Industrial Machine Intelligence
The Golden Braid of Data Streams, AI, and Human Expertise

Drew Conway – Machine Learning in Oil and Gas, Canada
Google releases “MapReduce” paper

Hadoop 0.1.0 Release

Data Science Venn Diagram published

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AlphaGo defeats Lee Sedol

Google releases “BigTable” paper

IBM Watson wins Jeopardy

Gartner drops “big data” from Hype Cycle

U.S. Supreme Court hears arguments based on big data
18th Century
First mechanical loom (1784)

19th Century
First steam powered conveyor belt in Chicago meatpacking (1867)

20th Century
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21st Century
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Industry 4.0

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The Data Problem

Heterogeneous Data Streams
→ Streaming asset time-series data
→ Asset and operation meta-data
→ Historical operation databases

Data Lake

EXTRACT, TRANSFORM & LOAD

LEARN

BUILD PRODUCTS

EXTRACT VALUE

1. Resource Intensive
2. High Latency
3. Limited ROI

Alluvium | Machine Learning in Oil & Gas, Canada
The Tools Problem

Machine intelligence products often seek to replace expert operators. But, this fails by not...

1. Leveraging operator expertise
2. Limiting cognitive focus
3. Reflecting reality of operator job
Data-driven Decision Making in Industrial Operations

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At the edge  In the control room  At headquarters

React & Record  Observe & Orient  Investigate & Improve
# Rapid Forensic Analysis

<table>
<thead>
<tr>
<th>PAIN</th>
<th>Our assets and operation generate more data than we are capable of analyzing.</th>
</tr>
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<tbody>
<tr>
<td>CAUSE</td>
<td>Industrials leads all sectors in connected device growth at a rate of 24% per annum. The volume of data produced by this operational technology vastly outstrips an organization’s ability to effectively leverage it.</td>
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</table>

**Reduce Complexity**

Primer is designed to distill massive streams of raw sensor and production data into usable insights for expert operators. This allows your team to rapidly move through massive amounts of data to identify where and when deviations and changes are happening in data, identify the sources of those issues, and take action.

[Alluvium Primer](http://alluvium.io/primer)
Operational Transparency

PAIN
Our current methods for regularly reviewing operational data are laborious and error prone.

CAUSE
Operational technology teams must perform regular (daily) inspection and analysis of asset data. Legacy tools still require considerable manual inspection of large amounts of data under heavy time and resource constraints.

See Everything
Primer can analyze an entire database with a single mouse click. This allows plant operators and managers to see the stability of their production from plant-level down to a single asset or sensor. The auto-generated reports can then be used to set the priority and agenda for an entire operational team.

Alluvium Primer | http://alluvium.io/primer
Early Warning

**PAIN**

We cannot identify new or unique operational disruption conditions before they occur.

**CAUSE**

New failure conditions or disruptions patterns are very difficult to identify or predict by their very nature. In addition, it can be challenging to broadcast institutional knowledge gleaned from these incidents even after they have occurred.

**Always Learning**

Primer’s artificial intelligence adapts to your specific operation and assets. It does this by learning from your operators’ input every time the tool is used. By constantly refining the AI, Primer can detect subtle or new patterns in data, which provide early warnings to your operators to fix problems before they occur.
How We Do It

Our proprietary Stability Score™ is a simple metric that pulls together historical or real-time data and gives operators a way to quickly see changes in plant and production systems, down to a single asset or sensor, and decide on the changes that matter.
Air Emission Event Reporting Database

<table>
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<tr>
<th>Regulated entity name</th>
<th>Physical location</th>
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<td>City, County: BAYTOWN, HARRIS</td>
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<tr>
<th>Regulated entity RN number</th>
<th>Type(s) of air emissions event</th>
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<tr>
<td>RN102579307</td>
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<td>08/27/2013 8:30AM</td>
<td>08/27/2013 4:45PM</td>
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This is based on the:
- FINAL REPORT

Cause: FCCU3 Selective Catalytic Reduction (SCR) system tripped causing NOx emissions to increase.

Action taken: SCR system was returned to normal operations.

Emissions estimation method:
- Process and engineering knowledge were used to determine the released quantities. Portions of the unit emissions are authorized by Permit #18287/PSD-TX-730M4/PAL7. There is no impact to production. This event has ended. All customers' needs were met.
FCCU3 Selective Catalytic Reduction (SCR) system tripped causing NOx emissions to increase.

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Alert 1
Aug 24 - 25

SUMMARY
Instability was observed for about 2 days: from Aug 24 2013 06:00 am to Aug 25 2013 09:00 pm.

OPERATOR EVALUATION
Import Check
Ignore
Discuss

Operator Notes...

STABILITY ANALYSIS

B
100

View Analysis A
100

View Analysis T
100
Flaring event begins
What happened here

Mattered here
SUMMARY

Instability was observed for about 2 days: from Aug 24 2013 06:00 am to Aug 25 2013 09:00 pm.
Systematic thermal anomaly
Three days before flaring event