

The background of the entire image is a dark blue gradient. On the left side, there is a faint, stylized image of the San Francisco Bay Bridge. On the right side, there is a faint silhouette of the San Francisco skyline, including the Transamerica Pyramid. The OSIsoft logo is centered at the top in white.

OSIsoft®

USERS CONFERENCE 2016

April 4-8, 2016 | San Francisco

TRANSFORM
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Mill Use Cases with Today's PI System

Presented by **Gopal GopalKrishnan, P.E.**
Solution Architect
OSIsoft, LLC.

UC 2016 - Industry Day - Paper and Pulp Track

Mill Use Cases with Today's PI System

This is **part 2** of a UC 2015 presentation titled [What if Expedia Showed your Mill's Operations Data](#) - your goal is to get rapid insights from data to drive operational and business intelligence. Self-service data analytics tools are now easier to use and deploy; they are also extensible and include the integration of open source packages such as R (<http://cran.r-project.org/>), d3js <http://d3js.org> and others. Join us in this session for an end-to-end walk-through – from data collection, data modeling, extraction, to creating web based dashboards and KPIs, including support for mobile devices. The demo uses [PowerBI Desktop \(free download\)](#) and the PowerBI extensibility framework ([Visuals Gallery](#)) along with PI Integrator for Business Analytics ([Learning Videos](#)). We will also discuss use cases for predictive analytics and machine learning.

For hands-on experience, please enroll in the TechCon Labs:

<http://www.osisoft.com/uc2016/sf/day4.html> - Operational Insights Using Real-time Dashboards and Self-service Business Intelligence

<http://www.osisoft.com/uc2016/sf/day3.html> (or on Day 4) - Use Data Science for Machine Learning and Predictions based on PI System data

<http://www.osisoft.com/uc2016/sf/day3.html> (or on Day 4) - Condition-based Maintenance with AF

Speaker: Gopal GopalKrishan, gopal@osisoft.com

Duration: 30 minutes

What we'll cover

- UC 2015 talk recap
- New capabilities in AF, EF...
- PI Integrator for BA
 - Visual and Statistical Analytics - BI tools
 - Production Reporting - Dashboards, KPI, ...
 - Energy Reporting
 - Custom visuals
 - Predictive Analytics - machine learning, R, open-source
- Call to Action + Q & A

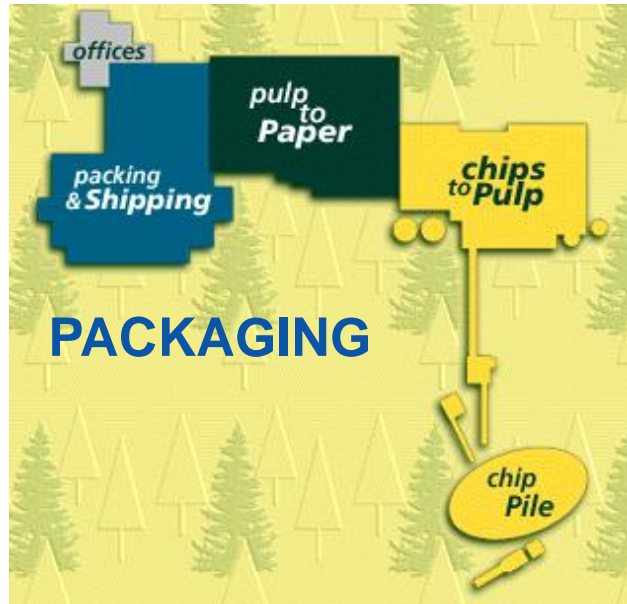
UC 2015 talk re-cap

- Asset Framework (AF) and Event Frames (EF) applied to the forest products use cases
- Use of interactive Business Intelligence
- Self-service visual analytics tools

What if Expedia Showed your Mill's Operations Data

Paper Mill

PAPER MACHINE



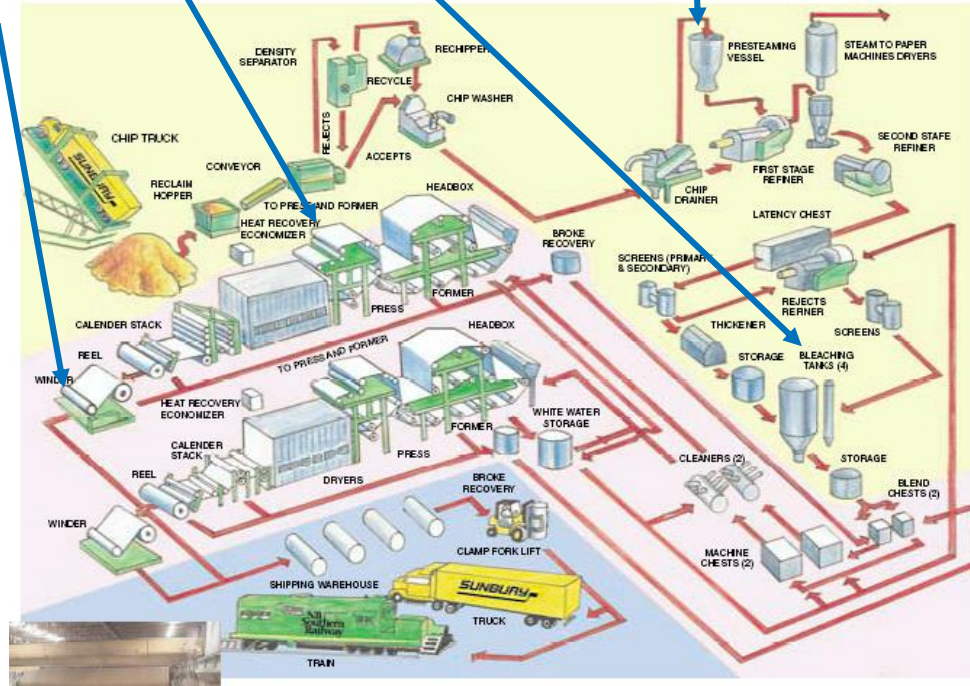
http://www.glatfelter.com/learning/interactive_tour.aspx
http://www.tappi.org/paperu/all_about_paper/paperClips.htm

PULPING - Bleach Plant

PAPER MACHINE

PACKAGING

PULPING



PULPING - Digester

Digester - Templates and Calculations

EL_BatchDigester

General Attribute Templates Ports Analysis Templates

Filter

Name	Description
Category: <None>	
Black Liquor	Total Black Liquor
Blow Back Valve	Blow Back Valve
Blow Time	Blow Time
Chips	Chips Fed
H Factor-Actual	H Factor-Actual
H Factor-Target (Line)	H-Factor-Target (Line)
H Factor-Target (Unit)	H-Factor Target (Unit)
LastHoldDuration	
LastIdleDuration	
LastLoadDuration	
LastReadyDuration	
Level	Level
Overpressure	Overpressure
Pressure A	Pressure A

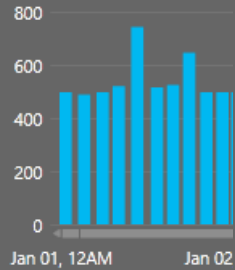
General Child Elements Attributes Ports Analyses Version

Filter

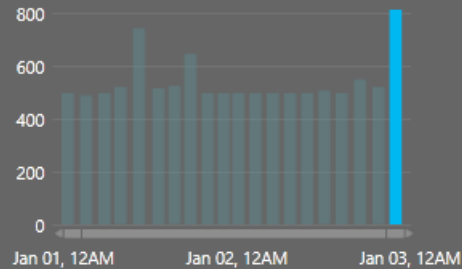
Name	Value
Category: <None>	
Black Liquor	4134.61 US gal
Blow Back Valve	1
Blow Time	2134.13281
Chips	54.28259 ton
H Factor-Actual	0
H Factor-Target (Line)	500
H Factor-Target (Unit)	I/O Timeout
LastHoldDuration	0 min
LastIdleDuration	0 min
LastLoadDuration	14 min
LastReadyDuration	0 min
Level	35.98305 in
Overpressure	0 psi

Digester – Operations Analysis

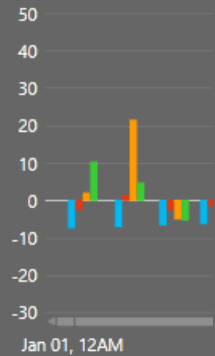
H by StartTime



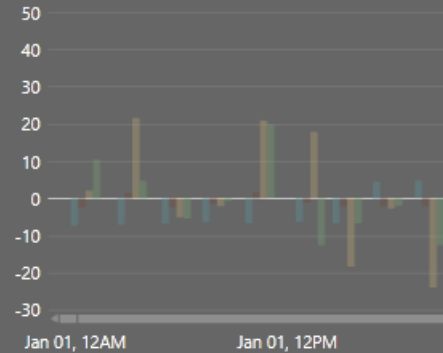
H by StartTime



BL4000, TTop340, St



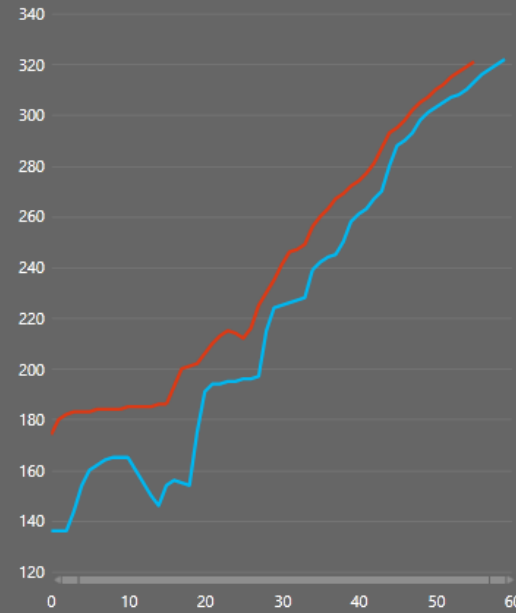
BL4000, TTop340, Steam40K, and Dur135 by



Digester

Digester - Heating Phase

Heat-Temp-Top by TimeAfter, and EventFrame



EF

DigCyc 20150101 00:35:38
■ DigCyc 20150101 03:13:38
DigCyc 20150101 05:43:58
DigCyc 20150101 08:01:58
DigCyc 20150101 10:25:58
DigCyc 20150101 13:16:38
DigCyc 20150101 15:23:58
DigCyc 20150101 17:39:38
DigCyc 20150101 20:01:38
■ DigCyc 20150101 22:09:38
DigCyc 20150102 00:19:58
DigCyc 20150102 02:36:38
DigCyc 20150102 04:59:38
DigCyc 20150102 07:25:38
DigCyc 20150102 09:43:38
DigCyc 20150102 12:00:38

Winder – Template and Calculations

General | Attribute Templates | Ports | Analysis Templates

Filter

Name
Speed
Speed Reference
Speed Setpoint
Start Command
Tension
Tension Reference
Tension Setpoint
Thread Mode
TimeBetweenReels
TimeBetweenSets
Unwind Coupling Closed
Unwind Coupling Open
Unwind Coupling OpenDuration_24hr
Unwind Coupling OpenDuration_Last
Category: Status
Category: Winder-Rider Roll
Category: Winder-Unwind

General | Child Elements | Attributes | Ports | Analys

Filter

Category: <None>

Acceleration
Acceleration Rate
Deceleration Rate
SetDuration
Speed
Speed Reference
Speed Setpoint
Start Command
Tension
Tension Reference
Tension Setpoint
Thread Mode
TimeBetweenReels
TimeBetweenSets
Unwind Coupling Closed
Unwind Coupling Open
Unwind Coupling OpenDuration_2

General | Child Elements | Attributes | Ports | Analyses | Version

Name	Schedule	Output(s)
f SetDuration	"Speed";"Speed"	SetDuration
f SlitterMovingCount_Daily	Natural	SlittersMovingCount_Daily
f SlitterMovingDuration	Natural	SlittersMovingDuration_...
f TimeBetweenReelAndBetweenSets	"Start Comman...	TimeBetweenSets; TimeB...
f UnwindCplOpen	Offset=86340;...	Unwind Coupling OpenD...

Name	Expression
PrevT	PrevEvent('SetDuration','')
Duration	Float('*' - PrevT)/60
PrevStart	FindEq('Start Command','*-1s','*-24h','True')
DeltaFromPrevStart	*' - PrevStart
CplOpenTrue	If FindEq('Unwind Coupling Open','*',PrevStart,"True")="No Result"
BtwSet	If 'Start Command'="True" and PrevVal('Start Command','*')="False"
BtwReel	If 'Start Command'="True" and PrevVal('Start Command','*')="False"

[Add a new expression](#)

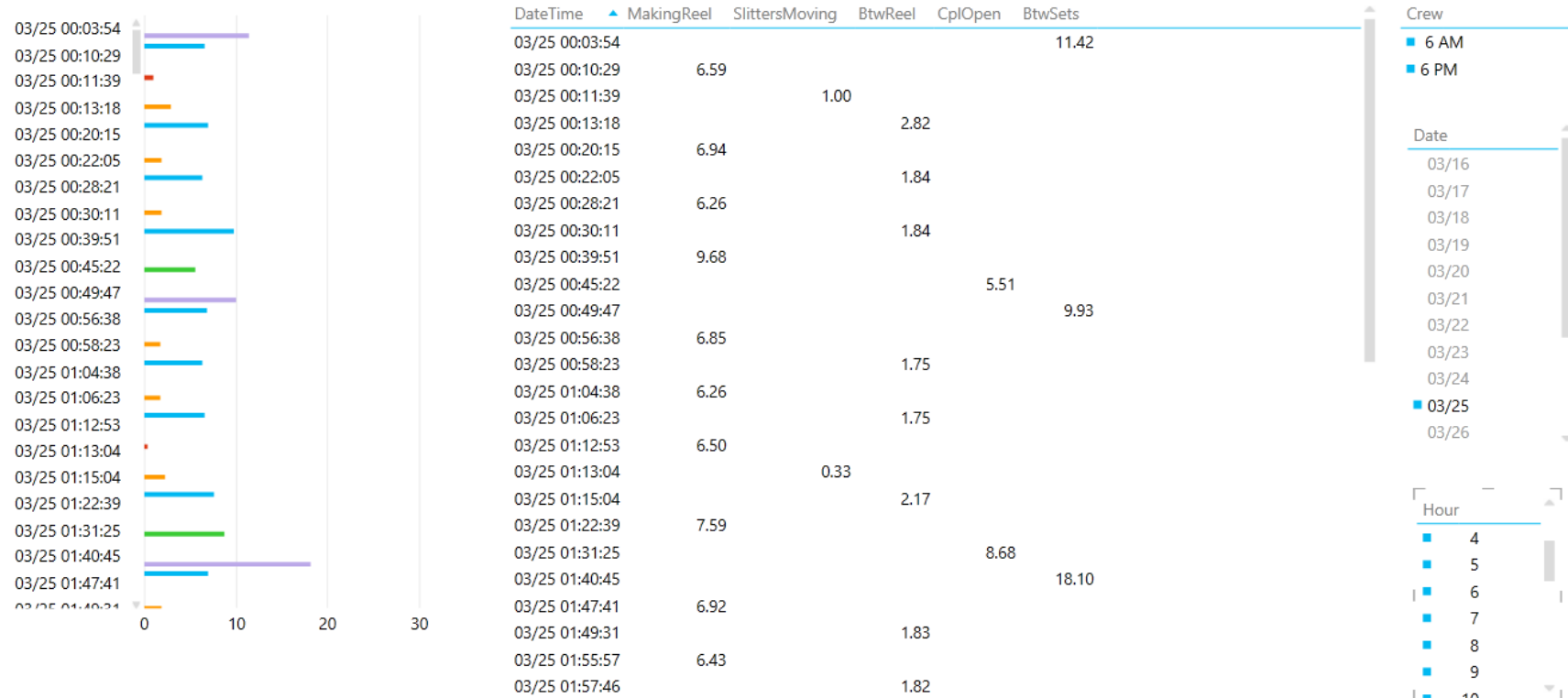
Scheduling: ☒ Event-Triggered ☐ Periodic

Trigger on: Start Command, Start Command

MakingReel, SlittersMoving, BtwReels, CplOpen,BtwSets

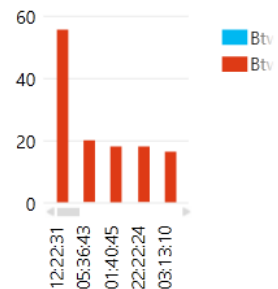
Making Reel, SlittersMoving, BtwReels, CplOpen, BtwSets

MakingReel, SlittersMoving, BtwReel, CplOpen, and



Between Sets and Reels (minutes)

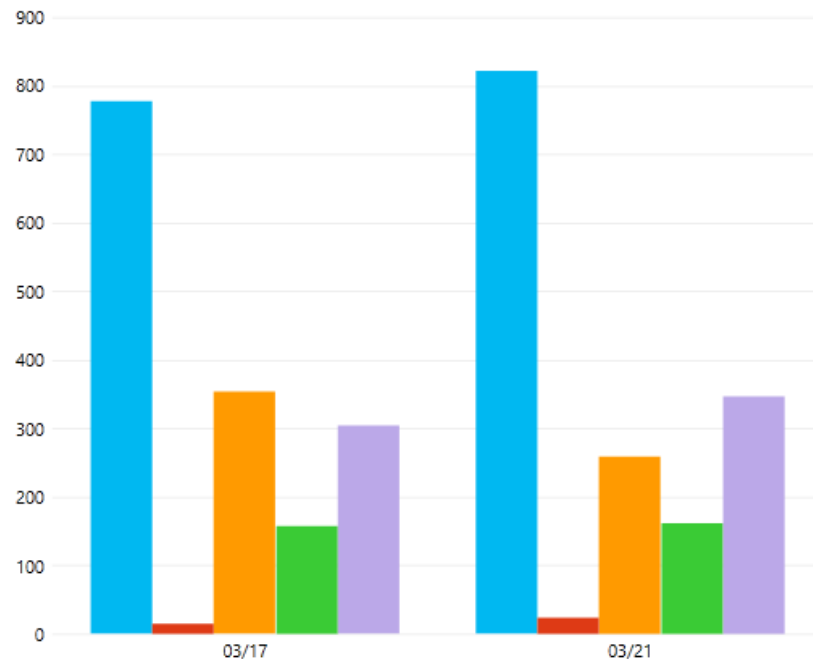
BtwReel, and BtwSets by TimeOnly



TimeOnly	Date	BtwSets
12:22:31	03/25	55.56
05:36:43	03/25	19.94
01:40:45	03/25	18.10
22:22:24	03/25	17.87
03:13:10	03/25	16.51

Winder by day - MakingReel, BtwReels, BtwSets

MakingReel, SlittersMoving, BtwReel, CplOpen, and BtwSets by Date



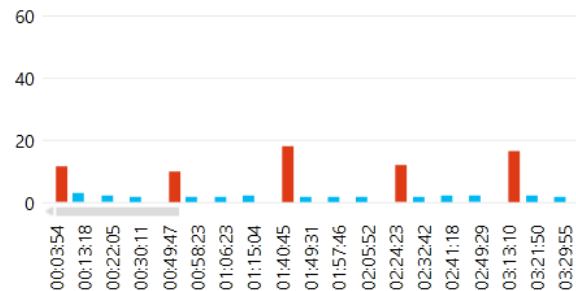
Date

03/16
03/17
03/18
03/19
03/20
03/21
03/22
03/23
03/24
03/25
03/26
03/27
03/28
03/29
03/30
03/31

DayType

WkDay
WkEnd

BtwReel, and BtwSets by TimeOnly



Live auto-refresh interactive BI screens

- Production Reporting - Packaging line
- Energy reporting – Motors, Fans, Agitators...
- Refresh – hourly, daily etc.

For hands-on experience, please enroll in the TechCon lab

<http://www.osisoft.com/uc2016/sf/day4.html> - Operational Insights Using Real-time Dashboards and Self-service Business Intelligence

Production Reporting

<https://app.powerbi.com/view?r=eyJrIjoibWVjYz00OWEtZmJkNy00ZWQ3LTgzNmUtMzM3MThjMTIyOGIwIiwidCI6ImE0NDVIZTgxLTJiOTEtNDgwNi04ODNiLTkYzY3M2Q1OTE0NyIsImMiOiZ9>

Select Data > Modify View > Publish

PM1

TimeStamp	Day of the Week
2/15/16 9:01 PM	Monday
2/15/16 9:02 PM	Monday
2/15/16 9:03 PM	Monday
2/15/16 9:04 PM	Monday
2/15/16 9:05 PM	Monday
2/15/16 9:07 PM	Monday
2/15/16 9:08 PM	Monday
2/15/16 9:09 PM	Monday
2/15/16 9:10 PM	Monday
2/15/16 9:11 PM	Monday

Date

Aug-22

Aug-23

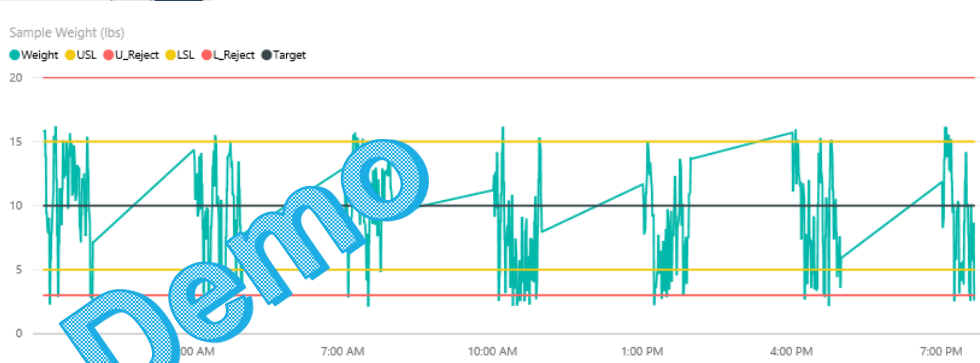
Aug-24

Aug-25

Shift

AM

PM



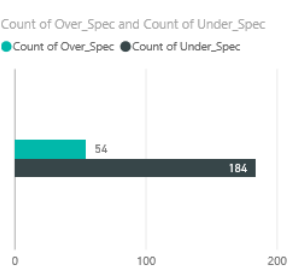
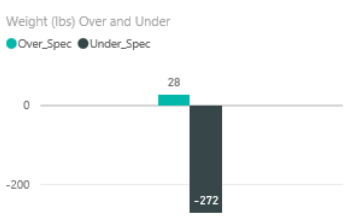
Grade_Weight

RECYCLE3 50

RECYCLE7 90

SEMIGLOSS 10

SEMIGLOSS2 100



Target (lbs)	Actual (Average) lbs	% Delta
10	9.11	-8.94
Total Weight (lbs)		
8.25K		
Count		
906		
UnderWeight Reject Count		
63		
OverWeight Reject Count		
(Blank)		

SingleRun MultiRun Report MultiRun Chart

Energy Usage Reporting

Energy Per Ton (Expected)

Edit Filters

☐ Event Frame Name

Production Run 2015-0

☒ Event Frame Template

RunTime

Add Filter

Next

Matches

Found 100 Matches

Production Run 2015-02-24 00:00:00.000

Production Run 2015-02-24 00:00:00.000

Production Run 2015-02-24 00:00:00.000

Production Run 2015-02-24 00:00:00.000

Production Run 2015-02-24 00:00:00.000

Production Run 2015-02-24 00:00:00.000

Production Run 2015-02-24 01:59:00.000

Production Run 2015-02-24 02:19:00.000

Production Run 2015-02-24 02:35:00.000

Production Run 2015-02-24 04:22:00.000

Production Run 2015-02-24 05:31:00.000

Production Run 2015-02-24 05:32:00.000

Production Run 2015-02-24 06:40:00.000

Element

☐ Agitator 1204

☐ Agitator 1205

☐ Agitator 1304

☐ Agitator 1305

☐ Fan 5163

☐ Fan 5164

☐ Fan 8144

☐ Pump 3809

☐ Pump 3810

☐ Pump 5301

☐ Pump 5302

☐ Pump 8209

☐ Pump 8210

Asset Type

☐ Agitator

☐ Fan

☐ Pump

Location

☐ Houston

☐ Tulsa

☐ Wichita

Size

☐ Extra Large

☐ Large

☐ Medium

☐ Small

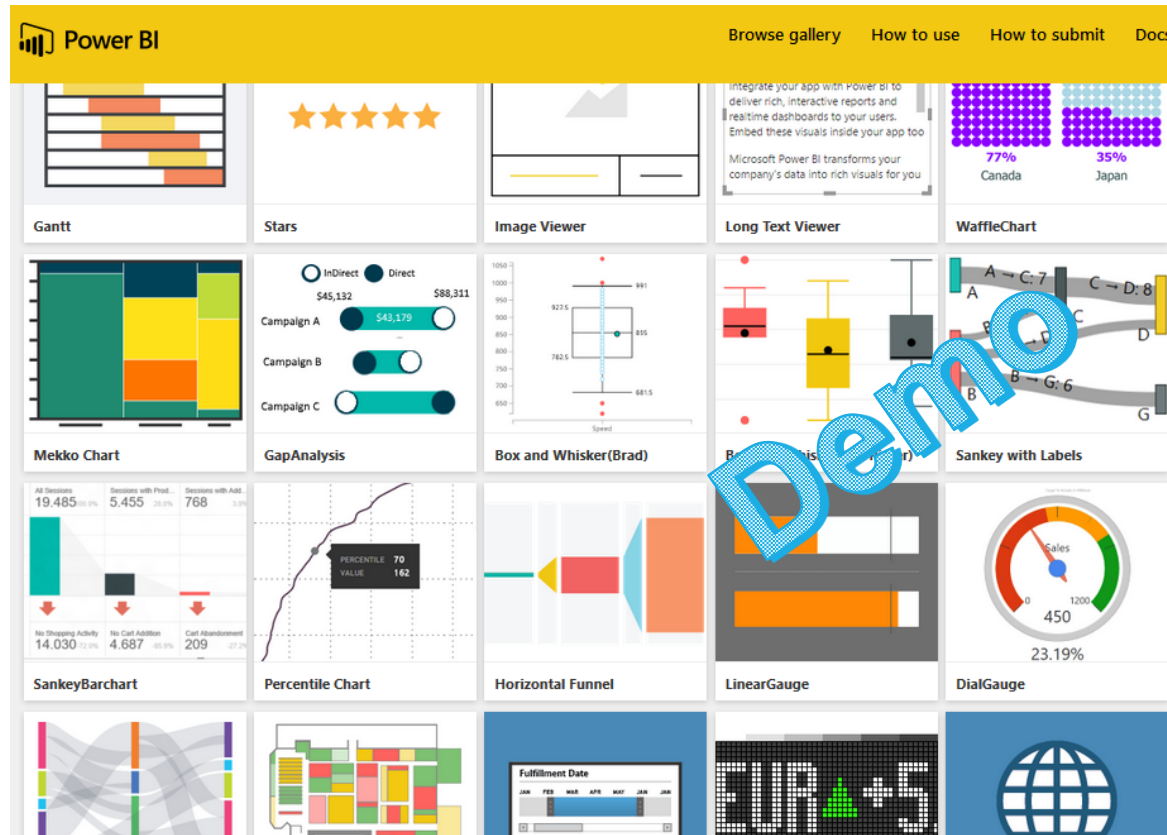
Average of Energy Percent Deviation by Month

Energy Per Ton (Actual) by Location

of Events by Element

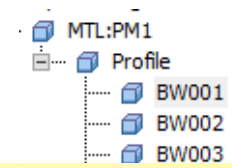
Energy Per Ton (Actual) and Energy Per Ton (Expected) by Average Production Rate (Actual)

<https://app.powerbi.com/visuals/>



Custom Visuals with R script

R Script



⚠ Duplicate rows were removed from the data.

```
# Remove duplicated rows
# dataset <- unique(dataset)
require("ggplot2")
library(ggplot2)
plot=ggplot(dataset)
plot=plot+aes(x=Pos,y=DateTime,fill=DeltaPct) +geom_raster()
plot=plot+scale_fill_gradientn(colours=c("red","yellow","green", "green","green","yellow", "red"))
plot=plot+ scale_y_continuous(breaks=seq(min(dataset$DateTime),max(dataset$DateTime),2))
plot
```

Visualizations

Values

Box

Time

DeltaPct

Pos

DateTime

Filters

Box(All)

DateTime(All)

DeltaPct(All)

Pos(All)

Time(All)

Page level filters

Drag data fields here

Fields

Search

GradeEvents

Grades

prf

prf2

Prf60boxes

☒ Box

☐ date

☒ DateTime

☒ DeltaPct

☐ GrdIndex

☐ Hour

☐ Max

☐ Measure

☐ PM

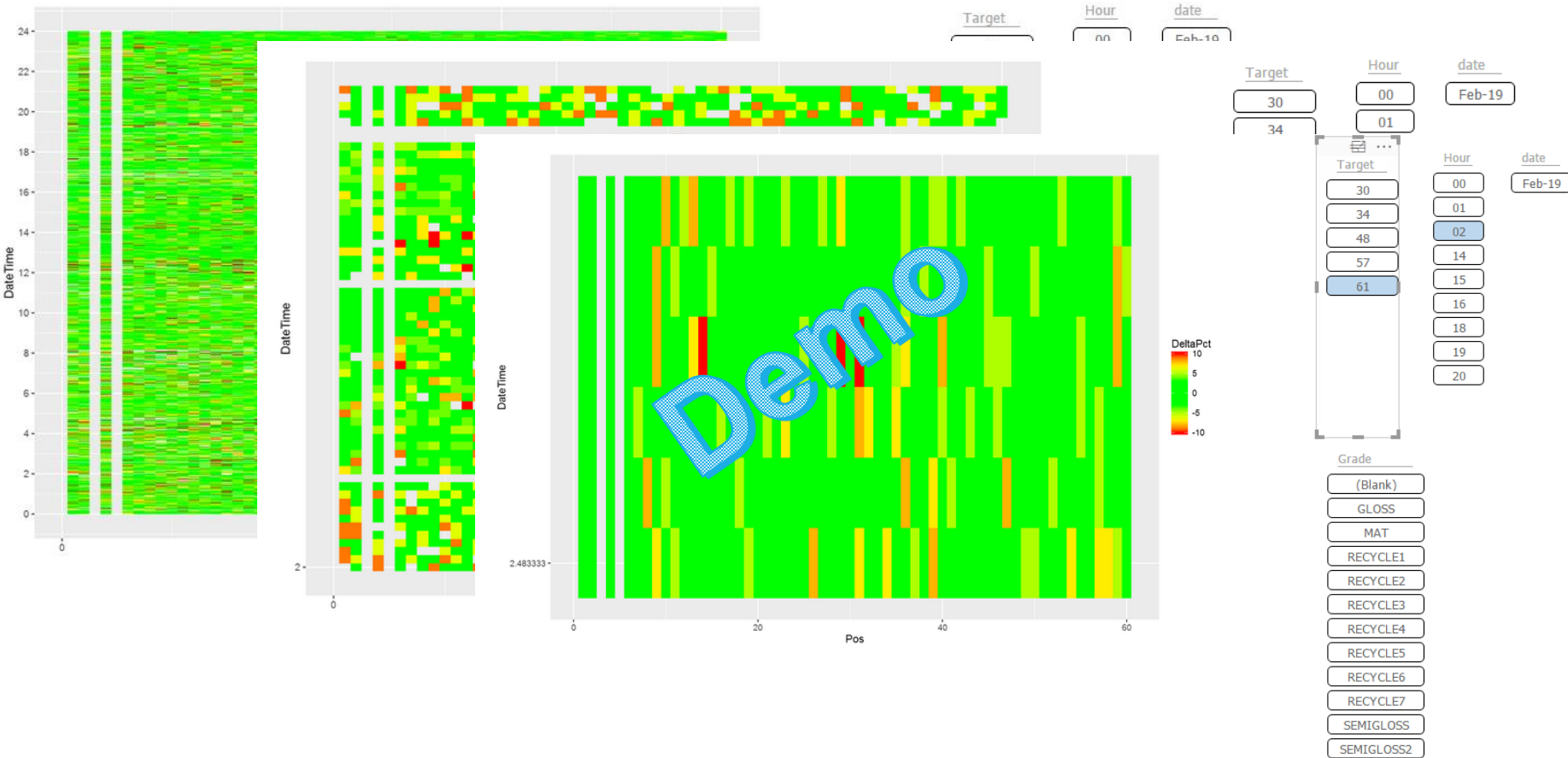
☒ Pos

☐ Target

☒ Time

```
plot=plot+aes(x=Pos,y=DateTime,fill=DeltaPct) +geom_raster()
plot=plot+scale_fill_gradientn(colours=c("red","yellow","green", "green","green","yellow", "red"))
plot=plot+ scale_y_continuous(breaks=seq(min(dataset$DateTime),max(dataset$DateTime),2))
plot
```

Basis Weight - Profile



Predictive Models and Statistical/Machine Learning

- Multivariate techniques
 - Reduce time for grade change
 - Lab data – predict quality
 - Equipment failure
 - Sheet-break
 - ...
 - ...

Predict engine failure/remaining useful life

Lab Exercise

In a deployment with about 100 engines which are similar, sensor data such as rpm, burner fuel/air ratio, pressure at fan inlet, and twenty other measurements plus settings for each engine – for a total of about 2000 tags – are available. On average, an engine fails after 206 cycles, but it varies widely - from about 130 to 360 cycles.

Using an open source tool such as R for machine learning, you will create a multivariate model to predict engine failures within approximately a 10 cycle window ***before they fail***. The lab will walk through the end-to-end data science process – preparing the dataset, visually exploring it, partitioning the data for training and testing, validating the models using previously unseen data, and finally deploying the model with AF asset analytics for predictive maintenance.

Level: 300 (familiarity with R will be useful but is not a requirement)

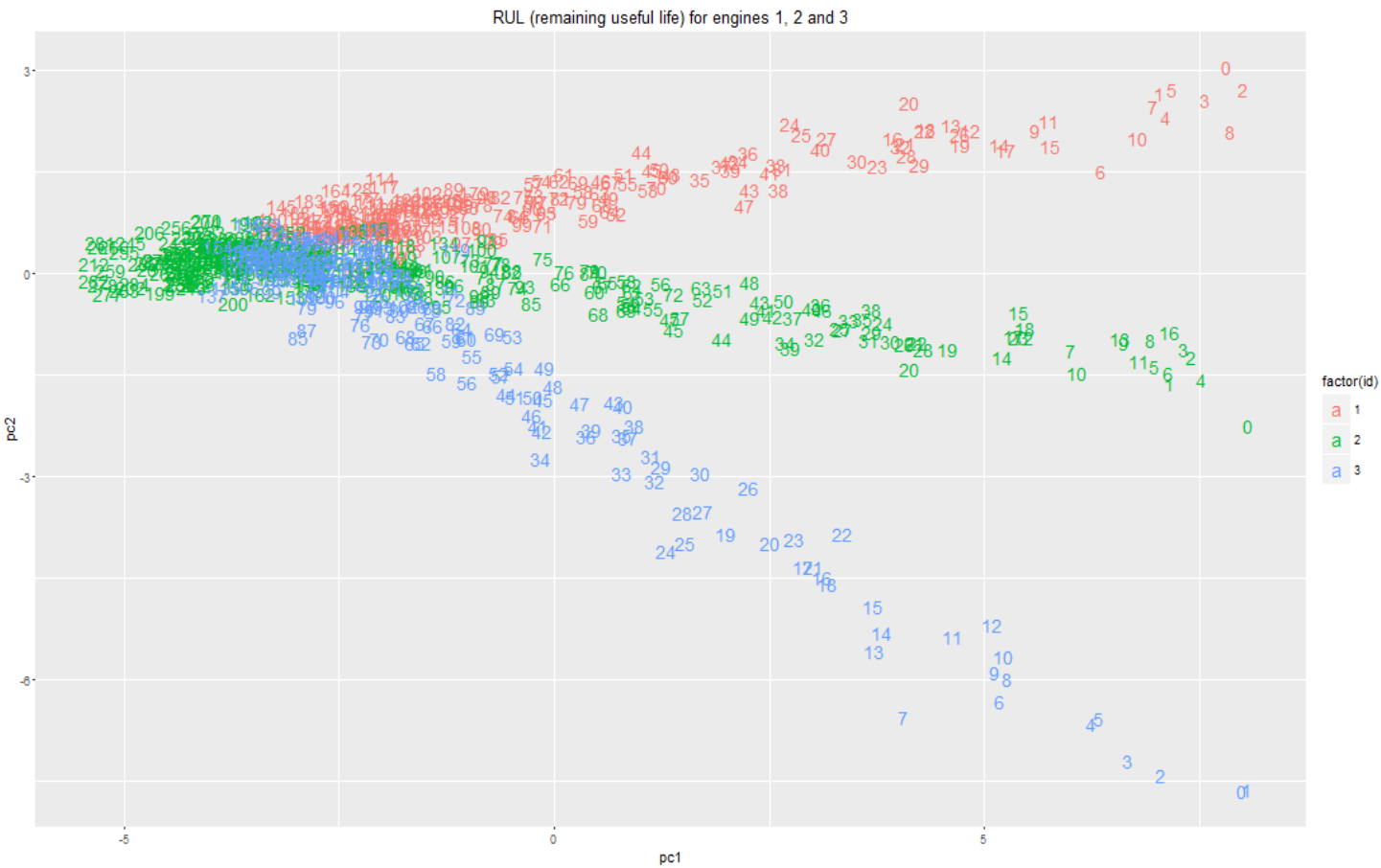
For hands-on experience, please enroll in the TechCon lab – Day3 or Day 4

<http://www.osisoft.com/uc2016/sf/day3.html> - Use Data Science for Machine Learning and Predictions based on PI System data

Engine data

	A	B	C	D
1	id	cycle	setting1	setting2
2	1	1	-0.0007	-0.0004
3	1	2	0.0019	-0.0003
4	1	3	-0.0043	0.0003
5	1	4	0.0007	0
6	1	5	-0.0019	-0.0002
190	1	189	-0.0006	0.0002
191	1	190	-0.0027	0.0001
192	1	191	0	-0.0004
193	1	192	0.0009	0
194	2	1	-0.0018	0.0006
195	2	2	0.0043	-0.0003
196	2	3	0.0018	0.0003
197	2	4	0.0035	-0.0004
198	2	5	0.0005	0.0004

	A	B	C	D
1	id	cycle	setting1	setting2
2	1	1	-0.0007	-0.0004
3	1	2	0.0019	-0.0003
4	1	3	-0.0043	0.0003
5	1	4	0.0007	0
6	1	5	-0.0019	-0.0002
20625	100	193	-0.0001	0.0001
20626	100	194	-0.0011	0.0001
20627	100	195	-0.0002	-0.0001
20628	100	196	-0.0004	-0.0001
20629	100	197	-0.0016	-0.0001
20630	100	198	0.0004	0.0001
20631	100	199	-0.0011	0.0001
20632	100	200	-0.0032	-0.0001
20633	100	201	-0.0001	0.0001



Engine failure prediction

```
# get pci equation
pcleq = ""
for (i in 1:17) {
  p
}

## +(
44*0.
984*-
5))/0
7'-(3

# get
pc2eq
```

File Search View Go Tools Help

Database Query Date Back Check In

Elements

Engine_1

General Child Elements At

Name Expression

zpc1 +('setting1

zpc2 +('setting1

pcma3 (zpc1+PrevV

if pcma3>6.

Failure then "Will

Scheduling: Event-Trig

Trigger on Any Input

Time Series Data

Archive Sampled Plot Summary Data Pipe

Attribute: Predicted Status

Start Time: 2/21

Retrieval Type: Time

Filter:

Trend

Start Time: 2/20/2016 11:59:00 PM End Time: 2/21/2016 5:00 am

Engine_1|Status Engine_1|Predicted Status

Stopped Will Fail

3 1

2.5

2

1.5

1

0.5

0 0

2/20/2016 11:59:00 PM 5.02 hours 2/21/2016 5:00:00 AM

Add Attributes... Add PI Points... Traces... Close

PI System Sandbox

<https://pisquare.osisoft.com/community/developers-club>

PI Server – Site 1



PI Server – Site 2



PI System – sandbox

Win 2008 R2 or Win 2012
- 80GB disk and 8GB RAM

Office Excel 64 bit – 2010 or 2013
Power BI (does not depend on Office)

PI Server 2015 (PI DevClub license is OK)
SQL 2014 (SQL Express is OK)
AF 2015 (Server and Client)
EFGen
PI SMT
PI Builder

PI ODBC, PI Integrator for BA

PI DataLink 2015
PI ProcessBook 2016
PI Coresight 2016

Call to Action

- Get a PI Developers Club subscription
<https://pisquare.osisoft.com/community/developers-club>
- Deploy a PI System sandbox
- Start with simple AF/EF models and calculations to answer specific questions
- Get started with *visual* and *predictive* analytics

Contact Information

Gopal GopalKrishnan, P.E.

gopal@osisoft.com

Solution Architect

OSIsoft, LLC.

Questions

Please wait for the **microphone** before asking your questions

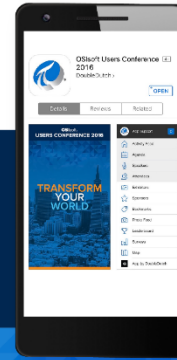


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감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado

The background of the slide is a dark blue gradient with a faint, stylized image of the San Francisco skyline, including the Golden Gate Bridge and the Transamerica Pyramid. The OSIsoft logo is positioned at the top center.

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