



Industrial IoT & Big Data Analytics: Capturing Value in the PLM Environment

- About LNS Research**
- What is the IoT and Digital Transformation?**
- A New Model for System Architecture**
- Closing the Data Science Divide**
- Actionable Recommendations**

Our Mission is Driving Industrial Transformation

We are thought leaders and trusted advisors for Business, IT, and Automation executives

Our differentiators:

- Experienced analysts
- Primary social research
- Deep industry contacts
- Interactive data visualizations



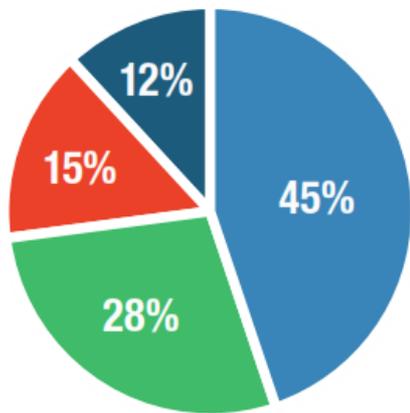
LNS Research's Council Members Include



Research Demographics: Metrics that Matter Survey



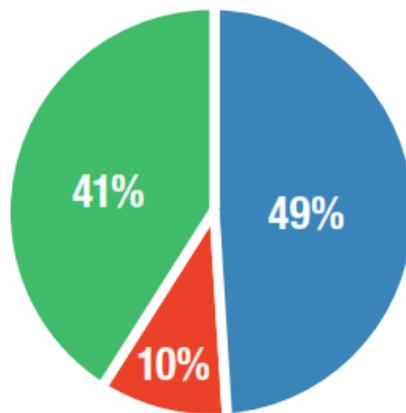
300+ executives and senior leaders took LNS Research's MtM Survey in 2015 & 2016



2016 Metrics That Matter Survey
GEOGRAPHY

COLOR BY HQ LOCATION

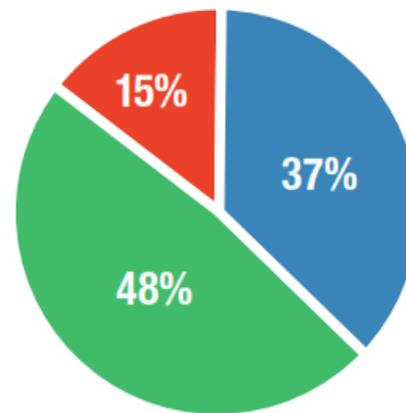
- North America
- Europe
- Asia/Pacific
- Rest of World



2016 Metrics That Matter Survey
REVENUE

COLOR BY COMPANY REVENUE

- Small: Less than \$250 Million
- Medium: \$250 Million - \$1 Billion
- Large: More than \$1 Billion



2016 Metrics That Matter Survey
INDUSTRY

COLOR BY INDUSTRY

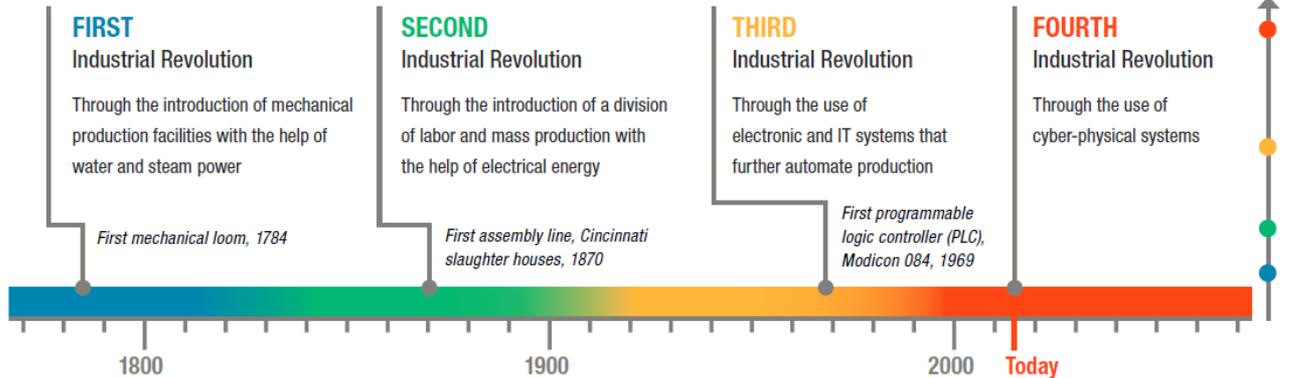
- Process Manufacturing
- Discrete Manufacturing
- Batch Manufacturing

What is the IoT and Digital Transformation?



In 2011 we saw the emergence of Industry 4.0 as a concept.

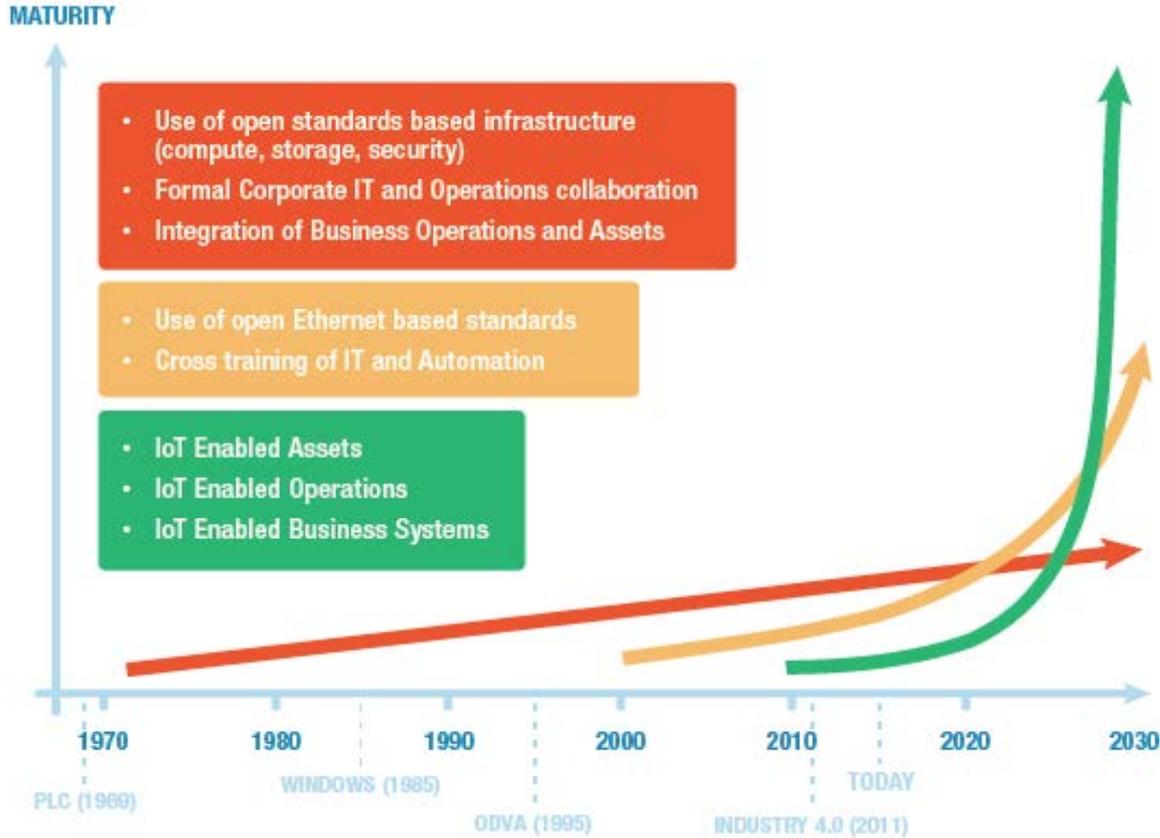
From Industry 1.0 to Industry 4.0



© DFKI, 2011

- Governments of U.S. and Germany have invested \$1B+
 - Smart Manufacturing Leadership Coalition
 - Industry 4.0 (Steam, Division of Labor, Automation, Cyber-Physical Systems)
- Industry Associations
 - Industrial Internet Consortia
 - IoT World Forum

IT-OT Convergence



OT is new name for Industrial Automation.

Three ongoing and accelerating trends.

- Automation and Industrial Software on Windows/Linus
- Automation on Standard unmodified Ethernet
- Devices on Internet

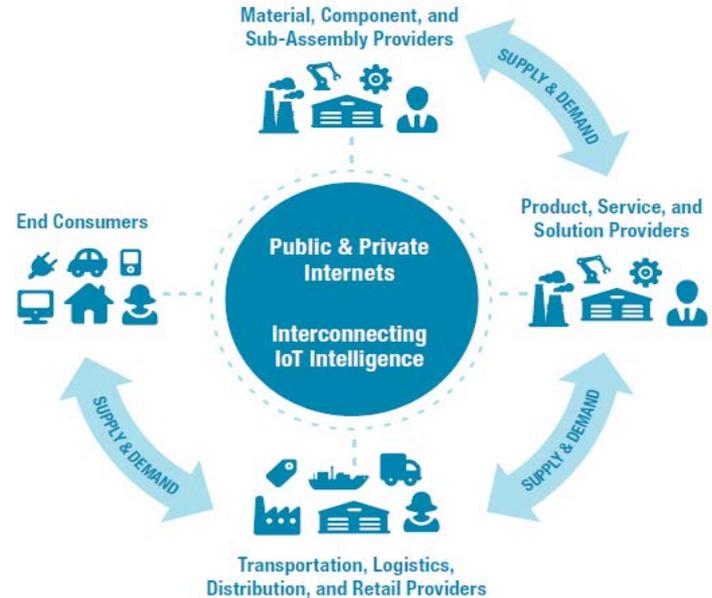
Also refers to enterprise organization – hybrid IT and automation groups.

(Industrial) Internet of Things

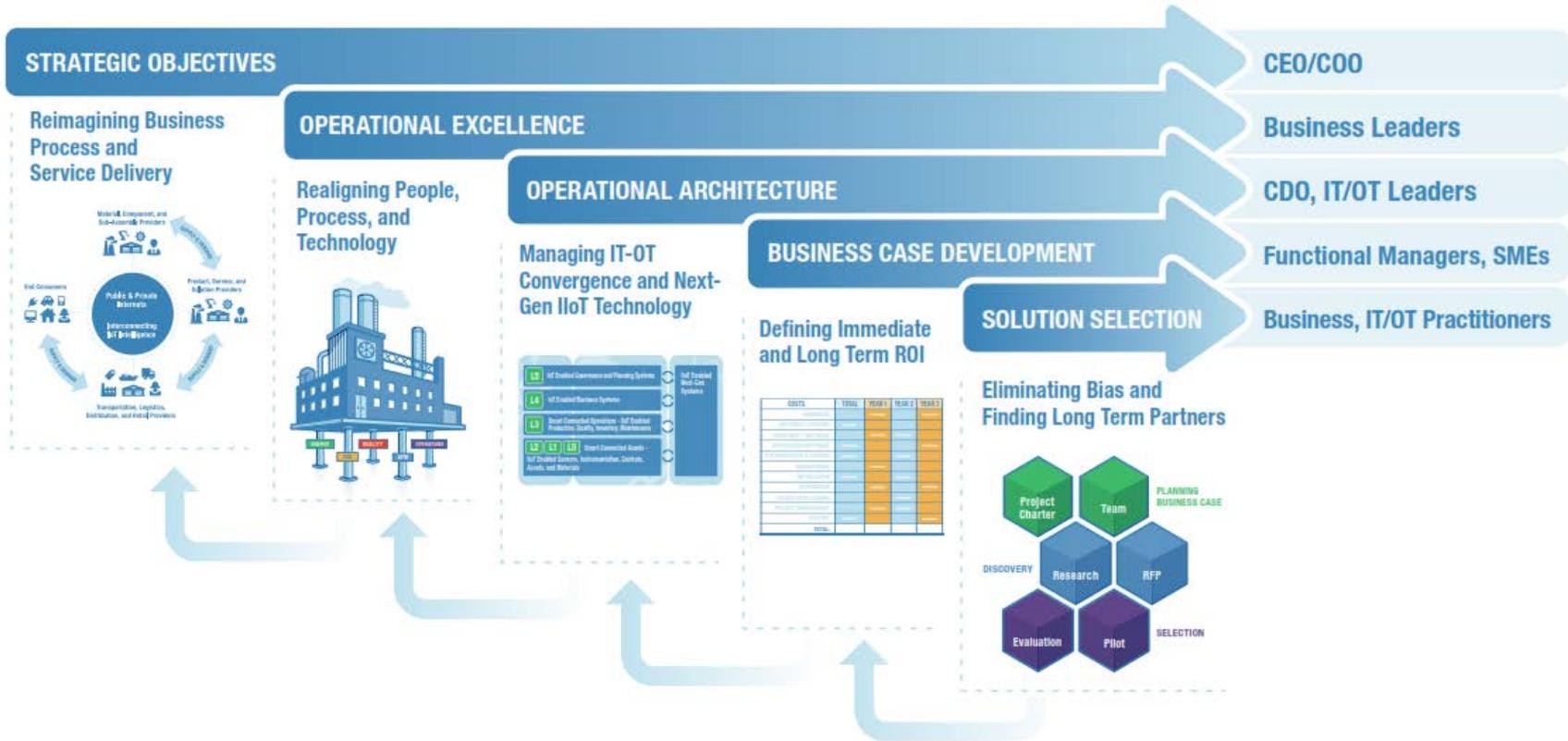


- IoT refers to network of networks enabling new cyber-physical systems
- By 2020, over 50 billion devices expected to be connected via IoT (Cisco)
- Digital Transformation refers to the social and business disruption

IoT for Extended Manufacturing Enterprise Value Chains



Digital Transformation Framework



Setting Strategic Objectives: Role of PLM = V+R



Internal

- **Smart Connected Enterprise:
Real Time->Predictive-
>Autonomous**

SMART CONNECTED ASSETS

Converged Sensors, Instrumentation,
Controls, and Assets

AWARE OF AND CAN REACT TO:

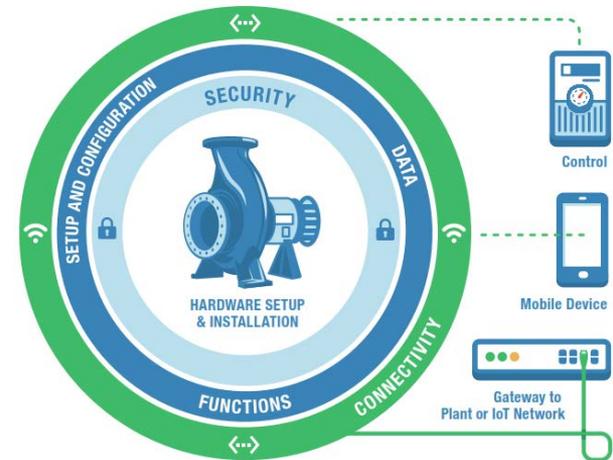
Design and Configuration
Internal and External Operating Conditions
Past Performance
Predicted Future Failure
MRO Inventory (Internal and External)
Raw Material
Supplier Performance
Customer Requirements
Environmental Impact



External

- **Smart Connected Products:
Product->Service->Experience**

SMART CONNECTED DEVICE



A New Model for System Architecture



Enabling Tech: Industrial Internet of Things Platform



CONNECTIVITY

- Network Infrastructure - Wired, Wifi, and Cellular
- Standards - Serial/Proprietary > Ethernet/Open
- Machine 2 Machine/Data Acquisition - Embedded, Gateways, APIs, Web Services, OPCUA, Modbus TCP/IP, MQTT, etc.
- Device Management
- Complex Event Processing
- Alarms, Condition Based Monitoring
- Data Transport and Speed
- Security - Authentication, Access Control, Intrusion Detection/Prevention, Firewalls, Application Whitelisting, Antivirus/Spyware, Cryptography, Logging, Data Tagging, Compliance, etc.

CLOUD

- Private/Public/Hybrid
- IaaS - Compute, Storage, Network
- PaaS - Run Time, Queue, Traditional DB/DW | Data Historian | In-Memory Database | Hadoop/Data Lake
- SaaS - Traditional Enterprise Applications, Next-Gen IoT Enabled Applications
- Security - Authentication, Access Control, Configuration Management, Antivirus/Spyware, Cryptography, Logging, Data Tagging, Compliance

BIG DATA ANALYTICS

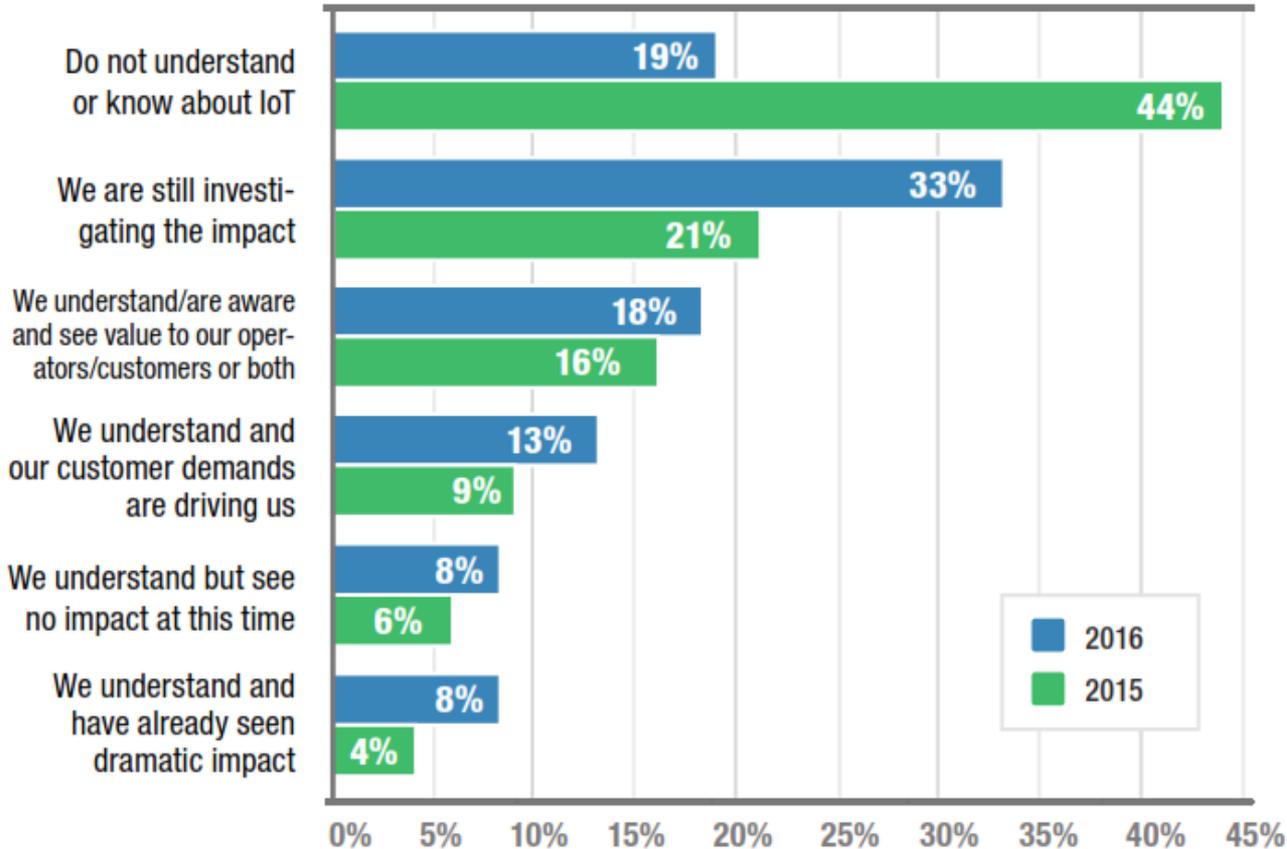
- Statistical Programming: R, SAS, SPSS
- Search, Text Mining, Data Exploration
- Analytics: Image/Video, Time Series, Geospatial, Predictive Modeling, Machine Learning, etc.
- Statistical Process Control • Optimization and Simulation
- Metrics and KPIs • Visualization

APPLICATION DEVELOPMENT

- Integrated Development Environment: JAVA, HTML5
- IIoT Data Model and Execution Engine
- Workflow and Business Logic Modeler
- Collaboration, Social
- Mobile
- Search
- Security - Authentication, Access Control, Configuration Management, Cryptography, Logging, Compliance

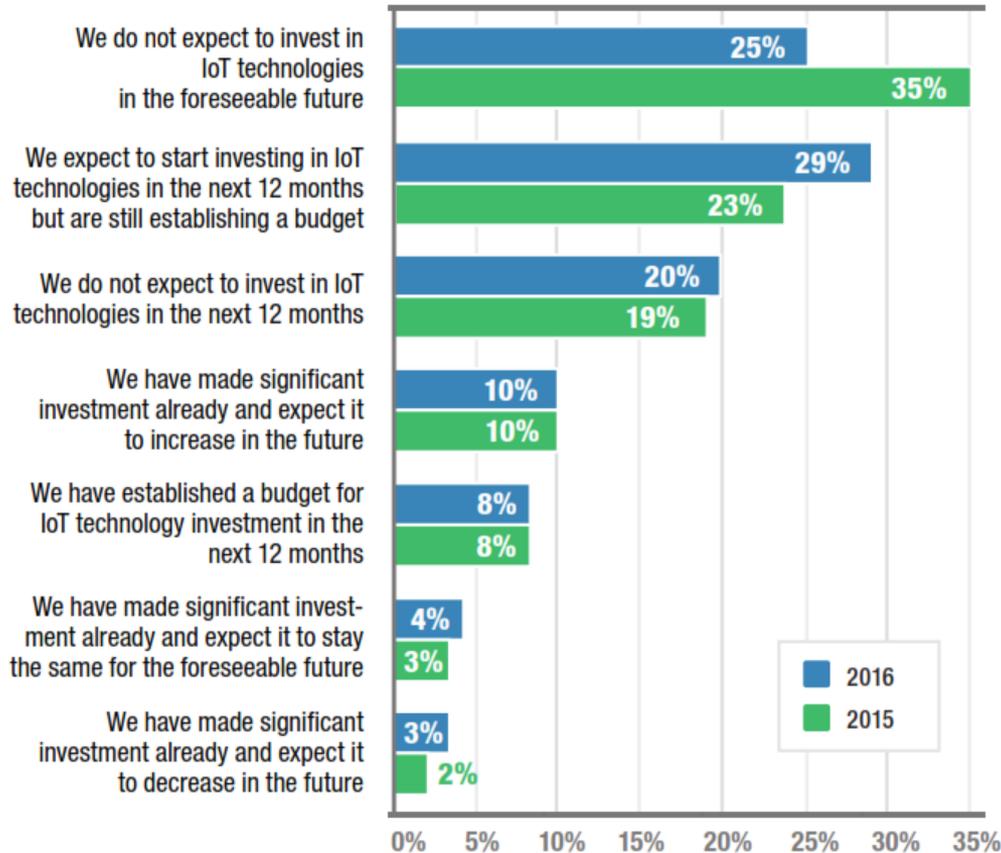
- **Starting in 2014 a battle of the platforms started.**
- **Still an ecosystem play today.**
- **Space still needs definition.**

The Impact of IIoT Today



- Lack of education is diminishing rapidly
- Strong correlation between lack of education and adoption plan

Current IIoT Adoption

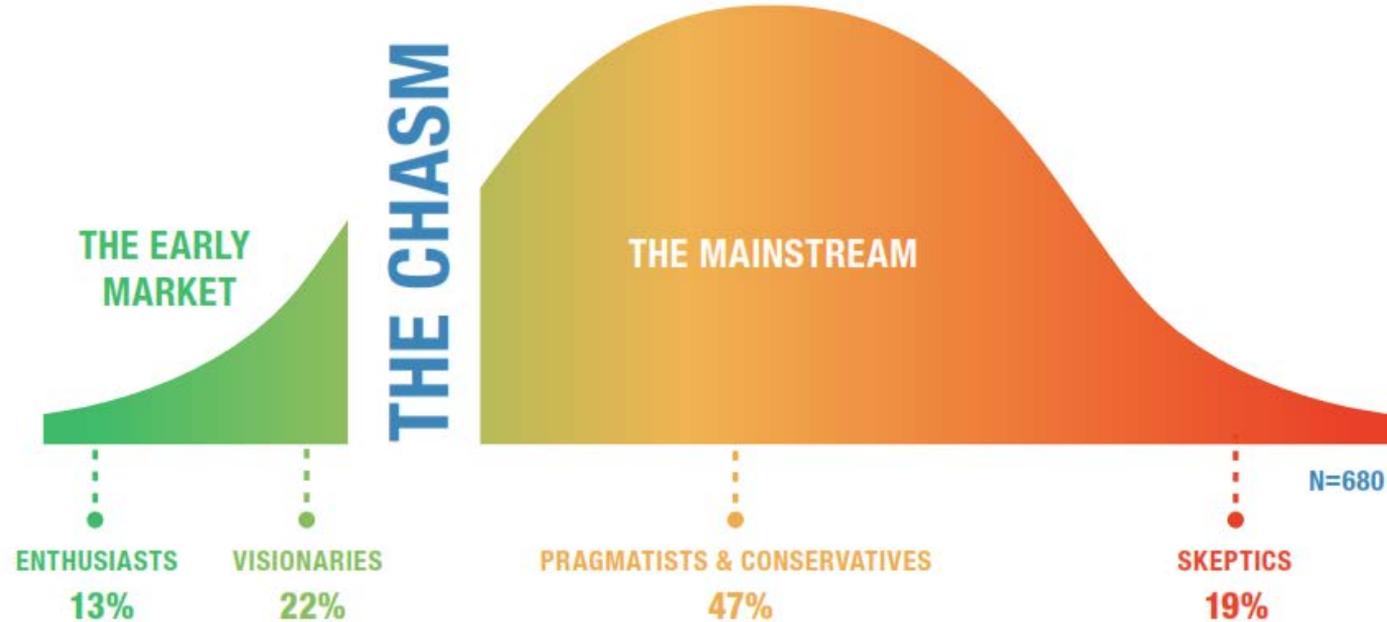


- 3/4 of market is eventually expecting to Invest in IIoT
- 51% of market making investment in next 12 months

Crossing the Chasm



- We are at the tipping point of IIoT adoption
- Early adopters are spread across industries



Traditional Enterprise Architecture (ERP) View



CORPORATE SYSTEMS - Defined by Sites and Organizational Structure

ANALYTICS HR, Procurement, Finance and Accounting, IT Management

PLANNING HR, Procurement, Finance and Accounting, IT Management

EXECUTION HR, Procurement, Finance and Accounting, IT Management

MANAGEMENT SYSTEMS - Defined by Sites and Organizational Structure

ANALYTICS Quality, Environment, Health, Safety, Energy, Sustainability, Risk

PLANNING Quality, Environment, Health, Safety, Energy, Sustainability, Risk

EXECUTION Quality, Environment, Health, Safety, Energy, Sustainability, Risk

VALUE CHAIN SYSTEMS - Defined by Sites and Organizational Structure

ANALYTICS Marketing Sales Engineering Suppliers Asset Management Manufacturing Warehousing Distribution Retail Service

PLANNING Marketing Sales Engineering Suppliers Asset Management Manufacturing Warehousing Distribution Retail Service

EXECUTION Marketing Sales Engineering Suppliers Asset Management Manufacturing Warehousing Distribution Retail Service

- Enterprise Architecture has traditionally been managed by IT
- No room for IoT or cyber-physical systems

Traditional Enterprise Architecture (Automation) View



Purdue/ISA95 Model

- No Value Chain View
- Limited integration and adoption across hierarchy

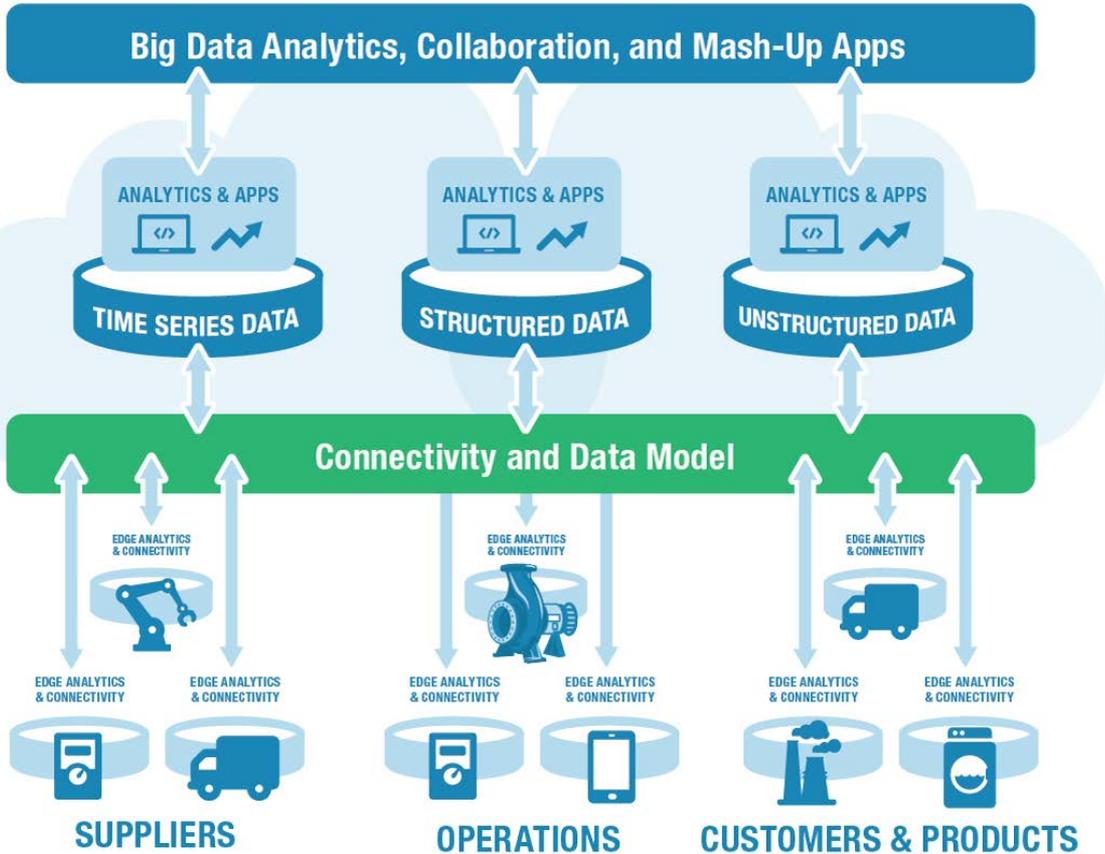
Traditional Enterprise Architecture (PLM) View



- Enabling the Digital Thread and Digital Twin
- Bring together the virtual and real across the value chain.
- Limited view of business and transactions



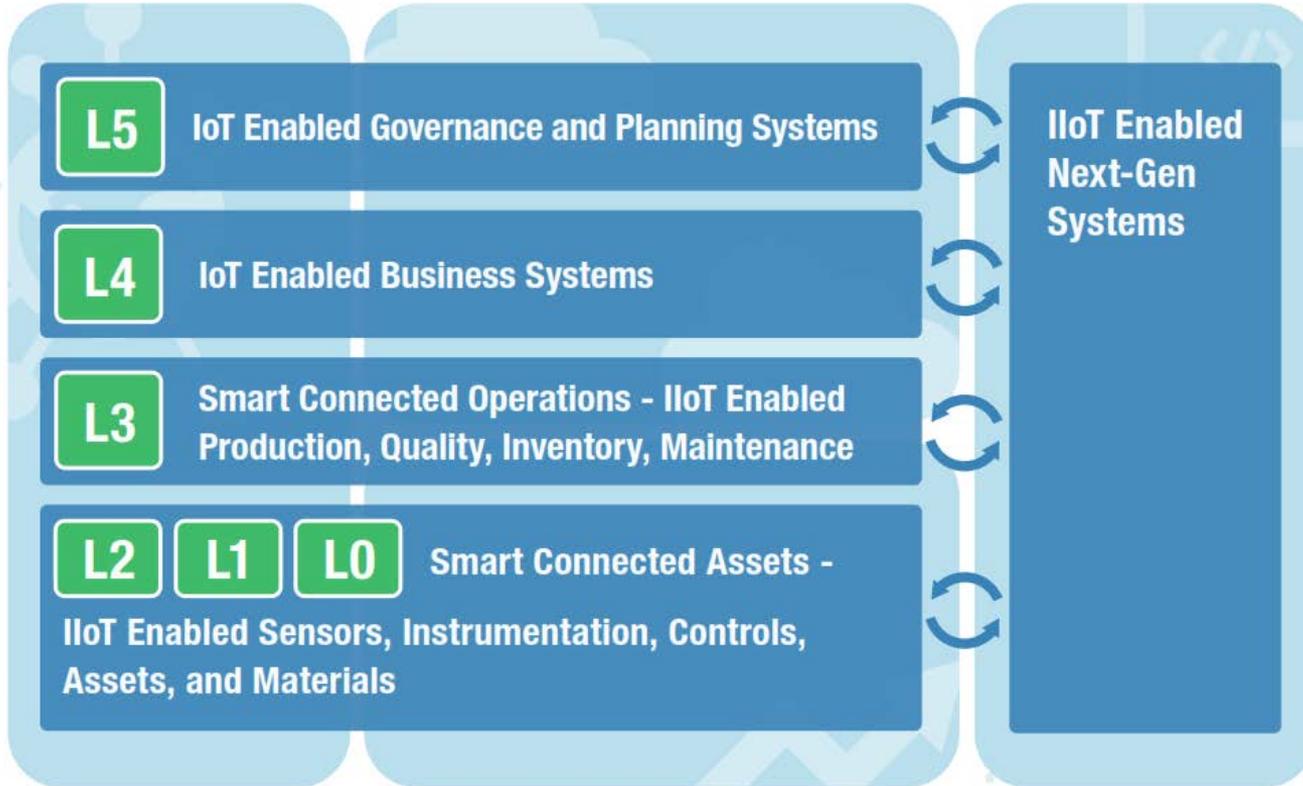
Operational Architecture: Managing IT/OT Convergence



Operational Architecture broadens scope for IT-OT Convergence

Aligns automation, engineering, business

Next-Generation Manufacturing Systems Architecture

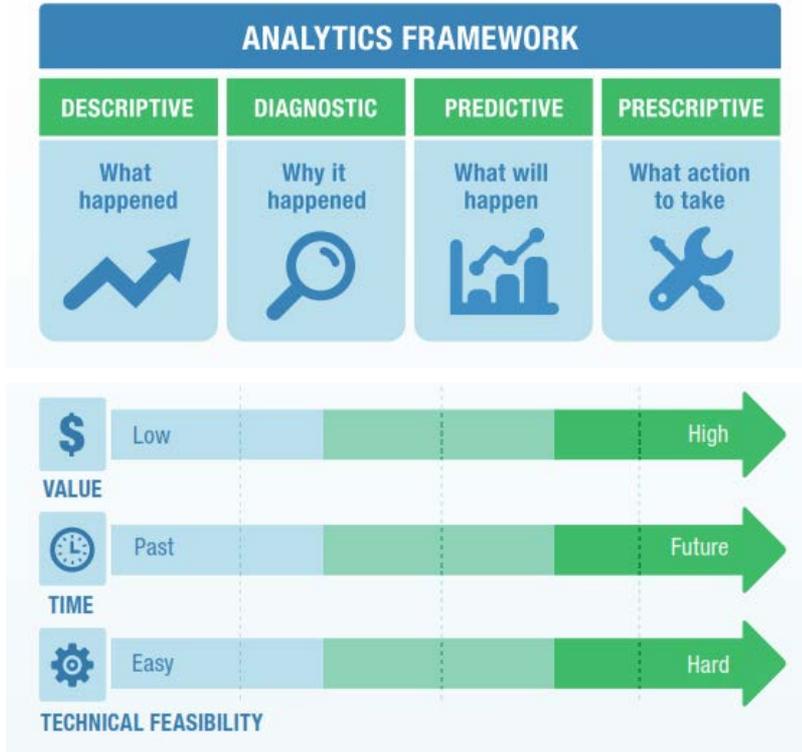


- **No Value Chain View**
- **Limited integration and adoption across architecture**

Trends in Big Data and Analytics

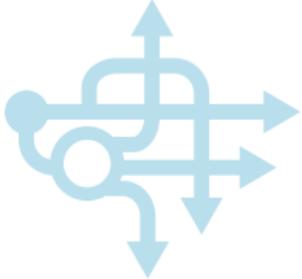


The Data Science Divide: Engineers and Data Scientists



- Analytics are understood in terms questions answered
- Predictive and prescriptive analytics traditionally delivered as physics based by engineers with PLM.
- Big Data and Machine Learning is delivered by Data Scientists and driving technical feasibility shifts

Understanding Big Data and Machine Learning



BIG DATA is most simply understood not just in terms of size, but in terms of the ability to manage volume, velocity, and variety of data, including structured, semi-structured, and unstructured.



MACHINE LEARNING is most simply understood as the set of models and algorithms that don't rely on the analyst to presuppose relationships between variables and different data elements.

A Different View of the Questions to be Answered



IIoT ANALYTICS

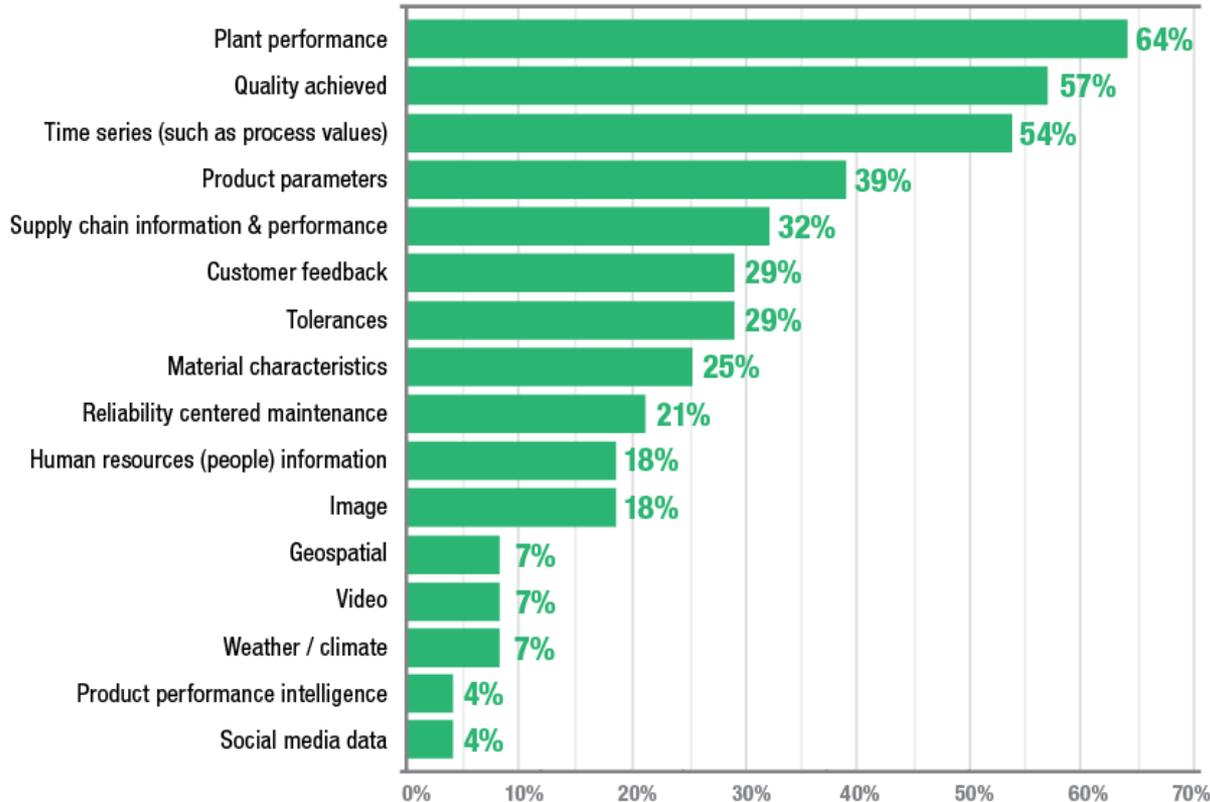


- Crossing the Data Science divide is about being open to new tools and methodologies
- Think about traditional FMEA for a product and how this will change with IIoT?
- But is it happening today?

Data Used in Corporate Analytics

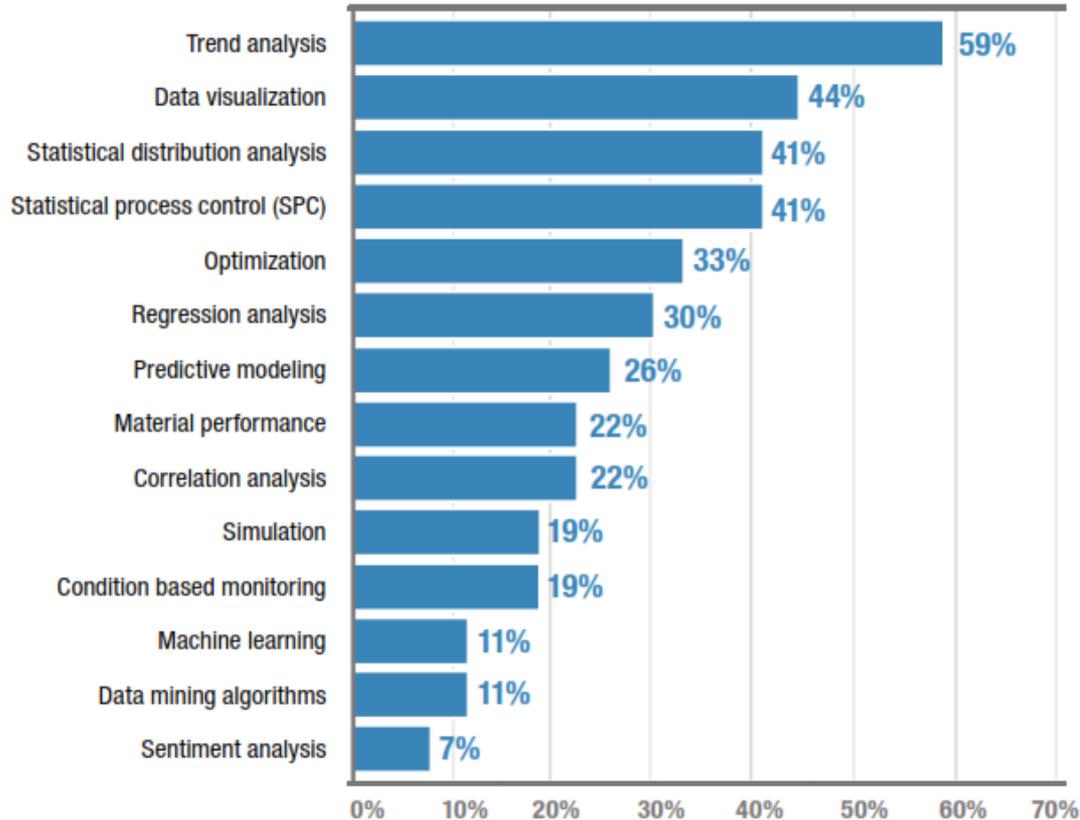


What types of data are used in your enterprise analytics system?



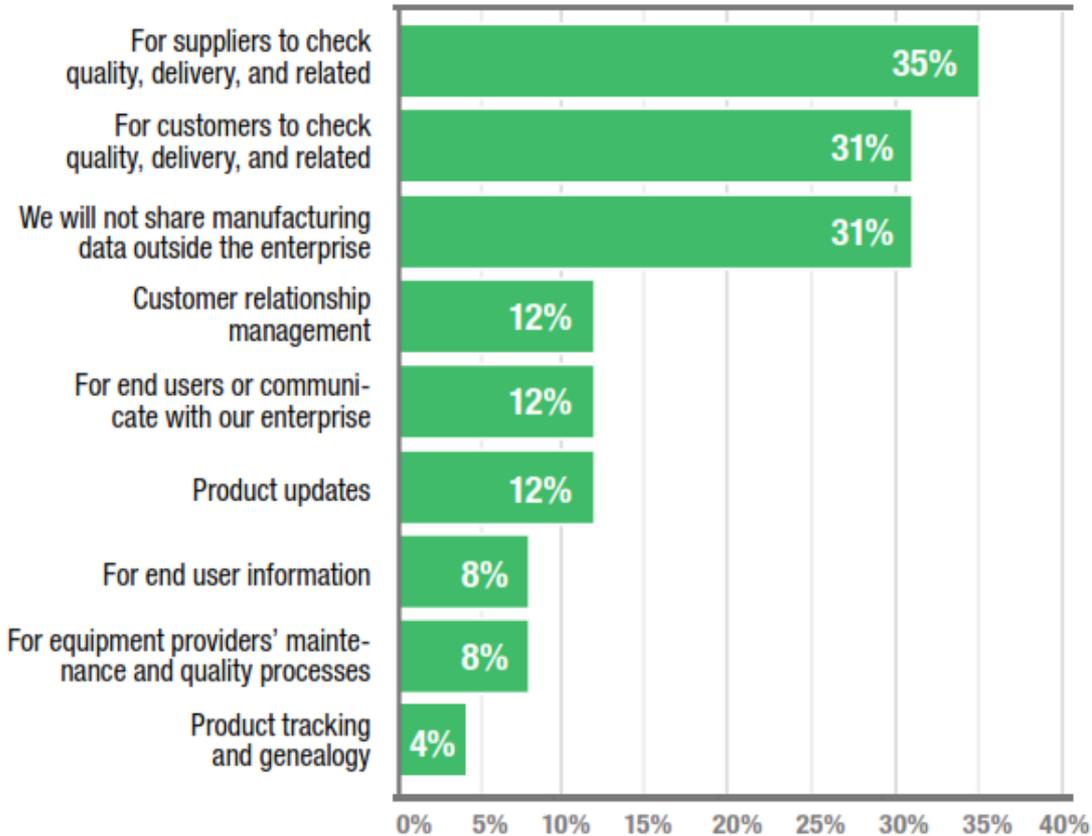
- Companies include very little unstructured data in corporate analytics programs.

Algorithms Used in Manufacturing



- Most adoption is for structured data and Descriptive or Diagnostic analytics
- Adoption of Big Data analytics is still woefully low

Sharing Data Outside the Enterprise

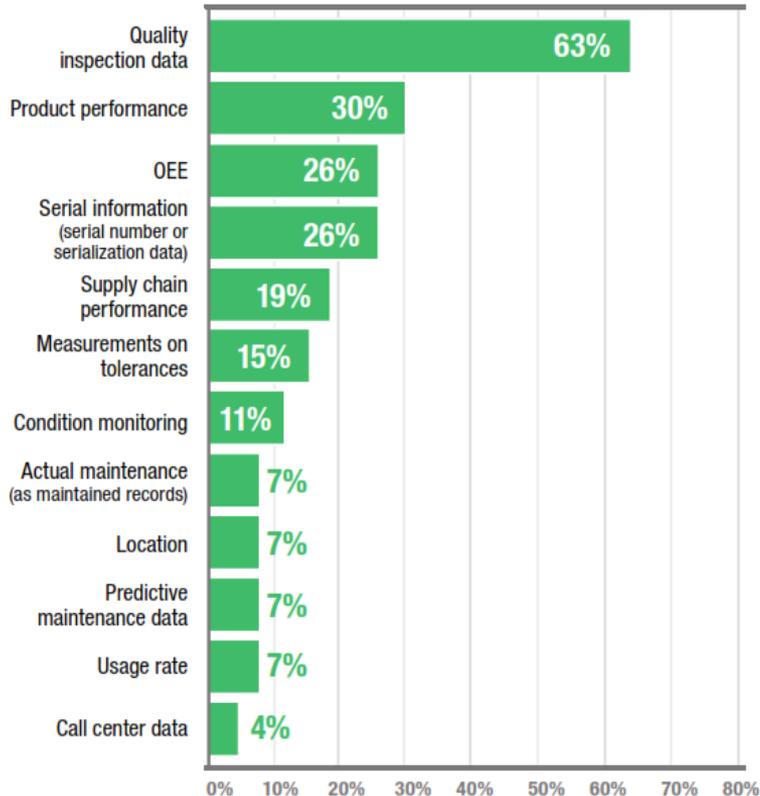


- Data is largely shared outside the enterprise for supply chain collaboration.
- Business model transformation and enabling new strategic objectives is still a long way off.

Connected Product Data

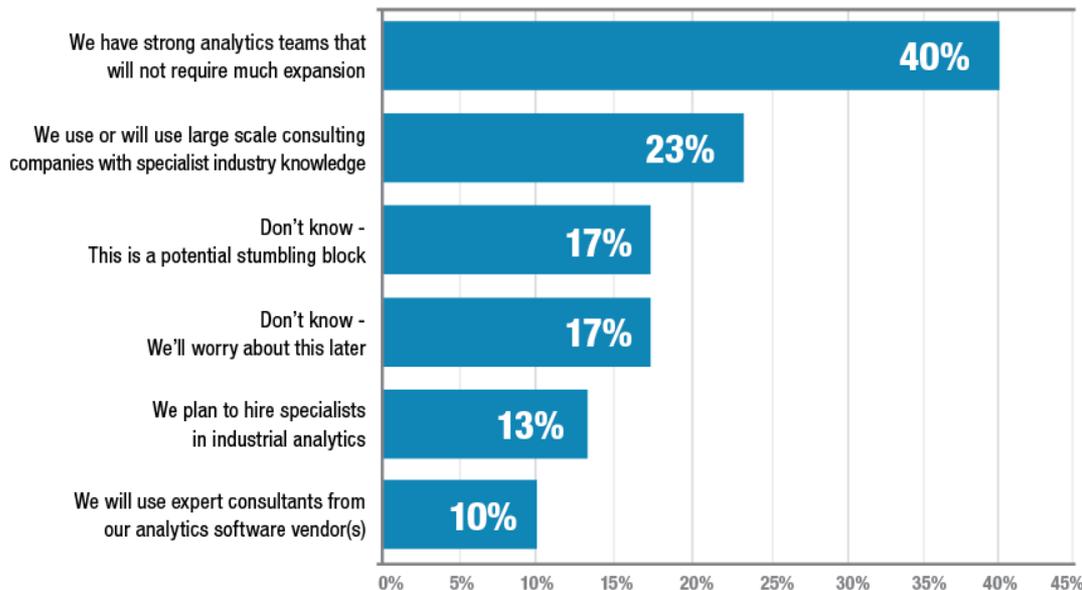


Gathering product data



- Quality is by far the number one use of collected product data
- Analytics and closing the loop on quality for new experiences will drive success

From where does your company get or plan to get its analytics expertise?



- Many Companies already feel mature with current analytics capabilities.
- Limited scope and definition of analytics
- Engineering and Data Scientists collaboration still coming

Recommended Actions



Actionable Recommendations



- **Institute a formal Digital Transformation framework that ties together all levels of the organization with a strategic vision.**
- **Deployed an IoT enabled Big Data architecture that shares data outside of the enterprise and breaks down internal hierarchy and silo's**
- **Enable Digital Transformation by bringing together engineers and data scientists for prescriptive and predictive PLM analytics**
- **View the business case as a journey that delivers value across the product lifecycle.**



Thank You!!