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6 myths about machine learning that M&R pros must overcome

Blair Fraser, CMRP, CRL

Accelix™
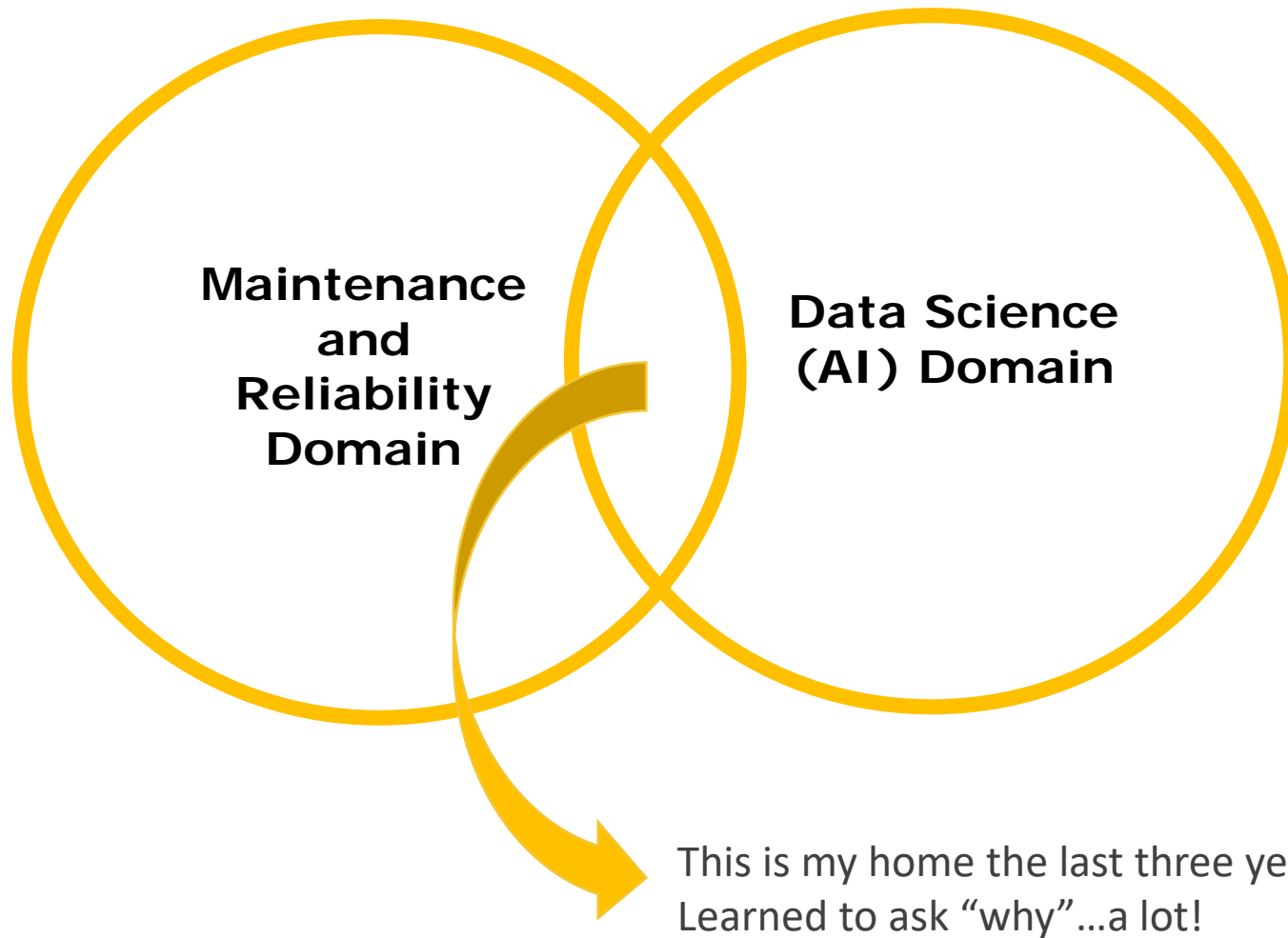
Webinar Series

Blair Fraser, CMRP, CRL

- Not a Data Scientist

- 20+ years in the Maintenance and Reliability field

- Electrician by trade, Instrumentation and Automation Engineering by education and lifelong learner.

- Co-Founder & Chief Customer Officer at Quartic.ai

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What we do

Quartic.ai combines **IIoT** **and** **Artificial Intelligence** **to deliver applications that improve the reliability, efficiency and quality of manufacturing operations.**

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What gives me the right to talk to you?

Maintenance and Reliability Domain

Data Science (AI) Domain

This is my home the last three years. Learned to ask "why"...a lot!

- Three years of learning through failure and success.

- Implemented many projects from idea to completion.

- Work beside some of the TOP data scientist in the world!

- Work beside some of the TOP M&R professional in the world.

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POLL QUESTION No. 1

How far along are you with machine learning applications at your facility?
(Click only one answer)

- Pilot completed; implementation complete or in process

- Pilot program underway

- Research and planning stage

- It's on our list

- Not on our radar at this time

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#1 - NOT READY
We aren't mature enough

There is a misconception inside of many asset intensive companies regarding "machine learning readiness". Is a maintenance and reliability-centered machine learning project only appropriate for companies with top quartile manufacturing programs?

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?

If you could ask a piece of equipment just one question, what would it be?

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How best to apply AI
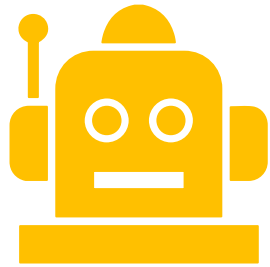
AI as assistant

Delegate repetitive analysis to Machine Learning.

AI as extension of human intelligence

Data analysis or creation of rules impossible for humans
– solve unsolved problems
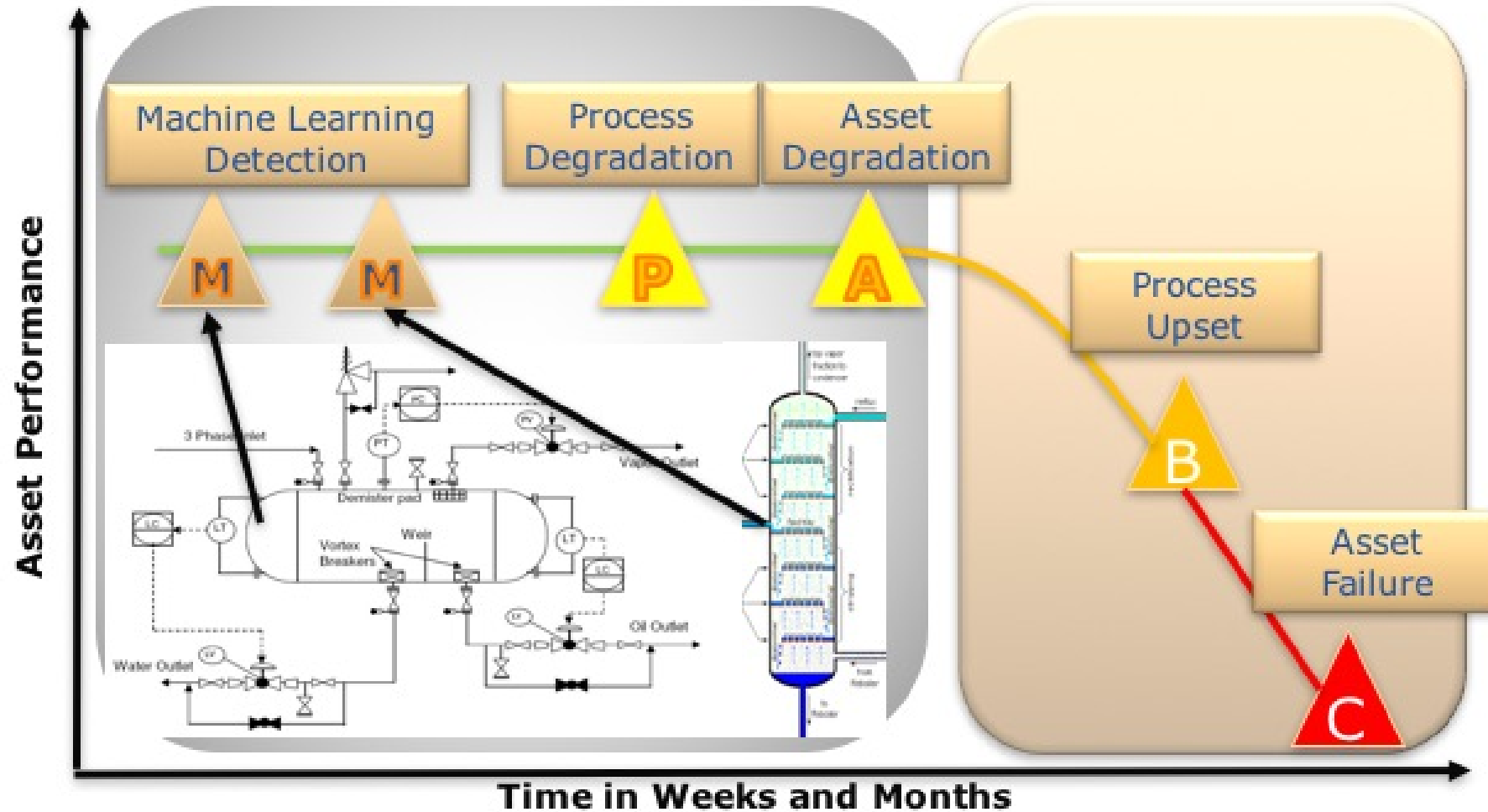
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Image courtesy of ARC Advisory

Business case and best fit applications

PROGNOSTICATION (EARLY DETECTION OR OUTCOME PREDICTION) HAS VALUABLE BUSINESS IMPACT

- Intervention (human or control system) based on early insight can have a measurable impact on throughput, quality, energy consumption, equipment performance or workforce efficiency.

Criteria #1

COGNITIVE INSIGHT GENERATED BY AI ENABLES A MANUFACTURING DECISION, WHICH OTHERWISE

- Is impossible to generate with human analysis given the number of variables and the complexity of their relationships
- Would lead to subjective conclusions with variability (introduced by human inferences)

Criteria #2

AVAILABILITY OF RELEVANT DATA

- Sufficient historical data (with labels) is available, or
- Process cycle times allow collection of sufficient training data in a reasonable amount of time

Criteria #3

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Am I ready for Machine Learning?

What is your quartile?

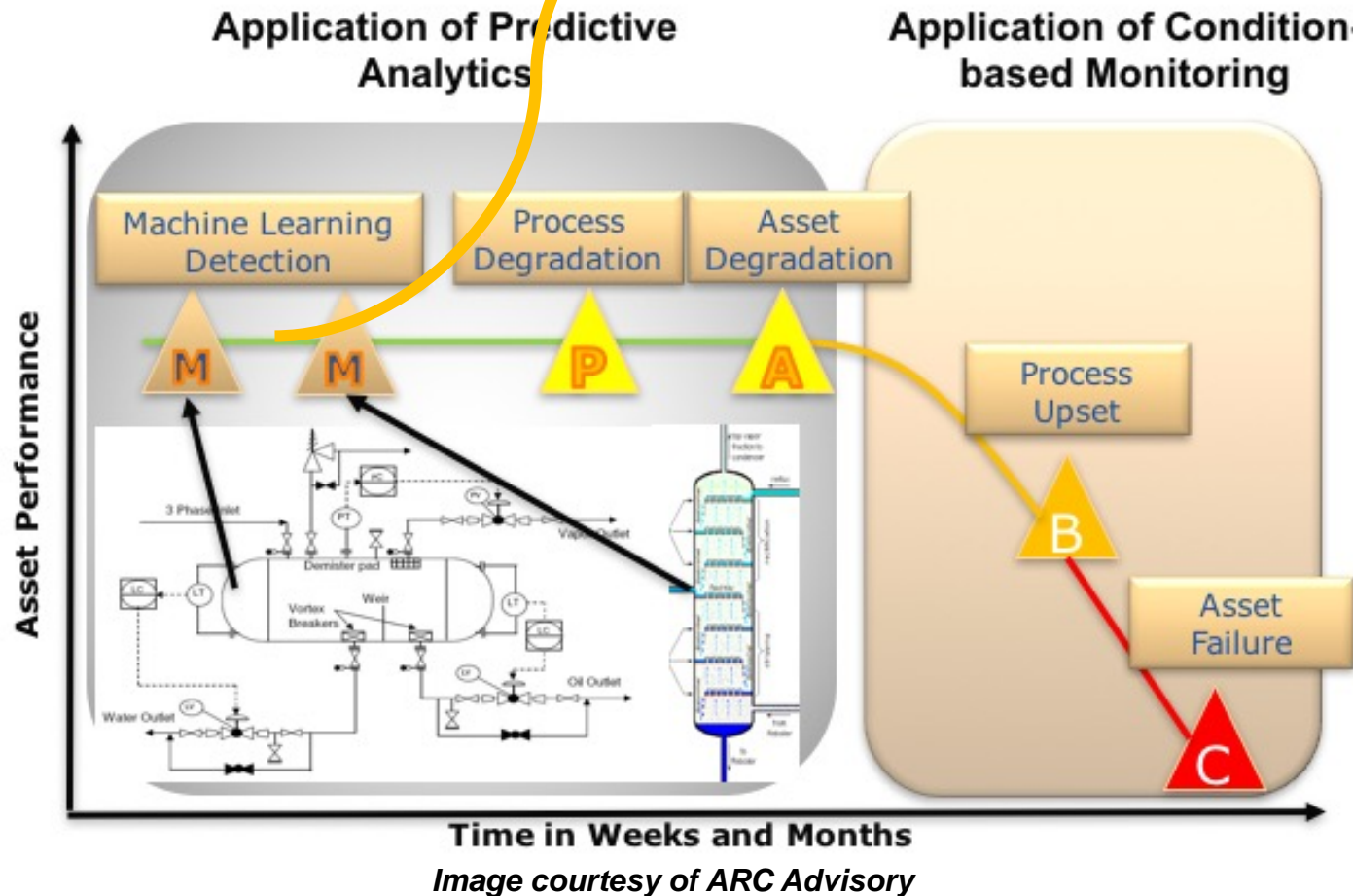|	1st	2nd	3rd	4th
Reactive maintenance (%)	9	19	47	64
Maintenance cost/RAV (%)	2.1	3.7	9.2	13.3

Source: Dr. Klaus Blache, 2017 study, UT-RMC

The reality is that most organizations with a reasonably healthy maintenance and reliability foundation are excellent candidates for early adoption. In fact, deploying a machine learning application inside of your maintenance and reliability organization may bring a surprisingly quick return.

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Reality check

If Machine Learning detects something here, do you have the **people and processes** in place to do something about it?

Application of Predictive Analytics

Application of Condition-based Monitoring

Machine Learning Detection

Process Degradation

Asset Degradation

Process Upset

Asset Failure

M M P A B C

Asset Performance

3 Phase Inlet

Vapor Outlet

Demister pad

Vortex Breakers

Weir

Oil Outlet

Water Outlet

LT

LT

PT

Time in Weeks and Months

Image courtesy of ARC Advisory

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#2 - DATA PROBLEMS
HOW MUCH IS ENOUGH?

A successful machine learning project is **not** dependent on an enormous data set with pre-existing failure data.

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The Industrial Internet of Things
Volume T3: Analytics Framework

IIC:PUB:T3:V1.00:PB:20171023

Published by the Industrial Analytics Task Group in October 2017, the Industrial IoT Analytics Framework (IIAF) provides **guidance and assistance for decision makers** in the development, documentation, communication and deployment of Industrial Internet of Things Analytics Systems.

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Types of analytics requires different data
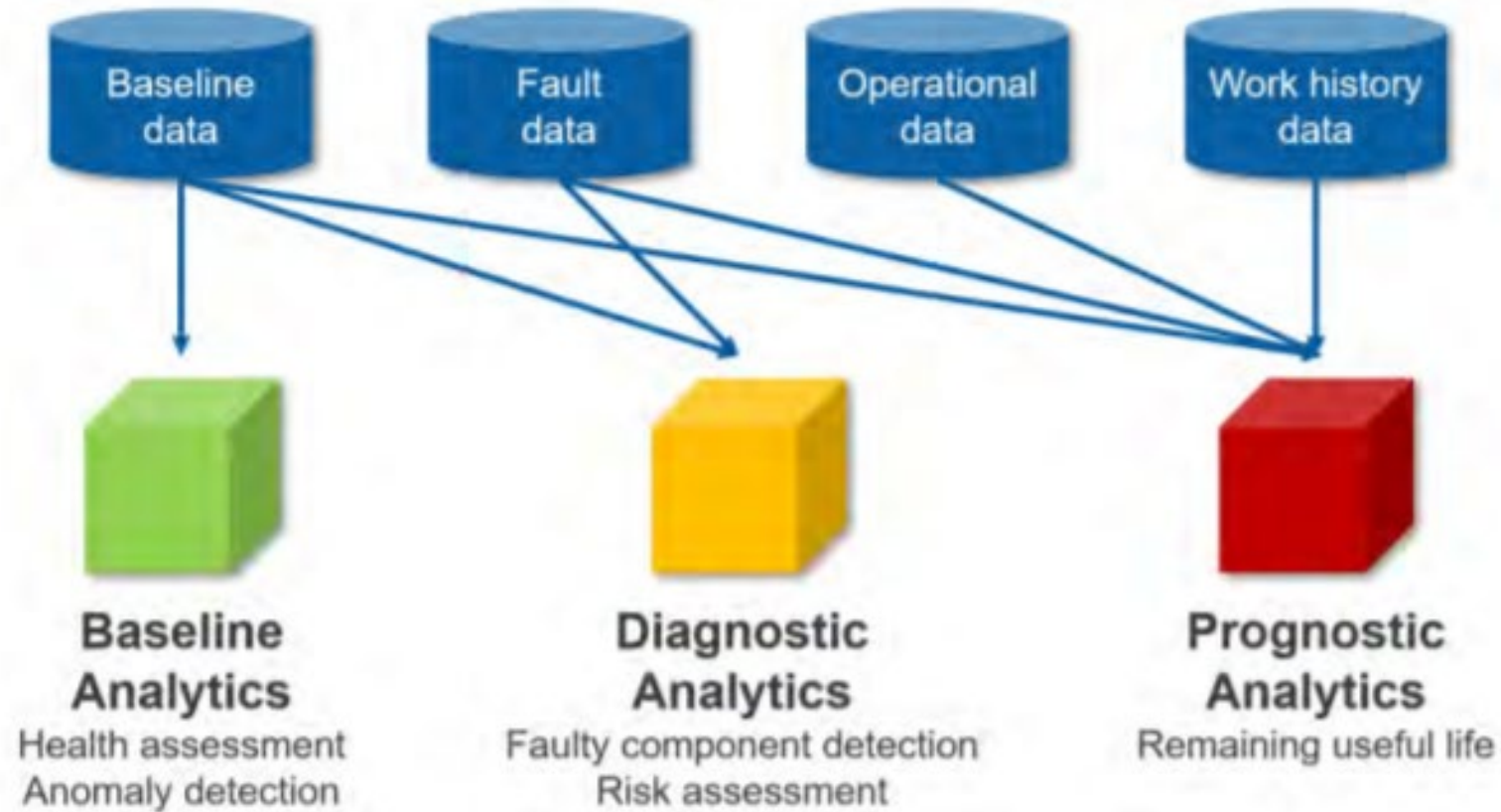
Image courtesy of Industrial Internet Consortium

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POLL QUESTION No. 2

Are you currently getting <u>useful</u> asset-condition insights from the data you are collecting? (Click only one answer)

- Yes

- Maybe/somewhat

- No

- Under construction; get back to us later

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#3 – PROVING THE ROI

HOW CAN I JUSTIFY THE INVESTMENT??

The investment required to purchase, implement, and scale any cross-enterprise manufacturing technology can be daunting.
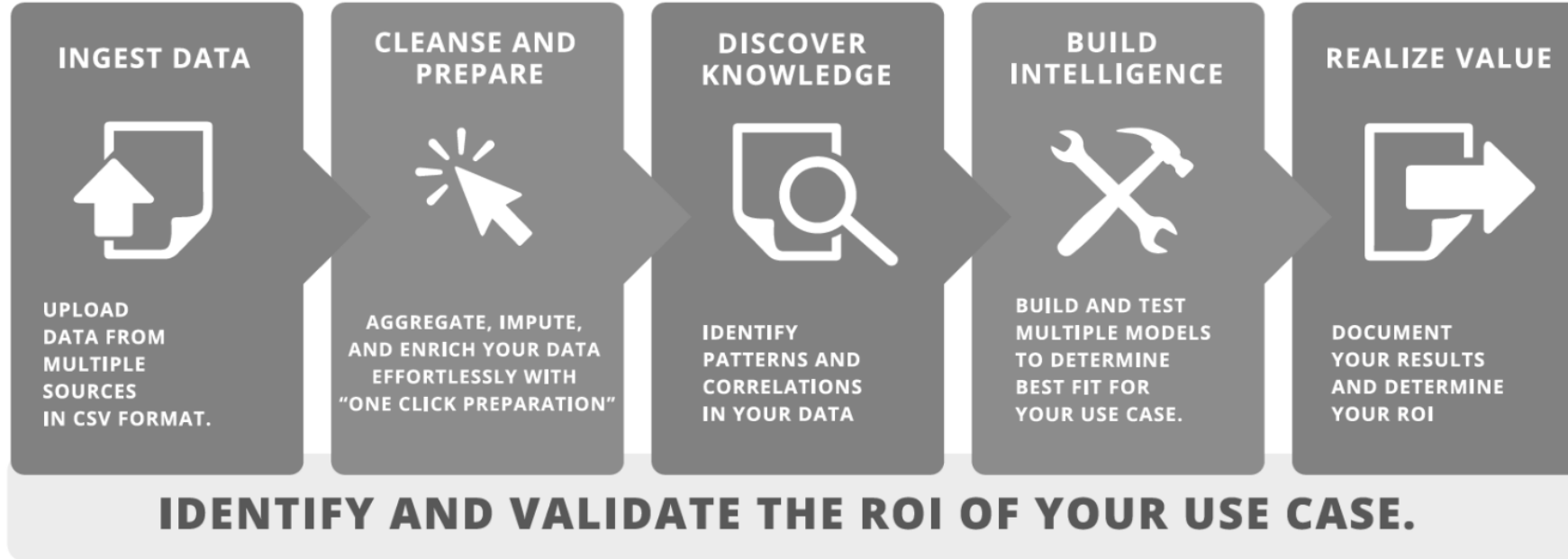
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Boil the ocean strategy

" Erhardt said the number one reason that **AI projects fail** is that "people try to **boil the ocean** with a greenfield opportunity" instead of focusing on a **specific project** or aspect of the company that seems particularly ripe for the use of AI. ... **Knowing what specifically you want to solve with AI is crucial.** "

— Jeff Erhardt, VP of Intelligent Systems, GE Digital

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You can start with OFFLINE data

CONDUCT MULTIPLE POC's WITH EASE, SPEED AND INDEPENDENCE

INGEST DATA
UPLOAD DATA FROM MULTIPLE SOURCES IN CSV FORMAT.

CLEANSE AND PREPARE
AGGREGATE, IMPUTE, AND ENRICH YOUR DATA EFFORTLESSLY WITH "ONE CLICK PREPARATION"

DISCOVER KNOWLEDGE
IDENTIFY PATTERNS AND CORRELATIONS IN YOUR DATA

BUILD INTELLIGENCE
BUILD AND TEST MULTIPLE MODELS TO DETERMINE BEST FIT FOR YOUR USE CASE.

REALIZE VALUE
DOCUMENT YOUR RESULTS AND DETERMINE YOUR ROI

IDENTIFY AND VALIDATE THE ROI OF YOUR USE CASE.

NO DATA SCIENCE. NO CODING. NO RISK.

Image courtesy of Quartic.ai

You CAN start with OFFLINE data; you DON'T have to stream data and invest in a platform to prove YOUR use case.

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#4 – SENSORS?
I NEED IIOT SENORS TO DO THIS.

The vast majority of manufacturers have more than enough condition data available to build and deploy high-performing machine learning models without investing in new sensors.

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You don't need more data; you need better questions!

97% of data sits unused in organizations. The time and effort to acquire, secure, and store this information is significant, but the underlying cost of failing to utilize this information is massive.
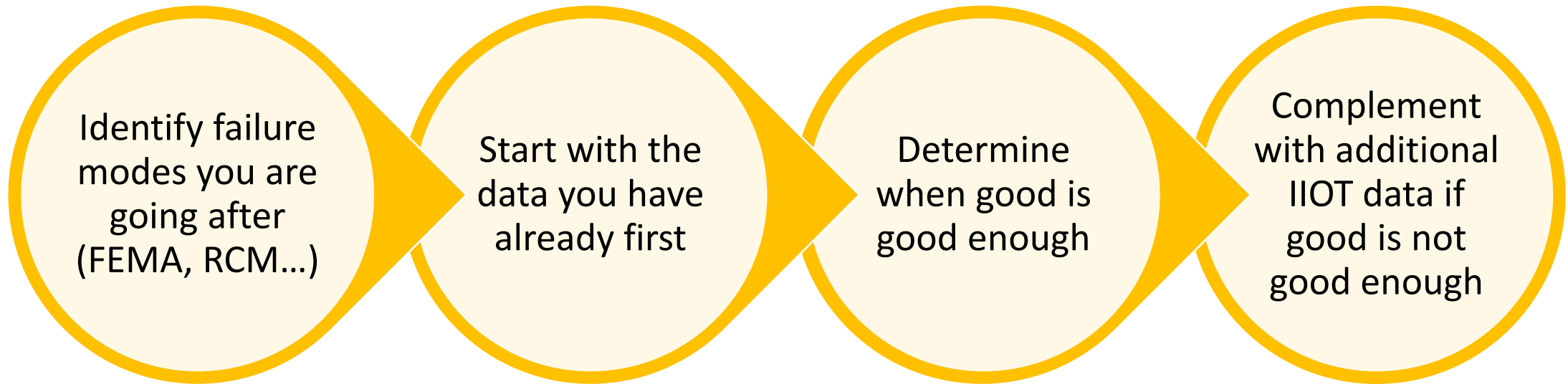
— Gartner

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Machine Learning targets equipment failure from "process abuse"

82%

Or more of damage to equipment is not caused by normal wear-n-tear but is **process induced** caused by operating equipment out of safety and design conditions such as **cavitation or no feed conditions in pumps, or liquid entertainment and carry-over in compressors.**

— ARC Advisory

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When is "good" good enough

Identify failure modes you are going after (FEMA, RCM...)

Start with the data you have already first

Determine when good is good enough

Complement with additional IIOT data if good is not good enough
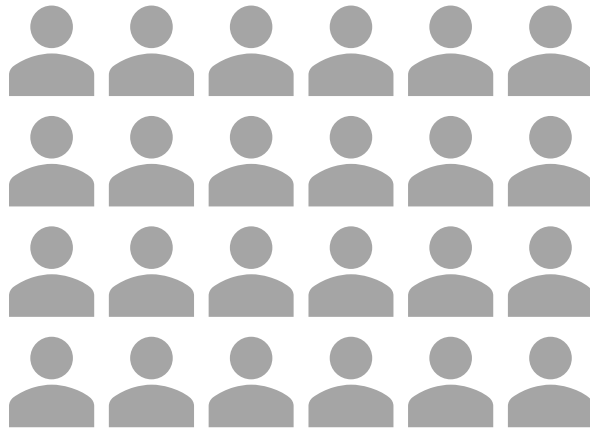
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#5 – DATA SCIENTISTS?
I NEED A TEAM OF EXPERTS IN-HOUSE

The requirement for in-house data science expertise to help build and monitor machine learning initiatives is, in some cases, required, but often not.

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Availability of data scientist in manufacturing

For every 1 data scientist in a manufacturing plant, there are 162 subject matter experts that maintain, operate and design our assets and processes waiting to use their knowledge and experience to explore and develop insights that were not previously possible.

**staff devoted to industrial operations
(The subject matter experts)**

**staff devoted
to
Data Science**

162 SME's

1 Data Scientist

*Data taken from a pharmaceutical manufacturing site of 1300 employees.

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"AI can be used to solve a lot of problems nowadays, but you are going to **need domain expertise to find, define, and design the problems.**"

— Xiaozhou Wang, Chief Scientist, Quartic.ai

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Some applications of machine learning can be automated

Algorithms		
Anomaly Detection (Baseline)	**Classification (Diagnostic)**	**Regression (Predictive)**
One-Class SVM	Neural Networks	ARMA
PCA-based	Support Vector Machine	Linear Regression
Gaussian Mixture Model (GMM)	Decision Forest	NN Regression
Logistic Regression	Bayes Classifier	Bayes Regression

Create multiple anomaly or failure agents

Variables with the highest correlation to failure or anomaly agent

Image courtesy of Quartic.ai
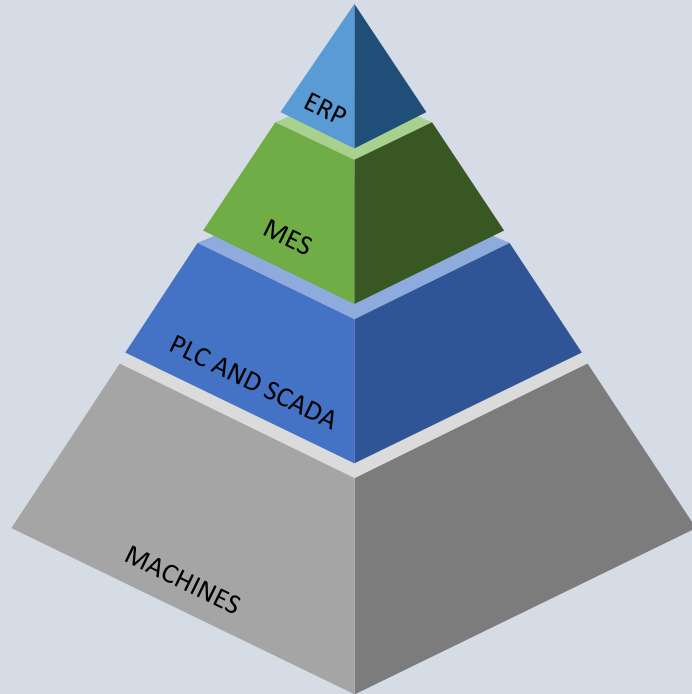
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#6 – WORKING WITH "IT"?
WILL I HAVE GO TO BATTLE?

Any disruptive technology will draw attention from your resident tech overlords - and rightfully so. As plant floor technology continues to evolve, IT executives are careful not to support "rip and replace" projects that will force costly changes to foundational technology architecture.

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Here to there without a care in the world

Current State

Hierarchical Architectures Silos and Pyramids

Vision of Industry 4.0

Locally Controlled Modules without Hierarchy

ERP

MES

PLC AND SCADA

MACHINES

Defined by ISA95/IEC62264

Internet of Services

Internet of Things
("Cyber-physical' systems)
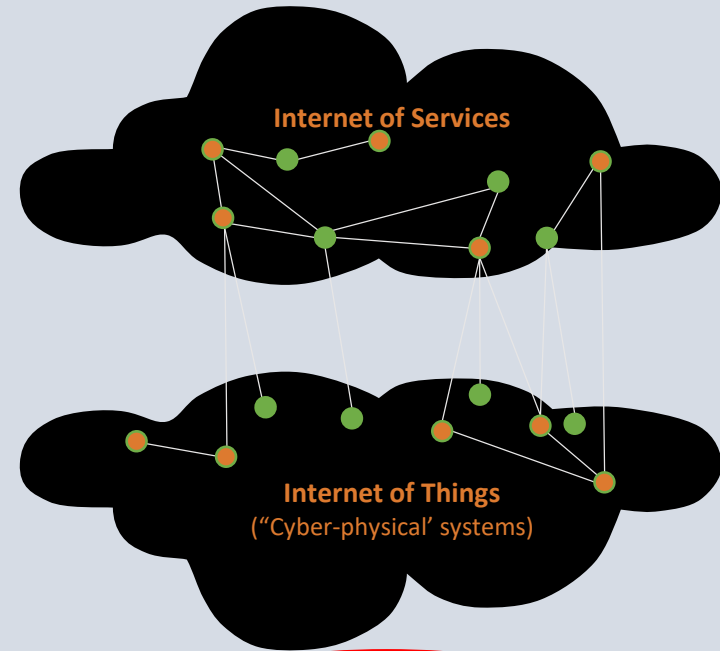
Defined by IIRA/RAMI4.0

Image courtesy of Quartic.ai

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Co-exist with IT and automation

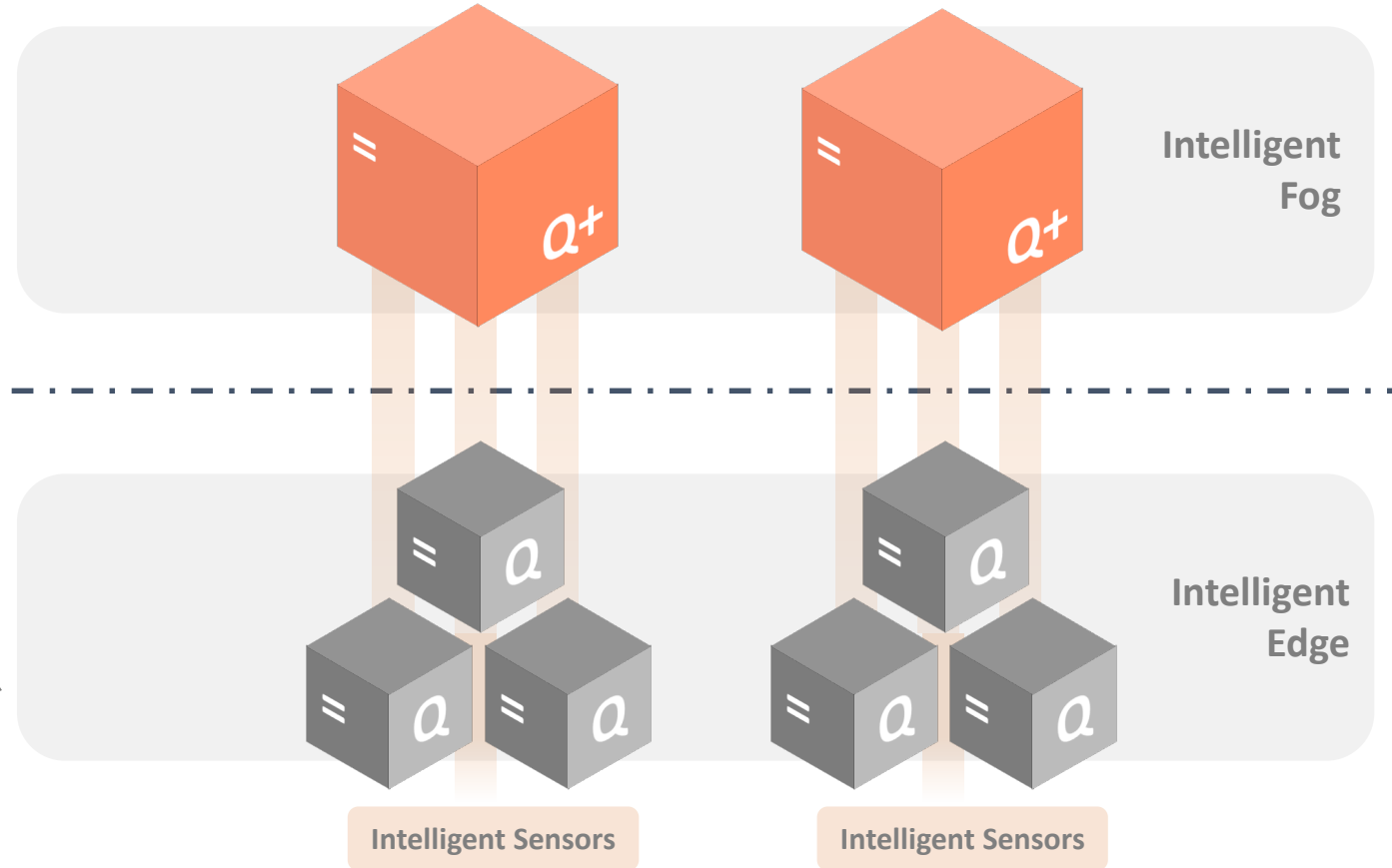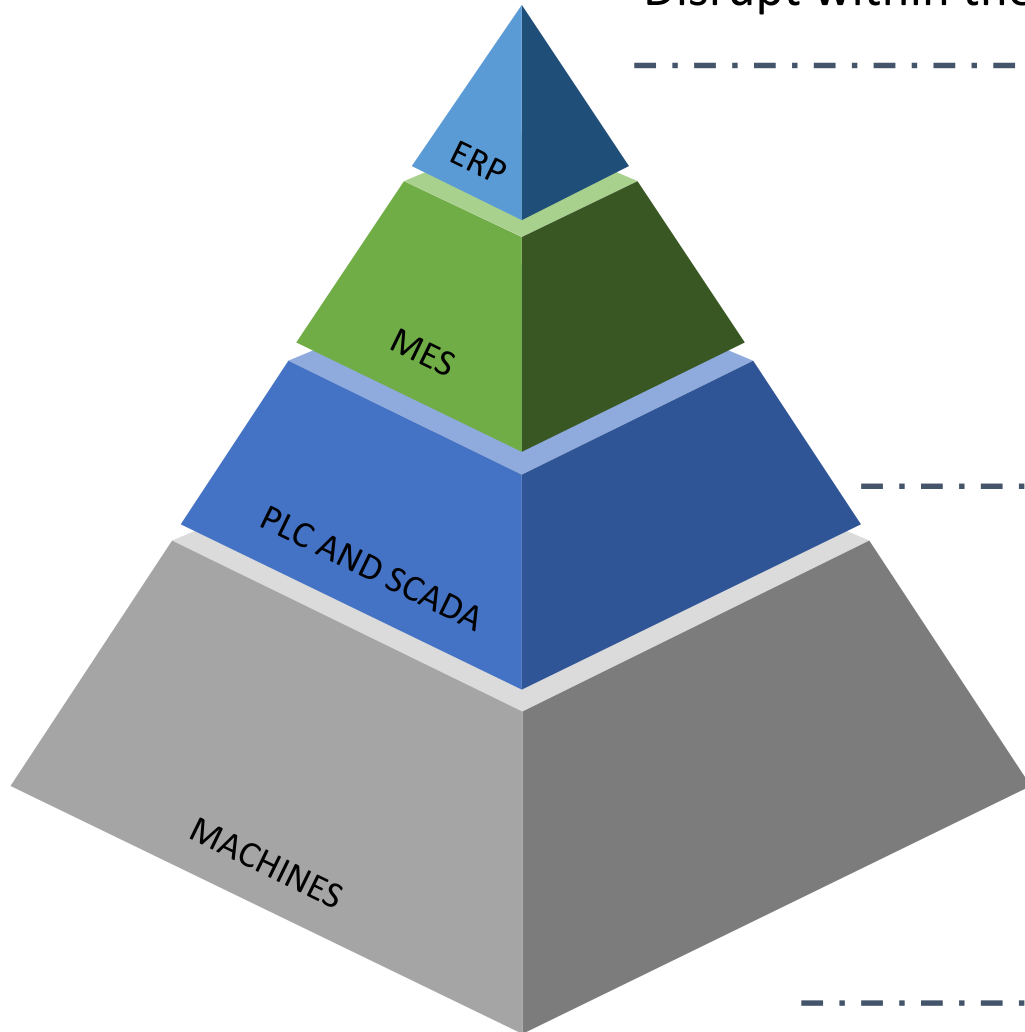Disrupt within the boundaries of your existing IT & OT network architecture

ERP

MES

PLC AND SCADA

MACHINES

Intelligent Fog

Intelligent Edge

Intelligent Sensors

Intelligent Sensors

Image courtesy of Quartic.ai

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Machine learning does not equal cloud

OT = PLC/SCADA/BMS/HISTORIANS
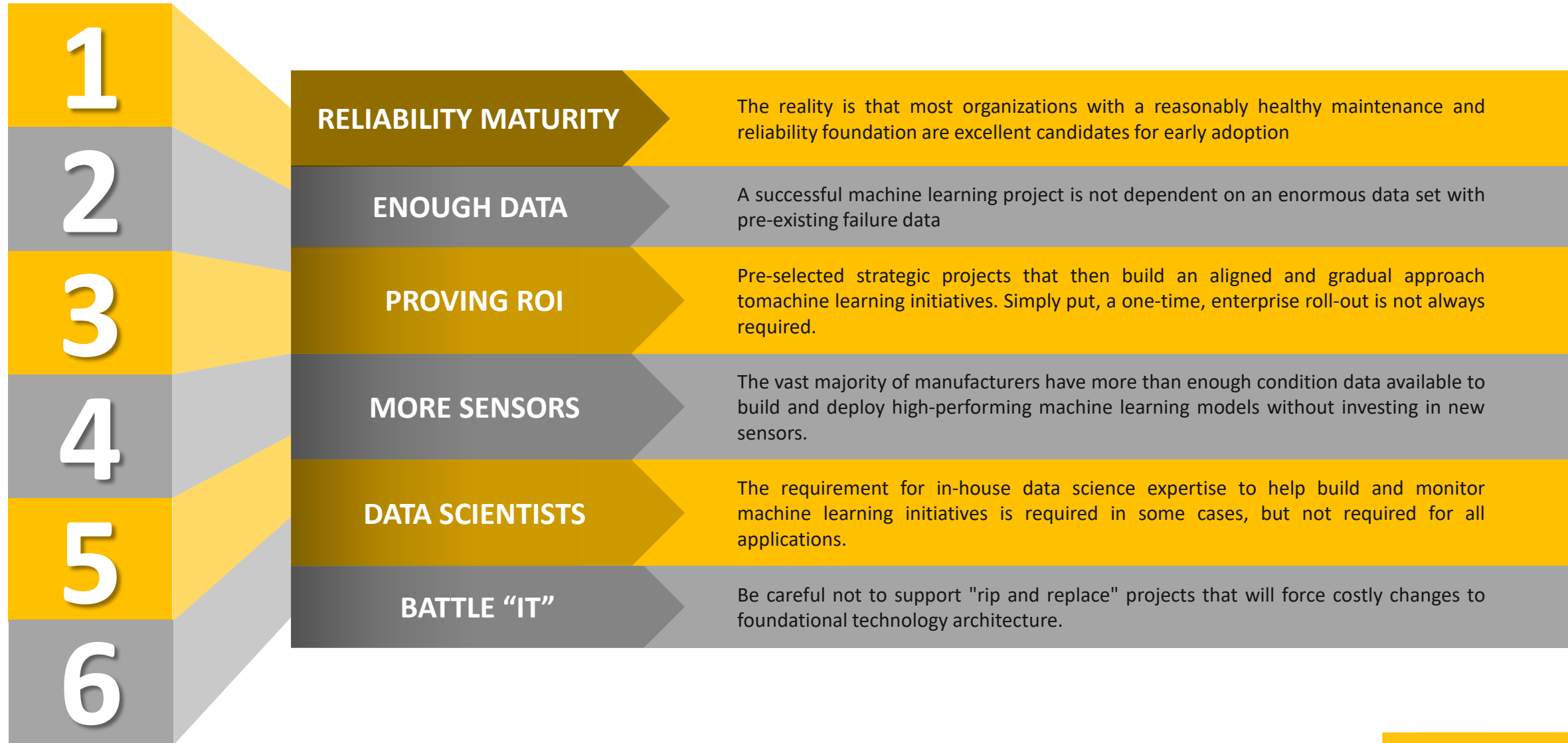*Image courtesy of Quartic.ai*
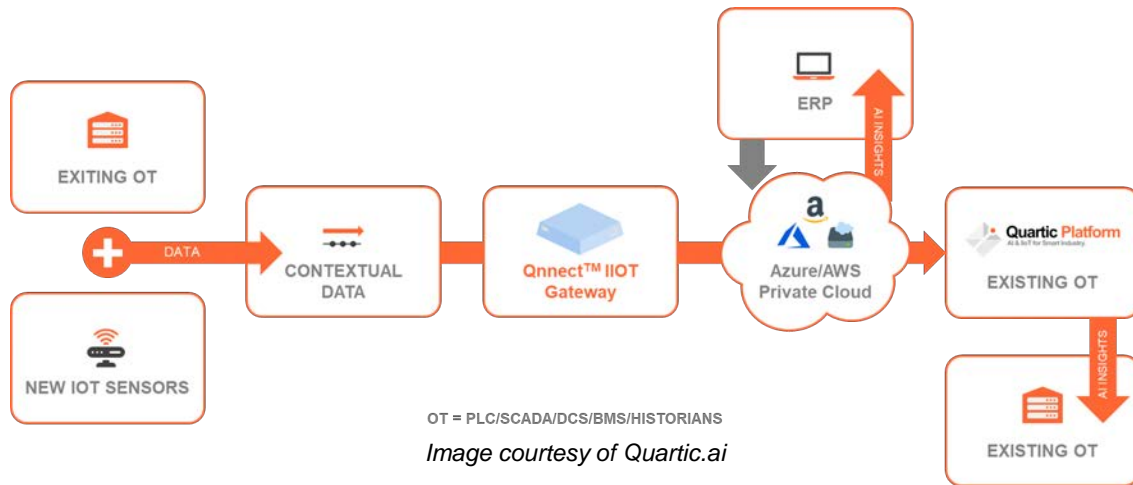
You can leverage the compute and storage capabilities of the cloud....but if security and data IP is a concern...

You can run machine learning completely on premises, with data not leaving the four walls of your facility.

OT = PLC/SCADA/DCS/BMS/HISTORIANS
Image courtesy of Quartic.ai

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Summary

#	Topic	Description
1	**RELIABILITY MATURITY**	The reality is that most organizations with a reasonably healthy maintenance and reliability foundation are excellent candidates for early adoption
2	**ENOUGH DATA**	A successful machine learning project is not dependent on an enormous data set with pre-existing failure data
3	**PROVING ROI**	Pre-selected strategic projects that then build an aligned and gradual approach tomachine learning initiatives. Simply put, a one-time, enterprise roll-out is not always required.
4	**MORE SENSORS**	The vast majority of manufacturers have more than enough condition data available to build and deploy high-performing machine learning models without investing in new sensors.
5	**DATA SCIENTISTS**	The requirement for in-house data science expertise to help build and monitor machine learning initiatives is required in some cases, but not required for all applications.
6	**BATTLE "IT"**	Be careful not to support "rip and replace" projects that will force costly changes to foundational technology architecture.

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QUESTIONS?

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Thank you!

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