Reducing Beer Production Time with Predictions

Presented by **Brian Faivre – Brewmaster**

Tim Alexander – Assistant Brewmaster

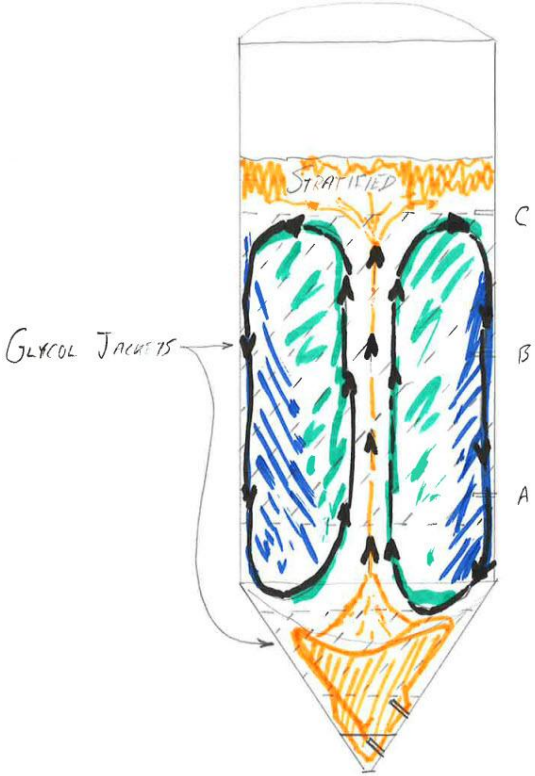
Deschutes Brewery – History

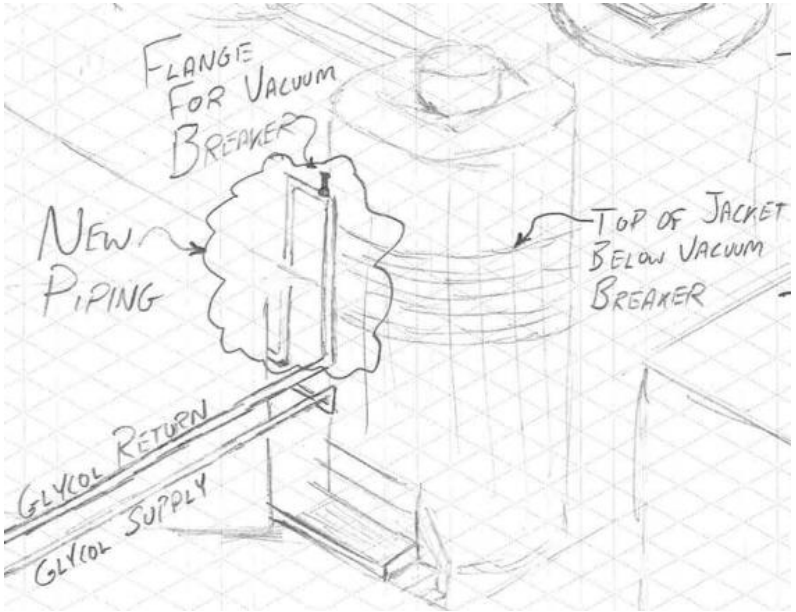
- Located in Bend, OR
- Founded in 1988
- Pub opened in Portland, OR in 2007

Deschutes Brewery – Production Facility

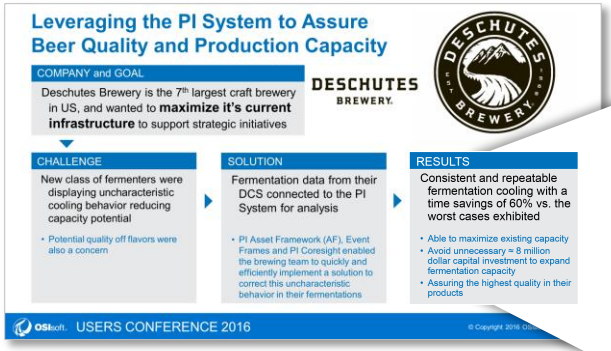
- 2 brewhouses
- 50+ vessels
- Bottling and kegging
- 7th largest craft brewer in the US

Constantly Improving Quality and Efficiency





Our Successes So Far: Highlights from SF 2016



RESULTS

Consistent and repeatable fermentation cooling with a time savings of 60% vs. the worst cases exhibited

- Able to maximize existing capacity
- Avoid unnecessary ≈ 8 million dollar capital investment to expand fermentation capacity
- Assuring the highest quality in their products

Diagnosed uncharacteristic behavior in fermenters

- PI Asset Framework
- Event Frames
- PI Coresight

SF 2016 presentation:
What's Really Going on with your Beer Fermentation

Posted on www.osisoft.com

Can we use any of these buzz words?

Machine Learning

Internet of Things

Data Warehouse

Advanced Analytics

Data Science

Process Efficiency

Data Lakes

Business Intelligence

Beer Quality

Predictive Analytics

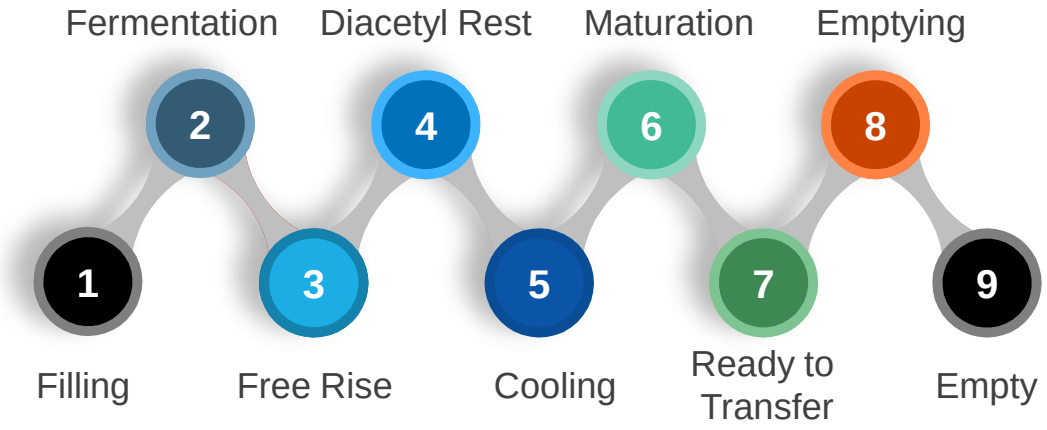
Data Mining

Big Data

Advanced Visualization

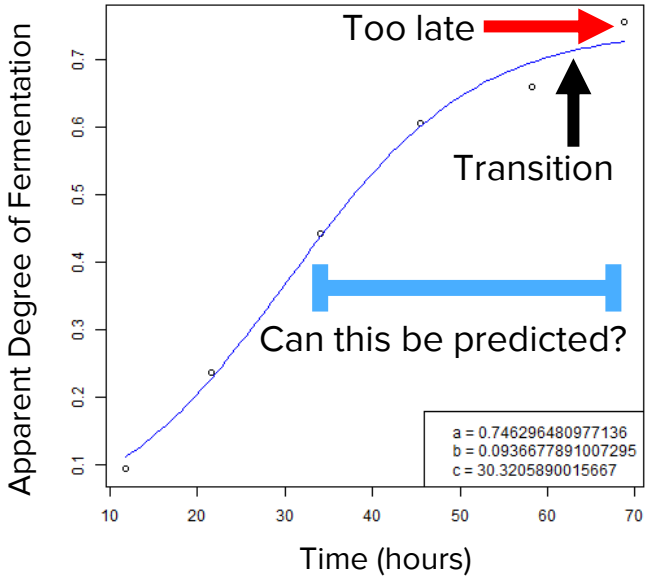
Operational Intelligence

Need to Predict Transition from Fermentation to Free Rise

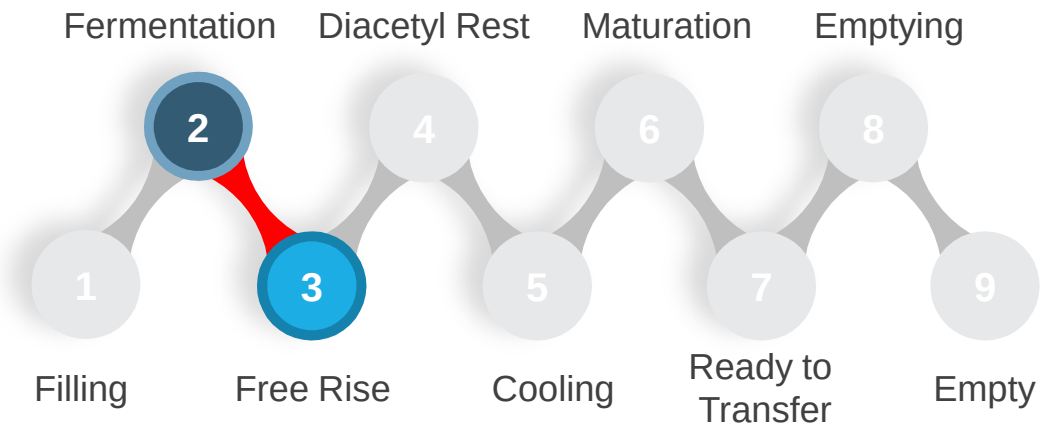


Challenge

Transition occurs between infrequent manual measurements



Need to Predict Transition from Fermentation to Free Rise



Constraints

- One manual density measurement per vessel every 8-10 hours
- Large capital expenditure not an option

Impact

- Up to 72 hours lost in production

Options

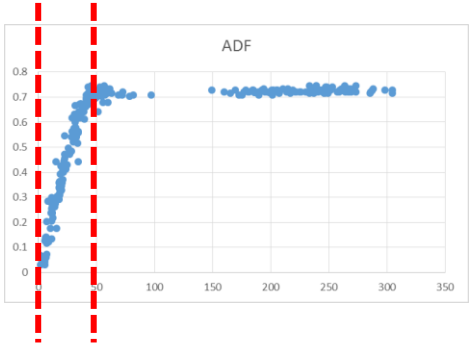
- $750k for inline density meters
- Manually predict transition in spreadsheets

Predictive Analytics in a Spreadsheet

Bring Raw Data In

	A	B	C	D	E	F	G	H
1	FV	Brand	FV Full	FV Full °P	°P Timestamp	°P	Hours since FV Full	ADF
2	FV43	Fresh Squeezed	10/20/15 7:48 PM	16.50142	10/20/15 9:31 PM	15.4	1.720277778	0.066747
3	FV44	Fresh Squeezed	9/29/15 7:31 AM	16.50996	9/29/15 9:17 AM	16	1.767777778	0.030888
4	FV39	Fresh Squeezed	8/13/15 4:16 AM	16.5059	8/13/15 7:52 AM	15.8	3.595555556	0.042767
5	FV39	Fresh Squeezed	10/11/15 3:05 AM	16.5057	10/11/15 7:43 AM	15.6	4.632777778	0.054872
6	FV46	Fresh Squeezed	7/10/15 3:44 AM	16.51289	7/10/15 8:34 AM	15.6	4.834722222	0.055284
7	FV40	Fresh Squeezed	8/27/15 3:01 AM	16.49278	8/27/15 8:11 AM	15.6	5.175555555	0.054132
8	FV40	Fresh Squeezed	7/15/15 2:05 AM	16.52212	7/15/15 7:30 AM	15.8	5.411944444	0.043706
9	FV42	Fresh Squeezed	8/31/15 2:53 PM	16.50258	8/31/15 8:20 PM	16	5.466388889	0.030454
10	FV43	Fresh Squeezed	10/7/15 2:55 AM	16.50425	10/7/15 8:24 AM	14.4	5.494722222	0.127498
11	FV38	Fresh Squeezed	10/1/15 1:38 AM	16.49718	10/1/15 7:54 AM	14.2	6.263611111	0.139247
12	FV46	Fresh Squeezed	7/23/15 3:29 PM	16.50286	7/23/15 10:06 PM	15.5	6.626944444	0.060769
13	FV43	Fresh Squeezed	12/3/15 1:46 AM	16.50147	12/3/15 8:24 AM	14.2	6.6375	0.139471
14	FV40	Fresh Squeezed	11/15/15 1:52 AM	16.30823	11/15/15 8:31 AM	14	6.650833333	0.141538
15	FV40	Fresh Squeezed	7/3/15 1:39 AM	16.51333	7/3/15 8:44 AM	14.6	7.079722222	0.115866
16	FV38	Fresh Squeezed	10/28/15 11:49 PM	16.53811	10/29/15 [illegible]			0.201844
17	FV39	Fresh Squeezed	7/27/15 1:55 PM	16.4914				
18	FV42	Fresh Squeezed	7/31/15 11:41 PM	16.50569				
		Fresh Squeezed	8/5/15 10:30 PM					

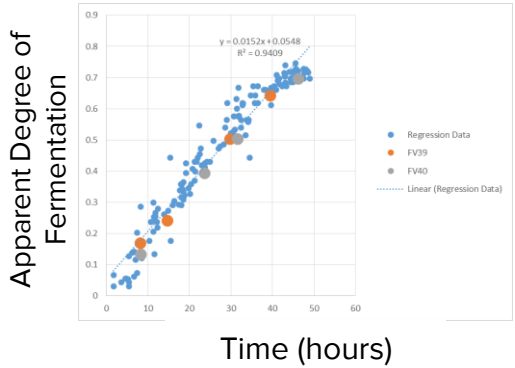
Clean it Up



New Challenges

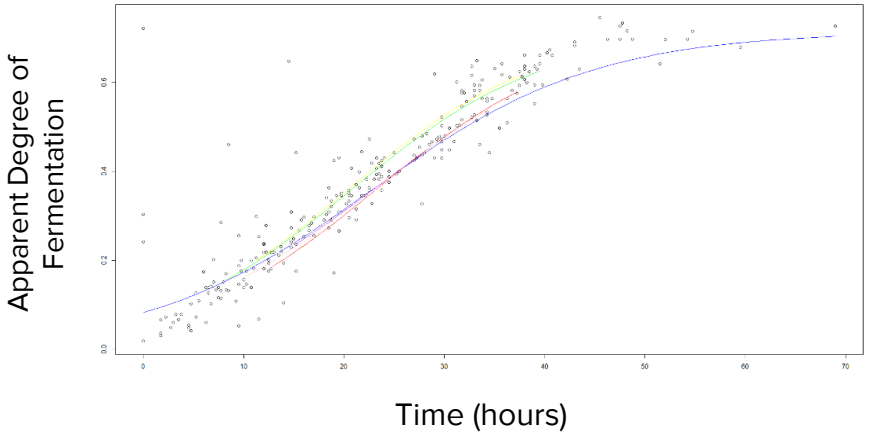
- How can the **data preparation** be **automated**?
- How can the **predictions** be **operationalized**?
- How can the **predictions** become **more accurate** over time?

Fit to a Line

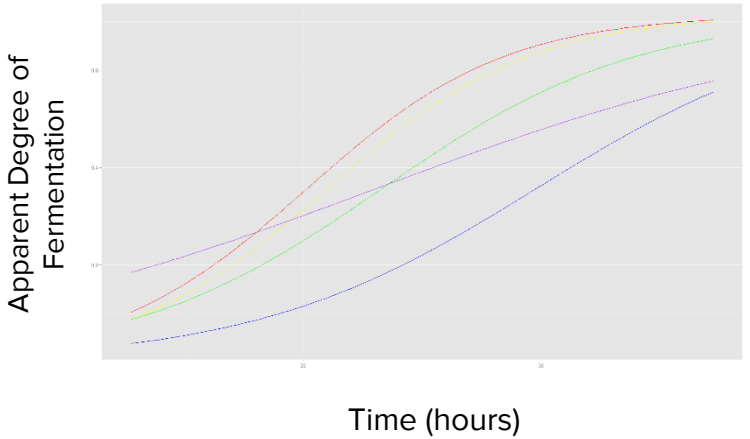


Beer Brand Portfolio Complicates Predictability

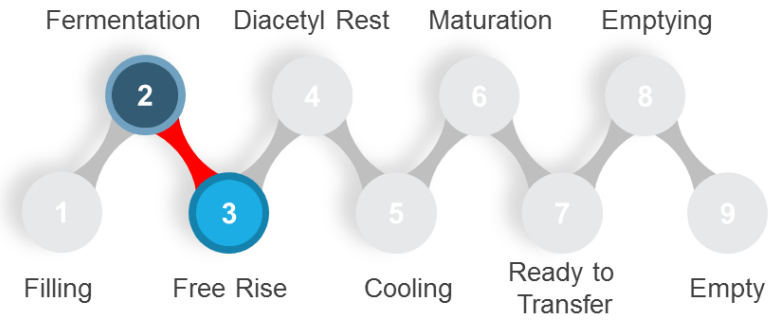
Variety within Batches for a Brand



Diversity in Beer Brands



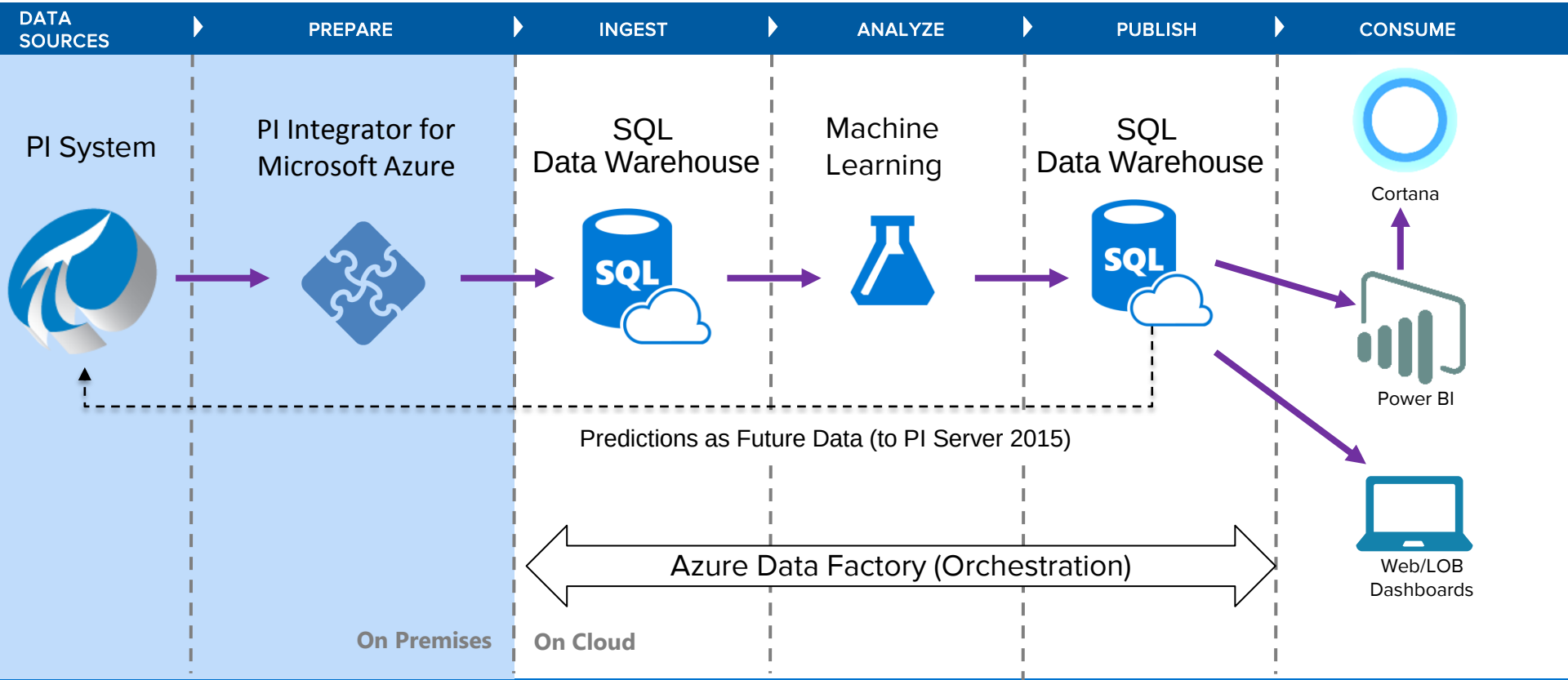
Need to Predict Transition from Fermentation to Free Rise



Challenges

- Transition occurs between manual density measurements
- Each batch of beer requires **data preparation**
- **Predictions** need to be **accurate and operationalized** to enable action
- Batch variety and brand diversity require **predictive model to learn**

How to Operationalize Predictions



Machine Learning Model

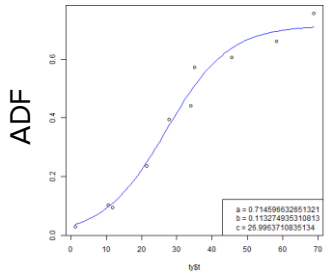
Proposal

Early Density Readings → Transition Time

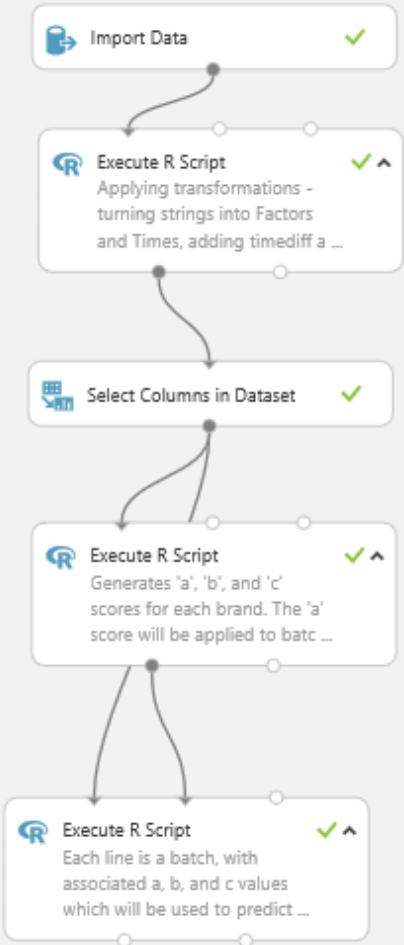
Hypothesis

Transition time influenced by

- Brand of beer
- Fermentation dynamics (temperatures, pressures,..)
- Vessel's dimensions & volume



Time in Phase

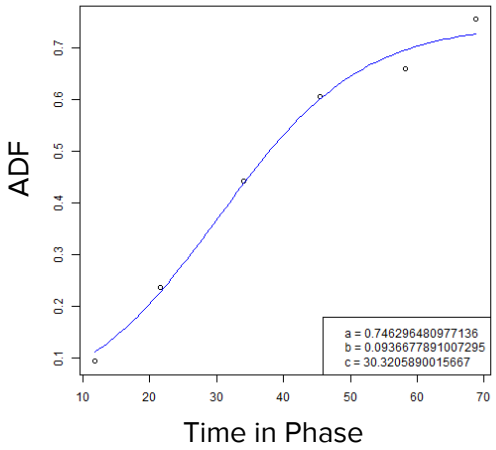


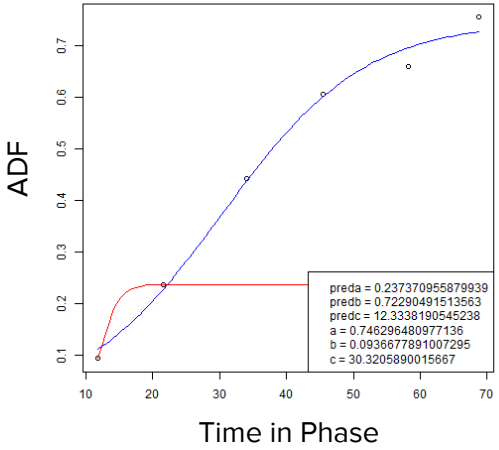
Azure ML Predicts Accurate Transition Time

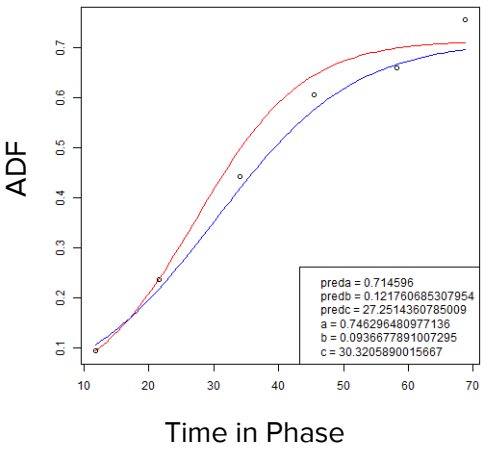
Benchmark: Measure accuracy against a standard (based on historical data)

Predict: Use 2 early densities to estimate transition time

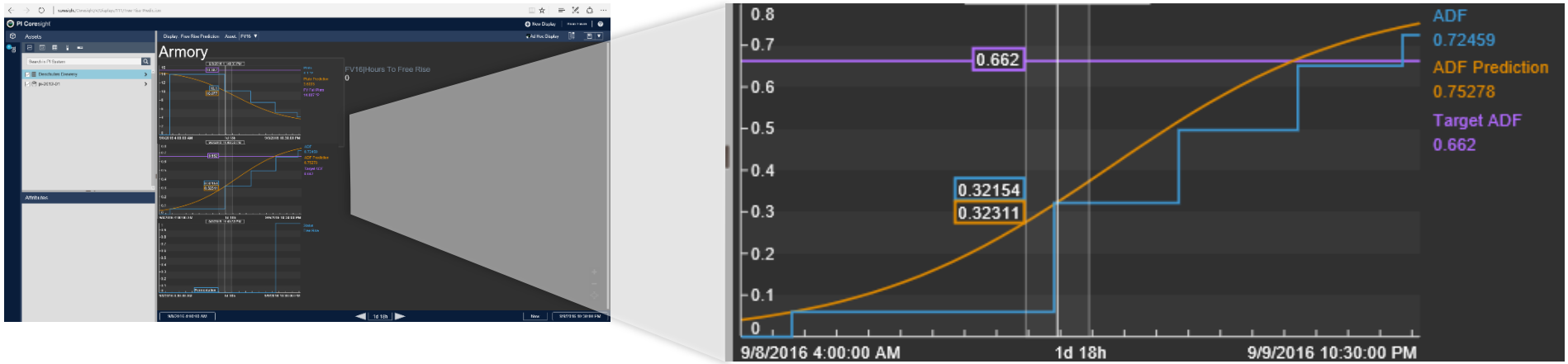
Refine: base predictions on brand for greater accuracy







Operationalizing Predictions on When the Transition Occurs



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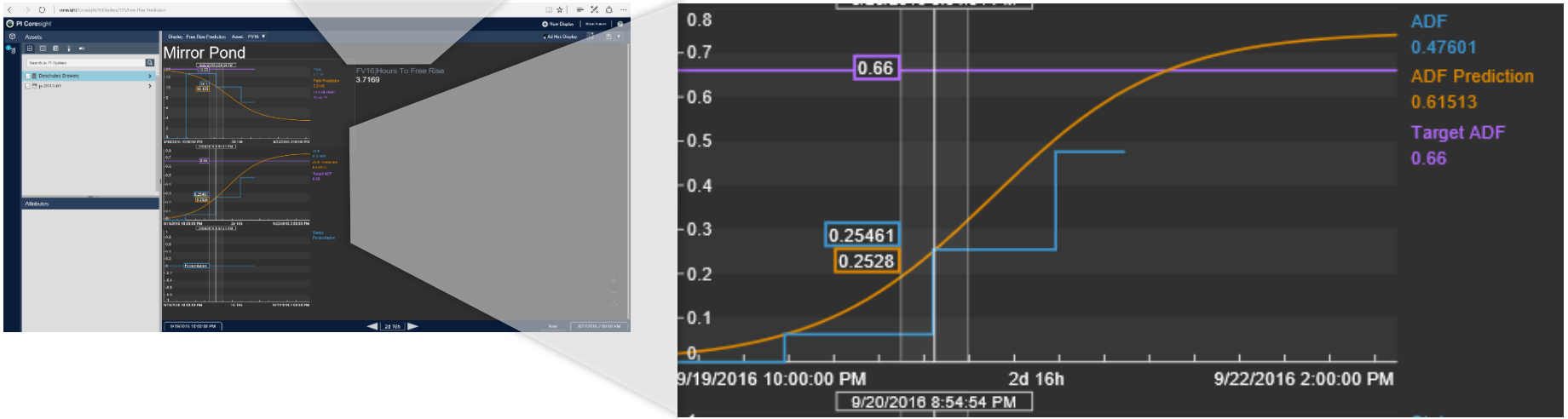


Leveraging the PI System and Cortana Intelligence to Increase Process Efficiency

COMPANY and GOAL

Deschutes Brewery is the 7th largest craft brewery in US, and wanted to maximize production with its existing infrastructure to fund construction of a 2nd brewery in Roanoke, VA

CHALLENGE

Batch's phase transition happens between manual density measurements occurring every 8-10 hours

- Impact: Losing up to 72 hours in production time

SOLUTION

Use data science to achieve accurate predictive analytics for determining a batch's density measurements

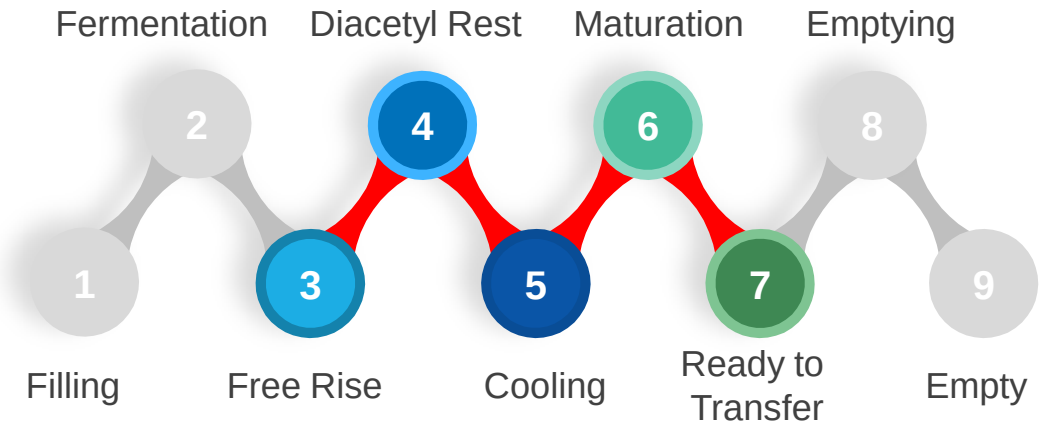
- PI System
- PI Integrator for Microsoft Azure
- SQL Data Warehouse
- Azure Machine Learning
- Azure Data Factory

RESULTS

Ability to eliminate production time losses and increase production capacity

- Accurate predictions of when a batch's phase transitions from fermentation to free rise

Future Opportunities



- Incorporate predictions into beer making process
- Roll out predictions for more beer brands
- Test if predictions can cue a batch that is deviating
- Apply similar predictive methods to other transitions

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Questions

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

State your **name & company**

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감사합니다

谢谢

Danke

Gracias

Merci

Thank You

ありがとう

Спасибо

Obrigado