Smarter Operations Through Industrial Analytics

October 2018

Arundo optimizes industrial assets leveraging software and advanced analytics

Calgary

Oslo

Seattle

London

Stockholm

Houston

Palo Alto

Key facts

- Founded in 2015 – now 102 "Arundites" (21 PhDs)
- Bringing "Silicon Valley" into asset-heavy industries
- Providing industrial cloud software to enable rapid value from machine learning models at scale

We are **20** nationalities...

... and speak **17** languages

Our employees have a deep and diverse set of backgrounds and experiences:

intel Google CERN Shell pason NOV GE Statkraft

Pivotal MathWorks HALLIBURTON SBM OFFSHORE TOSHIBA McKinsey&Company

Microsoft Aker Solutions ABB SIEMENS accenture AES UK & Ireland

Schlumberger ExxonMobil NASA Honeywell ENERNOC BCG The Boston Consulting Group DUPONT

MIT Stanford University UiO University of Oslo NTNU Imperial College London

RICE Carnegie Mellon University

PRINCETON UNIVERSITY A&M UT COLUMBIA UNIVERSITY UCL Georgia Tech

About Preminor

Preminor is a management consultancy specializing in implementation of supply chain optimization technologies for oil & gas.
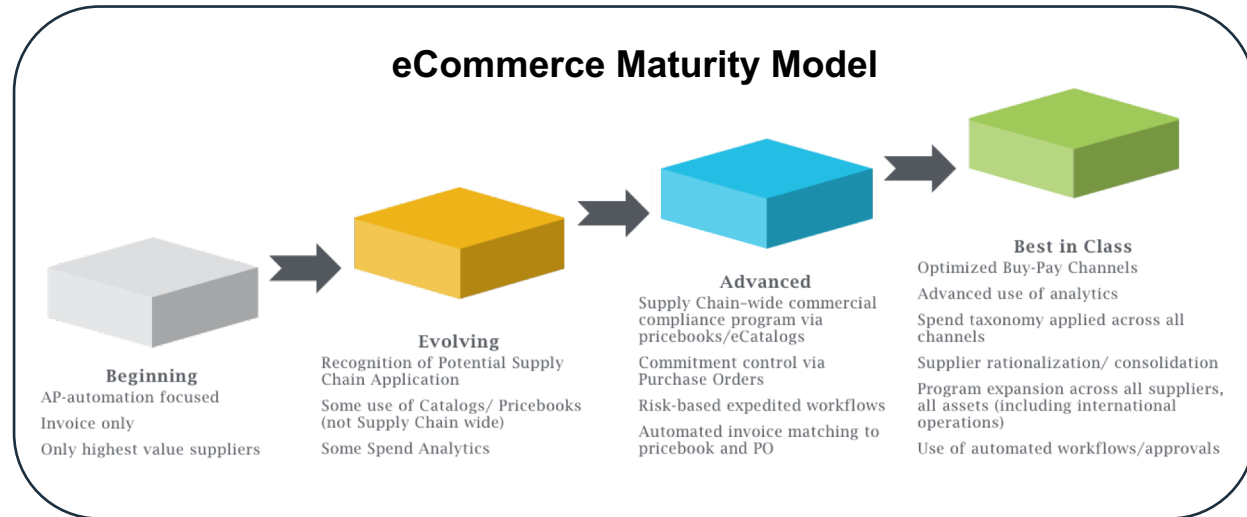
PIDX Contributors since 2000, and former workgroup chairmanship.

Practice Areas in:
- Master Data Management
- Supply Chain Processes
- Supply Chain Technology
- Analytics

eCommerce Maturity Model

Beginning
AP-automation focused
Invoice only
Only highest value suppliers

Evolving
Recognition of Potential Supply Chain Application
Some use of Catalogs/ Pricebooks (not Supply Chain wide)
Some Spend Analytics

Advanced
Supply Chain–wide commercial compliance program via pricebooks/eCatalogs
Commitment control via Purchase Orders
Risk-based expedited workflows
Automated invoice matching to pricebook and PO

Best in Class
Optimized Buy-Pay Channels
Advanced use of analytics
Spend taxonomy applied across all channels
Supplier rationalization/ consolidation
Program expansion across all suppliers, all assets (including international operations)
Use of automated workflows/approvals

Legacy physical assets/systems present unique adoption barriers for oil and gas
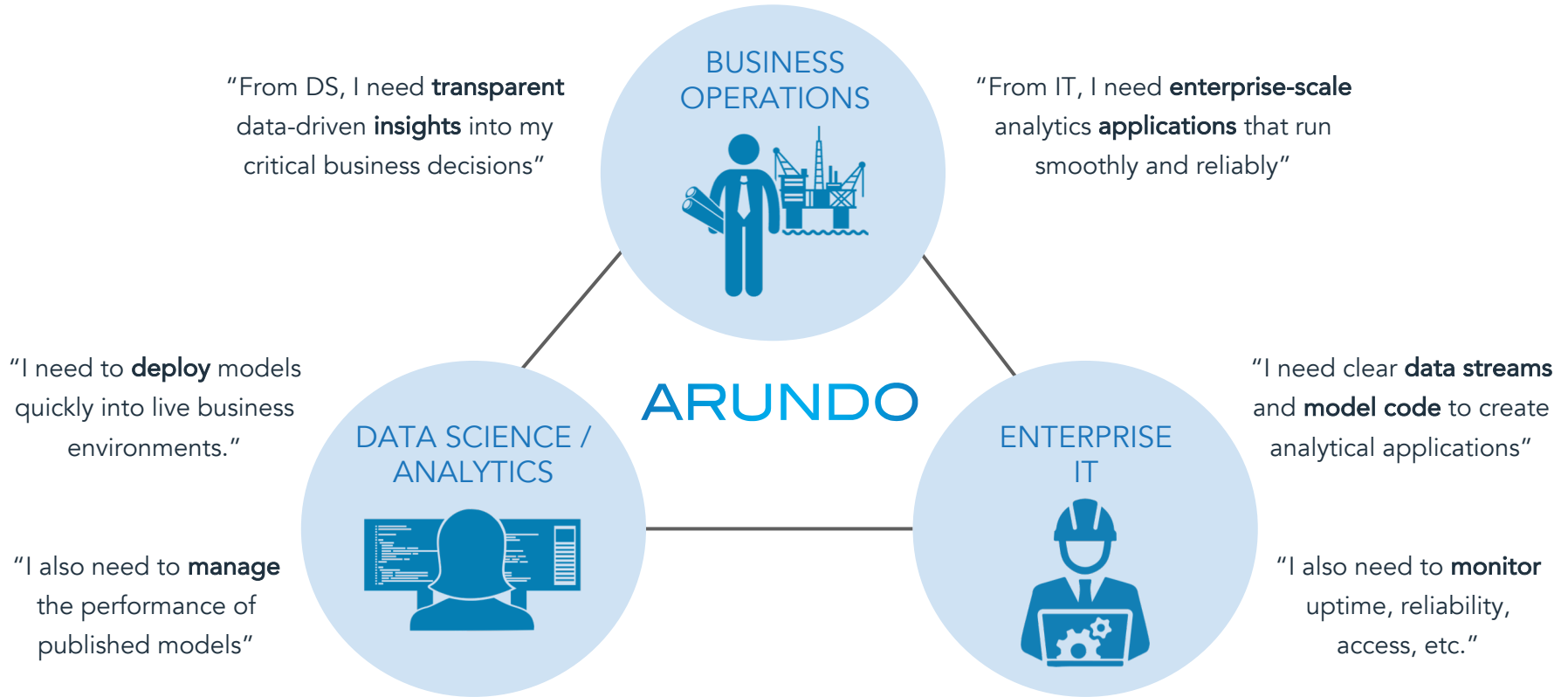

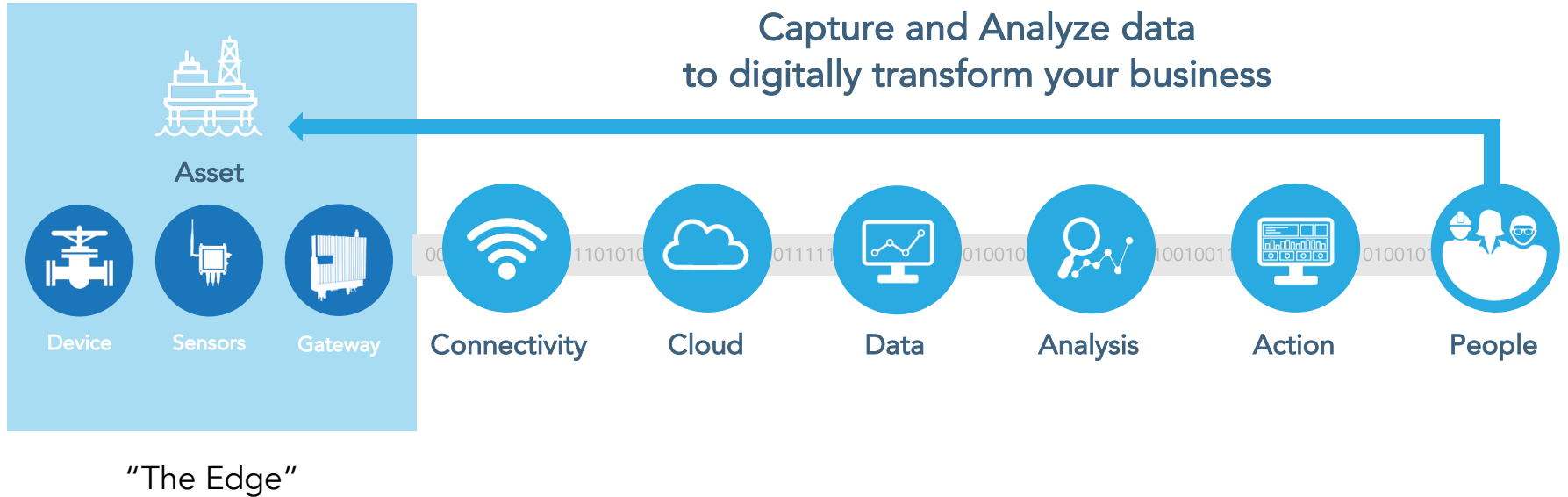**Legacy** physical assets weren't built for IIoT

Complexity in existing IT infrastructure

Perception: large **"plumbing" investments** needed to capture value

There is also an organizational gap between operations, data science and IT

BUSINESS OPERATIONS

"From DS, I need **transparent** data-driven **insights** into my critical business decisions"

"From IT, I need **enterprise-scale** analytics **applications** that run smoothly and reliably"

ARUNDO

"I need to **deploy** models quickly into live business environments."

DATA SCIENCE / ANALYTICS

"I also need to **manage** the performance of published models"

"I need clear **data streams** and **model code** to create analytical applications"

ENTERPRISE IT

"I also need to **monitor** uptime, reliability, access, etc."

End-to-End solutions are required for industrial companies to overcome these challenges and unlock value from data

Asset

Device

Sensors

Gateway

"The Edge"

Capture and Analyze data
to digitally transform your business

Connectivity

Cloud

Data

Analysis

Action

People

Machine learning models and IoT enabled applications developed to date

Equipment
- Fault detection / prediction for compressors
- Fault detection / prediction for heat exchangers
- Streaming analytics for pumps (with OEM pump manufacturer)
- Condition based monitoring for large manufacturer

Transport and Logistics
- Logistics / shipping capacity optimization
- Truck dispatching, safety control and invoice control
- Prediction of freshwater consumption for cruise ships
- Ship performance monitoring, including predictive model for optimal hull cleaning

Subsurface / well
- Oil-in-water detection / prediction model using data from 300+ sensors
- Machine-assisted well log interpretation

Asset / system
- Prediction of gas break-through using 4D seismic interpretation
- Automatic labeling and categorization of seismic data and documents
- Prediction of estimated ultimate recovery and decline curves for onshore US

Utilities
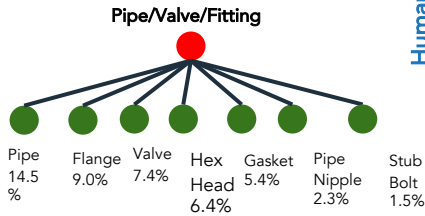- Detection of earth faults and installation errors from AMS meters

Data processing
- Predictive model for labeling of failure / maintenance logs to ISO standard
- Application to identify sensors and placement from P&ID documents
- Invoice interpretation and handling

Use Case 1: Supply chain invoice mapping

Pipe/Valve/Fitting

| Pipe 14.5% | Flange 9.0% | Valve 7.4% | Hex Head 6.4% | Gasket 5.4% | Pipe Nipple 2.3% | Stub Bolt 1.5% |

Human Labels (historical)

Confusion matrix
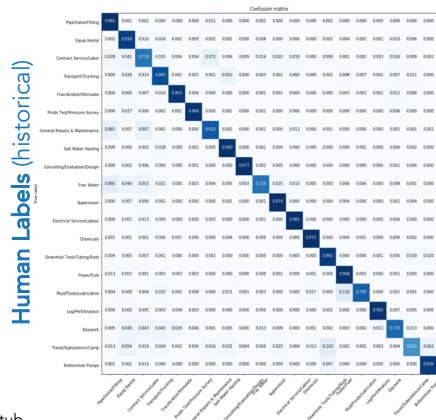
Artificial Neural Network Labels

CUSTOMER'S CHALLENGE

- A large upstream operator wanted to improve and automate existing supply chain processes

- Client desired more granular mapping of invoices to GL to facilitate more accurate spend benchmarking

- Client also desired an automated process to reduce the error and manual work associated with mapping ~3M invoices/year

ARUNDO'S SOLUTION

- Expanded GL code hierarchy to provide better accuracy with additional invoice data fields

- Demonstrated benefits of leveraging ML in the AP process to streamline invoice mapping

- Leveraged ML models to develop a data-driven and automated invoice mapping based on historical data

IMPACT

10% increase in invoice/GL mapping accuracy across ~3M invoices

Use Case 2: Compressor failure detection for upstream operator
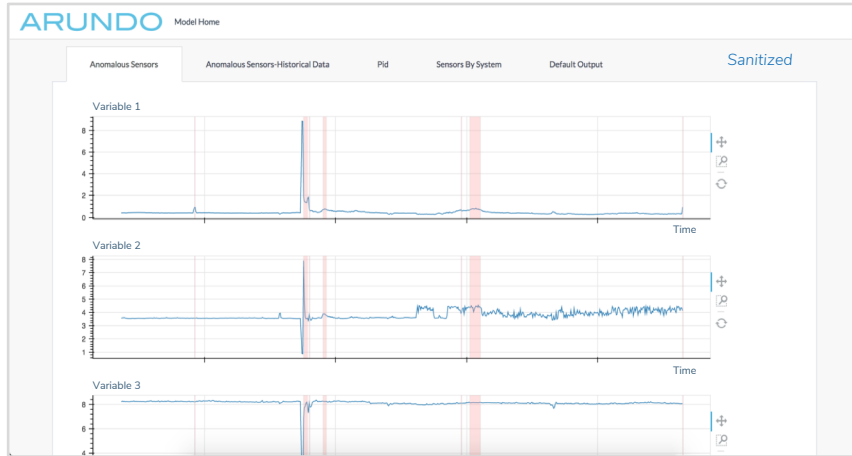
CUSTOMER'S CHALLENGE

- Failures on compressors are low-frequency events with high-impact consequences

- Control systems do not adequately capture compressor status and are unable to prevent failures on their own

- A single failure can cause production loss costing tens of millions of USD

ARUNDO'S SOLUTION

- Developed a cloud-based machine learning system to provide early warning of abnormal compressor behavior

- Unsupervised model that learn behaviors of the export compressors over multiple years and detects failures

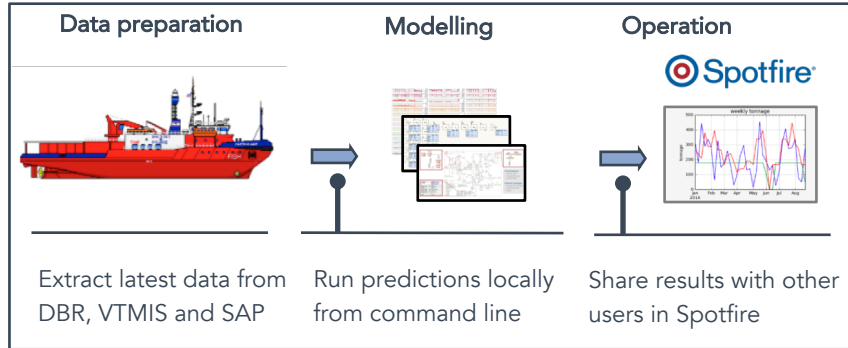- System raised an alert two weeks in advance and also identified the most anomalous sensors on the compressor

IMPACT

300-370 kboe
reduced production loss
(single identified failure)

USD 12-16 M
annual value

Use Case 3: Supply chain forecasting for upstream operator

Data preparation	Modelling	Operation
Extract latest data from DBR, VTMIS and SAP	Run predictions locally from command line	Share results with other users in Spotfire

CUSTOMER'S CHALLENGE

- Low predictability of short to medium demand of drilling equipment
- Unexpected peaks in the demand of drilling equipment is managed by buying expensive additional vessel capacity in the spot market
- Need to reduce sub optimal utilization available logistics capacity and reduce logistics related non productive time on contracted rigs

ARUNDO'S SOLUTION

- Developed a machine learning model by combining data from multiple sources to understand the need for drilling equipment
- Leveraged supervised learning approach to learn the relationship between the drilling plans and the actual shipped tonnage of drilling equipment to the rigs
- Model was deployed with a visual tool ready to be used by the business units for decision support

IMPACT	Reduced rates by 5% for 30% of fleet (short-term contracts)	Reduced idle long-term chartered vessels by 20 vessel days

Use Case 4: Onshore Initial Production Prediction

Truth   Model
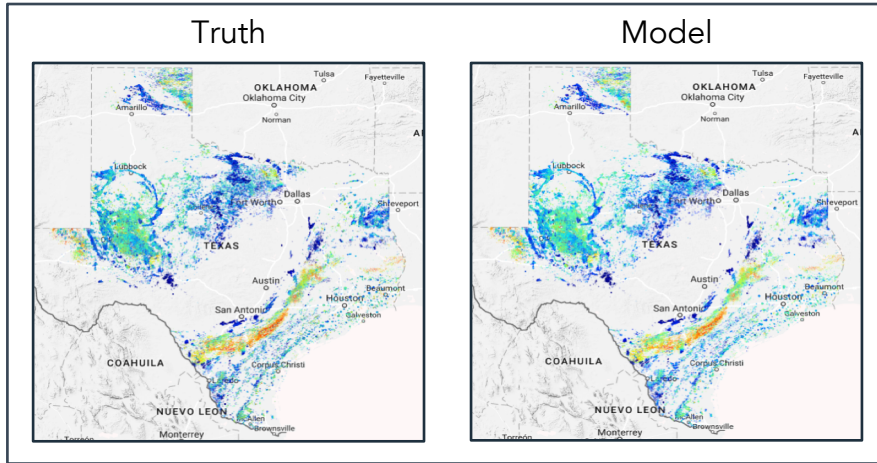
CUSTOMER'S CHALLENGE

- Production data provider aims at transformation from selling raw data to selling data-driven analytics
- Predicting initial production of proposed drilling is critical for field development decision making
- Traditional analog-based methodology struggles in regions with limited historical data
- Client wants to take advantage of its rich data lake to build data-driven production forecast models

ARUNDO'S SOLUTION

- Applied ensemble machine learning models to learn from historical data how G&G features and D&C specs impact initial production
- Provided a SaaS solution hosting the trained machine learning model online to predict initial production
- A cloud-based platform where data-driven and physics-based models can be tested, operationalized and managed cross multi-disciplinary teams

IMPACT

In-depth understanding of important features impacting initial production

Direct reference for field development decision makers on the potential of proposed opportunities

Reach out if you would like to learn more

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