Improving First Pass Yields and SMT Line Utilization for High Mix Low Volume Electronics Manufacturing

Optimal Electronics Corporation
Austin, TX
www.Optelco.com
Electronics Assembly

• **First Pass Yield**
  - Common issues
  - Example improvement solutions
  - Measuring first pass yield

• **SMT Line Utilization**
  - Common challenges
  - Example improvement solutions
  - Measuring downtime and SMT OEE
What is your First Pass Yield %?

- 98%
- 95%
- 92%
- 89%
- ...

What is your First Pass Yield %?

Context of First Pass Yield

• First time NPI builds
• Production builds – initial run versus re-occurring
• Assembly complexity
• Measurement point
  • SMT line versus
  • Post SMT assembly
First Pass Yield Variables

Materials

• Components miss-labeled
• Wrong parts placed – kitting, wrong reel on feeder
• Miss-match part rotation on reel and SMT placement program
• Non-approved part manufacturer for assembly
• Mixed vendors for “no-mix” parts
• Expired moisture sensitive parts
• Incorrect PWB
• Forgot to insert handplace parts
<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components miss-labeled</td>
<td>✓ Component Verification – LCR, ...</td>
</tr>
<tr>
<td>Wrong parts placed – kitting, wrong reel on feeder</td>
<td>✓ Kitting</td>
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<tr>
<td></td>
<td>✓ Offline/Online Setup Verification</td>
</tr>
<tr>
<td>Miss-match part rotation on reel and SMT placement program</td>
<td>✓ Part Rotation Check</td>
</tr>
<tr>
<td>Non-approved part manufacturer for assembly</td>
<td>✓ Part Verification to Manufacturer</td>
</tr>
<tr>
<td>Mixed vendors for “no-mix” parts</td>
<td>✓ No Mix Verification</td>
</tr>
<tr>
<td>Expired moisture sensitive parts</td>
<td>✓ MSD Management</td>
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<tr>
<td>Correct PWB</td>
<td>✓ PWB Verification</td>
</tr>
<tr>
<td>Forgot to insert handplace parts</td>
<td>✓ Handplace setup/placement verification</td>
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</table>
Optel connects to an LCR meter. MPN or marking verification where LCR not applicable
## Kitting the Right Parts / Correct QTY

### Inventory View

<table>
<thead>
<tr>
<th>Slot</th>
<th>Mod</th>
<th>Machine</th>
<th>IPN</th>
<th>Qty</th>
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### Storage View

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<th>Machine</th>
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<td>Kitted: 2344</td>
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<td>43003</td>
<td>Benner</td>
<td>0050396479</td>
<td>1454</td>
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</table>
Off Line Setup Verification

- Assigning reel to feeder for parts in an a setup
- Component feeder rotation and feeder type displayed
- Feeder is rejected if broken or needs maintenance
- Reel is rejected if part number is not found in the setup, if its quantity is too low, or if a moisture sensitive reel has expired
- Check for “no-approved vendors”

Example of scanning reel to feeder for a setup on Universal Genesis machine.
- Orange highlighted license plate indicates a queued splice reel. License place in yellow to the far right is new spliced reel.
- Red highlight in scrap and rate columns indicates high scrap rate
- Yellow indicates that reel is about to exhaust using a configurable alert (# of panels to exhaust)
Raw PCB Verification/Serialization

- Optel can serialize PCBs with labels or Laser Etcher 2D Matrix barcode
- 3rd party data can be imported into Optel DB if already serialized
Manual Assembly

- Optel verifies setup and provides material traceability for hand placed parts
- Component traceability included
First Pass Yield Variables

Line Setup
- Incomplete/incorrect line setup
- Wrong routing for assembly
- Wrong stencil revision, support plate, paste, adhesive
- Wrong SMT program (e.g., revision)

Process Issues
- Solder paste dehydration, paste-takt-time to oven exceeds limit
- Bad solder paste print
- Wrong replacement reel or wrong spliced reel
- Incorrect reflow oven program (profile/speed)
- Process routing error, post SMT
- Deviations
- No first article inspection
Optel Process and Quality Traceability

- Panel Serialization Module
- Screen Printer Module
- Screen Printing
- PCB Serialization
- SMT Visual Inspection
- Pick and Place
- Reflow Oven
- First Article Inspection
- AOI
- Hand Assembly
- Rework / Repair
- Solder
- Hand Placement & Inspection & defect collection
- Kiosk Module
- Kiosk Module
- Test Module
- Kiosk Module
- Box Build
- ICT or Flying Probe
- Functional Test
- Final Assembly
- Coatings
- Final Visual Inspection
- Pack and Ship
- Ship/ Quality Mod.
- Inspect station & defect collection
- Test Module
- MRP / ERP Accounting / Other
- OPTEL MES

- Order Entry
- BOM
- Quote
- Invoice

Auxiliary
- Inspection & defect collection
- FAI & defect collection
- Reflow Oven Module
- Setup Verification

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## Line Setup/Process Solutions - First Pass Yield

<table>
<thead>
<tr>
<th>Line Setup/Process Issues</th>
<th>Example Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Incomplete/incorrect line setup</td>
<td>✓ Line setup work instructions</td>
</tr>
<tr>
<td>❑ Wrong routing for assembly</td>
<td>✓ Process enforcement serial to assembly routing</td>
</tr>
<tr>
<td>❑ Wrong stencil revision, support plate, paste, or inadequate warm up time; Solder paste dehydration</td>
<td>✓ Screen printer setup verification – program; stencil; solder paste, support plates</td>
</tr>
<tr>
<td>❑ Wrong SMT program (e.g., revision)</td>
<td>✓ Placement machine setup verification</td>
</tr>
<tr>
<td>❑ Bad solder paste print</td>
<td>✓ Solder Paste Inspection (SPI)</td>
</tr>
<tr>
<td>❑ Incorrect reflow oven program (profile/speed)</td>
<td>✓ Reflow oven – speed; program; zone temperatures; paste takt time</td>
</tr>
<tr>
<td>❑ Wrong replacement/spliced reel</td>
<td>✓ Materials setup verification</td>
</tr>
<tr>
<td>❑ Process routing error, post SMT</td>
<td>✓ Circuit serial # process enforcement</td>
</tr>
<tr>
<td>❑ Deviations</td>
<td>✓ Approved alternate parts</td>
</tr>
<tr>
<td>❑ No first board check</td>
<td>✓ First article inspection</td>
</tr>
</tbody>
</table>
Electronic Documentation for Line Setup

EDoc Reports

- Routing Sheet
- Line Setup Sheet
- Machine Setup Sheet
- Parameter Cards – Screen Printer and Reflow Oven
- Feeder Usage
- Board Support

Electronic Documentation

<table>
<thead>
<tr>
<th>Slot</th>
<th>Module</th>
<th>Part Number</th>
<th>Description</th>
<th>Feeder</th>
<th>Rotation</th>
<th>Noz</th>
<th>Package</th>
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<tbody>
<tr>
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<td>218 CAP LF X7R 0003 0.1UF 10V 20%</td>
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<td>0</td>
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</table>
Assembly routings and process enforcement settings are defined for each operation.

An operation can be enforced in routing or enforced at shipping.
Screen Printing Verification

- Verifies panel serial number matches work order number
- Checks solder paste type
- Checks stencil ID
- Records operator ID
- Tracks solder paste acclimation time
- Tracks solder paste takt time
- Locks machine if machine setup is not verified
- Verifies program and revision

An IO controller is used to lock machine if setup is not verified
## Interface with SPI

- Depending on the model, Optel will parse output file, or SPI machine will be configured to save data directly to a file or MS SQL server.
- Optimal data parser will consolidate all parametric data to Optel Database.

### KOH-Young Defects Defined as Fail Codes in Optel

<table>
<thead>
<tr>
<th>FailCode</th>
<th>Description</th>
<th>Type</th>
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<td>E.Bridge</td>
<td>KY-SPI Bridge Failure</td>
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<td>E.Bridging</td>
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<td>SPI</td>
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<td>E.Insufficient</td>
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<tr>
<td>E.Position</td>
<td>Error Position</td>
<td>SPI</td>
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</table>

KY-SPI-Test Results File

[Optel DB Diagram]
Reflow Oven Control

- Records actual temperature of each zone by PCB serial number
- Verifies correct recipe is loaded on the machine
- Compares saved profile temperatures with actual readings from machine
• Optimal data parser reads all parametric data and assigns it to the PCB serial number in the Optel Database.
Quality Management

- Graphical hand assembly
- Process control & traceability
- First article inspection
- Defect data collection
- Test data collection
- Yield calculation and reporting
- Use at:
  - Visual inspections stations
  - Rework
  - Repair/RMA
  - Where defects recorded/ repaired
First Article Inspection
Hot Quality Spot Visualization
## First Pass Yield Measurement

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<th>Operation</th>
<th>Side</th>
<th>% Completed</th>
<th>Pass</th>
<th>Fail</th>
<th>Scrap</th>
<th>First Pass Yield</th>
<th>Final Pass Yield</th>
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<td>0.0%</td>
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Confidential
Productivity Improvements
Keep Machines Running Faster and Longer
Line Utilization Challenges

• Material setup time
• Line setup
• Kitting shortages
• Line balancing
• Feeder failures
• Expired MSD parts
Productivity Improvements

- Dynamic Production Scheduling
- On time machine programs, setup kits, and other resources
- Eliminate downtime due to unexpected component shortages
- Apply lean kitting
- Advanced component outage warning
- Excess scrap warning
- Moisture sensitive component tracking
- Duty cycle based feeder maintenance
- Real time ERP inventory adjustments
Mobile Kitting

1. Find By LP or IPN
2. Put Away
3. Mass Put Away
4. Kitting
5. Pick to Special Order
6. Pick to Part
7. Move to INTRANRTS
8. LP History
9. Delete License Plate
10. Print RTS or MSD Label
11. Logout

Enter Option

e, x or 00 from any input returns to home.
Lean Kitting
Dynamic Scheduling

GROUP SETUP 1

GROUP SETUP 2

3 more work orders up to 50% production increase

changeover/setup =

work order =
Dynamic Scheduling

Dynamic re-optimization as new work orders enter the production stream.
Production Schedule by Line

- Production Schedule in Gantt format to show setup timing
- Setup details include: estimated start/stop time, shifts, and work order information

Dynamic Production Schedule

Updated: 9/9/2013 11:52:42 PM (406ms) - Refresh

<table>
<thead>
<tr>
<th>Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line: All</td>
</tr>
<tr>
<td>Start Date: 9/10/2015 5:00 AM</td>
</tr>
<tr>
<td>Select WorkOrder: All</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Setup #</th>
<th>Work Order No</th>
<th>Start Date</th>
<th>End Date</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>SHI-501-1036-21-00ST1000050 (B)</td>
<td>9/10/2015 5:40 PM</td>
<td>9/10/2015 6:52 PM</td>
<td>76</td>
</tr>
<tr>
<td>11</td>
<td>SHI-501-1025-20-00ST1000034 (B)</td>
<td>9/10/2015 6:52 PM</td>
<td>9/10/2015 9:07 PM</td>
<td>200</td>
</tr>
<tr>
<td>11</td>
<td>SHI-501-1032-20-00ST1000048 (B)</td>
<td>9/10/2015 9:07 PM</td>
<td>9/10/2015 10:27 PM</td>
<td>105</td>
</tr>
</tbody>
</table>
Line Setup Status

- Line Setup Status report shows setup details including planned/produced circuits
- Allows users to set setup status throughout factory and define/track issues

![Line Setup Status](image)
Case Study

Challenge
- High Mix/Low Volume: 50 board avg.
- Poor Machine Utilization
- Minimize Setup Time across 6 lines

Solution
- Implemented Optel Scheduling & Material Management

Results
- Reduced set up time by 65%
- Slashed Total Set ups by 80%
- Nominated for Chairman's Award

• Before Optel Scheduling
  - Machine Utilization: 23%
  - 20 –30 Changeovers/week
  - 1 hour avg. set up time

• With Optel
  - Machine Utilization: 40%
  - 3-6 Changeovers/week
  - 20 minute avg. set up time
Downtime Data Collection

- If the machine down time exceeds pre-defined “Downtime Threshold Time” Optel displays a dialog for the operator to select downtime reason and enter a comment if needed.
- Downtime reasons are defined by the customer.
Real-Time Performance Monitoring
Performance Monitoring

- Real time performance monitoring typically displayed on a monitor hang above the line, but it can also be viewed plant wide.
### Machine OEE and Utilization

**Current Setup: 314**

- **Open Time:** 00:16:31, Placements: 62,233 / 73,040 (85%)
- **Run Time:** 00:04:34, Boards Built: 3,346 / 3,720 (90%)

**Next Setup: 315**

- **Feeders**
  - **Verified:** 0
  - **Total:** 0

**A1 Efficiency**

<table>
<thead>
<tr>
<th>Ideal Cycle Time</th>
<th>Actual Cycle Time</th>
<th>Machine Efficiency</th>
<th>OEE</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>01:11</td>
<td>01:11</td>
<td>100.0%</td>
<td>27.7%</td>
<td>27.7%</td>
</tr>
</tbody>
</table>

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Performance Metrics Monitored

• MyData Time Performance by Category
  • Run time
  • Setup time
  • Idle time
  • Down time (customer defined)
  • Break time

• Setup Status
  • Open Time
  • Run Time
  • Next Setup Feeder Status

• Machine Efficiency
  • Ideal Cycle Time
  • Actual Cycle Time
  • Machine Efficiency
  • OEE
  • Utilization
Pareto Chart – Total Event Time

Overall Equipment Effectiveness

Updated: 11/20/2013 03:19 PM - Refresh - Export


Time Range: Last 3 Hours ▼ Total Downtime Pareto ▼

A1

Failcode Downtime Chart
- Downtime (Min)
- Cumulative % Hours

A2

Current Setup: 314

Next Setup: 315

Open Time
00:15:31
Placements: 42,233 / 73,040
85%
Verified
Total
0.0%

Run Time
00:04:34
Boards Built: 3,346 / 3,720
90%

A1 Efficiency
Ideal Cycle Time
01:11
Actual Cycle Time
01:11
Machine Efficiency
100.0%
OEE
27.7%
Utilization
27.7%

Current Setup: 314

Next Setup: 315

Open Time
00:15:07
Placements: 50,212 / 64,410
78%
Verified
Total
0.0%

Run Time
00:06:49
Boards Built: 3,346 / 3,720
90%

A2 Efficiency
Ideal Cycle Time
01:1
Actual Cycle Time
01:1
Machine Efficiency
100.0%
OEE
45.2%
Utilization
45.2%

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3/3/2015
Summary

**Time is Money**
- 15 – 80% reduction in set ups
- 33 to 75% reduction in setup time
- 50 to 80% reduction in part counting & locating time

**Reduce Costs**
- 50+% reduction in feeder failures
- 33+% Scrap reduction
- 5 to 50% Lower headcounts

**Build More with less**
- 10-25% improved machine utilization
- 100% - the right parts on the right boards