An IoT Enabled Factory

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- Area of Focus at Northrop Grumman:
  Digital Technologies
  - Industrial Internet of Things
  - Augmented and Virtual Reality
  - Digital Twin & the Digital Thread
- Background:
  - Manufacturing of Spacecraft and Aircraft
  - MR&O
  - Educational Outreach

Agenda

- **What is Industrial IoT (IIoT)?**
- **Manufacturing Data Challenges**
- **The Values of a Connected Factory**
- **Northrop Grumman Corporation IoT Development**
- **IoT Challenges**

Industrial Internet of Things (IIoT)

- Network of physical devices, vehicles, buildings and other items - embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data
- Growth potential by implementing IIoT will generate $12 trillion of global GDP by 2030[2]
- Enable rapid manufacturing of new products, dynamic response to product demands, and real-time optimization of manufacturing production and supply chain networks, by networking machinery, sensors and control systems together[1]
- Future, successful companies will be able to increase their revenue through internet of things by creating new business models and improve productivity, exploit analytics for innovation, and transform workforce.[2]

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1. Ersue, M; Romascanu, D; Schoenwaelder, J; Sehgal, A (4 July 2014). "Management of Networks with Constrained Devices: Use Cases".
2. *Daugherty, Paul; Negm, Walid; Banerjee, Prith; Alter, Allan. "Driving Unconventional Growth through the Industrial Internet of Things" (PDF). Accenture. Retrieved 17 March 2016.*
3. Drawing that represents the Internet of Things. Includes connected objects, a drone with a 3km range, a connected plant. "Connect the world!", *Wilgengebroed on Flickr 2012 –* https://www.flickr.com/photos/wilgengebroed/8249565455/, This file is licensed under the Creative Commons Attribution 2.0 Generic license

The Values of a Connected Factory

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30-50% reduction of total **Machine Downtime**

Asset Utilization

- Routing flexibility
- Machine flexibility
- Remote monitoring and control
- Predictive maintenance
- Augmented Reality for MRO

Productivity increase by **3 - 5%**

Resource or Process Effectiveness

- Smart energy consumption
- Intelligent lots
- Real-time yield optimization

45 - 55% increase of **productivity** in technical professions through **automation of knowledge work**

Labor Efficiency

- Human robot collaboration
- Remote monitoring and control
- Digital performance management

Costs for inventory holding decreased by **20 - 50%**

Inventories

- Batch size 1
- Real-time SC optimization

Costs for quality reduced by **10 - 20%**

Quality

- Digital quality management
- Advanced process Control (APC)
- Statistical process Control (SPC)

Forecasting accuracy increased to **85+%**

Supply and Demand Match

- Data-driven design to value
- Data-driven demand prediction

20 - 50% reduction **in time to market**

Time to Market

- Rapid experimentation
- Concurrent engineering
- Customer co-creation/ open innovation

10 - 40% reduction of **maintenance costs**

Service/ After-Sales

- Predictive maintenance
- Remote maintenance
- Virtually guided self-service

4. Industry 4.0 at McKinsey's model factories, Copyright © McKinsey & Company, Inc. April 2016 https://operations-excellence.mckinsey.com/files/downloads/2016/digital40modelfactoriesbrochure1.pdf

Manufacturing Data Challenges

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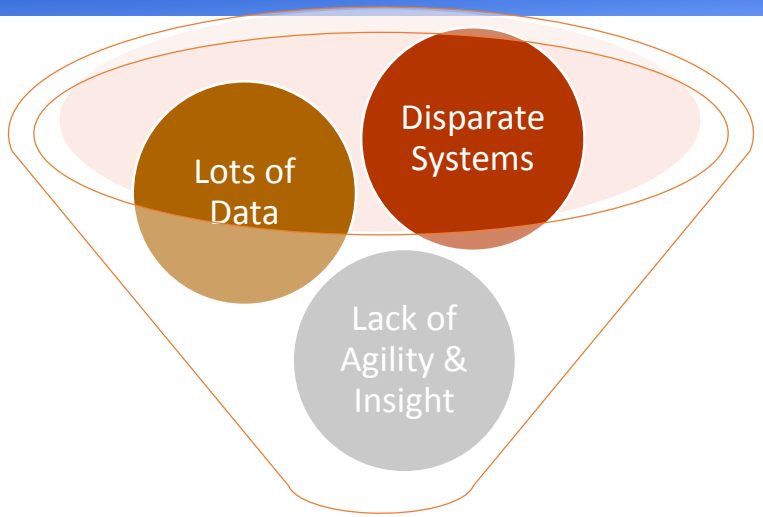

Companies that have real-time visibility into metrics exhibit 10% better OEE

Companies with real-time visibility into Mean Time to Repair have 9% higher OEE

5. 2013-2014 Manufacturing Metrics that Really Matter Summary Report, © April 2014 MESA International and LNS Research, http://www.infinityqs.com/sites/infinityqs.com/files/files/Research/2013-2014_Metrics_that_Matter_Summary_Report_--_Final.pdf

OEE = Overall Equipment Effectiveness

A Smart Enterprise

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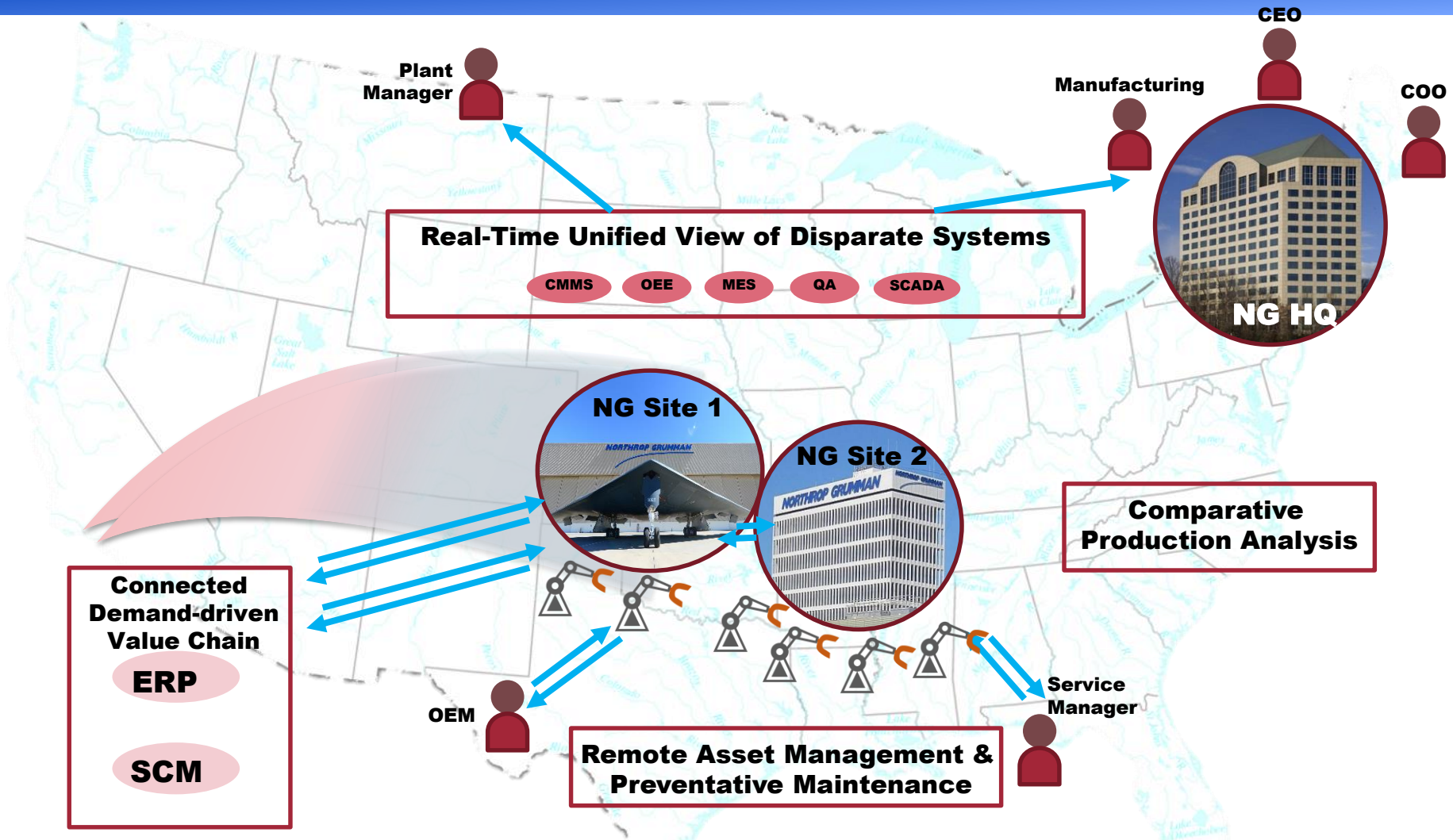

6. "US map - rivers and lakes", US Department of Interior (12 November 2004). http://nationalatlas.gov/

Northrop Grumman Corporation Automated Visibility Metrics

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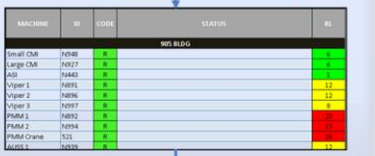
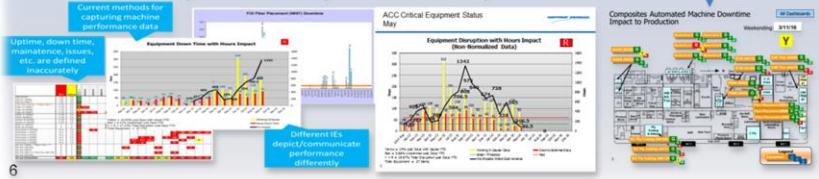
Current NG Automatic Visibility Dashboards

Awareness & Cybersecurity Challenges

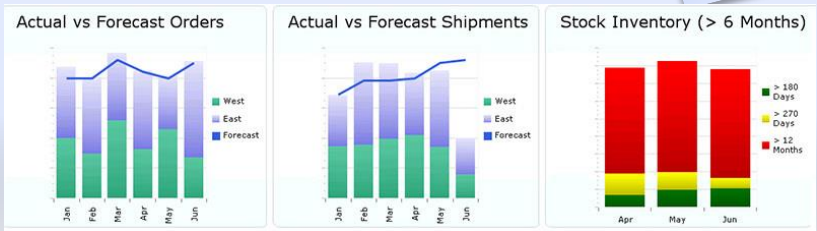
Automation Metrics of the Past

- Metrics off of current ACC Automation are created manually based off of operator feedback, interviews, & line walks
- System lacks real time data flow and communication between departments
- As-built data & Real-time Performance are not effectively utilized to optimize cost
- Machine performance metrics are defined inconsistently
- Duplicate metrics are manually re-created for communicating performance





Informed Decision Making



7. EngineerTech. "SharePointDashboard." N.p., Oct.-Nov. 2011. Web. https://commons.wikimedia.org/wiki/File:SharePointDashboard.jpg. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license

Northrop Grumman Corporation IIoT Development

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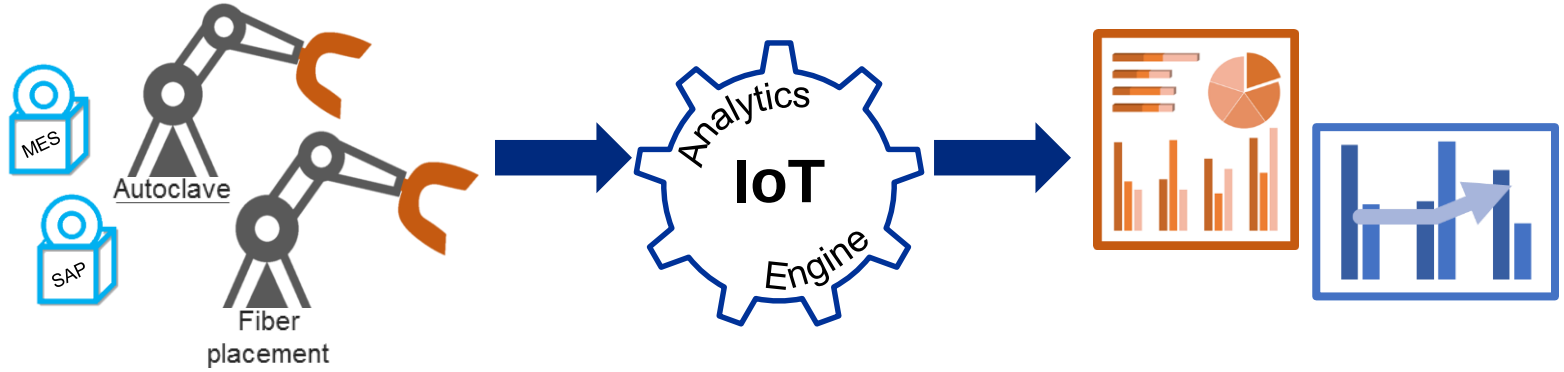
Connectivity		Visibility		Analytics
Assets	Business Systems	Utilization Data	Metrics and KPIS	Machine Learning



- **Asset health: increase asset utilization**
  - Condition based maintenance
  - Predictive and prescriptive maintenance
  - Machine vendor remote monitoring, diagnosis, and repair
- **Visibility: rapid and informed decision making**
  - Greater breadth, volume, and resolution of information
  - Information from beyond the WAN
  - Benefit from analytics
- **Energy management: minimize energy cost**
  - Activity based costing
  - Peak demand charge avoidance, energy usage optimization
- **Connected supply chain: customer intimacy, increase quality**
  - Digital thread
  - Supplier and customer visibility and information exchange

Benefits

30-50% reduction of total **Machine Downtime**

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Automation visibility

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Predictive-Prescriptive Maintenance

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Quality Optimization

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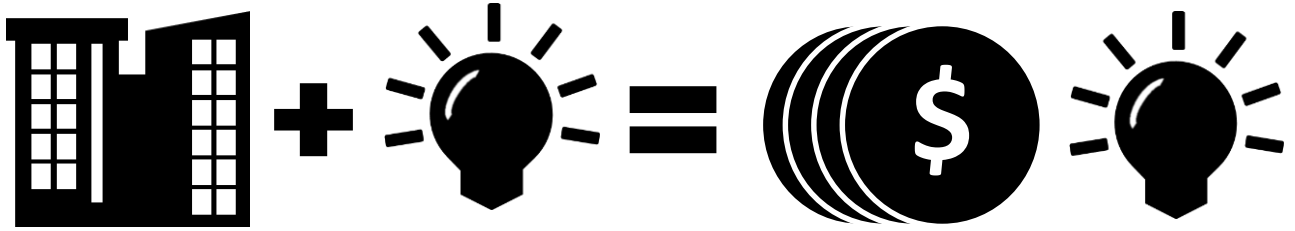
IIoT Challenges



Old Company New Technology Expensive New Technology

- Data is not always in the frame of reference
- Many data sources, formats, types
- Manufacturing process diversity
- Lack of system interoperability, flexibility, visibility
- Changing business, products, processes
- Demands on IT resources
- Deployment disruptions, risk, and cost
- Bridging/Merging IT and OT
- Cybersecurity

Questions?

References

1. Ersue, M; Romascanu, D; Schoenwaelder, J; Sehgal, A (4 July 2014). "Management of Networks with Constrained Devices: Use Cases". Slide 3.
2. *Daugherty, Paul; Negm, Walid; Banerjee, Prith; Alter, Allan. "Driving Unconventional Growth through the Industrial Internet of Things" (PDF). Accenture. Retrieved 17 March 2016.* Slide 3.
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7. EngineerTech. "SharePointDashboard." N.p., Oct.-Nov. 2011. Web. https://commons.wikimedia.org/wiki/File:SharePointDashboard.jpg . This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license, https://creativecommons.org/licenses/by-sa/3.0/deed.en . Slide 7.