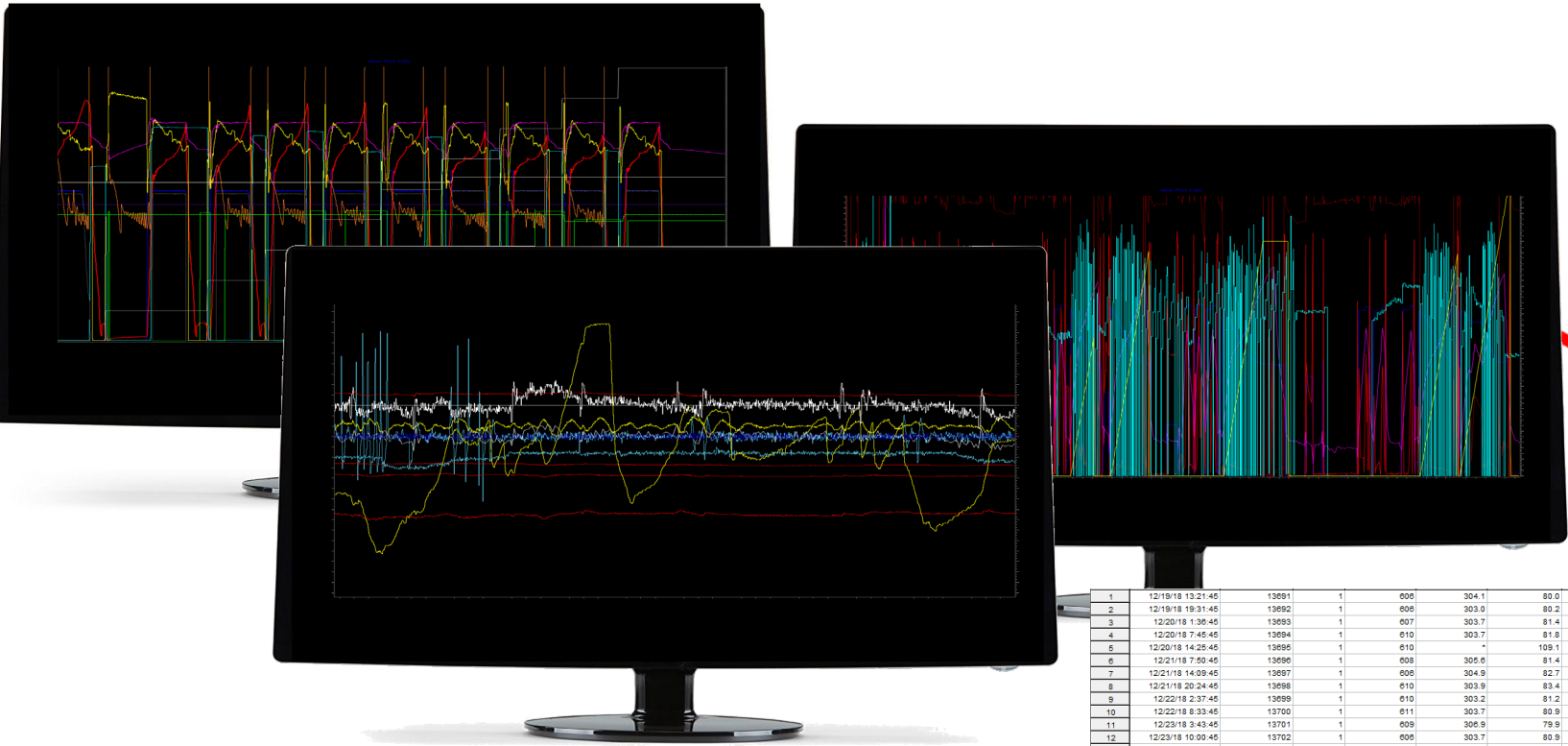
- Key Process Variables Monitored Automatically
- Standardized Global Data Structure
- Supports Global Growth & Economies of Scale

Stabilization

- Statistical Actionboards enable Engineers & Operations to minimize Firefighting
- Improved Process Control
- Improved Equipment Reliability

Innovation

- “Data at your fingertips” enables Engineers to do more Engineering
- Advanced Analytics & Machine Learning techniques unlock unknown correlations and pre
- Positions Albemarle as a global leader in Digital Manufacturing & Industry 4.0

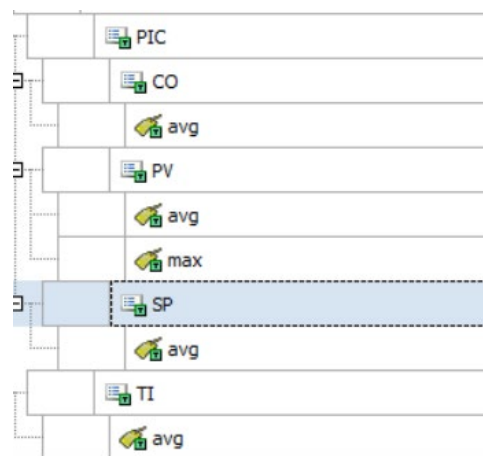


1	12/19/18 13:21:45	13691	1	606	304.1	80.0	2098	44.5	22	104	107	77	164.40	7149	6419.3	2.3	8847.334
2	12/19/18 18:31:45	13692	1	606	303.0	80.2	2048	44.5	23	101	136	77	164.01	7148	6380.6	2.3	8409.153
3	12/20/18 1:30:45	13693	1	007	303.7	81.4	2226	44.5	24	101	125	77	164.13	7149	6386.1	2.3	8478.928
4	12/20/18 7:45:45	13694	1	610	303.7	81.8	2316	44.5	25	98	132	77	164.01	7151	6327.4	2.3	8499.395
5	12/20/18 14:29:45	13695	1	610	-	109.1	2090	44.5	26	98	100	79	162.23	7150	6338.3	2.3	8611.953
6	12/21/18 7:50:45	13696	1	608	305.6	81.4	1227	45	27	108	148	80	162.42	7149	6447.5	2.3	8683.598
7	12/21/18 14:09:45	13697	1	606	304.9	82.7	2054	45	28	98	146	79	162.27	7151	6362.6	2.3	8832.448
8	12/21/18 20:24:45	13698	1	610	303.9	83.4	2061	45	29	97	144	80	162.08	7150	6406.9	2.2	7730.021
9	12/22/18 2:37:45	13699	1	610	303.2	81.2	-	45	30	97	87	80	162.21	7150	6440.3	2.2	8021.211
10	12/22/18 8:33:45	13700	1	611	303.7	80.9	2013	45	31	97	117	78	162.12	7150	6323.9	2.3	8285.421
11	12/23/18 3:43:45	13701	1	609	306.9	79.9	2140	45	32	107	87	80	162.38	7148	6526.2	2.3	7762.932
12	12/23/18 10:00:45	13702	1	606	303.7	80.9	2176	45	33	98	137	81	162.26	7149	6197.5	2.2	6291.748
13	12/23/18 16:50:45	13703	1	611	306.2	85.1	2084	45	34	96	137	82	162.29	7151	6414.4	2.2	7666.285
14	12/23/18 22:54:45	13704	1	-	311.6	81.9	2048	45	35	102	126	74	162.70	7152	6028.4	2.3	10093.03
15	12/24/18 7:31:45	13705	1	002	309.4	81.4	2090	45	36	94	280	71	162.48	7155	5982.3	2.4	11320.12
16	12/24/18 14:37:45	13706	1	645	309.5	84.2	2043	45	37	96	183	74	161.79	7157	5706.0	2.3	11832.73
17	12/24/18 20:33:45	13707	1	603	312.2	85.6	2068	45	38	99	105	79	162.27	7153	6345.2	2.2	9536.7
18	12/25/18 2:45:45	13708	1	603	309.8	82.2	2050	45	39	94	119	70	162.32	7156	5818.0	2.2	11451.3
19	12/25/18 10:40:45	13709	1	603	310.2	81.5	1877	45	40	96	244	72	162.21	7153	6043.8	3.0	11545.26
20	12/25/18 17:26:45	13710	1	602	312.4	85.1	2055	45	41	96	167	77	162.22	7154	6183.0	2.9	10347.01
21	12/26/18 0:00:45	13711	1	609	309.1	84.7	2022	45	42	96	168	80	158.78	7151	6091.4	2.8	8602.66
22	12/26/18 6:03:45	13712	1	569	309.7	83.9	2146	45	43	94	139	72	158.57	7158	5812.0	2.8	11360.13
23	12/26/18 12:55:45	13713	1	603	312.7	83.9	2022	46	44	99	173	79	162.28	7153	6170.2	2.6	9911.619
24	12/26/18 18:22:45	13714	1	605	307.8	85.4	2051	45	45	98	137	81	162.18	7150	6102.3	2.9	7056.47
25	12/27/18 1:04:45	13715	1	606	308.3	84.7	1971	45	46	100	111	81	162.26	7150	6211.3	2.9	7109.498
26	12/27/18 6:48:45	13716	1	606	308.8	83.8	2158	45	47	101	109	80	162.03	7149	6233.1	2.9	8123.546
27	12/27/18 12:44:45	13717	1	609	313.8	84.4	2019	45	48	106	112	80	161.58	7147	6333.8	2.9	8759.883
28	12/27/18 18:53:45	13718	1	603	307.8	84.7	1897	45	49	104	130	78	161.39	7149	6197.8	2.8	8932.923
29	12/28/18 2:10:45	13719	1	602	307.0	85.2	2097	45	50	104	128	79	161.53	7150	6237.0	2.9	9511.07
30	12/28/18 7:06:45	13720	1	602	309.8	85.0	2012	45	51	103	130	78	161.62	7151	6183.3	2.7	9639.528
31	12/28/18 16:17:45	13721	1	598	308.8	85.6	1937	45	52	118	288	85	161.21	7151	6504.8	2.7	9886.975
32	12/28/18 22:40:45	13722	1	597	312.8	86.3	1953	45	53	120	120	85	161.08	7151	6000.9	2.9	10409.81
33	12/29/18 5:20:45	13723	1	598	307.0	85.0	1852	45	54	117	130	83	161.17	7151	6356.3	2.7	9537.83
34	1/11/19 19:03:45	13725	3	565	307.9	86.4	2031	45	56	108	438	56	160.93	7148	6067.6	2.9	10104.2
35	1/12/19 2:10:45	13726	1	599	300.7	87.9	1967	45	57	119	166	85	160.92	7150	6326.3	2.6	7165.784
36	1/12/19 8:16:45	13727	1	577	305.3	85.4	1966	45	58	117	109	84	160.97	7151	6336.5	2.8	10049.31
37	1/12/19 15:02:45	13728	1	602	303.1	83.5	1944	45	59	117	152	82	160.99	7148	6277.2	2.8	8655.688
38	1/12/19 21:23:45	13729	1	602	306.0	84.0	1797	45	60	118	126	85	160.93	7148	6433.7	2.9	9641.389
39	1/13/19 4:11:45	13730	1	605	302.9	82.6	1735	45	61	119	156	83	160.85	7144	6283.6	2.9	8946.879
40	1/13/19 10:39:45	13731	1	602	303.4	83.5	2006	45	62	118	132	83	160.97	7147	6282.8	2.7	9694.854
41	1/13/19 17:16:45	13732	1	603	302.9	82.5	1946	45	63	116	124	80	160.97	7147	6046.4	2.9	9161.319
42	1/13/19 23:45:45	13733	1	602	304.9	83.1	2076	45	64	119	122	81	160.89	7145	6236.5	2.9	9758.116
43	1/14/19 6:23:45	13734	1	602	303.3	83.5	2041	45	65	117	140	80	160.99	7147	6148.1	2.9	9389.709
44	1/14/19 12:50:45	13735	1	602	303.7	83.9	2026	45	66	117	136	81	161.01	7147	6171.1	2.9	9540.422
45	1/14/19 19:23:45	13736	1	602	304.3	83.9	2013	45	67	118	135	82	161.83	7147	6187.4	3.0	9524.605
46	1/15/19 1:47:45	13737	1	602	305.9	83.6	2004	45	68	120	120	82	161.73	7146	6279.8	2.9	9932.080
47	1/15/19 8:05:45	13738	1	603	309.9	83.7	1977	45	69	121	121	82	161.88	7146	6287.2	2.9	9844.036
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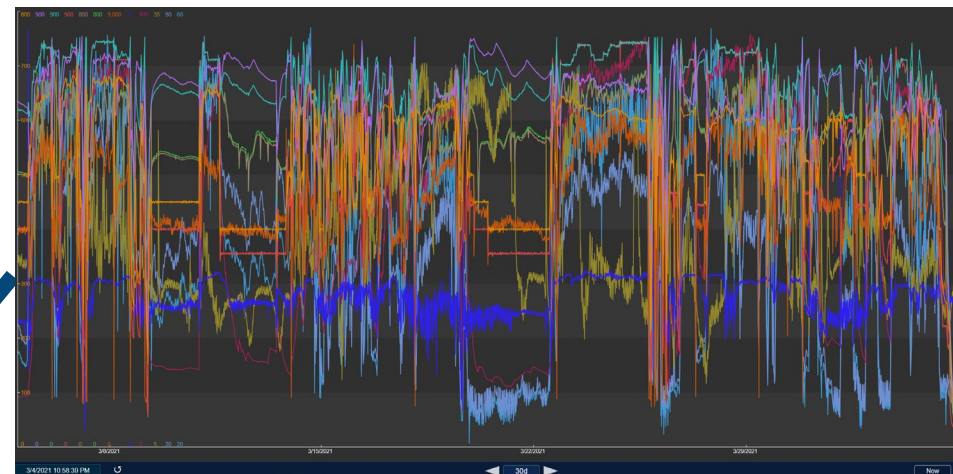
Scaling Event Frames as an Analytics Engine

- Event Frames created to be triggered when unit is down, starting up, or running at steady state.
- PI Vision utilized when deciding which attributes to capture and what summary analytics were needed for best analysis of calciner performance
- Query to align EF on an hourly basis onto a single row.
- Filter Dataset by Relational Fields:
 - Product
 - Recipe
 - Campaign
 - Unit Operation
 - Shift
 - Status Flag
 - Weather
- LIMS Laboratory data can be merged with PI Process data to predict production rate and quality issues

PI Builder – Automated Event Frame & Output Analytic Generator
Capture Key Process Indicators

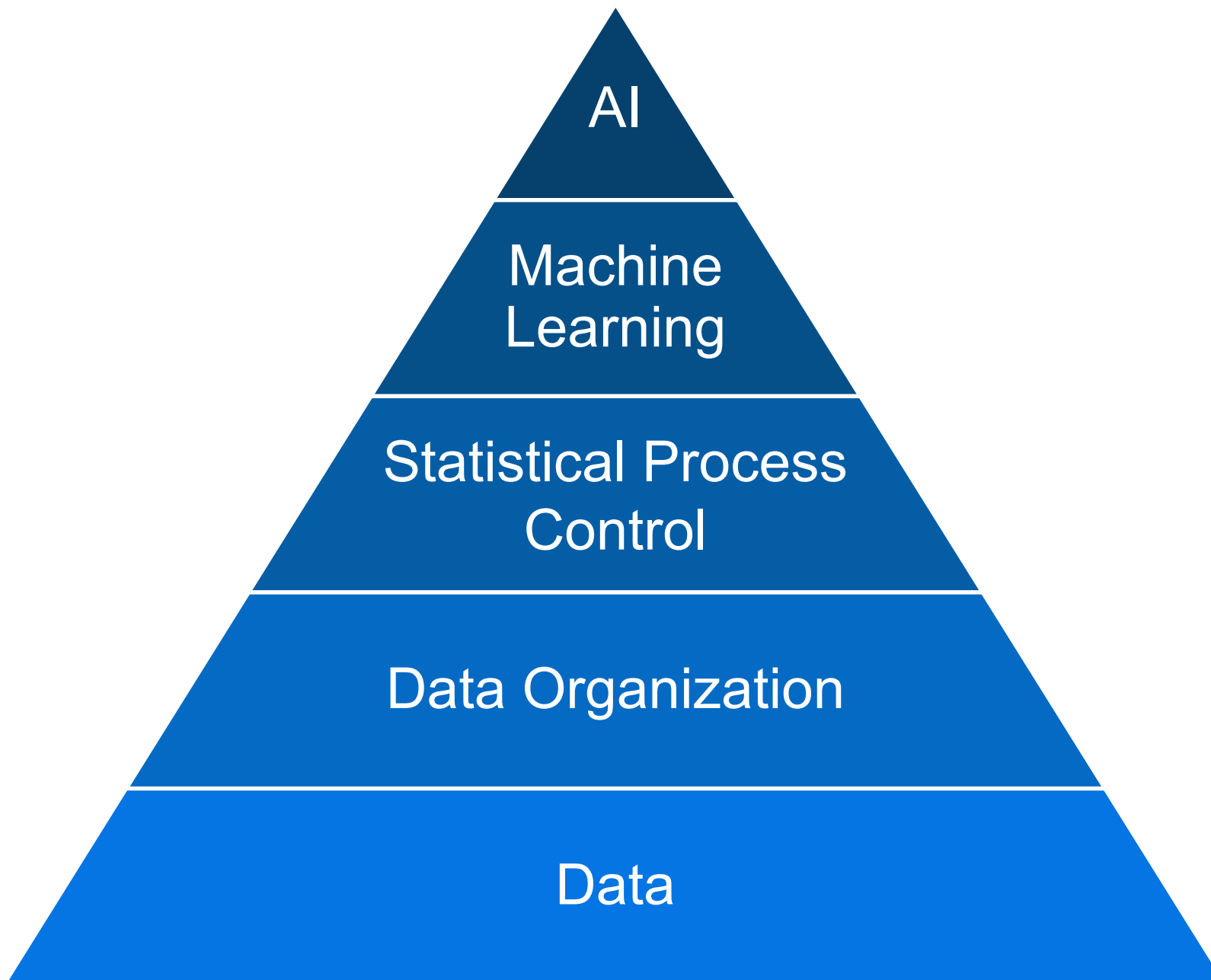


PI Vision – Time Series Trend



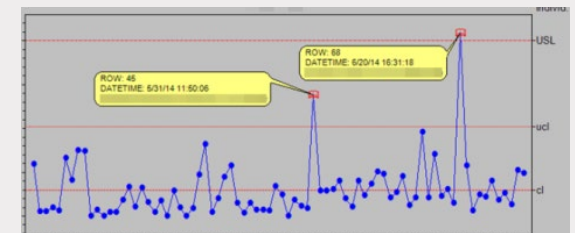
Time Series Data converted to NWA Automated Dataset

Running	0.3718942	2.909119	216.495739360325	-0.1321941	383.8147
StartUp	-0.4279914	-0.2840576	322.800671033938	0.1736194	63.82583
Running	-0.4223962	-0.3425598	305.745576461575	0.1763347	62.66646
Shutdown	-0.4734771	-0.324707	298.052300682118	0.1772715	61.86706
Running	0.2159671	0.4127502	220.930605507834	-0.1006555	313.9682
Down	-0.5094602	-0.2527466	284.357069405793	0.1859251	60.79785
StartUp	-0.5613872	-0.3166433	278.476235098077	0.2133375	68.21075
Running	-0.5736619	-0.4169922	284.672640178253	0.2123941	73.50066
Running	-1.567335	0.441864	137.47848793637	-0.1428007	371.2763
Running	-0.5626348	8.453369E-03	302.569833874968	0.2008539	71.44946
Running	-1.412884	0.4262085	102.067914653533	-0.1506102	391.2102
Running	-0.5321657	-0.1895752	360.978972766925	0.2073481	70.59
Running	0.4135617	0.4399414	93.1883761218026	-0.1381268	359.4965
Running	-0.539593	-0.2280273	406.759095291282	0.2069507	73.80465
Running	0.4200543	0.4533997	88.5530691171817	-0.1277233	384.5705
Running	-0.5278784	-0.1741943	414.219982169718	0.196907	75.8298
Running	0.4203337	0.4443359	86.7404389693375	-0.1268579	388.081
Running	-0.5972258	-0.2887268	408.247829732666	0.1513973	124.4997
Running	0.4149729	0.4399414	84.805173803336	-0.1262336	389.712
Running	-0.5588144	-0.2571411	414.147331082345	0.213384	71.81898
Running	0.4115543	0.441864	84.9105852121235	-0.1293062	392.6315
Running	-0.5406891	-0.131073	435.808046336968	0.2040336	69.80434
Running	-0.174948	0.419342	86.0640458073636	-0.1368737	400.9058
Running	-0.5188184	-0.279631	400.768887646535	0.237986	80.87172
Running	0.2648312	0.9035645	142.866938346426	-0.133588	368.343
Running	-0.5269991	-0.2887268	425.40655445341	0.2053514	80.04122
Running	0.4027434	0.6423645	171.854726951085	-0.1557973	370.0322
Running	-0.5193281	-0.2077026	443.191644130461	0.2043966	81.53143
Running	0.6225884	1.469473	212.481242306819	-0.1425536	389.6417
Running	-0.5414297	-0.3021851	466.241302642243	0.1967892	83.35027
Running	0.4620438	1.298311	258.126796187667	-0.1338388	391.7454

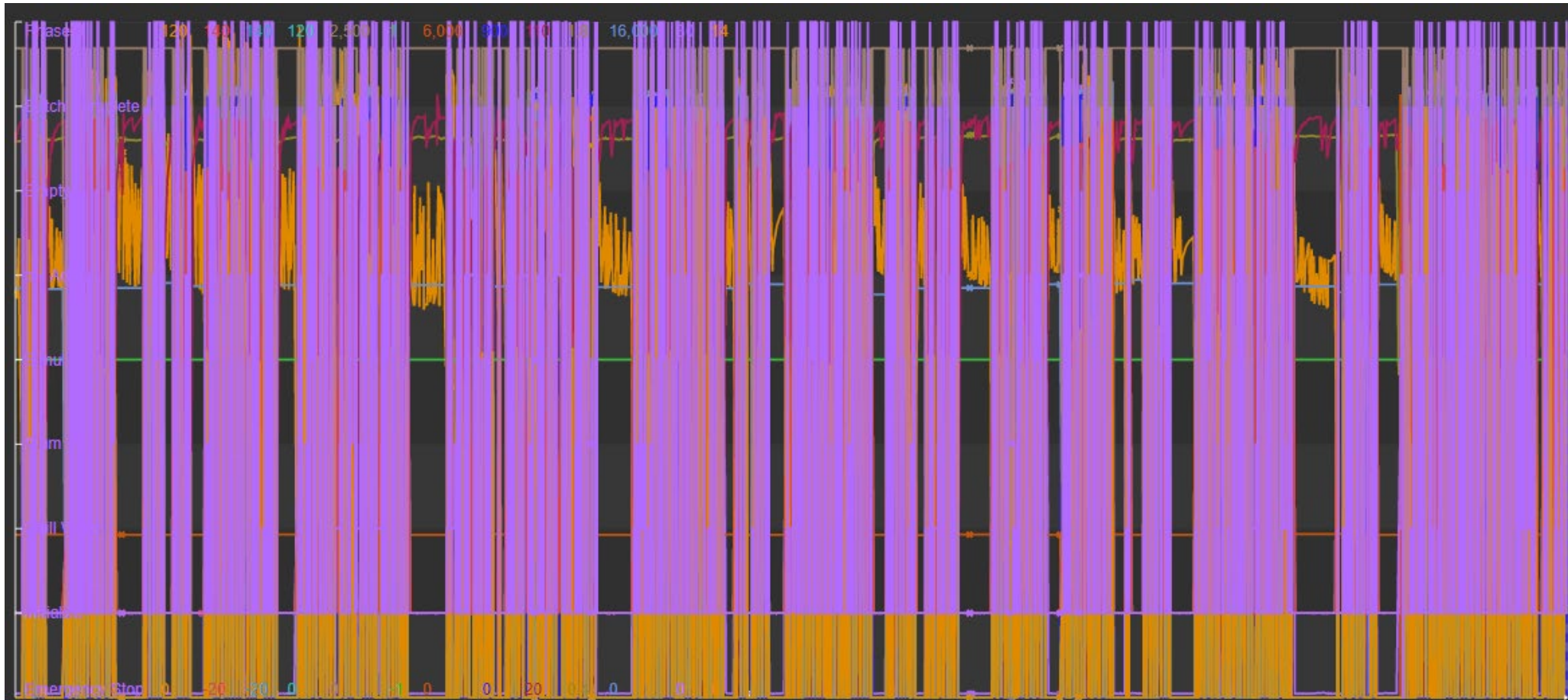


Statistical Process Control

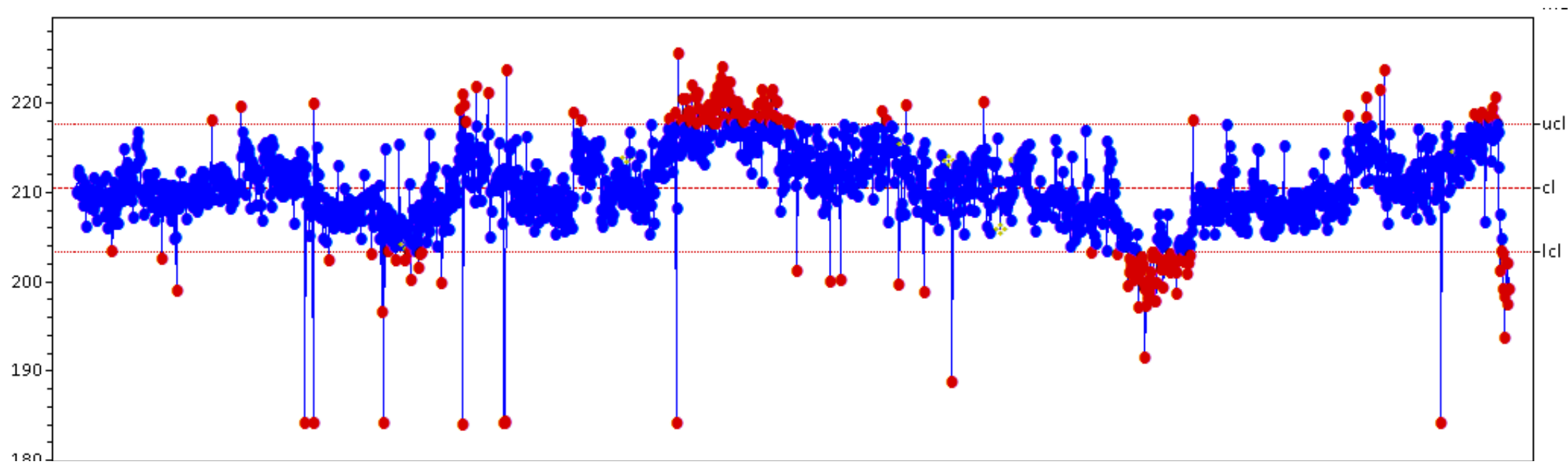
- SPC
- Eliminating Noise
- Focus on What Matters

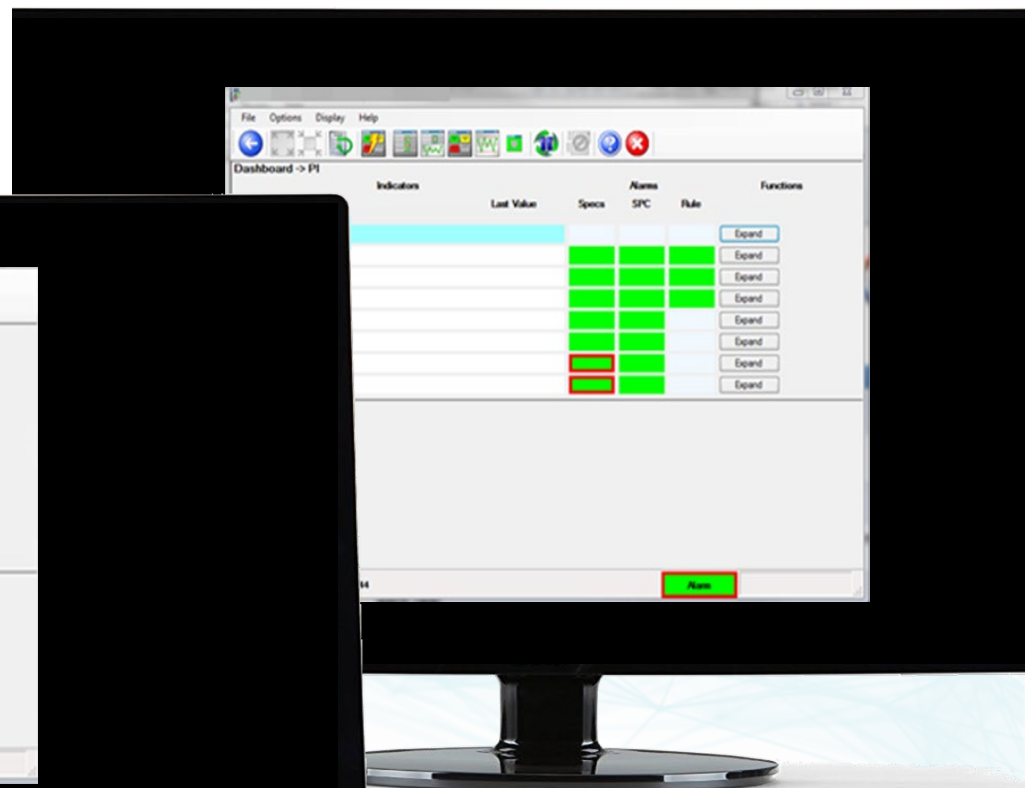
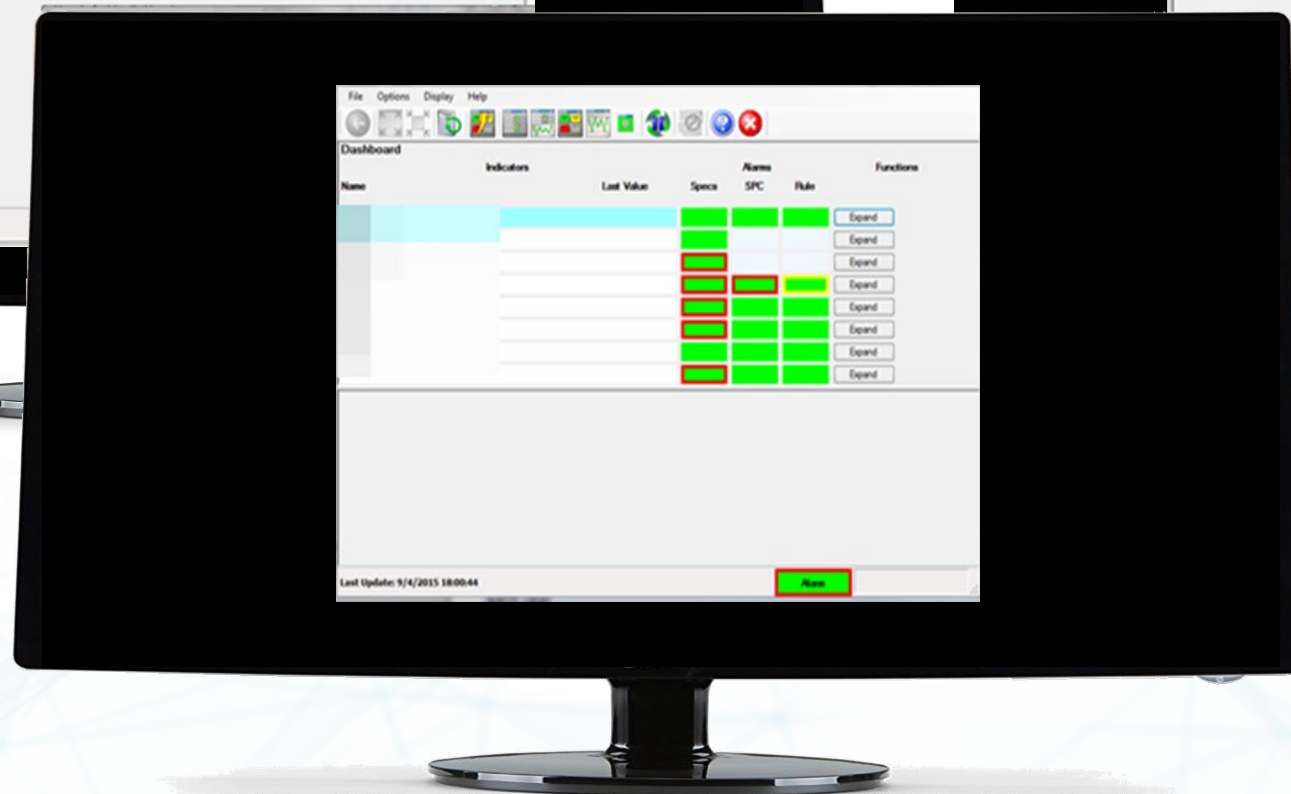
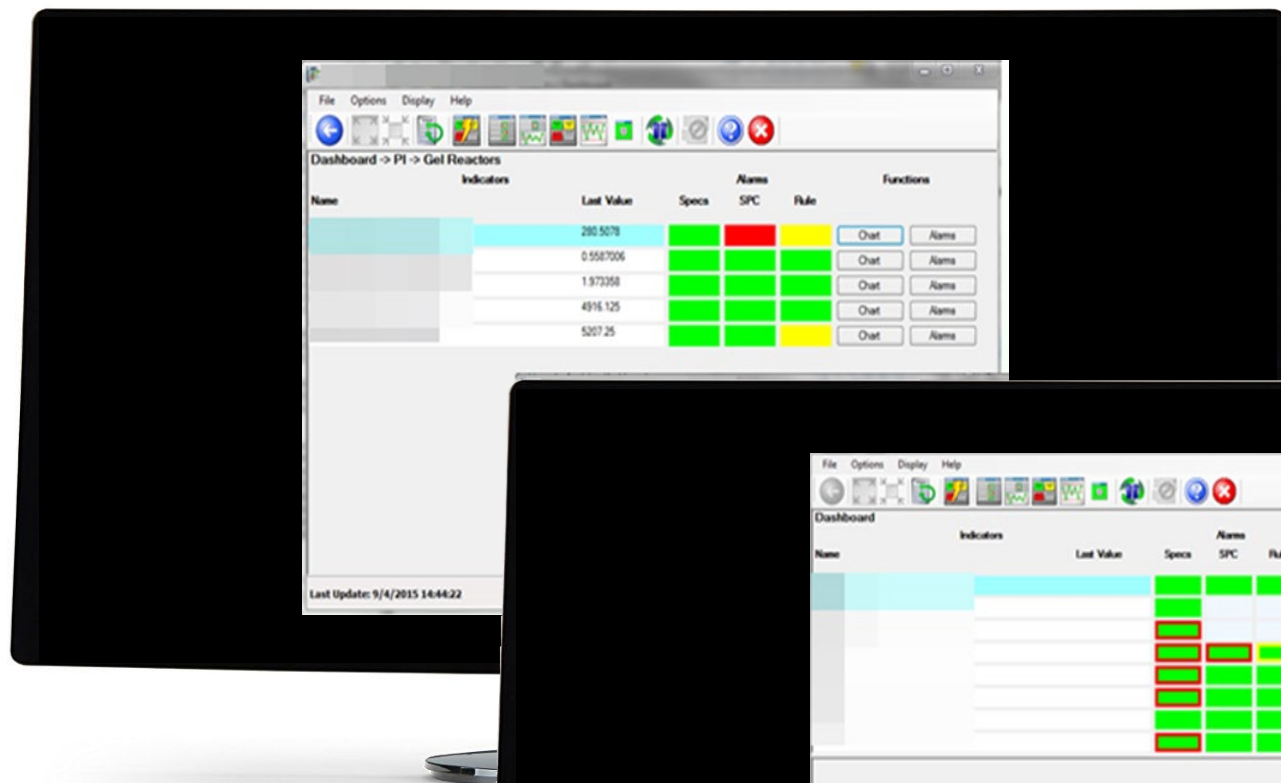


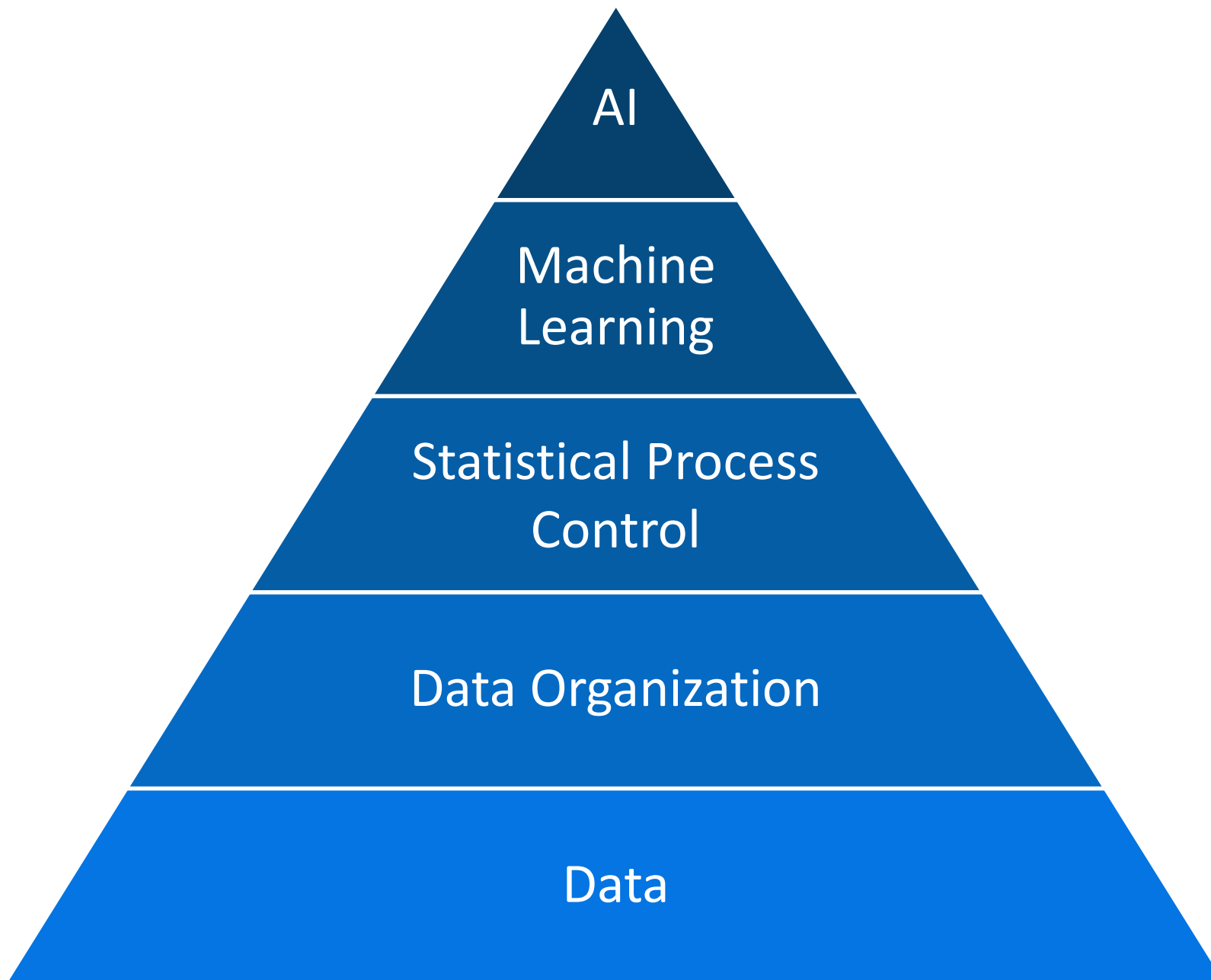
3 Month PI Vision Trend – No Event Frames



3 Month Statistical Analysis – w/ Event Frames

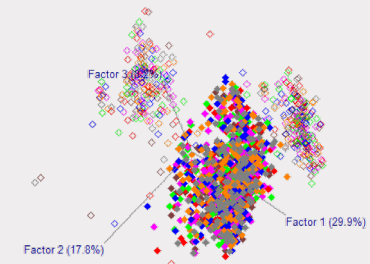






Machine Learning

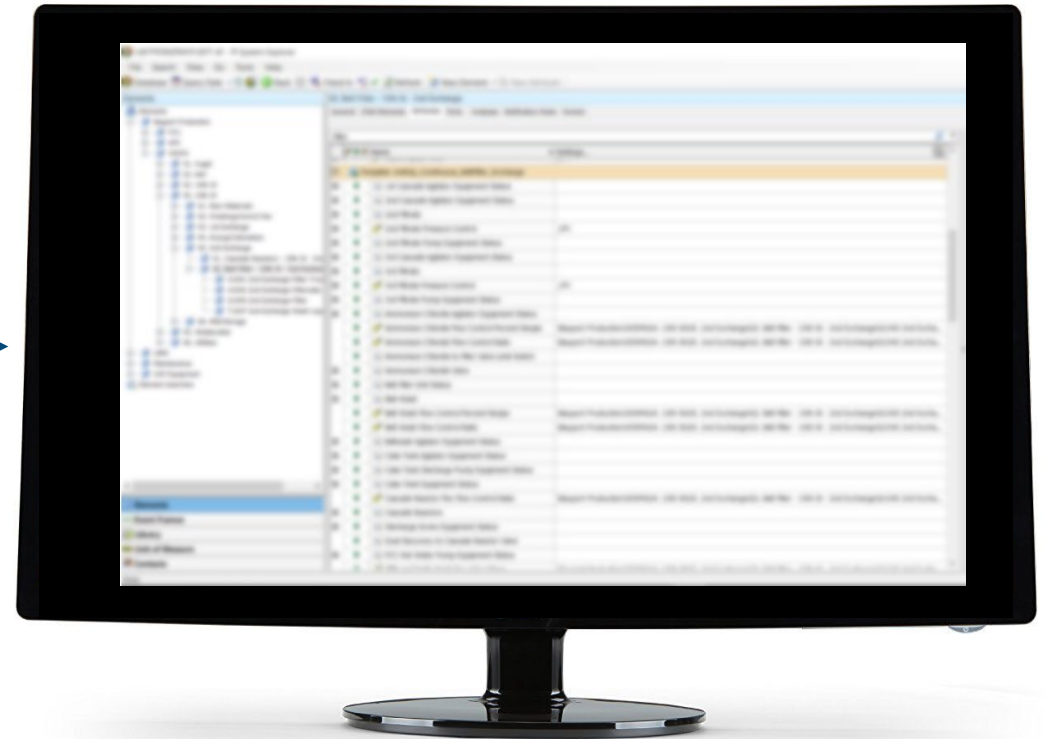
- Multi-dimensional Models
- Discovering Unknown Correlations
- “Signals Between the Signals”



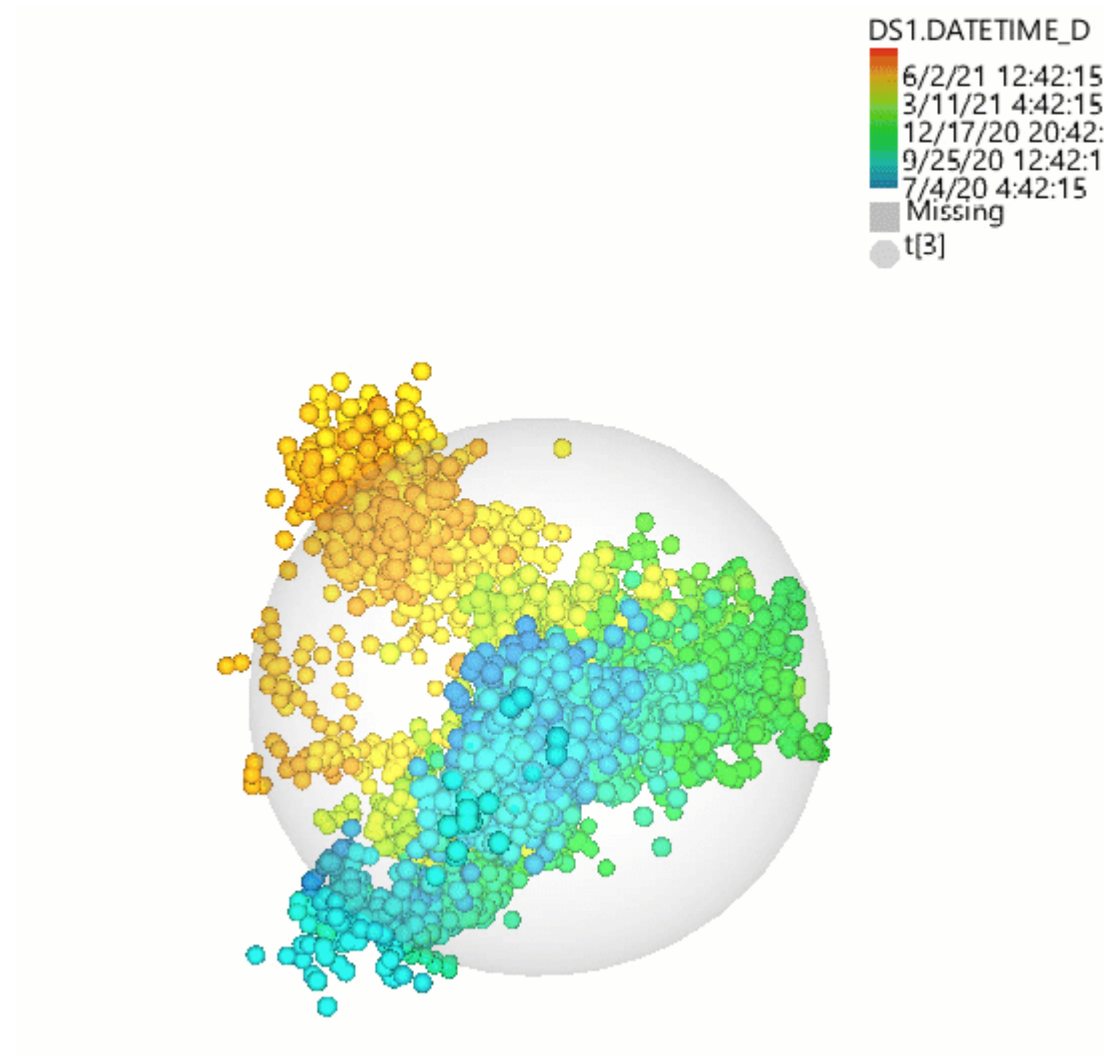
The “Black Box” Unit Operation

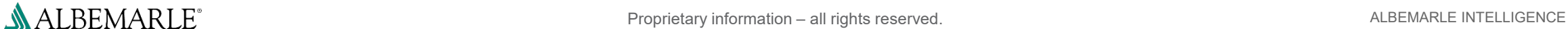


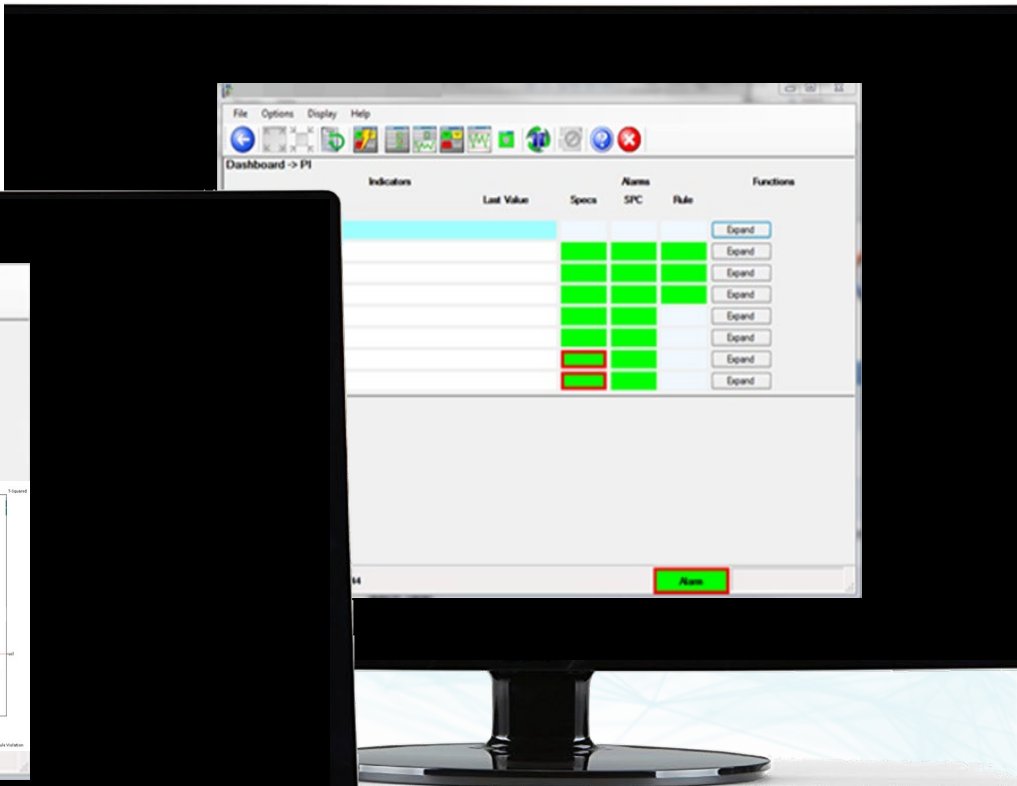
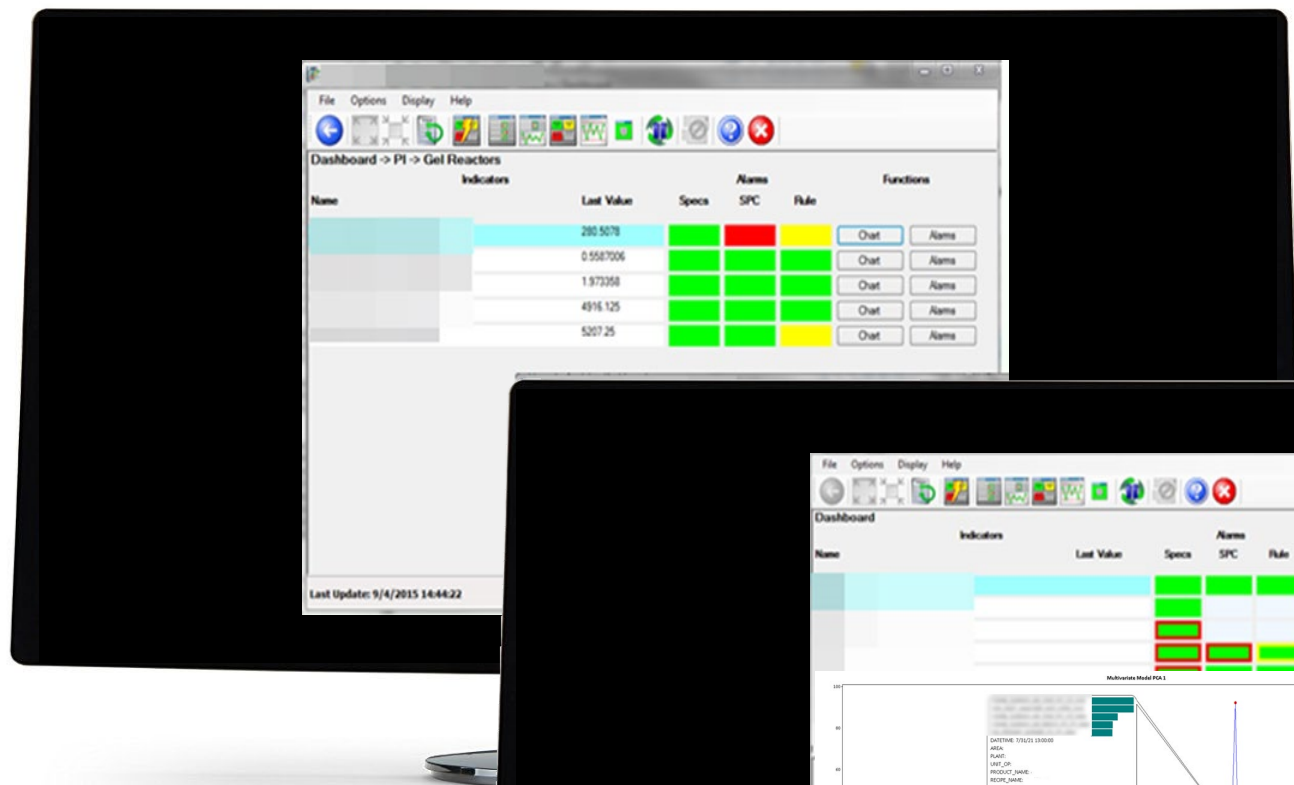
DEFINE



Dissecting the “Black Box” with Machine Learning







SARTORIUS SIMCA®

Northwest Analytics

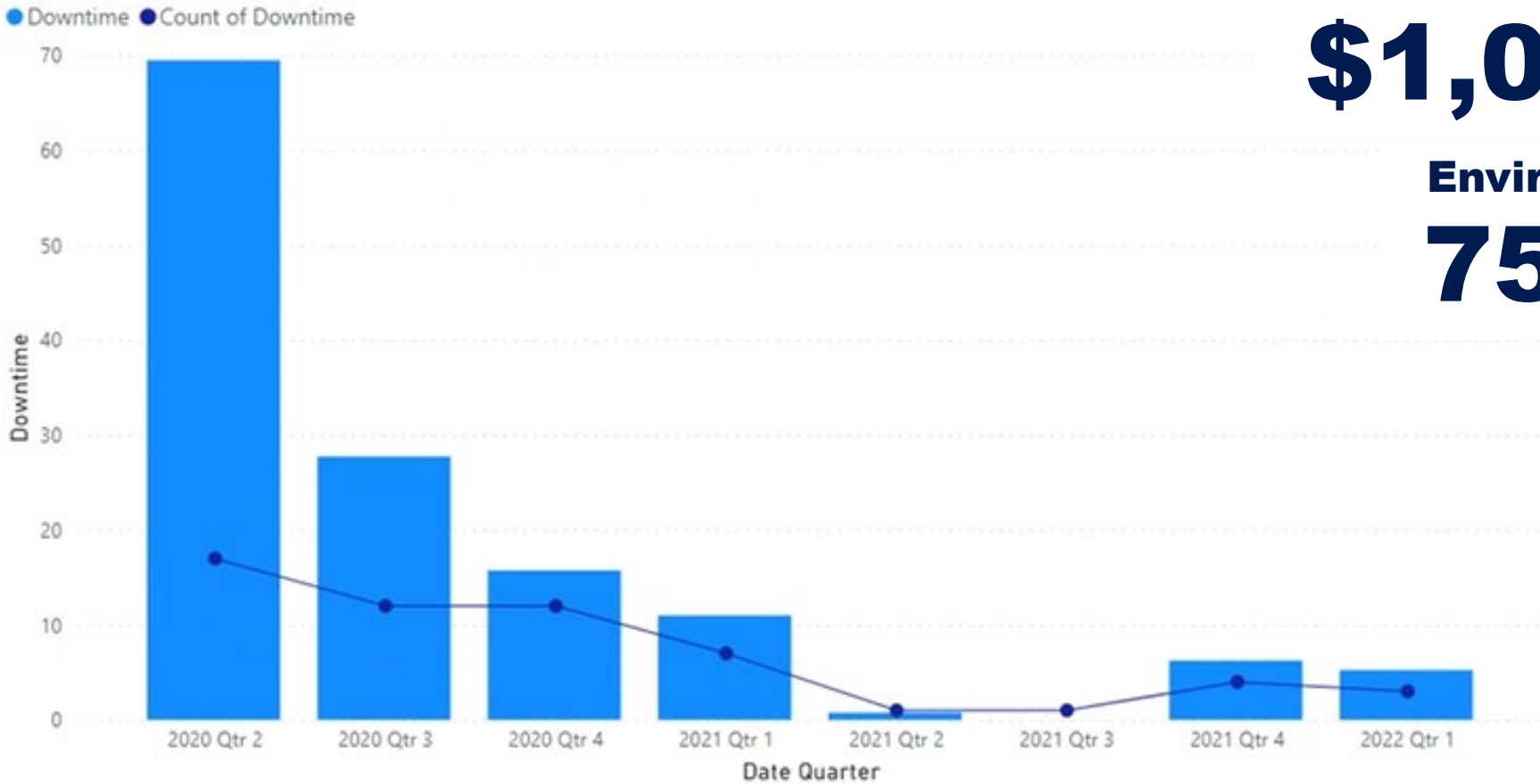
ALBEMARLE®

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ALBEMARLE INTELLIGENCE

The “Black Box” Real-Time Machine Learning Model

Downtime and Count of Downtime by Year and Quarter

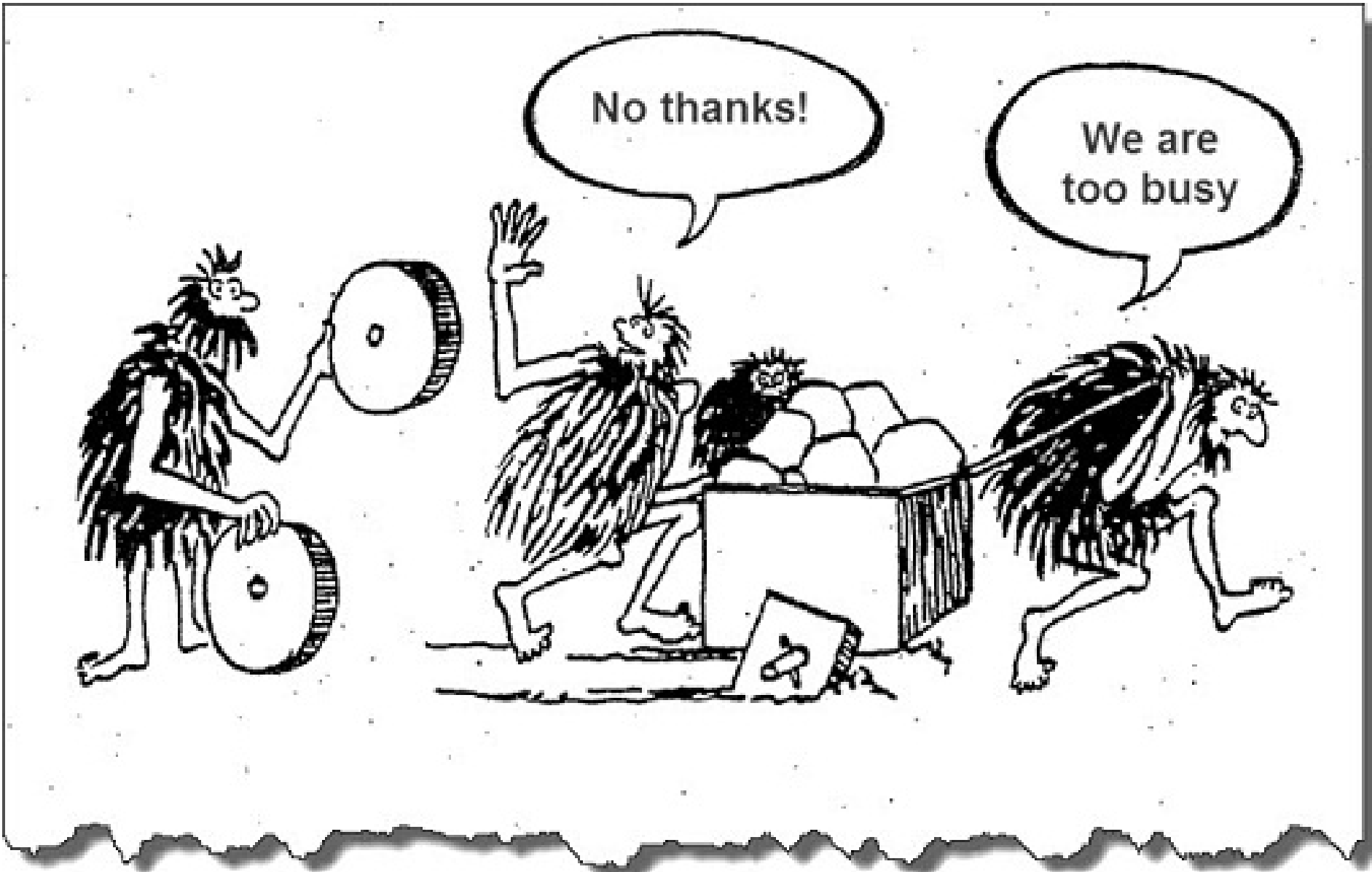


OEE Improvements
\$1,000,000/yr
Environmental Incidents
75% reduction



Data = AI = Value

AI

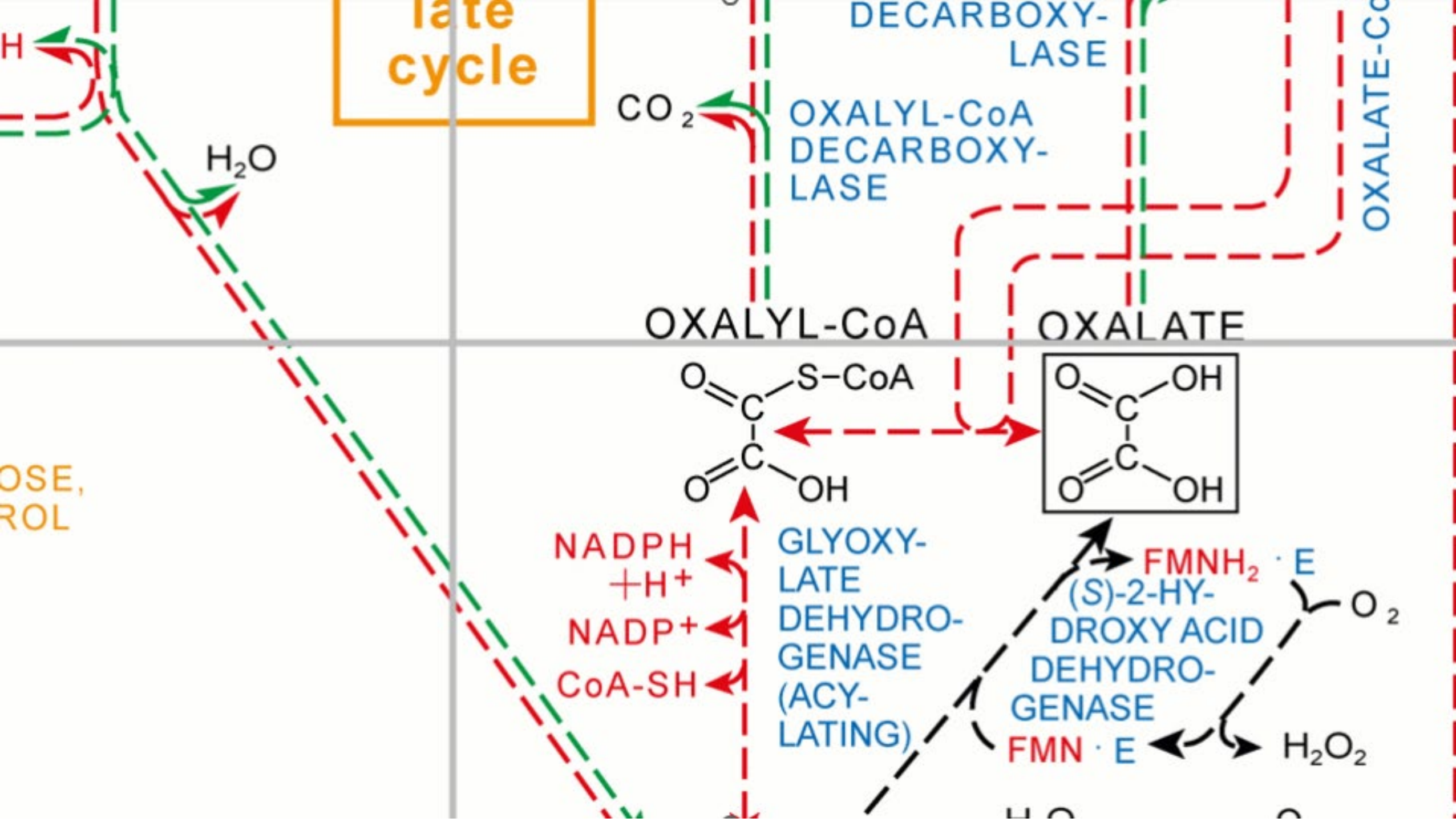


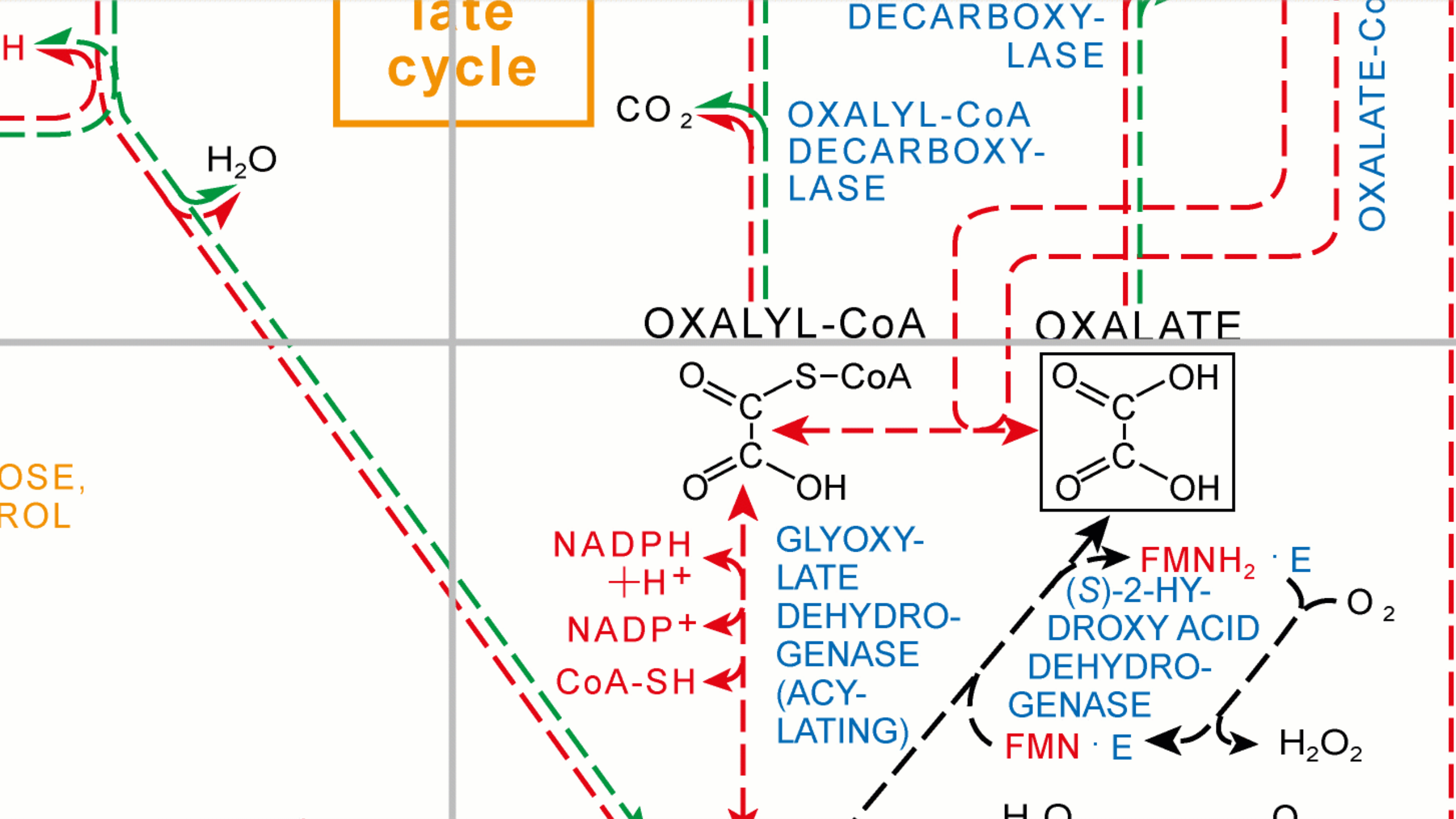


CALORIC SURPLUS

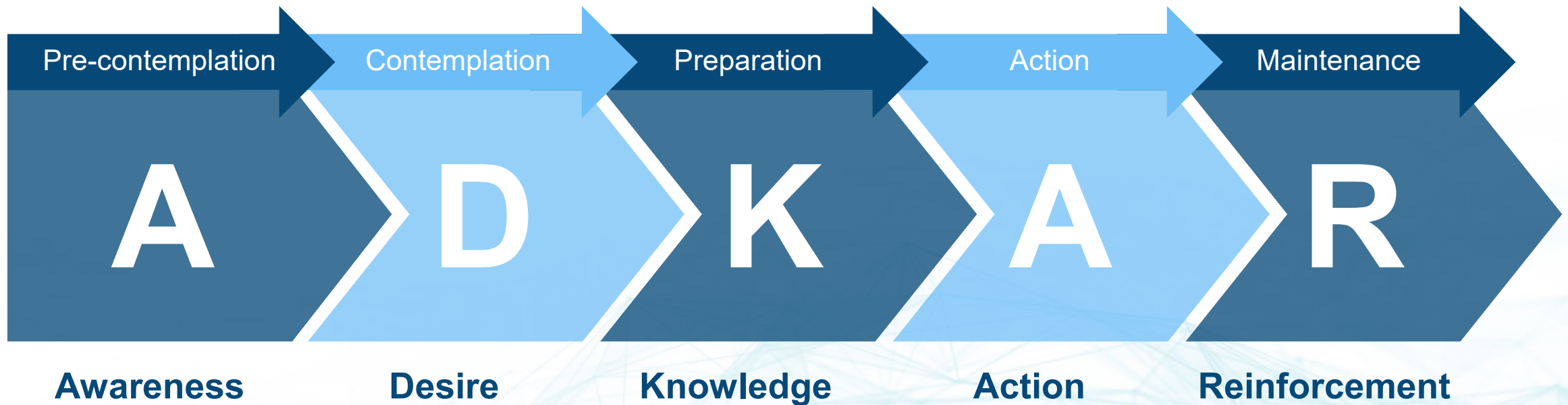
(THIS PERSON WILL GAIN WEIGHT)



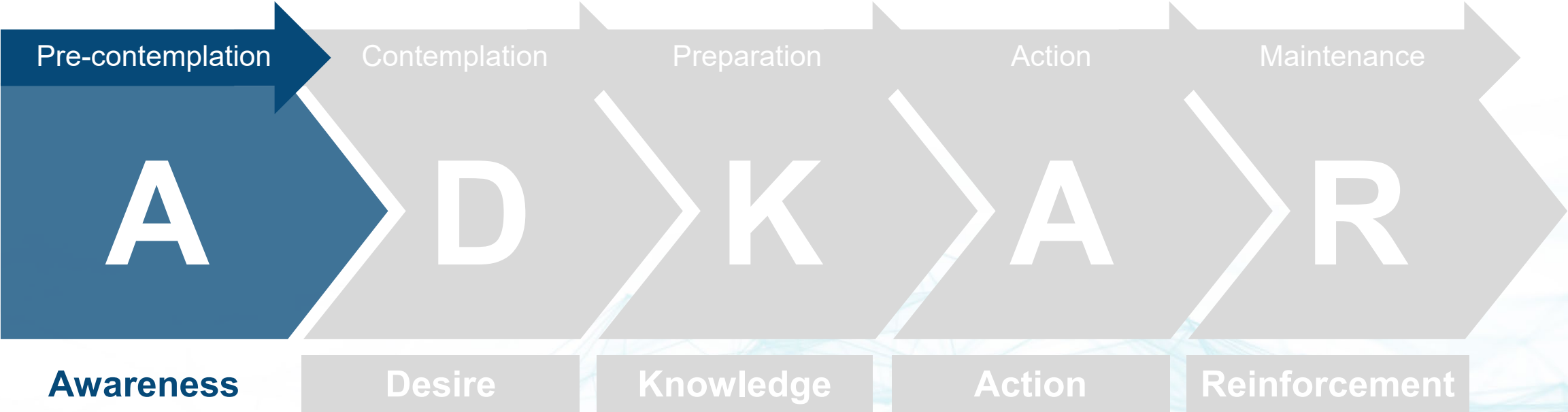




ADKAR Change Management



ADKAR Change Management





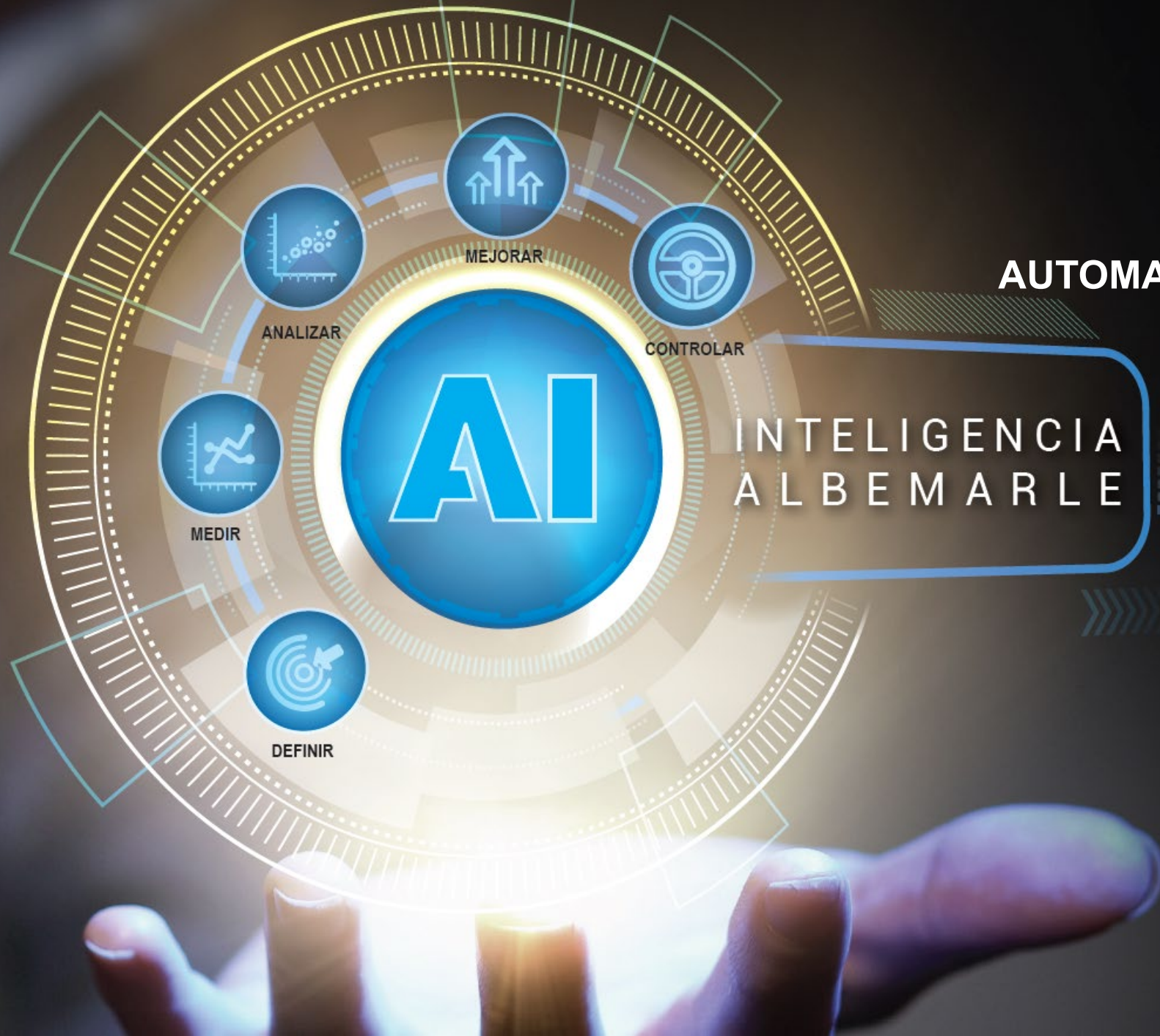
Automated Information

Analytics Innovation

Actionable Insight



Albemarle People
Empowered by Technology
Unlocking the value of information



AUTOMATIZACIÓN DE LA INFORMACIÓN

ANALÍTICA CON INNOVACIÓN

ACCIONES INFORMADAS



Personal de Albemarle,
Empoderados por la Tecnología,
Liberando el Valor de la Información



雅保智能

自动信息

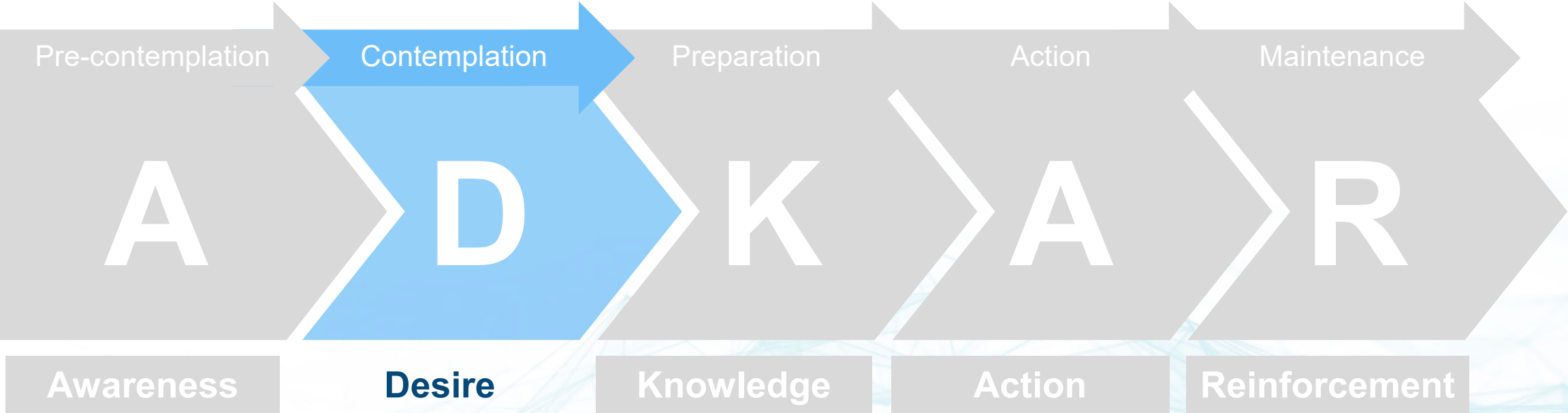
分析创新

切实可行的洞察



雅保人，
技术赋能，
释放信息的价值

ADKAR Change Management



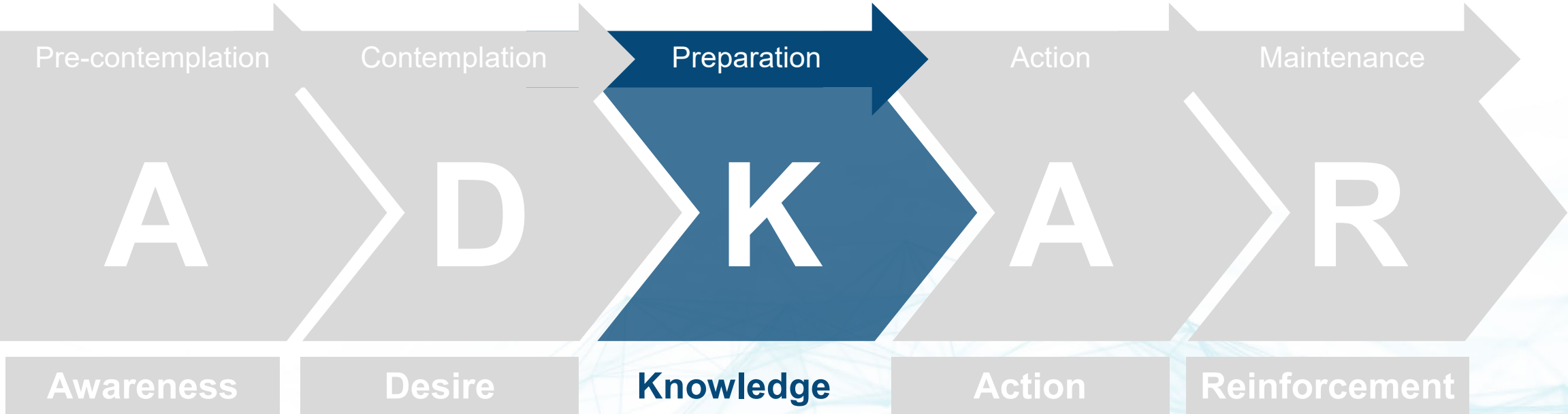
JUST SAY NO TO WHACK-A-MOLE



BRINGS THE HAMMER DOWN
ON PROCESS ISSUES



ADKAR Change Management

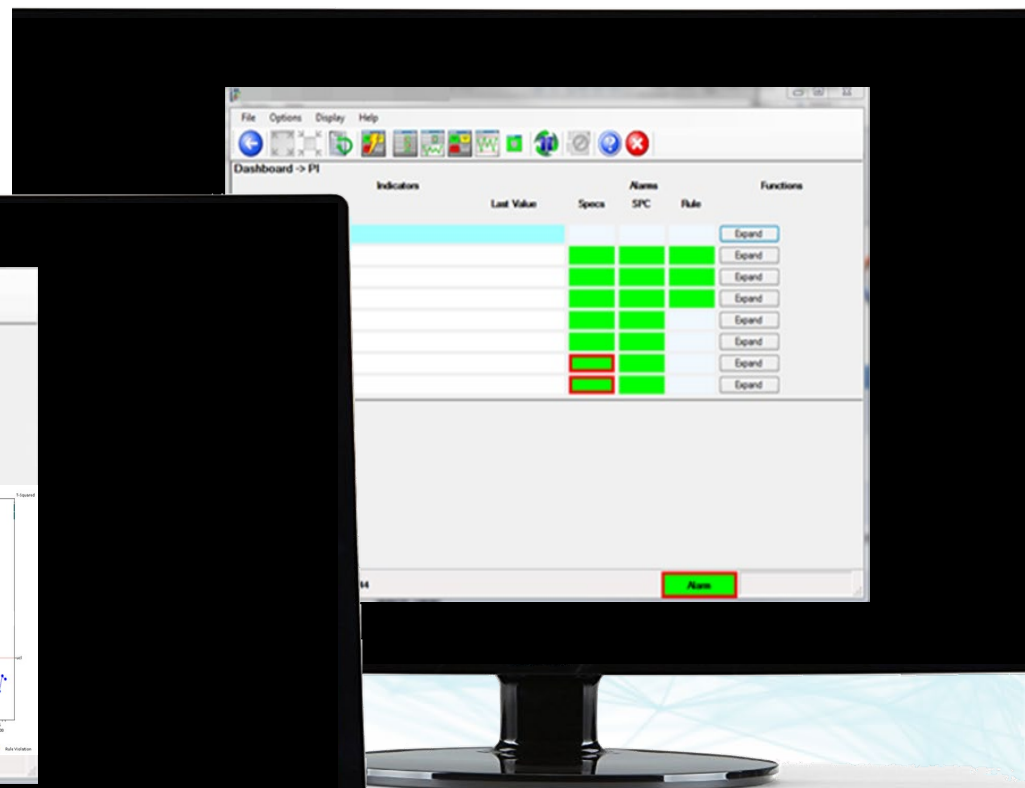
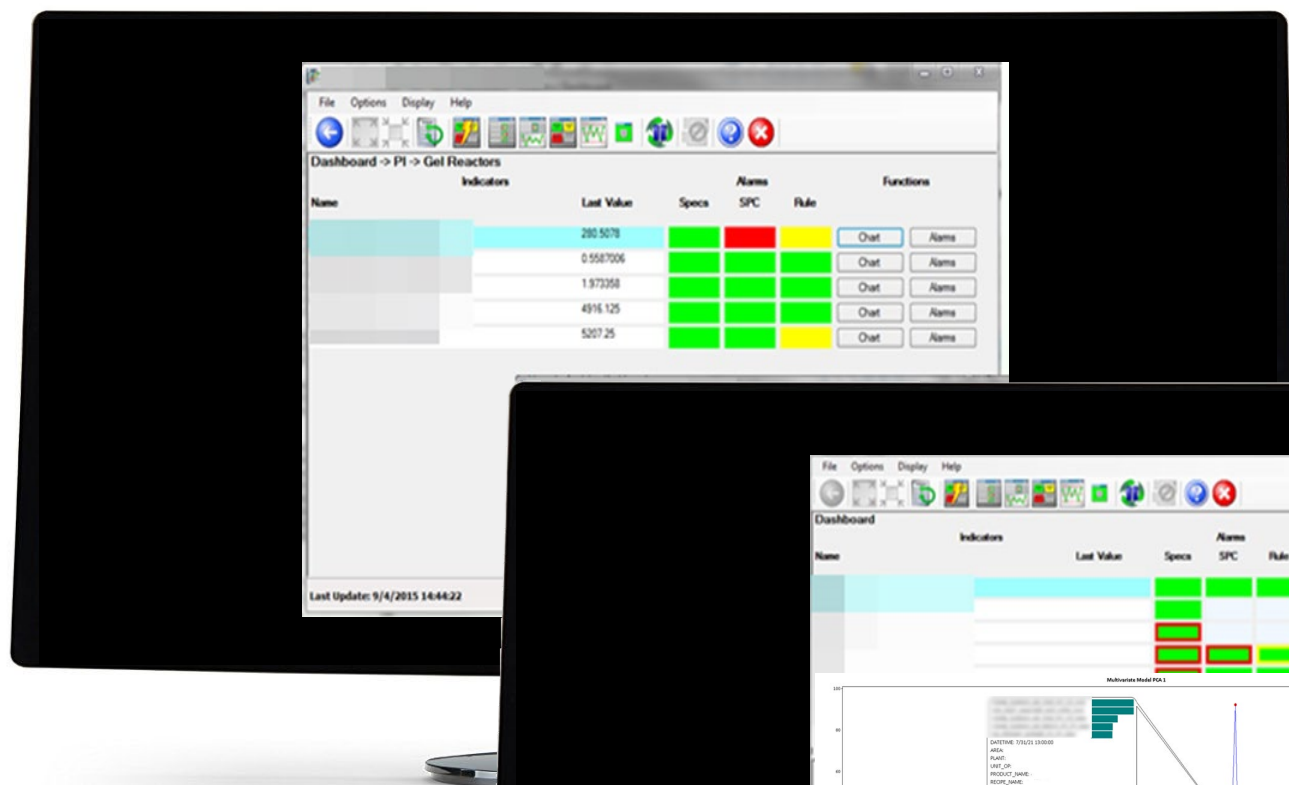


Implementation Roadmap



ADKAR Change Management

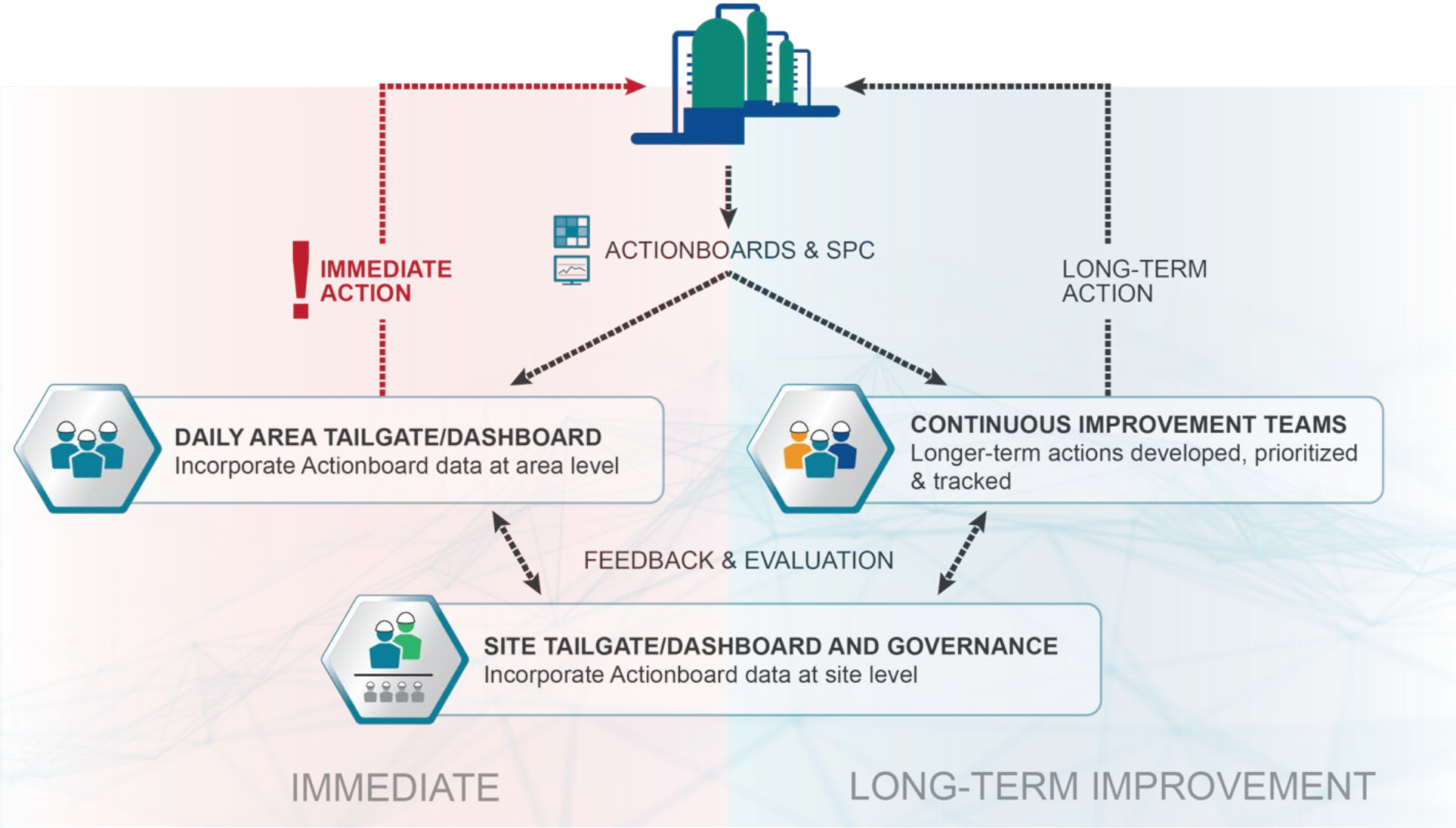




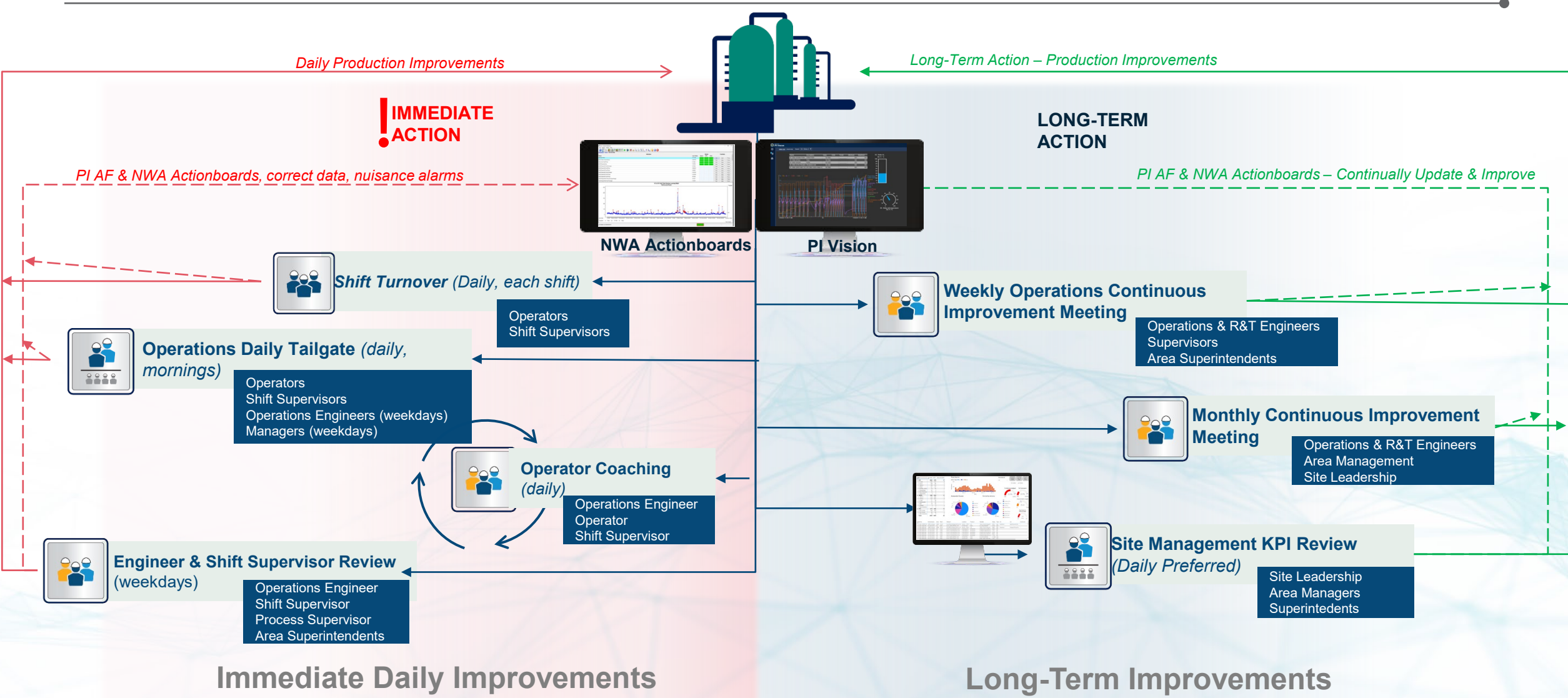
Control Rooms of the Future



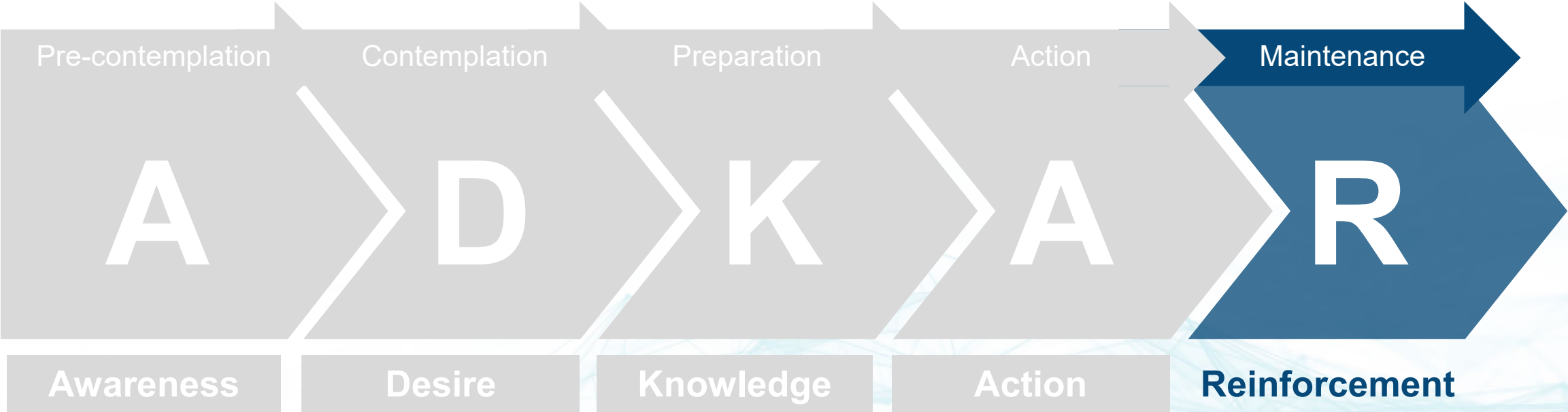
AI-Powered Continuous Improvement



Actionboard Standard Work – Continuous Improvement



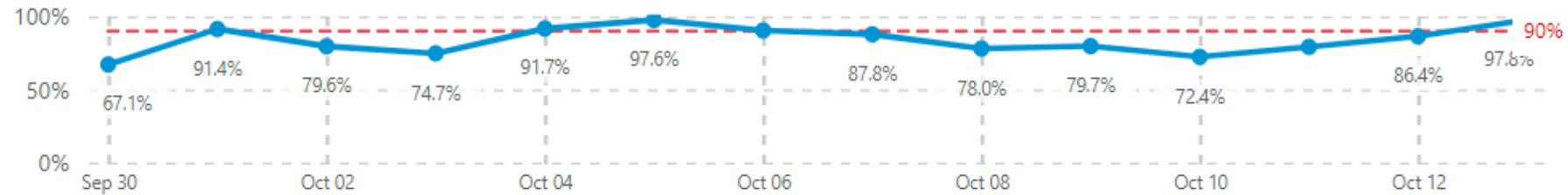
ADKAR Change Management



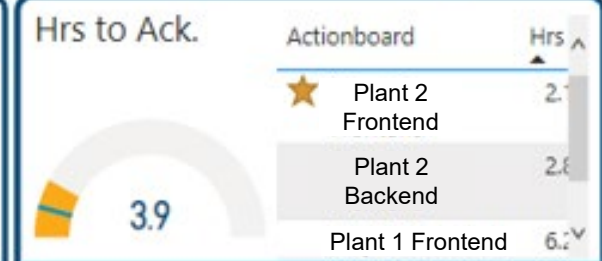
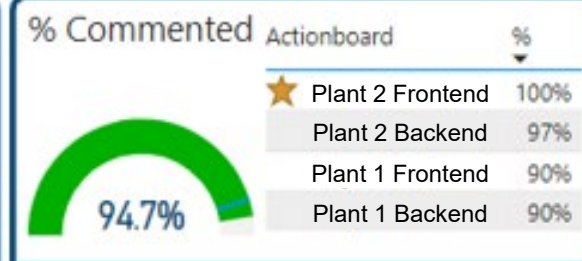
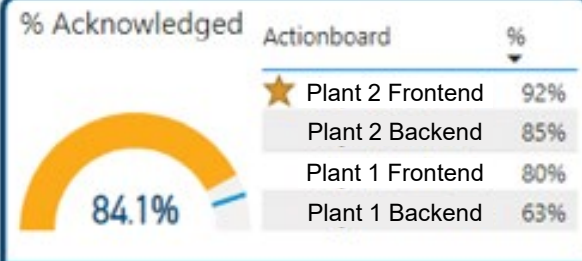
**YOU CAN LEAD A HORSE
TO WATER, BUT...**



% ALARMS ACKNOWLEDGED | Were the cause and action registered for the alarms generated?



HOURS TO ACKNOWLEDGE | Was action taken in the moment that the alarm occurred?



Alarms Acknowledged as "No Action"

	Plant 1 Backend	Plant 1 Frontend	Plant 2 Backend	Plant 2 Frontend
A	0%	0%	0%	0%
B	0%	0%	0%	0%
C		0%	0%	0%
D	0%	0%	0%	0%

Alarms Generated per Hour

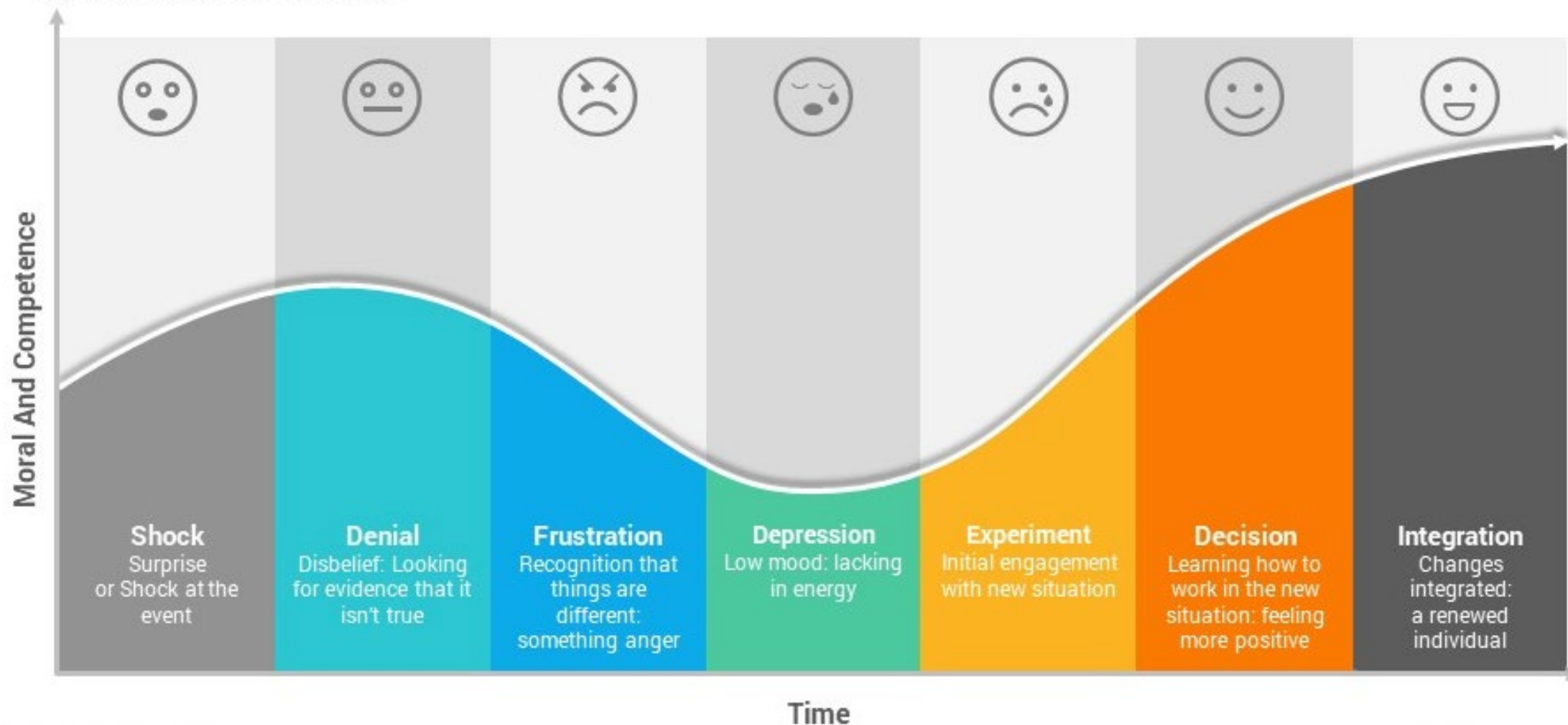
	Plant 1 Backend	Plant 1 Frontend	Plant 2 Backend	Plant 2 Frontend
A	0.2	1.1	2.2	2.0
B	0.3	1.2	1.7	1.8
C		0.9	2.1	2.4
D	0.2	1.0	1.7	1.9

Nuisance Alarms

	Plant 1 Backend	Plant 1 Frontend	Plant 2 Backend	Plant 2 Frontend
A	0%	0%	3%	0%
B	0%	0%	4%	0%
C		1%	1%	12%
D	0%	0%	6%	0%

Kübler-Ross Change Model Curve Template

Emotional Response to Change

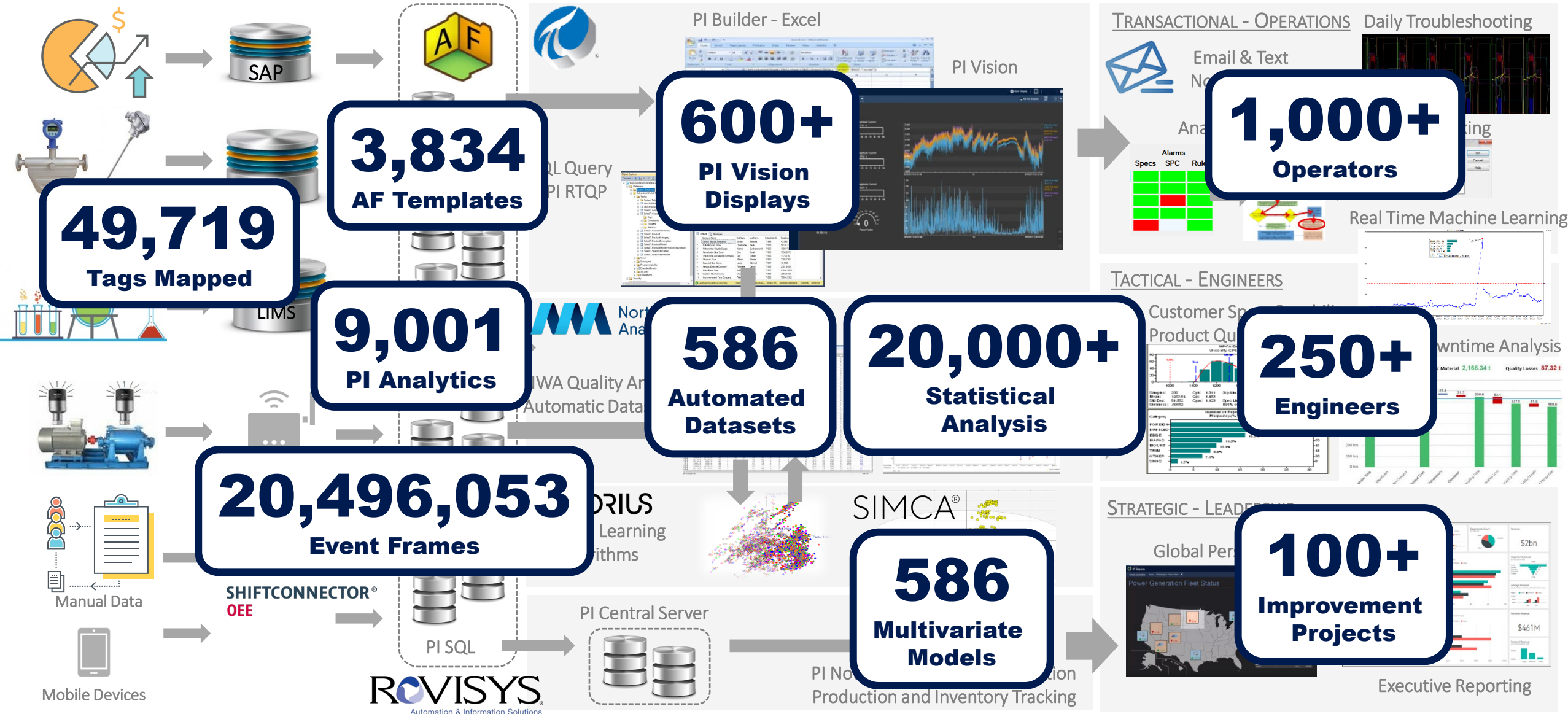


DATA SOURCES

AVEVA PI ASSET FRAMEWORK

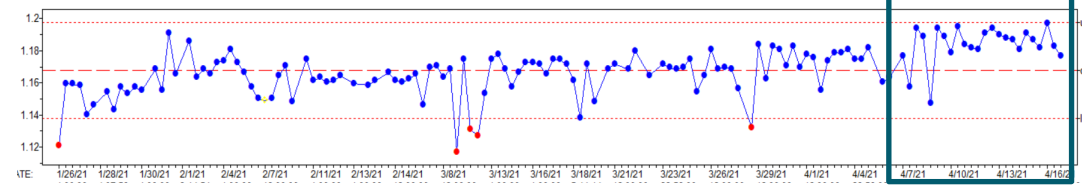
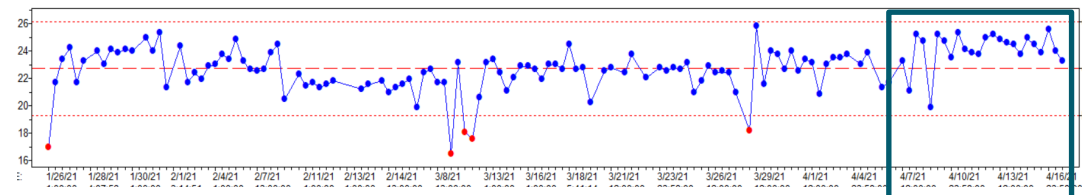
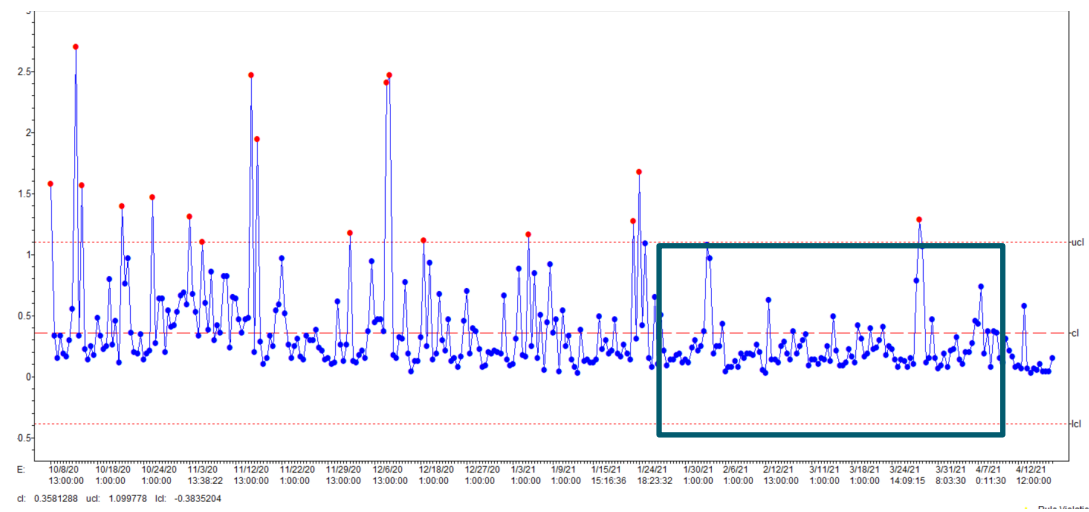
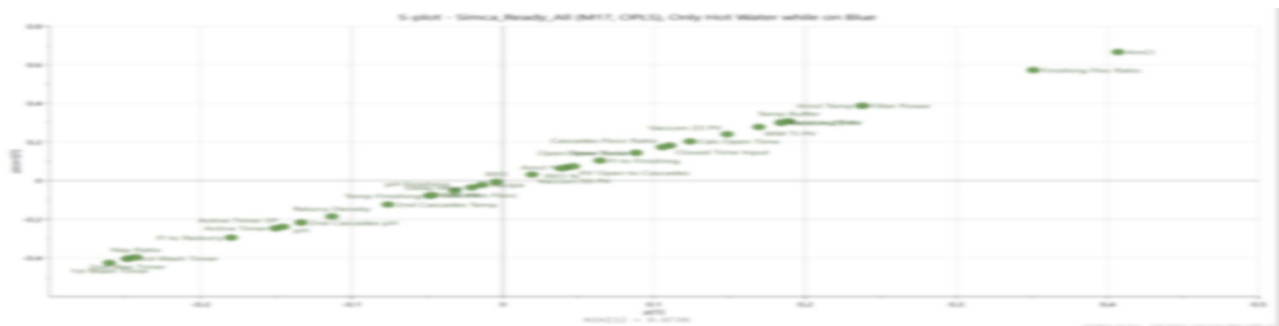
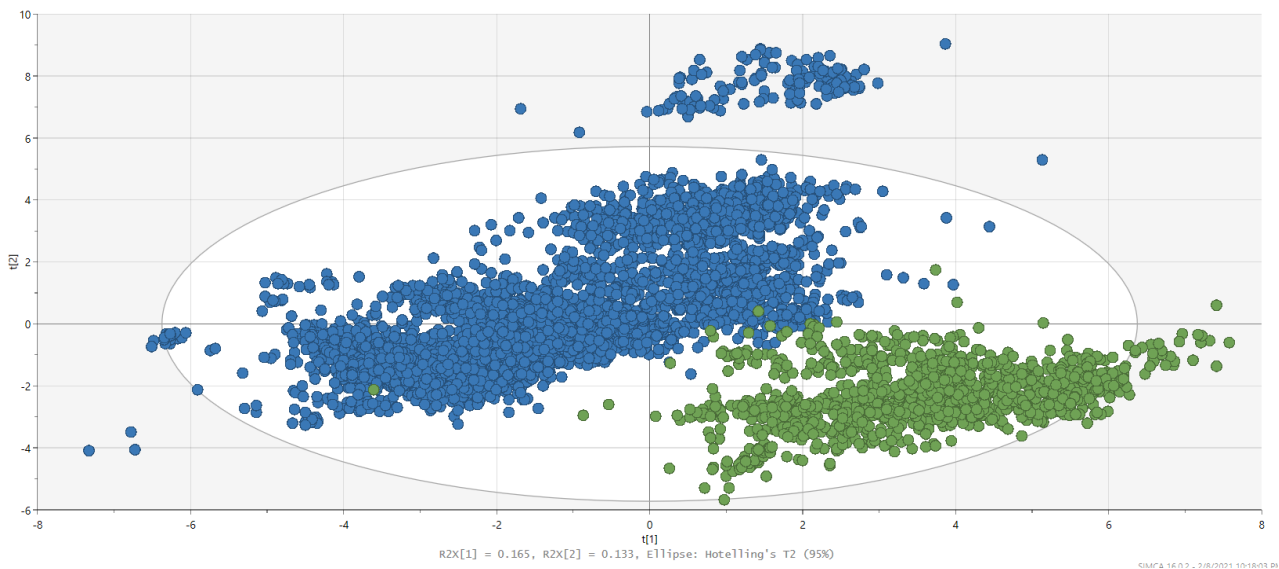
DATA ANALYTICS SUITE

USER ROLES

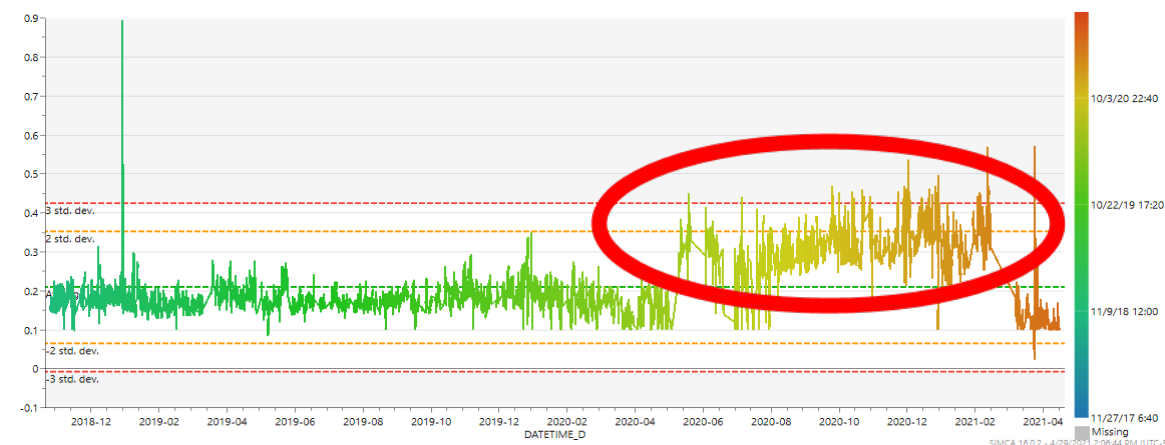
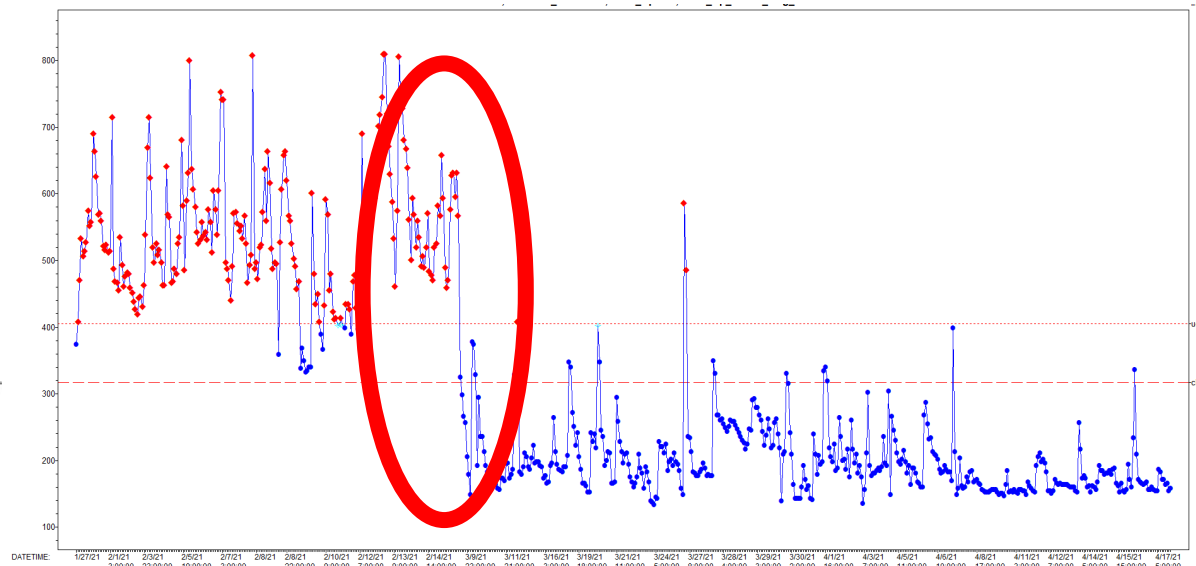
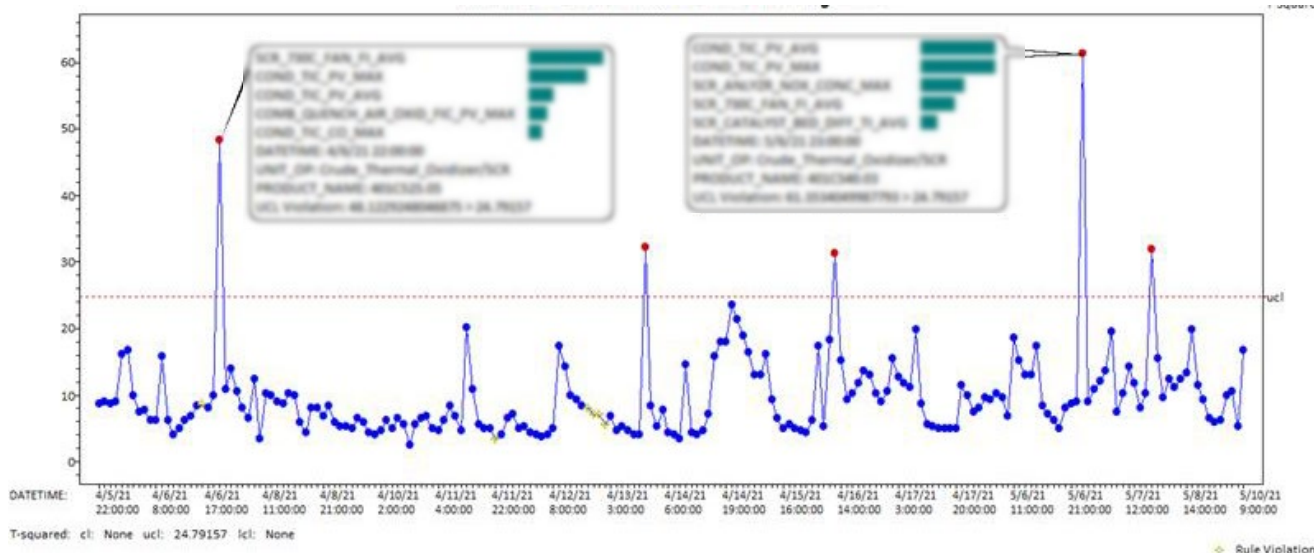


Albemarle Intelligence – Engineer Improvement Project

Capacity & Quality Improvements
\$450,000/yr



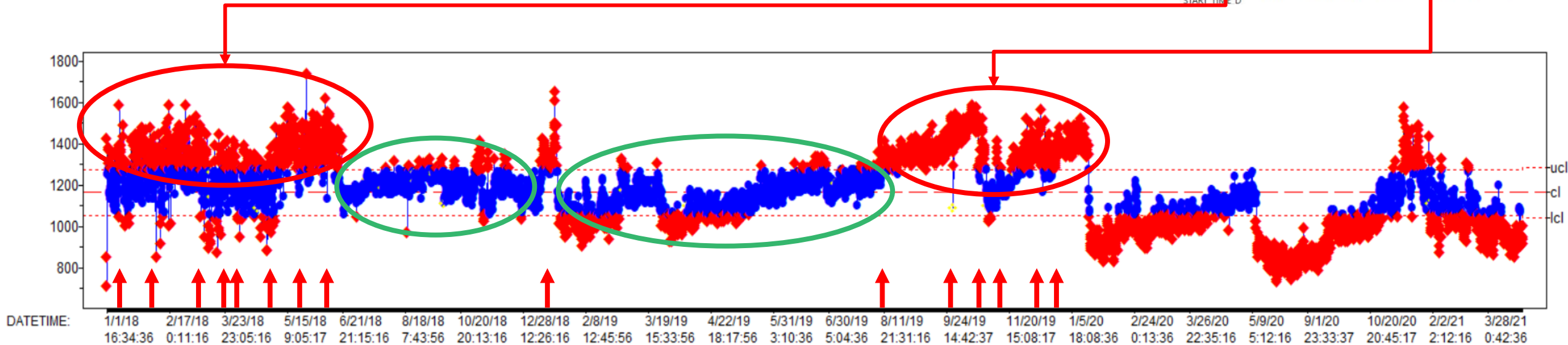
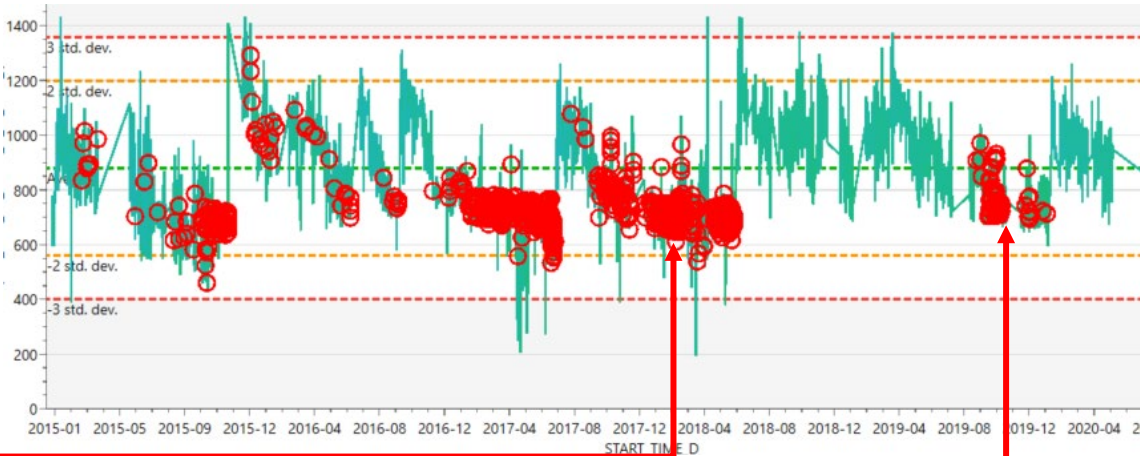
\$350,000/yr



Albemarle Intelligence – Engineer Improvement Project

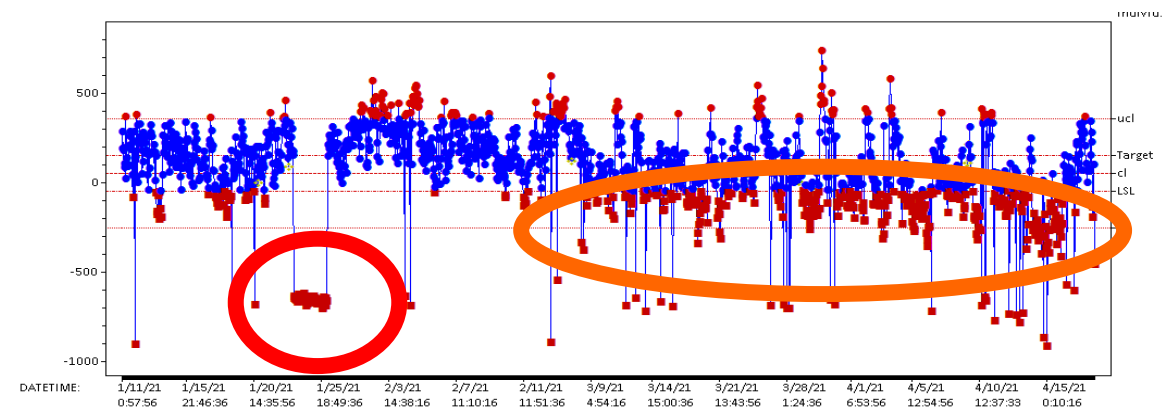
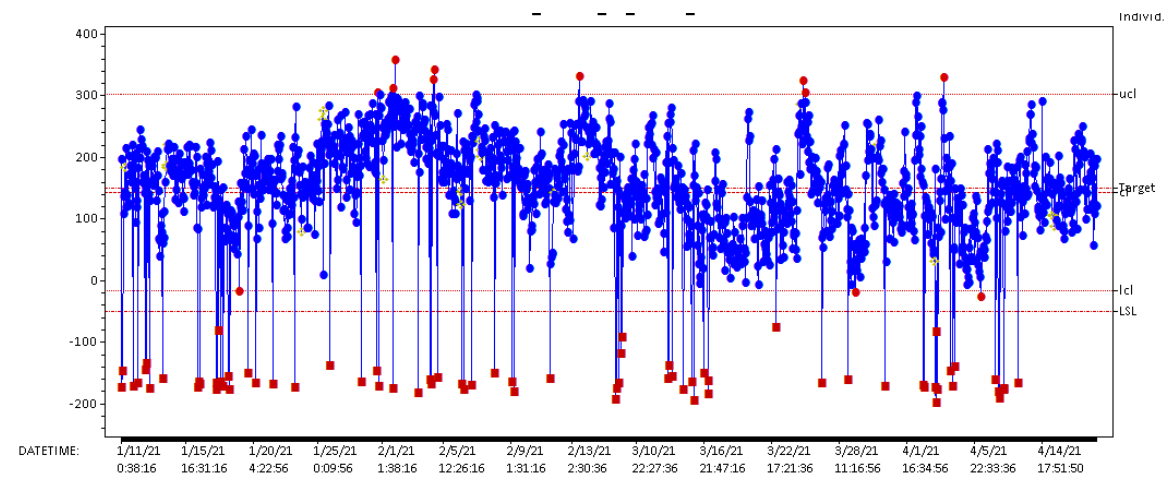
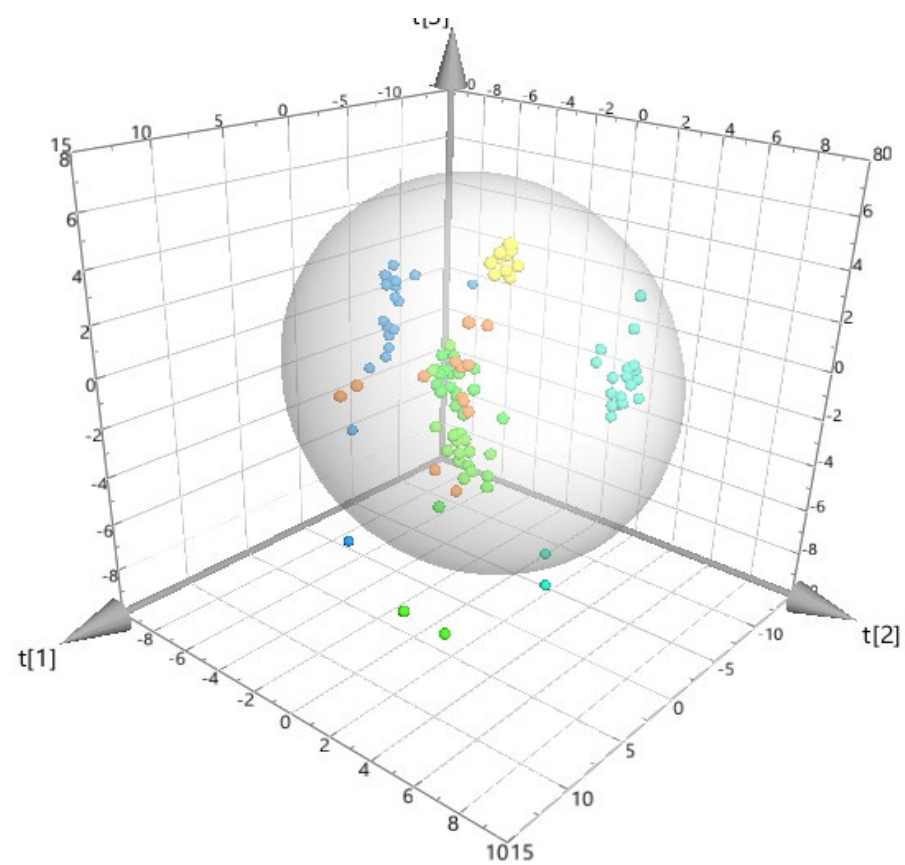
Maintenance Equipment Reliability Improvement

\$220,000/yr



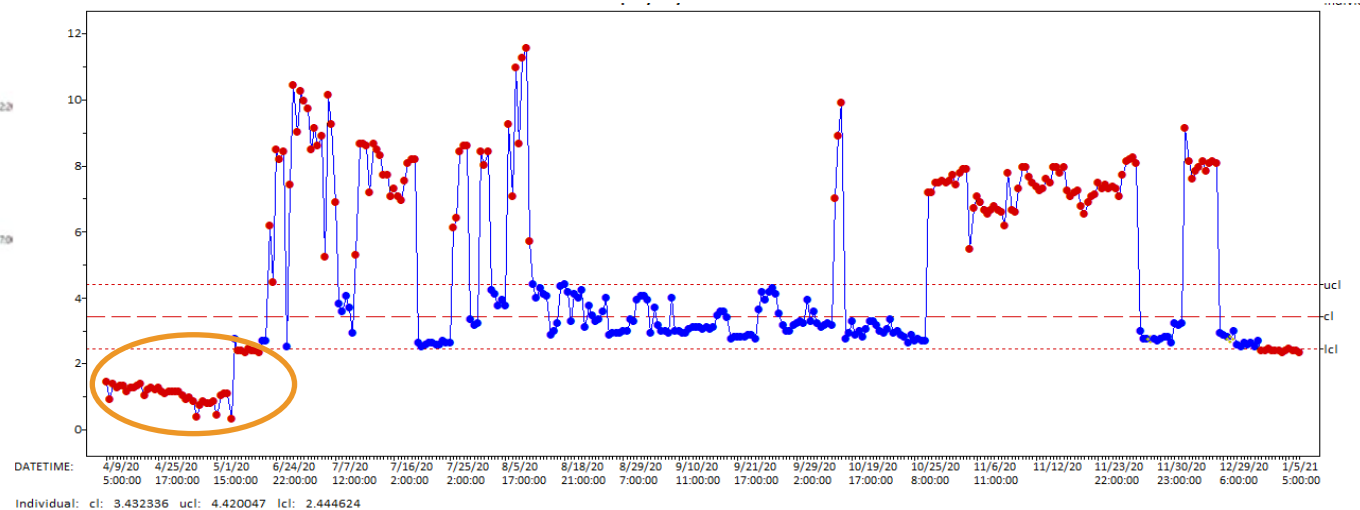
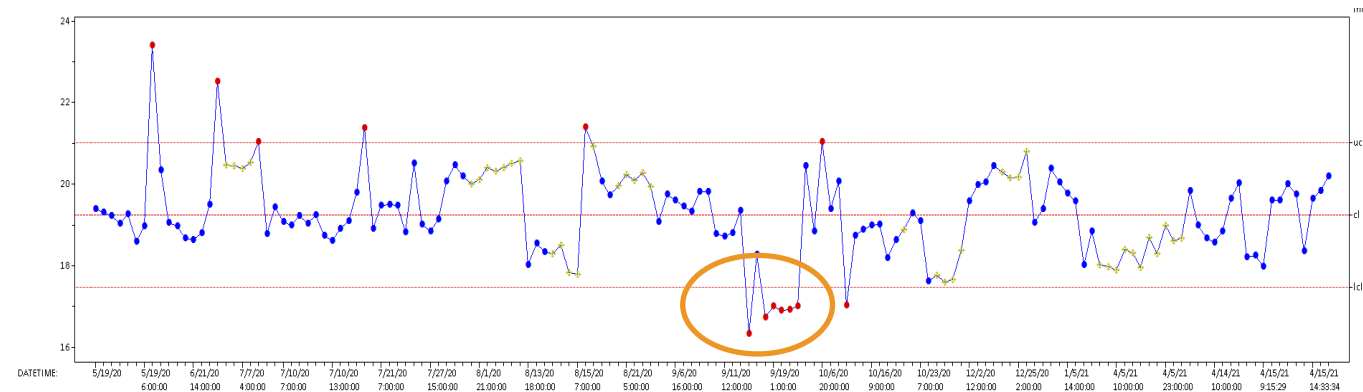
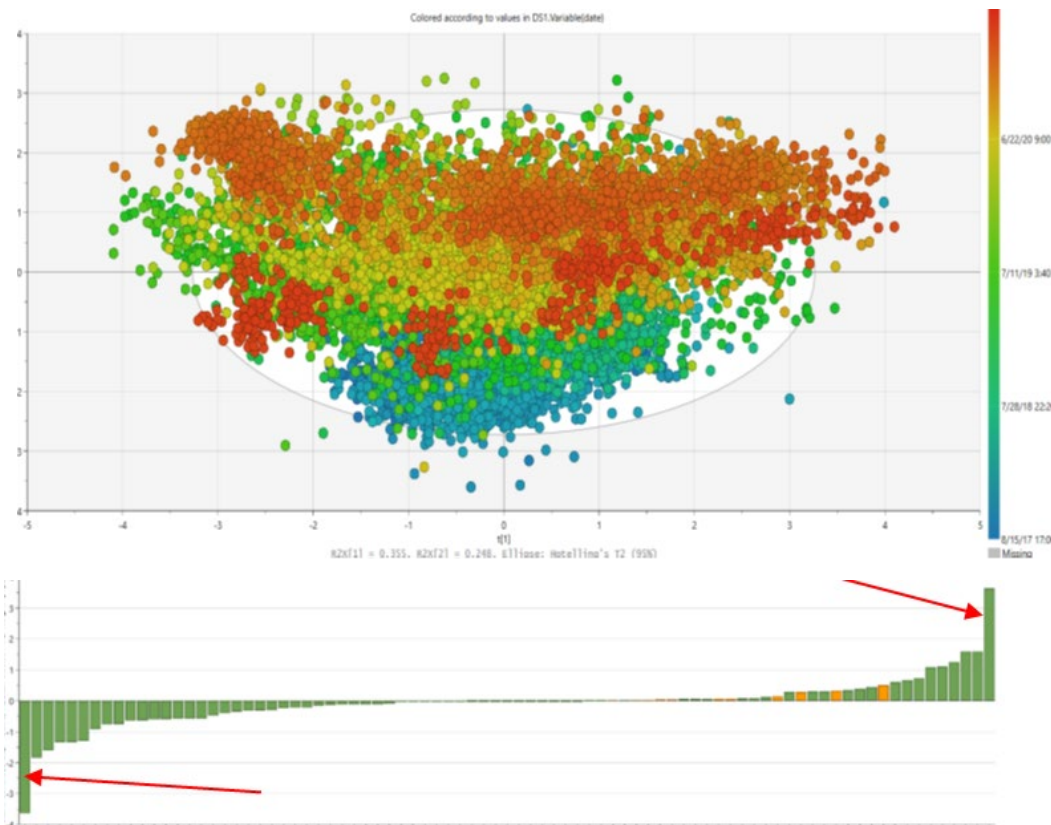
Albemarle Intelligence – Engineer Improvement Project

Raw Material Utilization, Quality, and
Customer Satisfaction Improvements
\$150,000/yr



Albemarle Intelligence – Engineer Improvement Project

Quality and Rate Improvements
\$840,000/yr



















ALBEMARLE®
VALENTINA CASTILLO V.
Ingeniero Proceso







ALBEMARLE[®]
LUIS BAEZA
Ingeniero Confiabilidad





VIVIANA ESPINOZA P.





Current Estimated Improvements

>\$50,000,000/yr

Amsterdam, Netherlands

Magnolia, AR, USA

Xinyu, China

Bayport, TX, USA

LaNegra, Chile

Estimated improvements include projects at multiple sites with various time periods and benefits including cost savings, cost avoidance and/or revenue enhancement.



**ALBEMARLE PEOPLE,
empowered by technology,
unlocking the value of information.**

World Class Chemical Manufacturing



Challenge

Scaling Machine Learning & AI across a global enterprise, within a Specialty Chemical Company with thousands of unique chemical processes with massive amounts of data

Solution

Deployed the latest AVEVA PI System technology including PI AF, PI Event Frames, PI Analytics, Northwest Analytics SPC, and Sartorius SIMCA Multivariate Analysis

Benefits

Beyond \$50,000,000 annual improvements via increased production, operational efficiency, improved raw material utilization, improved quality, improved equipment reliability, significantly accelerated 'Time to Value' for Advanced Analytics & Machine Learning projects



Jonathan Alexander

Manufacturing AI & Advanced Analytics Manager

- Albemarle
- jonathan.alexander@albemarle.com



THANK YOU

謝謝

DZIĘKUJĘ CI

NGIYABONGA

TEŞEKKÜR EDERİM

DANKIE

TERIMA KASIH

GRACIES

WHAKAWHETAI KOE

DANKON

TANK

TAPADH LEAT

SALAMAT

SPASIBO

GRAZIE

MATUR NUWUN

ХВАЛА ВАМ

MULTUMESC

PAKMET CIZGE

고맙습니다

GRAZIE

شكرا

FAAFETAI

ESKERRIK ASKO

HVALA

GO RAIBH MAITH AGAT

БЛАГОДАРЯ

GRACIAS

ТИ БЛАГОДАРАМ

MAHADSANID

TEŞEKKÜR EDERİM

OBRIGADO

TAK

DANKE

MAHALO IĀ 'ŌE

TAKK SKAL DU HA

MERCI

DI OU MÈSI

ĐAKUJEM

RAHMAT

MERCI

GRAZZI

PAKKA PÉR

HATUR NUHUN

PAXMAT CAĞA

CẢM ƠN BẠN

WAZVIITA

FALEMINDERIT

ありがとうございました

SIPAS JI WERE

TERIMA KASIH

UA TSAUG RAU KOJ

ТИ БЛАГОДАРАМ

СИПОС

KÖSZÖNÖM

KEA LEBOHA

MISAOTRA ANAO

БЯРЛАЛАА

ТАРАДХ ЛЕІВН

ДЗЯКУЎ

FAAFETAI

ESKERRIK ASKO

HVALA

TEŞEKKÜR EDERİM

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PAKKA PÉR

PAXMAT CAĞA

CẢM ƠN BẠN

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СИПОС

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Please wait for the microphone

- State your name and company



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