Realizing the Benefits of a Better FMEA tool

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Chuck Boots
Introduction: Chuck Boots

Chuck Boots: Technical Presales Consultant II

- 20+ years of manufacturing/quality experience
- Bachelor of Science, Business Management
- 5 years as Siemens customer 3 years in current role
- Apollo RCA, Int/Ext/Supplier auditing, Six Sigma

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Mary V. McAtee: Technical Presales Consultant II

QM/FQC/LQC

- Mechanical Engineer with 30+ years Quality and Reliability Engineering Experience

- New England Research Center: R&D Infrared Detector Development

- MA/Com Space Center: Leading Provider of High Reliability Microelectronics

- Lead Assessor: ISO 9001, ISO 14001, OHSAS 18000, TS 16949
FMEAs and Risk Management: Not just for the Automotive Industry Anymore

- Failure Modes Effects Analysis (FMEA), both Design FMEAs and Process FMEAs evolved from the defense industry in the late 60s.

- The Automotive Industry embraced the concept for design, manufacturing and safety risk assessment.

- FMEAs have proved their worth and are increasingly becoming the standard in other industries including aviation, medical device and energy.
Spreadsheets the Historical Tool of Choice

Historically Design and Process FMEAs and Control Plans have been developed in Excel spreadsheet formats which has some inherent drawbacks:

• Spreadsheets are not optimal for collaborative working groups.

• Spreadsheets are limited in providing functionality that supports intelligent reuse and qualification by similarity

• Change Management across the process can be challenging.
# Sample Spreadsheet FMEA

## Potential Failure Mode and Effects Analysis (Process FMEA)

### Part Number:

### Part Description:

### Core Team:

### Process Failure (Process Function/Requirement)
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1-A</td>
<td>Chemicals Unload and verify weight</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level incorrect within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification to shipment documentation (Packing SL/ Bill of Lading)</td>
<td>8 / 10</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Damage weight</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level correct within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification</td>
<td>8 / 16</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-B</td>
<td>Door beams Unload and verify weight</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level incorrect within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification to shipment documentation (Packing SL/ Bill of Lading)</td>
<td>8 / 10</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Damage weight</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level correct within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification</td>
<td>8 / 16</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-C</td>
<td>Brackets Unload and verify weight</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level incorrect within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification to shipment documentation (Packing SL/ Bill of Lading)</td>
<td>8 / 10</td>
<td>None</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Damage weight</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level correct within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification</td>
<td>8 / 16</td>
<td>None</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Place height in storage location</td>
<td>Place in wrong location</td>
<td>Unable to locate material as intended</td>
<td>Operator Process Error</td>
<td>Operator Process Error</td>
<td>Physical Inventory</td>
<td>8 / 16</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Damage height</td>
<td>Unloaded wrong quantities</td>
<td>Inventory level incorrect within manufacturing system</td>
<td>Receiving Technician error</td>
<td>Training on receiving procedures</td>
<td>Visual freight verification to shipment documentation (Packing SL/ Bill of Lading)</td>
<td>8 / 16</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-A</td>
<td>Load Formula Chemicals</td>
<td>Wrong Formula Selected</td>
<td>Out of Spec. Material</td>
<td>Operator Error</td>
<td>Operator Training</td>
<td>Material Performance IPS-2001</td>
<td>5 / 10</td>
<td>None</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Formulas will not load</td>
<td>Wrong Formula Selected</td>
<td>Out of Spec. Material</td>
<td>Operator Error</td>
<td>Operator Training</td>
<td>Material Performance IPS-2001</td>
<td>5 / 10</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphorus will not react</td>
<td>Wrong Formula Selected</td>
<td>Out of Spec. Material</td>
<td>Operator Error</td>
<td>Operator Training</td>
<td>Material Performance IPS-2001</td>
<td>5 / 10</td>
<td>None</td>
<td></td>
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</tr>
</tbody>
</table>

### Action Results:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>M</td>
<td>I</td>
<td>E</td>
<td>N</td>
<td>A</td>
<td>M</td>
<td>I</td>
<td>E</td>
<td>N</td>
<td>A</td>
<td>M</td>
<td>I</td>
</tr>
</tbody>
</table>

### Prepared by:

### Date (Orig.):
Tree Structure Design and Process FMEA Advantages

Moving to a tool that utilizes a tree structure methodology provides many advantages:

- Tree structure FMEAs can take in content from block diagrams to form the backbone of the Process FMEA.
- Design & Process FMEAs can seamlessly take in content and updates from Bill of Materials (BOM) and Bill of Process (BOP) data maintained in other systems including ERP and PLM Systems such as SAP and Teamcenter.
- Querying and reusing data is much more straightforward and real-time to facilitate collaborative team efforts.
- Output can display in a variety of required regulatory formats including AIAG and VDA.
Tree Structure FMEA and Block Process Flowchart Diagram
### AIAG Example Output Format

#### POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS

**AIAG v3 & v4, VDA 96 supported**

<table>
<thead>
<tr>
<th>Process step/Function</th>
<th>Requirement</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity</th>
<th>Distribution</th>
<th>Potential Cause(s) of Failure</th>
<th>Controls Prevention</th>
<th>Controls Detection</th>
<th>RPN</th>
<th>Recommended Actions</th>
<th>Responsibility &amp; Target Completion Date</th>
<th>Actions Taken &amp; Target Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process 70.01: (1) Move (FMEA0000209)</strong></td>
<td>Bring correct part</td>
<td>Bring incorrect part</td>
<td>Minor process interruption</td>
<td>2</td>
<td>Incorrect material identification</td>
<td>Material identification tool</td>
<td>2 Visual verification</td>
<td>8 32</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process 70:</strong> (2) Machining (FMEA0000209)</td>
<td>Place cast in fixture</td>
<td>Place no cast in machining fixture</td>
<td>Minor process interruption</td>
<td>2</td>
<td>Process step skipped</td>
<td>Operator training</td>
<td>4 Visual verification</td>
<td>8 64</td>
<td>D: Last machining detection in task list</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process 70:</strong> (2) Machining (FMEA0000209)</td>
<td>Cast placed correctly</td>
<td>Cast misplaced in fixture</td>
<td>Machine crashes</td>
<td>7</td>
<td>Process step skipped</td>
<td>Operator training</td>
<td>4 Visual verification</td>
<td>8 224</td>
<td>P: Standard operation sheet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process 70:</strong> (2) Machining (FMEA0000209)</td>
<td>Future allows loading of the part incorrectly</td>
<td>None</td>
<td>Visual verification</td>
<td>8 445</td>
<td>P: Install or removing or machining fixture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process 70:</strong> (2) Machining (FMEA0000209)</td>
<td>Future cleanliness, chips in fixture</td>
<td>None</td>
<td>Visual verification</td>
<td>8 445</td>
<td>P: Cleaning the fixture by pressure washing</td>
<td></td>
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</tr>
</tbody>
</table>

**Notes:**
- RPN: Risk Priority Number
- AIAG v3 & v4, VDA 96 supported
- Siemens PLM Software

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Tree structure FMEAs permit locking lines of the FMEA during editing to assure only appropriate changes are made by the team.

- Revision controls and archive functionality can keep the team oriented and facilitate design by similarity activities.

- Drag and drop of components, subassemblies and assemblies as well as processes and sub processes from one FMEA to another permits easy reuse of data.

- The resulting “where used query net” is extremely valuable when assessing the potential impact of a proposed Engineering Change.
Reusing Data and Lessons Learned through Linkage
Why Family FMEAs?

Common Processes that Scale across products such as plating, paint and coatings are good candidates for family FMEAs.

- They can be readily referenced across products and when changed cascade through all the impacted products resulting in:
  - Less errors because a product where the process was changed was missed.
  - Easy queries on these processes can provide useful information when making an environmental or safety assessment of where certain processes and chemicals are used.
  - This is increasingly important with the advent of REACH and RoHS in the EU and other parts of the world.
Inheriting Data

Tree structure approaches to managing FMEAs and Control Plans can leverage the ability to inherit required data from a process FMEA into a Control Plan.

This eliminates redundant data entry and reduces opportunities for errors during the transfer of content.

Data flow from a Design or Process FMEA into a Control Plan can also continue the process further by bringing the data into Inspection Plans.
Process Flowchart to FMEA to Control Plan Relationship

1. Process Flowchart
2. FMEA
3. Control Plan
Control Plans to Inspection Plan
Closed Loop Quality logic expects failures identified during inspection to be communicated back to Engineering closing the loop as lessons learned.

Providing Engineers a fast, reliable means of querying and seeing how failures and defects relate to specific products, and processes permit agile adjustments based on accurate representations of current state of experienced risk.
Examples of Failure Feedback from Inspection to FMEAs
Change Management: Faster, Better Communication, and Understanding

When a Design or Process FMEA is changed:

• The entire team is made aware

• The changed FMEA becomes a new revision and the previous one is archived but available for future analysis.

• Data, when properly authorized, can flow into the Control Plan and then into the Inspection Plans.

• These changes are real time and that is crucial in distributed global manufacturing landscapes in place today.
Examples of Communication and Controls
Reporting and Analytics

Data is only numbers until it becomes useful information.

Seeing real time tracking of data and information in trending and reports can drive change and confirm validity of risk assumptions and effectiveness of controls.

Sharing Outputs in formats required by customers seamlessly saves time and creates trust and confidence.
Examples of Outputs

Distribution S/O

Frequency RPN
Siemens has invested energy, capital and resources in developing the most comprehensive Design and Quality solutions that scale across both industry sectors and enterprises of all configurations and sizes.

- Product and Application Lifecycle Management for electro-mechanical and embedded technology designs.
- Design and Process FMEAs and Advanced Product Quality Planning (APQP)
- Inspection, SPC and Supply Chain Management including Production Part Approval (PPAP)
- CAD Design Management

All these systems working together, leveraging the same data sources result in a “single source of truth” with the analytics and reporting to confirm, improve and evolve your business.
Quality Domains connected seamlessly across the Enterprise
Thank You
Please contact Mary.McAtee@siemens.com for any additional information.