IIoT: Predictive Analytics for Efficient Product Realization and Lifecycle Services

Can IIoT get us back to the past…?

Presented By: Louis J Pascarella
Chief Technical Officer, Geometric Ltd.
... everyone working together to make the best decisions every day.....

To produce the best products...

To Optimize Our Customers’ Experience...
Not Difficult when Scale is Small…

…and you wear lots of hats!
Not Difficult when Scale is Small…
… and you wear lots of hats!

…and everyone is in the same room….

Our Communication is.....

- Low Risk
- Low Latency
- High Context & Error Free
But Challenging when we... “Advance”
And We grow ....
And Now Our Communication has...

• Higher Risk
• Higher Latency
• Less Context & More Errors
Which Causes...

Too Many defects at Launch...

Program Timing is TOO long.....

Higher Logistics Costs & Inefficiencies
Growth Effects on Collaboration...

OEM Co-Location
- 100% Collaboration
- 0% Latency (min’s)
- 100% In-Context

OEM Geographical “Dispersement”
- < 100% Collaboration
- > 0% Latency (hours)
- < 100% In-Context

OEM Organizational “Dispersement”
- <<< 100% Collaboration
- >>> 0% Latency (Days/Wks)
- <<< 100% In-Context

Challenge

Supplier Extended Enterprise
- <<<< 100% Collaboration
- >>>> 0% Latency (Months)
- <<<< 100% In-Context
The Way Forward...
Traditional Product Realization Landscape...

Global Product Data Interoperability Summit | 2015

- Product Development
  - Reqs
  - BoM
  - PDM
  - CAD
  - CAE
  - Planned
    - Function
    - Performance
    - Safety
    - Reliability
  - Actual
    - Function
    - Performance
    - Safety
    - Reliability

- Manufacturing
  - ERP
  - Sourcing
  - Process Planning
  - Quality
  - MES
  - Scheduling
  - Planned
    - Product mix
    - Schedule
    - Process Plans
    - Routings
    - Execution
    - Safety
    - Time &Attendance
    - Quality
  - Actual
    - Function
    - Performance
    - Safety
    - Reliability

- Service & After Sales
  - Maintenance
  - Certification
  - FAA Compliance
  - Planned
    - Function
    - Performance
    - Safety
    - Reliability
  - Actual
    - Function
    - Performance
    - Safety
    - Reliability

Local Optimizations
By User Domains
Traditional Product Realization Landscape...

- **Product Development**
  - Planned: Function, Performance, Safety, Reliability
  - Actual: Function, Performance, Safety, Reliability

- **Manufacturing**
  - Planned: Product mix, Schedule, Process Plans, Routings
  - Actual: Execution, Safety, Time & Attendance, Quality

- **Service & After Sales**
  - Planned: Function, Performance, Safety, Reliability
  - Actual: Function, Performance, Safety, Reliability

**Local Optimizations By Domain**
Target Product Realization Landscape...

Global Product Data Interoperability Summit | 2015

Smart Engineering
- Reqts
- BoM
- PDM
- CAD
- CAE

Smart Factory
- Sourcing
- Process Planning
- Quality
- MES
- Scheduling

Smart Product
- Certification
- FAA Compliance

Product Development
- Function
- Performance
- Safety
- Reliability

Manufacturing
- Product mix
- Schedule
- Process Plans
- Routings
- Execution
- Safety
- Time & Attendance
- Quality

Service & After Sales
- Function
- Performance
- Safety
- Reliability
The Way Forward…

Global Product Data Interoperability Summit | 2015
What can be done today…

- Mfg Intelligence
- Energy Mgt
- Asset Mgt
  - Machine Maintenance
  - CAPEX Analysis
- Efficiency Monitoring
  - OEE
  - Waste Analysis
- Usage based Maintenance
- Usage based Design Validation
- Remote Diagnostics
- Condition History Reporting

- Eng Analytics
  - Chg Mgt
  - Issue Mgt
  - WIP Tracking
- Content Integrity
  - IP/EXP
- Surrogate Modeling
- Design for Mfg
Smart Engineering → MBSE

Global Product Data Interoperability Summit | 2015

Req | Function | Logical | Physical | Process | Resource
R1  | F1       | L1      | P1       | Process | Resource
R2  | F2       | L2      | P1       | Process | Resource
R3  | F3       |         |          |         |         

Mechanical

Electronics

S/W
Smart Factory → Analytics Driven Optimization

Product Development
- Reqmts
- BoM
- PDM
- CAD
- CAF

Manufacturing
- ERP
- Sourcing
- Quality
- Process Planning
- MES
- Scheduling

Service
- Maintenance
- Certification
- FAA Compliance

Smart Engineering
- Req
- Function
- Logical
- Physical
- Process
- Resource

Smart Factory
- Mechanical
- Electronics
- S/W
Smart Product → Captured Service Experience

Smart Engineering

Smart Factory

Smart Product

Product Development

- Req
- Function
- Logical
- Physical
- Process
- Resource

- R1
- F1
- L1
- P1
- Process

- R2
- F2
- L2
- P1

- R3
- F3

Manufacturing

- S/W
- Electronics
- Mechanical

- FRP
- Sourcing
- Quality
- Process Planning
- MES
- Scheduling

Service

- Maintenance
- Certification
- FAA Compliance

Req

Function

Logical

Physical

Process

Resource

Mechanical

Electronics

S/W
Smart Product → Captured Usage Experience

- **Product Development**
  - Reqts
  - BoM
  - PDM
  - CAD
  - CAE

- **Manufacturing**
  - ERP
  - Sourcing
  - Quality
  - Process Planning
  - MES
  - Scheduling

- **Service**
  - Warranty
  - Service
  - NHTSA

- **Fleet Usage**

**Smart Engineering**

**Smart Factory**

**Smart Product**

**Req**

**Function**

**Logical**

**Physical**

**Process**

**Resource**

- **Mechanical**
  - R1
  - R2
  - R3
  - F1
  - F2
  - F3
  - L1
  - L2
  - P1

- **Electronics**
  - S/W

- **Resource**
We Can now Build => Digital Thread
From the Digital Thread => To The Digital Twin

Global Product Data Interoperability Summit | 2015

Product Development
- Reqs
- BoM
- PDM
- CAD
- CAE

Manufacturing
- ERP
- Sourcing
- Process Planning
- Quality
- MES

Service
- Maintenance
- Certification
- FAA Compliance

Fleet Usage
- "As-Serviced" Events

"As-Designed" Events
"As-Built" Events
"As-Serviced" Events
"As-Experienced" Events

Digital Thread
- Analytics Engine
- Knowledge Engine
- Content Integrity (IP/EX)

Digital Twin
- Fidelity

CAE
PDM
CAD
"As-Designed" Events
"As-Built" Events
"As-Serviced" Events
"As-Experienced" Events

Content Integrity (IP/EX)
Where we are starting...
Requires a Digital Thread Platform......
Because…The Thread Platform must manage 3rd party tools links……
Because… The Thread Platform must manage/synthesize links……
Because… File-Based Integrations vs. Attribute Linkage Mgt ($n^2$ vs $2^n$)
Because… Shop Floor Data Collection is Heterogeneous/Granular

Example Protocols and Manufacturers:

- Allen Bradley PLCs
- DNP3
- ICCP
- GE Fanuc PLCs
- Mitsubishi PLCs
- Modbus Devices
- Modicon PLCs
- OMRON PLCs
- ROC/ROC+
- Siemens S7 PLCs
- ABB AC450, AC460 and AC410
- APACS
- Bailey DCS
- Fisher Provox
- Foxboro
- Honeywell TPS (TDC 3000)
- RS3 RNI
- Triconex
- Yokogawa
- + others

Example Historians and Databases

- OSI PI
- AspenTech InfoPlus 21
- GE-Fanuc Automation Proficy (iHistorian)
- Wonderware Historian (InSQL)
- MatrikonOPC Desktop Historian
- Honeywell PHD
- InStep eDNA
- Microsoft SQL Server
- All OPC-HDA Compliant Historian
Because… In-Flight Data Collection is Massive

- ~ 20GB per hour
- 8000 parameter/tests
The Digital Thread Platform must.....

Data Collection....

- Applications
- Databases
- Log files

- Devices
- Machines
- Sensors
- etc

- Meters
- Controllers
- Product
- Cloud
The Digital Thread Platform must...

Add ....

- Data Aggregation
- Data Normalization

- Applications
- Databases
- Log files

- Devices
- Machines
- Sensors
- Meters
- Controllers
- etc

- Product
- Cloud
The Digital Thread Platform must.....

Apply Context....

- ISA88/ISA95
- Mfg Processes
- PLM Processes
- Product Performance

- Data Aggregation
  - Applications
  - Databases
  - Log files
- Devices
  - Machines
  - Sensors
- Meters
- Controllers
- etc
- Product
- Cloud
The Digital Thread Platform must…..

Define Measurements, Domains, Ranges, Formulae….

- Metrics
- Targets

- KPIs
- Alerts

- ISA88/ISA95
- Mfg Processes

- PLM Processes
- Product Performance

- Data Aggregation

- Data Normalization

- Applications
- Databases
- Log files

- Devices
- Machines
- Sensors

- Meters
- Controllers
- etc

- Product
- Cloud
The Digital Thread Platform must…..

Monitor & Manage
Dashboards, Scorecards, Reports

- Metrics
- Targets
- KPIs
- Alerts
- ISA88/ISA95
- Mfg Processes
- PLM Processes
- Product Performance

- Data Aggregation
- Data Normalization

- Applications
- Databases
- Log files
- Devices
- Machines
- Sensors
- Meters
- Controllers
- etc

- Product
- Cloud
The Digital Thread Platform must.....
And then we can..... Have visibility on instrumented H/W & S/W
And then we can..... Monitor Program Progress & Analytics
And then we can..... Monitor Production Efficiencies
And then we can... Monitor Production Efficiencies → Energy per Product
And then we can..... Monitor Green House Gas Emissions By Product, By Geo, By Mfg Node....
And then we can..... Monitor In-Use Products
From the Digital Thread → To The Digital Twin → and Back…

Global Product Data Interoperability Summit | 2015

Product Development
- Reqs
- BoM
- PDM
- CAD
- CAE

“As-Designed” Events

Manufacturing
- ERP
- Sourcing
- Process Planning
- Quality
- MES

“As-Built” Events

Service
- Maintenance
- Certification
- FAA Compliance

“As-Serviced” Events

Fleet Usage

“As-Experienced” Events

Knowledge Engine
Content Integrity (IP/EX)

Digital Thread

Analytics Engine

Boeing is a trademark of Boeing Management Company
Copyright © 2015 Boeing. All rights reserved.

Copyright © 2014 Northrop Grumman Corporation. All rights reserved.

GPDIS_2015.ppt | 41
Thank You……