Where is Quality in Industry 4.0?

Conrad Leiva, iBASEt
September 2019
Where is Quality?

Source: Industrial Internet of Things Reference Architecture, IIC, 2019
Where is Quality?

Source: NISTIR 8107 - Current Standards Landscape for Smart Manufacturing Systems, Lu/Morris/Frechette, NIST, 2016
Where is Quality?

Source: nationalinterest.org
Where is Quality?

Source: Industry 4.0: The Case of the F-35, Laird, sldinfo.com, 2018
Where is Quality?

The F35 Digital Thread

Source: Industry 4.0: The Case of the F-35, Laird, sldinfo.com, 2018
Where is Quality? - Counting Defects

Quality is more than... Statistical Process Control (SPC)

Quality is more than... Inspection, data collection, checklists
The Quality Gurus said it best…

Quality cannot be left to end-of-the-line inspections, it needs to be led from top levels of management.

Joseph M. Juran

Quality is the result of a carefully constructed cultural environment. It has to be the fabric of the organization, not part of the fabric.

Philip Crosby

We have learned to live in a world of mistakes and defective products as if they were necessary to life. It is time to adopt a new philosophy in America.

W. Edwards Deming
Still Plenty of Quality Challenges to Tackle

Challenges in meeting Quality objectives

- Quality is too focused on compliance versus product and operational quality: 30%
- Quality is considered a "department", not a "responsibility": 27%
- Quality metrics are not effectively measured: 21%
- Disconnected data between manufacturing sites, business units, regions: 23%
- Inadequate visibility of supplier quality: 20%
- Immature or insufficient processes, such as root cause analysis, continuous improvement: 17%
- Lack of process harmonization; excessive process variation by site, region: 17%
- Lack of executive support: 13%
- Timely quality data, metrics, and processes are not accessible to all: 11%
- Corporate quality team lacks authority to enforce standardization: 10%
- Insufficient quality and technology competencies: 10%
- Organizational misalignment, insufficient quality resources where needed: 7%
- Disparate quality systems and data sources: 7%
- Not engaged early enough in the process: 6%
- Lack of IT support: 3%
Quality Challenges in Industry 4.0

- Complex design and configurations of products
- Complex products with more embedded electronics and sensors
- Complex production processes with smart machines, collaborative robots, 3D printing and composite materials
- Complex ecosystems of partners, suppliers and service providers requiring real-time communications and data
- More frequent changes in product and processes need to be implemented fast internally and into the supply chain
- Poor correlation between supplier certification in ISO9001/AS9100 and actual supplier performance
- More intimate interaction with Customers and Ecosystem
- Higher risk of knowledge drain from high percent of retiring workforce
- Higher risk to the brand from quality issues discussed through social media

Can we sustain quality levels with the same old Quality Management practices?
Do we need to redefine Quality?

**Quality** is the achievement of maximum customer value and satisfaction through fulfillment of customer expectations.

- “Customers” are defined by every link along the product/service lifecycle and value-chain including the end consumer/user.
- Expectations include tangible requirements and intangible expectations.
- Customers and expectations are evolving as products, markets and ecosystems evolve.
- Real-time data, interaction, optimization and ecosystem orchestration are part of the expectations.

The definition is not new, but we need to revisit methods against expectations.
Digital Simulation

Test and verify designs early

Source: Aerospace and Defense Simulation, mayahtt.com, 2018
Work Instructions

Illustrations provide clear instructions to the mechanic

Just click “Next” to navigate
Design and Process Change Management

Warning at top of work order.

Operator can compare

Production Technician must Acknowledge Changes
Augment the Workforce

Plan  Do  Check  Act -Correct  Act -Improve

Training Guidance Alerts
Quality Appraisal - Legacy Processes
Quality Appraisal - Industry 4.0
Many have this view of QMS vs MOM/MES…

**MOM**
- Process Definition
- Standard Procedures
- Resource Mgt
- Certification/Calibration
- Process Controls
- Documentation
- NonConformance Handling
- Deviation Approvals
- Metrics

**QMS**
- QA Manual
- QA Planning
- Resource Mgt
- Training/Certification
- Process Controls
- Documentation
- NonConformance Handling
- Metrics
- Audits
- CAPA
Reality should be more like this

Do more with fewer common tools and integrate processes and communications.
Data supports integrated EQMS + MOM/MES Value Proposition
IT and OT are Converging
The Digital Thread Begins in PLM

PLM

ERP

Sustainment

OBOM

MBOM

Data Analytics

Information Technology

Operational Technology

Augmented Reality

Optically Projected Work Instructions

Industrial Internet of Things

Seam Validation Management System

NextGenLM
IIoT Connected for Data and Intelligence…

Batch Data Processing — Aggregated Intelligence, Mixed Data Sets

Event Data Processing — Contextualized Data, Relational, Normalized

In-Stream Data Processing — IIoT Data, Unstructured, Time Series, Data Lakes

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Goal: More automated, more integrated, closer to real-time
Inspection and Test Verification

Data requirements cannot be skipped
Inspection and Test Verification

From CMM to XML to database...
Inspection and Test Verification

Or even better… Laser Trackers

Source: Laser Trackers – From Inspection to Manufacturing, engineering.com
Intelligent *Poka Yoke*

Source: Festo – BionicWorkplace
Work Flow driven Discrepancy Disposition and Correction

Integrated systems allow integrated disposition and rework instructions authoring and approval.
Integrated Discrepancy MRB and Rework Authoring

Rework instructions authored, approved and routed back to technician at the floor in minutes
Integrated systems streamline information flow

Old Procedures Cycle Time = Weeks

Slow Processes are Expensive Processes!

New Procedures Cycle Time = Hours

How long does it take today to process a Nonconformance and Corrective Action?
Manufacturing Operations Management for Electronics Manufacturing

Industry 4.0 technology demonstrators at the MTC in collaboration with industry leading partners

Automated Parts Placement and Component Traceability
Inspection and Rework Operations Efficiency

Augmented reality assisted virtual instructions

Integrated Visual Inspection Machine and Discrepancy Handling
Industry 4 is not just about the Smart Factory…
A Smart Factory is a Node in a Smart Value Chain
It is much cheaper to catch issues early in the lifecycle

Cost when issue discovered by:

Cost of Poor Quality far greater if it escapes and is caught by the customer!
Managing Quality in the Supplier Network

Traditionally focused on Receiving Inspection procedures
Managing Quality in the Supplier Network

Source Inspection

Self Inspection

Reducing Overhead

Receiving Oversight

Moving more to Source Inspection and Supplier Portal
From Intelligence Drill Down to Cause and Improvement Areas

Are we maintaining associations to the source data and the investigations so we can drill down and correctly prioritize areas for improvement?
Digital Twin for Root-Cause and Improvement Identification

Source: IBM Digital Twin: Designing for a connected, software driven world, IBM
Corrective and Preventive Actions

Integrated quality systems allows CAPA initiation from Supplier Quality, Production or Sustainment processes
Corrective and Preventive Action (CAPA)

Benefits of automating the CAPA process

- Quicker time to closure for open corrective and preventive actions
- Less time and effort required to determine root cause and resolve issue
- Less repeat and rework actions required with communication enabled
- Less exposure to risk with automation (email alerts, dashboards, etc.)
- Better connection between CAPA and other enterprise data sources
- Easier to develop closed-loop quality management processes
Where is Quality in Industry 4.0? – Embedded Throughout

Plan
- 3D Models
  - Simulations
- Work Instructions
- Augmented Reality
- Eng Change Mgt

Do
- Skills and Equipment Verification
- IIoT - Data Collection Analysis-Act layers Digital Twin data

Check
- Integrated Production and Quality Control
  - Ex: FAI/PPV
- Inspection and Test Verifications
  - Ex: 3D Scanning
- Digital Thread
  - Ex: Electronics - LASAM

Act -Correct
- Discrepancy documentation
- Defect Classification Metrics -
  - Artificial Intelligence
- Digital Twin analysis
  - Ex: Supply Chain CAPA - SCARs

Act -Improve
- Benchmark & Improve
  - Metrics Calculations maintain associations

Does it make sense to look at Quality as a separate parallel function?
To Do: Assess and Plan Quality for Industry 4.0

Tactical and Appraisal Focus

- Quality Management procedures are being formalized but still much ad-hoc coordination of remedies via email and phone
- Many silo quality systems throughout
- Focus on formalizing appraisal procedures for inspection, verification, sampling, and audits.
- Penalty focus for poor performance.
- Urgency culture expediting issue resolution
- Work Instructions paper or PDF documents
- Paper data collection sheets, Paper as-built docs
- Suppliers are qualified, rated, and periodically audited
- Quality for suppliers verified at receiving

Efficiency and Correction Focus

- Interaction via forms and reports defined between departments
- Aggregation of data is sparse and via spreadsheets and posted on bulletin boards
- Focus on formalizing MRB, discrepancy MRB, rework documentation, CAPA, and metrics.
- Number of suppliers reduced to focus on fewer key suppliers
- Helping supplier learn and implement Lean, Six Sigma processes
- Paperless online work instructions, 3D Derived Visuals, Integrated QA System, Integrated
- No central data governance for manufacturing data. Integrated digital as-built records with parts genealogy.
- Supplier downloads and uploads data like certificate-of-compliance via Supplier portal.

Collaboration and Prevention Focus

- Lean applied to information value stream across all internal departments and systems
- Quality management applications integrated across engineering, production, and receiving
- Work Instructions with 3D Model Views, 3D Bills of Resources, Integrated
- Production system integrated to quality control, personnel certification, and tool calibration
- Internal distributed data models and publish-subscribe data exchanges between systems and business intelligence platforms
- More supplier inspection managed at the source versus receiving
- Internal MRB and CAPA processes with suppliers
- Moved beyond just certifying suppliers to collaboration model via two-way data exchanges on supplier portal and social tools
- Full Digital Thread through product lifecycle that supports data for the product Digital Twin and augmented reality work instructions for production and service.
- Supplier’s QMS software fully integrated into two-way multi-level publish-subscribe supply chain QMS processes.
- Inspection requirements managed into the supply chain similarly to internal processes
- Suppliers are part of the workflow for change control and problem resolution
- Customer portal integrated to internal systems providing order status, delivery coordination, issue resolution, and product service management

Next Gen
Orchestration and Prescriptive Focus

- Orchestrated processes with suppliers for early detection of issues
- Business intelligence spans operations and supply chain and is associative to allow drill down to root-cause analysis data
- Leverage integrated quality data and artificial intelligence (AI) for more predictive and prescriptive analytics
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Takeaways: Prepare for the Future of the Quality Professional

- **Become more strategic** ensuring quality is injected throughout the process
  - Learn to work across many departments
  - Quality check on the entire product realization process should be part of the change management process
  - Be a champion for embedded quality checks and Intelligent Poka Yoke

- More focused on Corrective Action, Root-Cause Investigation and Continuous Improvement
  - Less focus on Defect Detection
  - Technology and AI will automate many prevention and appraisal activities

- More focused on *data as an asset*
  - Work on data quality and identification and correction of information gaps
  - Working side by side with data scientist helping explain what are rational or irrational relations among data in the digital twin
Opportunities for Quality in Industry 4.0!

Variety  Complexity  Changes  Speed  Quality
Questions?

More resources at www.iBASEt.com

Also at Booth 14

Download:
Quality Operations Resource Pack
THANK YOU