Role of SMT inspection in industry 4.0 implementation

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SMTA Capital Expo and Tech Forum – Aug. 22nd, 2019
Content

• The context of electronics manufacturing
• Industry 4.0 definition and promises
• Optical inspection position and role
• Feedbacks from the field: advises and results
Context of electronics assembly industry

- Global electronics manufacturing service market evolution ($Bn):
  - 2018: 542
  - 2023: 777
  - CAGR: +7.5%

Source: New venture Research, June 2019
SMT environment getting more complex

- Miniaturization
  - Introduces more defects
  - Increased equipment capabilities
  - In-line critical metrology

- Agile production
  - Higher mix/lower batch size
  - High process variability
  - High material variability

- Efficiency
  - Zero defect line desired
  - $10^x$ repair costs curve
  - Low TCO is expected

- Digitalization
  - Interoperability
  - Real-time process control
  - Actionable information
The 4th industrial revolution

Industry 1.0
Mechanization, water power, steam power
1800

Industry 2.0
Mass production, assembly line, electricity
1900

Industry 3.0
Computer and automation
1970

Industry 4.0
Cyber-Physical systems
2010

Time
Complexity
"Broadly, Industry 4.0 refers to Humans, machines and software applications that communicate and cooperate together for maximum efficiency of workforce and equipment, whatever the goal pursued."

Goran Zdravkovic, Head of Industry 4.0 at Mycronic Group
The promises of Industry 4.0

- Automated manufacturing lines boosting Overall Equipment Effectiveness (OEE) from 30% to 80%
- Anticipates variations in production conditions in real time
- Positive impact on efficiency: cuts scrap, improves quality, improves throughput
- Open the door to extreme customization, a.k.a. “Order of One” and “Batch Size 1.”
Process optimization: automated process adjustments based on actionable information

Production data preparation with minimal programming effort

Remote and predictive maintenance

Material handling optimized for flexible production

Traceability with identification of all items entering production

Production planning: flexibility without compromising throughput

Line control software: Real-time KPIs

Material handling: Common programming
Auto-check
Self-adjust
M2M communication
KPI: delivery performance (delivery ability multiplied by delivery reliability)

KPI: overall equipment effectiveness (OEE)

KPI: deadline compliance

KPI: number of full-time equivalents per assembly line

KPI: Daily output & Work in Progress

KPI: Daily output & Work in Progress
i4.0 infrastructure

- Material traceability
- Data preparation
- Material handling
- Line control

Or custom

Message broker

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i4.0: Sensor-based technologies to acquire data

Optical inspection systems
Sensors of the SMT line
Data quality relies on performances and capabilities of your SPI/AOI/AXI
How good are your data?

Quality raw data criteria:
- Accuracy
- Repeatability
- Checked by embarked SPC
- Not operator dependent
Correlate your data to optimize your FPY

Process improvement web-based software correlates results from all inspection systems to enable:
- Real time process monitoring
- Accurate Defect root cause analysis
- High first pass yield and line efficiency
Act on your process in real time

Closed loop / forward loop
Triggered by SPC or by process control
Enabled by M2M communication
Closed loop SPI – printer

- Cross-system collaboration: upstream control loops
- Whatever the brands of the equipment
Automatic repair loop: when every board counts

- 100% yield at any volume
- Jetter tops off, or adds missing solder paste based on inspection measurements
- Avoid washing boards
The advent of Artificial Intelligence

• Currently, research is underway to use the capabilities of artificial intelligence in SMT industry.  
  → First results show that technology fits perfectly with low volume / high mix needs

• Applied to optical inspection, AI will enable automation of time-consuming and repetitive tasks, such as:
  → Auto-programming of machines (SPI, AOI)
  → Self-review of inspection results

• Process Engineers will be only involved in programming of non-standard / odd-shaped components (connectors).

• Operators will focus on analyzing and correcting real defects identified (if any!).
Some advise for i4.0 implementation
Make sure that major stakeholders support the project and are involved

- Top Management / CEO:
  - Should explain the vision and the target to achieve to all other stakeholders
  - Should define steps and timeframe of the transition
  - Should make sure enough resources are allocated (people and budget)

- IT Dept / Cybersecurity Dept.:
  - A central stakeholder: make sure project is understood and supported by them
  - i4.0 should integrate cybersecurity constraints from the beginning

- Production:
  - Most concerned by operational changes
  - Manage resistance to change through pedagogy, team involvement and training
Some advise for i4.0 implementation

Do not overlook the specification stage

- Preparatory work can be done on interface simulator from MES or closed loop suppliers, but only 90% can be simulated

- You need to go down to the details of each task carried out by each operators in the shop floor
Some advise for i4.0 implementation

Prepare your hardware and server integration

- Understand your hardware environment: make an inventory of the functions and possibilities of each machine on your SMT assembly line

- Ask your machine suppliers if the functions you need are/will be available.

- Think about phasing the evolutions, don’t try to implement all at once

- Be ready to implement a new IT infrastructure such as AMQP server (Advanced Message Queuing Protocol) to enable bidirectional communication between SMT line equipment and various process control software (MES etc).
Feedback from the field: FPY improvement

Two examples from real customers

- **Customer #1:**
  Customer profile: OEM – Industrial – mid vol./mid mix
  
  **Results:**
  After implementing line control through data correlation, first pass yield was improved from 89.40% to 93.25%.

- **Customer #2:**
  Customer profile: EMS – Specialized on automotive products - mid mix/high volume/high reliability
  
  **Results:**
  After implementing line control through inspection data correlation, and reduction of tolerance windows, here are two examples of FPY improvements achieved:
  
  For product #1: FPY increased from 88% (2018 average) to 95% (Q1 2019)
  For product #2: FPY increased from 93% (2018 average) to 98% (Q1 2019)
Impact of optical inspection on KPIs

As a result:

✓ Overall Equipment Effectiveness increases
✓ Monthly output increases
✓ Work in progress decreases
✓ Worker utilization increases
✓ Delivery performance increases
Impact on profitability

- Average potential financial improvement for electronics manufacturers:
  - up to +6% on EBIT
  - up to +20% on ROCE
  
  Source: Roland Berger, oct. 2018

- Increase in revenue expected for first movers
Q & A
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