Micro Assembly for the Automotive Market, How to Execute?

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AGENDA

1. Introduction NME
2. Automotive Market & Trends
3. Case Study
4. Quality Standard & Requirements
5. Results
1. Neways Micro Electronics

Ceramic-based solutions for high-reliability applications and demanding environments.

Services
✓ microelectronic assembly services
✓ interconnectivity solutions on ceramic substrates
✓ prototyping, process development and volume manufacturing

Products
✓ environmental sensors
✓ imaging sensors
✓ hearables, implantable devices

Applications
✓ automotive HVAC
✓ industrial metrology
✓ thermal management
✓ vacuum electronics
2. Automotive Market & Trends
2. Automotive Market

Manufacturing evolution

- Craft production (1890-1908)
- Mass production (1908-1973)
- Lean production (1973–present)
2. Automotive Market

Current characteristics

- Strongly regulated market (IATF-16949) with stringent quality requirements
- Reduced NPD time, increased complexity
- Complex supply-chain
- High-volume market
- Profit-margin pressure
- Operational excellence

Elon Musk opens 2-nd plant in Tilburg (NL), 2015

The Automotive Supply Chain
2. Automotive Market Trends

- Premium quality infotainment
- Plug & Play mobile data
- Front view camera system
- Telematics & in-car wellness
- Car companion apps
- Multimodal HMI
- Auto wiper

- Night vision
- Battery (HEV/EV)
- LIDAR

- High beam control
- Front RADAR & camera
- LED/Laser head/fog lighting
- ADAS system control

- Blind spot detection
- Rear ultrasonic sensing & camera
- Park assist
- Rear collision avoidance

- Side RADAR surround view
- Proximity sensing capability
- Surround audio/stereo capability
- Enhanced safety features

Source: IDC, CB Insights, Sep’16
3. Case Study: Air Quality Sensor
4. Quality Standard & Requirements
The International Automotive Task Force (IATF 16949) defines explicitly the quality requirements for the automotive industry. Certification to IATF 16949 is mandatory for organizations who wish to manufacture parts for the automotive industry.
4. Core Tools

- APQP (Advanced Product Quality Planning)
- FMEA (Failure Mode and Effects Analysis)
- MSA (Measurements Systems Analysis)
- SPC (Statistical Process Control)
- PPAP (Production Part Approval Process)
4. Advanced Product Quality Planning (APQP)

- APQP ensures the *Voice of the Customer* is clearly understood, translated into requirements, technical specifications and special characteristics.

- Five concurrent activities
  - Planning
  - Product Design and Development
  - Process Design and Development
  - Product and Process Validation
  - Production
4. APQP – case study

**Product Plan flowchart**

**APQP deliverables**

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**Supplier APQP Process**

<table>
<thead>
<tr>
<th>Supplier APQP Element</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Product Engineering</td>
</tr>
<tr>
<td>Sources/Decision</td>
<td>1</td>
</tr>
<tr>
<td>Customer (Client)</td>
<td>1</td>
</tr>
<tr>
<td>RFQ</td>
<td>1</td>
</tr>
<tr>
<td>Design FMEA</td>
<td>R**</td>
</tr>
<tr>
<td>Design Review(s)</td>
<td>R**</td>
</tr>
<tr>
<td>Design Verification</td>
<td>R**</td>
</tr>
<tr>
<td>Subcontractor APQP</td>
<td>S</td>
</tr>
<tr>
<td>Facilities/Tools/</td>
<td>R</td>
</tr>
<tr>
<td>Prototype Build/</td>
<td>R</td>
</tr>
<tr>
<td>Prototype Build/</td>
<td>S</td>
</tr>
<tr>
<td>Drawings and</td>
<td>S</td>
</tr>
<tr>
<td>Specifications</td>
<td></td>
</tr>
<tr>
<td>Team/Feasibility</td>
<td>S</td>
</tr>
<tr>
<td>Manufacturing Process</td>
<td>R</td>
</tr>
<tr>
<td>Process FMEA</td>
<td>R</td>
</tr>
<tr>
<td>Measurement Systems</td>
<td>R</td>
</tr>
<tr>
<td>Pre Launch Control</td>
<td>R</td>
</tr>
<tr>
<td>Operator Process</td>
<td>R</td>
</tr>
<tr>
<td>Packaging Specifications</td>
<td>R</td>
</tr>
<tr>
<td>Production Control</td>
<td>R</td>
</tr>
<tr>
<td>Production Trial Run</td>
<td>R</td>
</tr>
<tr>
<td>Production Control</td>
<td>R</td>
</tr>
<tr>
<td>Production Validation</td>
<td>S</td>
</tr>
<tr>
<td>Production Part Approval</td>
<td>S*</td>
</tr>
<tr>
<td>ESW Part Delivery at MMD</td>
<td>S*</td>
</tr>
</tbody>
</table>

**Key**

- **S** = Sign
- **R** = Responsibile
- **T** = informing
- **I** = informed
- **F** = Formatted
- **E** = Editing

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[Image of Product Plan flowchart and APQP deliverables table]
4. Failure Mode and Effects Analysis (FMEA)

- FMEA ensures quality through prevention activities related to risk
  - Identify, prioritize and mitigate the risks during concept phase
  - \( RPN = \text{Severity} \times \text{Occurrence} \times \text{Detectability} \)

- Two broad categories
  - Design FMEA (DFMEA): provides refined special characteristics, inputs to testing and design improvements
  - Process FMEA (PFMEA): considers possible process weaknesses, improved process performance and control strategies on special characteristics

- Not a substitute for good engineering!
# 4. FMEA – case study

<table>
<thead>
<tr>
<th>Process Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity (S)</th>
<th>Occurrence (O)</th>
<th>Likelihood (L)</th>
<th>Control</th>
<th>Action</th>
<th>Recommended Action</th>
<th>Responsibility</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire bonding</td>
<td>Program not according to spec</td>
<td>Product not according to spec</td>
<td>3</td>
<td>Wrongly programmed</td>
<td>2</td>
<td>None</td>
<td>Job Set Up</td>
<td>Check first product only</td>
<td>3</td>
<td>Machine not released</td>
</tr>
<tr>
<td></td>
<td>Process interruption</td>
<td>Wrongly programmed</td>
<td>4</td>
<td>None</td>
<td>3</td>
<td>None</td>
<td></td>
<td></td>
<td>3</td>
<td>Incorrect wirebonding</td>
</tr>
<tr>
<td></td>
<td>Wrong program loaded</td>
<td>Production not possible</td>
<td>2</td>
<td>Program selection possible</td>
<td>3</td>
<td>None</td>
<td>Automatic machine stop</td>
<td>2</td>
<td>1</td>
<td>Only one available</td>
</tr>
<tr>
<td></td>
<td>Incorrect tool plate</td>
<td>Production not possible</td>
<td>2</td>
<td>Tool plate selected</td>
<td>3</td>
<td>None</td>
<td>Automatic machine stop</td>
<td>2</td>
<td>0</td>
<td>Only one available</td>
</tr>
<tr>
<td></td>
<td>Case not placed correctly</td>
<td>Production not possible</td>
<td>2</td>
<td>Proximity sensor</td>
<td>3</td>
<td>None</td>
<td>Automatic machine stop</td>
<td>2</td>
<td>0</td>
<td>Only one available</td>
</tr>
<tr>
<td></td>
<td>Damaged tool possible</td>
<td>None</td>
<td>5</td>
<td>Proximity sensor</td>
<td>3</td>
<td>None</td>
<td>Automatic machine stop</td>
<td>3</td>
<td>4</td>
<td>Incorrectly mounted</td>
</tr>
<tr>
<td>Wrong wire</td>
<td>Product not according to spec</td>
<td>Poor set up of production</td>
<td>5</td>
<td>Poor set up of wire thickness</td>
<td>4</td>
<td>None</td>
<td>Check: wire thickness</td>
<td>5</td>
<td>1</td>
<td>Improper in-line</td>
</tr>
<tr>
<td>Wrong component chosen</td>
<td>Wirebond not according to spec</td>
<td>Component not interchangeable</td>
<td>5</td>
<td>Component &amp; wire thickness</td>
<td>4</td>
<td>None</td>
<td>Check: component thickness</td>
<td>5</td>
<td>1</td>
<td>Improper in-line</td>
</tr>
<tr>
<td></td>
<td>Capillary wire not out</td>
<td>Wirebond not according to spec</td>
<td>5</td>
<td>No regular check on line</td>
<td>1</td>
<td>None</td>
<td>Visual check on surface</td>
<td>5</td>
<td>2</td>
<td>Improper bond coating</td>
</tr>
</tbody>
</table>
4. Measurement Systems Analysis (MSA)

- MSA measures the variation that exists within a measurement process
  - MSA is used to certify the measurement system for production use
- Five distinct parameters are considered
  - Bias
  - Linearity
  - Stability
  - Repeatability
  - Reproducibility
- For gages used to collect variable continuous data, *Gage Repeatability and Reproducibility (Gage R&R)* can be performed to evaluate the level of uncertainty within a measurement system.
4. MSA – case study

Summary:
- Quick glance at the charts looks good. Most of the points in top chart are outside the control limits, a lot of distinction, and variation is part-part.
- % Contribution is 0.55%, less than 1.0% - PASS
- % Study Variation is 7.36%, less than 10% - PASS
- % Tolerance is 6.40% less than 10% - PASS
- 19 Categories which is >10 recommended - PASS
4. Statistical Process Control (SPC)

- SPC demonstrates process stability and capability
  - Measures and controls quality by monitoring the manufacturing process
- Shift from *detection-based* to *prevention-based* quality controls
- Data is recorded and tracked using control charts (fi. Xbar – R chart)

  ![Xbar-R Chart of Strength](chart)

  ![Potential (Within) Capability](chart)

- Typically monitored parameters are the CTQs, SCs or items with high RPN.
4. SPC – case study
4. Production Part Approval Process (PPAP)

- PPAP demonstrates that all special characteristics have achieved a level of acceptable stability and capability
  - Summarizes the evidence collected through APQP

PPAP provides evidence that APQP has been successfully performed.
5. Results – case study

- 99.6% First Pass Yield
- 100% On-Time Delivery Rate
- Customer Reject Rate on Shipped Products 300 PPM
- 60,000 products/week

APQP provides a solid framework to robustly develop new products.
Thank you!
Any Questions?

The only constant is change