EVOLUTION OF QUALITY MANAGEMENT
SEMICON Taiwan
September 2016
HOW DID MLI WIN SO MANY AWARDS?

Samsung Awards: 2013, 2014
Ebara Award: 2012

MLI Awards Demonstrate Extensive Understanding of Customer Needs and Reflect Excellence in Business.
AGENDA for EVOLUTION OF QUALITY MANAGEMENT

1. Typical Learning Curve (5 Years Ago)
2. Quality Management System That Supported the Typical Learning Curve
   a. Raw Material Sourcing, Supplier Management, Incoming Inspection, Manufacturing, Finished Good
3. Accelerated Learning Curve (Today)
   a. Raw Material Sourcing, Supplier Management, Incoming Inspection, Manufacturing, Finished Good
5. Continuous Improvement
TYPICAL LEARNING CURVE
5 YEARS AGO
TYPICAL LEARNING CURVE for NEW MATERIALS
KNOWLEDGE vs. TIME

- Slow Start
  - Supply chain deep dive
  - Lack of focus on raw material control
  - GR&R, accuracy, linearity

- Steep Acceleration
  - Robust incoming quality analysis
  - Lack of robust metrology

- Plateau
  - Improved understanding of critical parameters that drive the process
  - Deep understanding of materials and processes achieved

- Excursions!

Time to Knowledge Acquisition

Depth of Material Knowledge

Introduction at Customer Site
TYPICAL LEARNING CURVE for NEW MATERIALS
KNOWLEDGE vs. TIME

1. SLOW START
   a. Focus was on delivering finished goods that met CoA and control limit requirements.
   b. No understanding beyond CoA:
      a. Insufficient understanding of material sensitivities and process interactions
   c. **Result** ➔ excursions as customer site!
2. STEEP ACCELERATION
   a. Tidal wave of activity to **improve material knowledge** to minimize excursions.
   b. Achieve understanding beyond CoA:
      ✓ Supply chain
      ✓ Raw material variation
      ✓ Finished good batch-to-batch
      ✓ Degradation
      ✓ Key vs. control parameters
TYPICAL LEARNING CURVE for NEW MATERIALS
KNOWLEDGE vs. TIME

3. PLATEAU
   a. A learning plateau was reached sometime after ramp
   b. Excursions at customer sites decline
   c. Less than ideal learning curve for you or your customers
      ✓ Costly
      ✓ Time consuming
      ✓ Learn in front of the customer
QUALITY MANAGEMENT: 5 YEARS AGO
TYPICAL LEARNING CURVE

SOP not Followed
Out of Spec
Out of Control
Package Failure

Poor Change Control
Equipment Failure

“Normal” Causes

Engineering Tests
Expedited Processing
Reliance on Automated Signals
Sub-Supplier Issues
Excessive Rework
Standard Environmental Conditions
Change Control of Personnel

“Abnormal” Causes

Inadequate RFCs
Cherry Picking
Unusual downtimes
Operation Beyond Characterized Range
Insufficient Data Review/Analysis
Special Customer Requests

Confidential and Proprietary
QUALITY MANAGEMENT: 5 YEARS AGO
RAW MATERIAL SOURCING less than OPTIMAL

1. Sourcing through distributors and/or manufacturers that were not always ISO certified

2. Limited to no evaluation of lot-to-lot variation from a single supplier prior to selection

3. Infrequent or no comparison of raw materials between suppliers

4. Second source consideration limited

5. Responsible sourcing not considered
1. Unlikely to have any type of agreement on process change control or quality operating system requirements

2. Purchase specifications not always in place

3. No drive for continuous improvement

4. Limited auditing activity

5. Limited business continuity planning
1. Lack of robust incoming raw materials testing with material acceptance based primarily on:
   a. Incoming CoA
   b. Concentration confirmation
   c. Trace metals testing

2. Limited use of statistical process control (SPC) charts for raw material acceptance / rejection

3. Little to no raw materials characterization
QUALITY MANAGEMENT: 5 YEARS AGO
LIMITED PROCESS UNDERSTANDING and CONTROL

1. Minimal understanding of critical parameters that drive the process
2. Minimal understanding of critical environmental variables that may affect critical quality attributes
3. Limited failure modes and effects analysis (FMEA) activity
4. Few measurement systems in place for critical process parameters
5. Process capability is uncertain
QUALITY MANAGEMENT: 5 YEARS AGO
HEAVY RELIANCE ON FINISHED GOOD CoA

RAW MATERIAL SOURCING
Purchase from distributors or manufacturers

SUPPLIER MANAGEMENT
Improved purchase specifications

INCOMING INSPECTION
Increased raw material testing

MANUFACTURING
Limited monitoring of manufacturing parameters

FINISHED GOOD
Approval of CoA Parameters only

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ACCELERATED LEARNING CURVE
ACCELERATE the LEARNING CURVE
KNOWLEDGE vs. TIME

Depth of Material Knowledge

Beyond CoA
Degradation
Shelf-Life
Critical process parameters
Metrology Validation
Robust IQA
Supplier Mgmt
Supply Chain
CoA

Time to Knowledge Acquisition

Introduction at Customer Site

Accelerated Start
Plateau
Deep understanding of materials and processes achieved
Purposeful action
ACCELERATED LEARNING for NEW MATERIALS
KNOWLEDGE vs. TIME

1. ACCELERATED START
Purposeful action in pursuit of comprehensive material knowledge sooner in the process.

a. Understanding **beyond the CoA** to establish baseline data for future reference and improved control:
   - Key vs. control parameters
   - Raw material variation
   - Batch-to-batch variation in the FG
   - Degradation
   - Temperature
ACCELERATED LEARNING for NEW MATERIALS
KNOWLEDGE vs. TIME

ACCELERATED START CONTINUED...

b. Understanding the entire supply chain
c. Supplier management
d. Validating metrology
e. Understanding critical process parameters and how they impact quality critical parameters
ACCELERATED LEARNING for NEW MATERIALS
KNOWLEDGE vs. TIME

ACCELERATING THE LEARNING CURVE

1. Does NOT mean that there is a delay in introducing products to the market.

2. DOES mean that
   1. Comprehensive material understanding is achieved sooner in the new product development process.
   2. Alignment with customer is possible
QUALITY MANAGEMENT: TODAY

"Normal" Causes

- SOP not Followed
- Out of Spec
- Package Failure
- Out of Control

"Abnormal" Causes

- Poor Change Control
- Equipment Failure
- Engineering Tests
- Expedited Processing
- Reliance on Automated Signals
- Sub-Supplier Issues
- Excessive Rework
- Standard Environmental Conditions
- Change Control of Personnel
- Inadequate RFCs
- Cherry Picking
- Unusual downtimes
- Operation Beyond Characterized Range
- Insufficient Data Review/Analysis
- Special Customer Requests

Special Customer Requests

- "Normal" Causes
- "Abnormal" Causes
UNDERSTAND THE SUPPLIER:

1. Purchase direct from manufacturers when possible
2. ISO certified
3. Willing to negotiate/discuss process change control
4. Agreeable to QOS requirements
5. Open to audits (paper or onsite)
6. Purchase specifications in place
7. Open to continuous improvement activity conversations
QUALITY MANAGEMENT: TODAY
SUPPLY CHAIN DEEP DIVE ➔ SEEK UNDERSTANDING

BUILD A RELATIONSHIP:
1. Focus on building stronger relationships, enhanced collaboration with key suppliers
   a. Improved business continuity planning
   b. Decreased risk
   c. Leverage assets and capabilities to generate a competitive advantage (instead of only focusing on purchasing goods and services at the lowest cost)
UNDERSTAND THE MATERIAL:

1. Conduct evaluation of lot-to-lot variation before selection
2. Evaluate materials from more than one supplier
3. Characterization / fingerprinting
4. Dedicated process equipment?
5. Manufacturing frequency / batch size
6. Cherry picking required?
QUALITY MANAGEMENT: TODAY
EQUAL ACCOUNTABILITY ACROSS SUPPLY CHAIN

RAW MATERIAL SOURCING
Purchased directly from manufacturer or produced in house

SUPPLIER MANAGEMENT
Improved purchase specifications. Dedicated manufacturing equipment. Change control.

INCOMING INSPECTION
Robust incoming raw material acceptance process including material characterization and functional testing

MANUFACTURING
Emphasis on manufacturing parameters to eliminate variation

FINISHED GOOD
Approval of CoA parameters, Raw Material parameters and Manufacturing parameters

Sub-suppliers
Supplier
YOU
Customer

CoA
Outgoing Quality Sampling Plans Aligned

CoA
Incoming Quality Sampling Plans Aligned

Equal accountability across the supply chain
In a perfect world, all suppliers would agree to equal accountability.

In reality, much of the burden for testing and controlling raw material quality resides with you.

YOU must be the gateway to quality.
QUALITY MANAGEMENT: TODAY
INCOMING INSPECTION is the GATEWAY

1. Robust incoming raw materials testing with material acceptance based on more advanced characterization:
   a. Functional testing
   b. Degradation profiling
   c. Mass spectrometry
   d. Impurity analysis and identification

2. Use of statistical process control (SPC) charts for raw material acceptance / rejection
EVOLUTION OF QUALITY MANAGEMENT: TODAY MANUFACTURING PROCESS UNDERSTANDING

1. Complete process traceability
2. Focus on elimination of variation
3. Critical parameters that drive the process are understood
4. Critical environmental variables that may affect critical quality attributes are understood
5. Robust failure modes and effects analysis (FMEA)
6. Measurement and control systems in place for critical process parameters
EVOLUTION OF QUALITY MANAGEMENT: TODAY

1. Robust gauge R&R studies to validate finished good metrology methods
2. Temperature control during transit to decrease variation
3. Finished good product release dependent upon all “iceberg” parameters:
   a. Raw materials
   b. Manufacturing process parameters within acceptable operating parameters
   c. CoA acceptance
   d. Shipping compliance
QUALITY MANAGEMENT: TODAY
CONTINUOUS IMPROVEMENT
CONTINUOUS IMPROVEMENT

When you’re finished CHANGING, you’re finished.

- Benjamin Franklin

Insanity: doing the same thing over and over again and expecting different results.

- Albert Einstei

Success does not consist in never making mistakes but in never making the same one a second time.

- George Bernard Shaw
CONTINUOUS IMPROVEMENT
ONE OF THE ‘COMMANDMENTS’ FOR CONTINUED SUCCESS

1. Further improvement is always possible
2. You can never be too busy to improve
3. All processes should be continuously re-evaluated and improvements implemented
4. Focus on “fire prevention” rather than “fire fighting”
5. Requires a shift to a long-term mind set
6. Sustainability and continuous improvement complement each other
CONTINUOUS IMPROVEMENT
ONE OF THE ‘COMMANDMENTS’ FOR CONTINUED SUCCESS

The Money Cliff

“...well, it depends on how much money you want to spend.”
CONTINUOUS IMPROVEMENT
ONE OF THE ‘COMMANDMENTS’ FOR CONTINUED GROWTH

The Problem Cliff

“The problem with that is......”
CONTINUOUS IMPROVEMENT
ONE OF THE ‘COMMANDMENTS’ FOR CONTINUED GROWTH

The Problem Cliff

The Money Cliff

The winds of change

I knew we could do it!
CONTINUOUS IMPROVEMENT
HOW TO IMPLEMENT CONTINUOUS IMPROVEMENT
THANK YOU.

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