Failure Mode and Effects Analysis based on *FMEA 4th Edition*

Mark A. Morris
ASQ Automotive Division Webinar

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Purpose of this Course

• Enable participants to understand the importance of FMEA in achieving robust capable designs and processes.

• Teach participants how to improve the efficiency and effectiveness of their FMEA efforts.

• Get the right people involved in the process of FMEA, and get results.

• Have Fun Learning!!!
Learning Objectives

Participants will be able to:

✓ Explain the purpose, benefits and objectives of FMEA.
✓ Select cross-functional teams to develop FMEAs.
✓ Develop and complete a FMEA.
✓ Review, critique, and update existing FMEAs.
✓ Manage FMEA follow-up and verification activities.
✓ Develop FMEAs in alignment with AIAG FMEA reference manuals.
Changes in the FMEA Manual (4th Ed.)

- Improved format, easier to read.
- Better examples to improve utility.
- Reinforces need for management support.
- Strengthens linkage between DFMEA/PFMEA.
- Ranking tables better reflect real world use.
- Introduces alternative methods in use.
- Suggests better means than RPN to assess risk.
- Recommends against threshold RPN values to initiate required action.
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POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(Process FMEA)

FMEA Number _____________
Page _____ of _____
Prepared by _________________________
FMEA Date (Orig.) _______ (Rev.) _______
Core Team ____________________________________________________________________________________________________________________________

Item __________________________________________________________________________
Model Year(s) Program(s) _____________
Process Responsibility ______________________
Key Date _________________________________________________________________________

Current Process Control (Detection) Function

Recommended Actions

Responsibility & Target Completion Date

Action Results

Actions Taken | Sev | Occ | Det | R. | P. | N.
|----------------|-----|-----|-----|----|----|----|

ASQ
## Process FMEA Analysis

|--------------|------------------------|-----------------------------|----------|---------------------------------------|------------|-----------------------------------|--------------------------------|---|--------|

**Process Step** is simply the focus of the analysis.

**Describe the function or requirement to be analyzed.**

**Describe how the item could potentially fail to perform its function.**

**State the effects of the failure in terms of the specific system, subsystem, or component being analyzed.**

**Identify potential causes of the item not performing its intended function.**

**This column is reserved for the methods that have been used to prevent a specific cause.**

**This column is used to document methods that have been used to detect either the cause or the failure mode.**
### Process FMEA Analysis

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- **Severity**: evaluates the impact of the effect.
- **Occurrence**: rates how often a specific cause is likely to result in the failure mode being analyzed.
- **Detection**: ranks our ability to detect either a cause or a resulting failure mode. Use best detection available.
- **Classification**: is an optional column commonly used to identify safety risks.
- **Risk Priority Number**: is the product of the severity, occurrence, and detection rankings.
Four Common Classes of FMEA

• System FMEA
  – Focuses on how interactions among systems might fail.

• Design FMEA
  – Focuses on how product design might fail.

• Process FMEA
  – Focuses on how processes that make the product might fail.

• Machinery FMEA
  – Focuses on how machinery that perform processes might fail.

The focus for this evening is on Process FMEA.
AIAG Model for Quality Planning

- Concept Initiation Approval
- Program Approval
- Planning
- Prototype
- Pilot
- Production Planning
- Product Design and Development
- Process Design and Development
- Product and Process Validation
- Production
- Feedback Assessment and Corrective Action

- Design FMEA
- Process & Machinery FMEA
Understanding a **Failure Sequence**

- **Direct Cause**
- **Failure Mode**
- **Immediate Effect**

- **Cause Detection**
- **Failure Mode Detection**
Is it a **Cause** or **Failure Mode**?

- **System Level**
  - Failure Modes
  - Effects
  - Causes

- **Subsystem Level**
  - Failure Modes
  - Effects
  - Causes

- **Component Level**
  - Failure Modes
  - Effects
  - Causes
Examples of Weld Process Failure Modes

• **System** (Welding Line)
  – Robot Failure
  – Loss of Incoming Water
  – No Signal to Weld

• **Subsystem** (Weld Gun)
  – Cracked Jaw
  – Failed Servo Motor
  – Failed Shunt

• **Component** (Servo Motor)
  – Overheats
  – Loss of Position
  – Premature Seal Failure
A Rational Structure for Quality Planning™

- **Product**
  - Design FMEA

- **Process**
  - Process FMEA

  - Customer Plant Control Plan
  - Tool Design
    - Machinery FMEA
      - Internal Processes
        - Process FMEA
        - Internal Process Control Plan
Motivation for Specific FMEAs

- Product
  - Design FMEA
- Process
  - Process FMEA
- Customer Plant
  - Control Plan
- Tool Design
  - Machinery FMEA
- Internal Processes
  - Process FMEA
  - Internal Process Control Plan

Life Cycle Cost

Customer Satisfaction

First-Time Capability

R&M

Customer Satisfaction
DFMEA Information Linkages

- Boundary Diagram, Parameter Diagram, etc.
- DFMEA
- DVP&R, PFMEA, etc.
The Underlying Message

• Don’t correct a weak product design by focusing on a super robust process.

• Don’t correct a weak process design by focusing on design changes to the product.
PFMEA Information Linkages

- DFMEA, Process Flow, Sequence of Operations
- PFMEA
- Work Instructions, Control Plans, etc.
Rational Structure and Project Specific Control Plans

- **Product**
  - Design FMEA

- **Process**
  - Process FMEA
  - Identify and Manage Information Required for Contract Review
  - Identify and Manage Deliverables Required for Design Review
  - Tool Design
    - Machinery FMEA
  - Internal Processes
    - Process FMEA
    - Identify and Manage Deliverables Required for Build & Buy-Off
  - Internal Process Control Plan
Three Phases of Control Plan

Phase 1
Control Plan for Prototype

Product
Design FMEA

Process
Process FMEA

Tool Design
Machinery FMEA

Customer Plant
Control Plan

Phase 2
Control Plan for Pre-Production

Internal Processes
Process FMEA

Internal Process Control Plan

Phase 3
Control Plan for Production
Containment Considerations

- Cost of Defects
- Risk of Defects
- Bracketing Strategies
- Protecting On-Time Delivery
- Cost of Stopping Production
- Cost of Recall Campaigns
- Benefits of Traceability
FMEA Teams

- Multi-functional teams are essential.
- Ensure expertise from manufacturing engineering, plant operations, maintenance, and other appropriate sources.
- Select team with ability to contribute:
  - Knowledge
  - Information
  - Experience
  - Equity
  - Empowerment
- Pick the right team members, but limit the number of team members based on the scope of the issues being addressed.
- In addition to the FMEA team.
  - Call in Experts as Needed
## Relevant Resources and Expertise

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<th>Customer</th>
<th>Program Management</th>
<th>Integration Responsible Individuals</th>
<th>Service Operations and Warranty</th>
<th>Safety</th>
<th>Manufacturing and Assembly</th>
<th>Materials, Packaging, and Logistics</th>
<th>Engineering and Statistical Analysis</th>
<th>Quality and Reliability</th>
<th>Equipment Manufacturer</th>
<th>Plant Maintenance</th>
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Common Team Problems

- No Common Understanding of FMEA
- Overbearing Participants
- Reluctant Participants
- Opinions Treated as Facts
- Rush to Accomplishments
- Digression and Tangents
- Hidden Agendas
- Going through the Motions
- Seeing FMEA as a Deliverable
A Process Flow for FMEA

1. Define the Scope
2. Define the Customer
3. Identify Functions, Requirements & Specifications
4. Identify Potential Failure Modes
5. Identify Potential Causes
6. Identify Potential Effects
7. Identify Current Controls
8. Identify & Prioritize Risk
9. Recommend Actions
10. Verify Results
1. Define the Scope

- Scope is essential because it sets limits on a given FMEA, that is, it makes it finite.

- Several documents may assist the team in determining the scope of a Process FMEA:
  - Process Flow Diagram
  - Relationship Matrix
  - Drawings, Sketches, or Schematics
  - Bill of Materials (BOM)
Process Flow Charts

High Level Flow Chart

Detailed Flow Chart
2. Define the Customer

• Four major customers need to be considered:
  – End Users
  – OEM Plants
  – Supplier Plants
  – Government Agencies (safety and environment)

• Customer knowledge can contribute precise definition of functions, requirements, and specifications.
3. Identify Functions, Requirements, Specifications

- Identify and understand the process steps and their functions, requirements, and specifications that are within the scope of the analysis.

- The goal in this phase is to clarify the design intent or purpose of the process.

- This step, well done, leads quite naturally to the identification of potential failure modes.
Defining *Functions*

- Describe the Functions in Concise Terms
- Use “Verb-Noun” Phrases
- Select Active Verbs
- Use Terms that can be Measured
- Examples:
  - Pick and Place Unit
  - Secure Part
  - Advance Part
  - Locate Part
  - Robot
  - Position Weld Gun
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## Process and Functional Requirements

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<td>CLEARANCE HOLE FOR 12MM BOLT</td>
<td>DRILL HOLE THRU</td>
<td>HOLE SIZE $\phi 12.5 \pm 0.25$</td>
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<td>LOCATION $\phi 0.5$@MMC</td>
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Identification of **Failure Modes**

**Functional Requirements**

- Omission of an Action
- Incorrect Actions

- Function Not Done
- Function Done Poorly

- Surprise Results
- Correct Actions
Example: **Failure Modes**

- **Color Change System**
  - **Spray Paint**
    - **Function**
      - **Dispense Paint Properly**
        - **Failure Modes**
          - No Paint
          - Spitting Paint
          - Stream of Paint
          - Too Much Paint
          - Too Little Paint
          - Void in Fan
Example: **Failure Modes**

Color Change System

Measure Fluid Flow

Function

Send Accurate Feedback Signal

Failure Modes

- No Feedback Signal
- Intermittent Signal
- Signal Too High
- Signal Too Low
- Feedback Signal with No Flow
- Flow Meter Restricts Flow
Example of Failure Modes

**Process Step:**

**DRILL HOLE THRU**

**Functional requirements or specifications:**

**HOLE SIZE**  
\[ \phi 12.5 \pm 0.25 \]

**Potential Failure Modes**

- No Hole
- Hole Too Large
- Hole Too Small
- Hole Violates MMC Boundary
- Hole Not Drilled Thru
Example of Failure Modes

Process Step:

DRILL HOLE THRU

Functional requirements or specifications:

LOCATION

Ø 0.5@MMC

Potential Failure Modes

- LOCATIONAL ERROR
  - AXIS OF HOLE VIOLATES TOLERANCE ZONE

- ORIENTATION ERROR
  - AXIS OF HOLE VIOLATES TOLERANCE ZONE

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<td>Hole violates MMC boundary</td>
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Failure Mode Identification Worksheet

Functional requirements or specifications:

Potential Failure Modes:

- 
- 
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5. Identify Potential Causes

- Potential cause of failure describes how a process failure could occur, in terms of something that can be controlled or corrected.

- Our goal is to describe the direct relationship that exists between the cause and resulting process failure mode.

- Document a unique failure sequence with each potential cause.
FMEA Worksheet Form
Transfer of Failure Mode to Worksheet

Process Item/Functional Requirement:
- Drill Hole Thru
- Hole Size: \( \phi 12.5 \pm 0.25 \)

- Failure Mode: Hole Too Large
- Cause 7
- Control 7
- Failure Mode Control

Effects:
- Effect 1
- Effect 2
- Effect 3
- Effect 4
Example of Causes

- **Cause 1**: Feed Rate too high
- **Cause 2**: Spindle speed too low
- **Cause 3**: Wrong size drill
- **Cause 4**: Dull drill
- **Cause 5**: Drill improperly sharpened
- **Cause 6**: Wrong tool geometry for material
- **Cause 7**: 

**Process Item/Functional Requirement:**

- Drill hole / Thru hole size: $\phi 12.5 \pm 0.25$
Example of Causes

- Cause 1: Missing Drill
- Cause 2: Broken Drill
- Cause 3: Improper Tool Offset
- Cause 4: CNC Program Error
- Cause 5
- Cause 6
- Cause 7

Process Item/Functional Requirement:
Drill Hole Thru
Hole Size: Ø 12.5 ± 0.25

Failure Mode: Hole Not Drilled Thru
## Identify Causes of Failure – Traditional Format

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- Clearances hole for 12 mm bolt:
  - Hole size
- Hole too large
- Feed rate too high
- Spindle speed too slow
- Wrong drill size
- Drill improperly sharpened
- Wrong tool geometry for material
- Hole not drilled thru
- Missing drill
6. Identify Potential Effects

- Potential effects of a process failure are defined as the result of the failure mode as perceived by the customer.

- The intent is to describe the impact of the failure in terms of what the customer might notice or experience.

- This applies to both internal and external customers.
Causes and Effects

Causes Precede the Failure Mode

Immediate Effect

Immediate Effect

Immediate Effect
**Two Focal Points** for Effects

An effect is the immediate consequence of the failure mode.

- What is the *pain* that is felt by the end user?

- What is the *pain* felt by downstream manufacturing or assembly operations?
Example of Effects

Process Item/Functional Requirement:
DRILL HOLE THRU
Hole Size
Ø 12.5 ± 0.25

Failure Mode:
HOLE TOO LARGE

Cause 1
FEED RATE TOO HIGH

Cause 2
SPINDLE SPEED TOO LOW

Cause 3
WRONG SIZE DRILL

Cause 4
DULL DRILL

Cause 5
DRILL IMPROPERLY SHARPENED

Cause 6
WRONG TOOL GEOMETRY FOR MATERIAL

Cause 7

Effect 1
VIOLATION OF SPEC

Effect 2
BOLT MAY NOT HOLD TORQUE
Example of Effects
## Identify Effects of Failure – Traditional Format

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<td>Hole too large</td>
<td>Bolt may not hold torque</td>
<td>Moderate</td>
<td>Feed rate too high</td>
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<td>Violation of specification</td>
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<td>Assemble with missing fastener</td>
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<td>Missing drill</td>
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7. Identify **Current Controls**

- Current Process Controls describe planned activities or devices that can prevent or detect the cause of a failure or a failure mode itself.

- There are two classes of controls:
  - Preventive controls either eliminate the causes of the failure mode or the failure mode itself, or reduce how frequently it occurs.
  - Detective controls recognize a failure mode or a cause of failure so associated countermeasures are put into action.

- Preventive controls are the preferred approach because they are most cost effective.
Two Types of Detection

Cause Detection
- Go/NoGo Gage

Failure Mode Detection
- Set-Up Validation Sign-Off

Direct Cause
Wrong Nozzle in Bin

Failure Mode
Wrong Paint Nozzle

Immediate Effects
- Paint Splatter
- Too Much Paint
- Too Little Paint
Example of Process Controls

Failure Mode: Hole Too Large

Process Item/Functional Requirement:
Drill Hole Thru
Hole Size Ø12.5 ± 0.25
Example of Process Controls

- Cause 1: Missing Drill
  - Control 1: Set Up Verification

- Cause 2: Broken Drill
  - Control 2: Load Meter

- Cause 3: Improper Tool Offset
  - Control 3: Set Up Verification

- Cause 4: CNC Program Error
  - Control 4: Set Up Verification

- Cause 5

- Cause 6

- Cause 7

Failure Mode: Hole Not Drilled Thru

Failure Mode Control: Functional Gage

Process Item/Functional Requirement:
- Drill Hole Thru
- Hole Size: Ø 12.5 ± 0.25
# Identify Current Controls – Traditional Format

<table>
<thead>
<tr>
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<td></td>
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<td></td>
<td></td>
<td>Wrong tool geometry for material</td>
<td>DOE Results</td>
<td>Set Up verification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Set Up Verification

Set Up Verification

First Piece Inspection

Load Meter

Set Up Verification

Set Up verification
8. **Identify and Prioritize Risk**

- Risk in a Process FMEA is identified in three ways:
  - Severity – which measures the effect.
  - Occurrence – to assess the frequency of causes.
  - Detection – ability to detect causes or failures.

- It is appropriate to assess these three scores through the understanding of your customer’s requirements.
<table>
<thead>
<tr>
<th>Effect</th>
<th>Severity of Effect on Product (Effect on Customer)</th>
<th>Severity Rank</th>
<th>Effect</th>
<th>Severity of Effect on Process (Effect on Manufacturing or Assembly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fails to meet Safety or Regulatory Requirements</td>
<td>Potential failure mode affects safe vehicle operation without warning or involves noncompliance with government regulations.</td>
<td>10</td>
<td>Fails to meet Safety or Regulatory Requirements</td>
<td>May endanger operator (machine or assembly) without warning.</td>
</tr>
<tr>
<td></td>
<td>Potential failure mode affects safe vehicle operation with some warning or noncompliance with government regulations.</td>
<td>9</td>
<td>May endanger operator (machine or assembly) with warning.</td>
<td></td>
</tr>
<tr>
<td>Loss or Degradation of Primary Function</td>
<td>Loss of primary function (vehicle inoperable, but does not affect safe vehicle operation).</td>
<td>8</td>
<td>Major Disruption</td>
<td>100% of product may be scrap. Stop production or stop shipment.</td>
</tr>
<tr>
<td></td>
<td>Degradation of primary function (vehicle still operates, but at a reduced level of performance).</td>
<td>7</td>
<td>Significant Disruption</td>
<td>Portion of a production run may be scrapped. Deviation from primary process, decreased line speed, or additional manpower required.</td>
</tr>
<tr>
<td>Loss or Degradation of Secondary Function</td>
<td>Loss of secondary function (vehicle still operable, but comfort or convenience functions do not work).</td>
<td>6</td>
<td>Moderate Disruption</td>
<td>100% of a production run may require off-line rework prior to acceptance.</td>
</tr>
<tr>
<td></td>
<td>Degradation of secondary function (vehicle still operates, but comfort or convenience functions perform at reduced levels).</td>
<td>5</td>
<td></td>
<td>Portion of a production run may require off-line rework prior to acceptance.</td>
</tr>
<tr>
<td>Annoyance</td>
<td>Appearance item or audible noise (vehicle still operable but not conform, annoys more than 75% of customers).</td>
<td>4</td>
<td>Minor Disruption</td>
<td>100% of a production run may require rework in-station before it can be processed.</td>
</tr>
<tr>
<td></td>
<td>Appearance item or audible noise (vehicle still operates but does not conform, annoys 50% of customers).</td>
<td>3</td>
<td></td>
<td>Portion of a production run may require rework in-station before it can be processed.</td>
</tr>
<tr>
<td></td>
<td>Appearance item or audible noise (vehicle still operates but does not conform, annoys less than 25% of customers).</td>
<td>2</td>
<td>Minor Disruption</td>
<td>Slight inconvenience to process, operation, or operator.</td>
</tr>
<tr>
<td>No Effect</td>
<td>No discernible effect.</td>
<td>1</td>
<td>No Effect</td>
<td>No discernible effect.</td>
</tr>
</tbody>
</table>
# Frequency of Occurrence

<table>
<thead>
<tr>
<th>Likelihood of Failure</th>
<th>Occurrence of Causes (Incidents per items or vehicles)</th>
<th>Occurrence Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>&gt; 100 per 1000</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>&gt; 1 per 10</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>50 per 1000</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>1 in 20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 per 1000</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1 in 50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 per 1000</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1 in 100</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>2 per 1000</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>1 in 500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.5 per 1000</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1 in 2,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.1 per 1000</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1 in 10,000</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0.01 per 1000</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1 in 100,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 0.001 per 1000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1 in 1,000,000</td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>Failure eliminated by preventive control.</td>
<td>1</td>
</tr>
</tbody>
</table>
## Detection by Current Control

<table>
<thead>
<tr>
<th>Detection Opportunity</th>
<th>Detection by Process Control</th>
<th>Detection Rank</th>
<th>Detection Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Detection Capability</td>
<td>No current process control; cannot detect; is not analyzed.</td>
<td>10</td>
<td>Near Impossible</td>
</tr>
<tr>
<td>Not Likely to Detect at any Stage</td>
<td>Failure and errors (causes) are not easily to detect (e.g.: random process audits).</td>
<td>9</td>
<td>Very Remote</td>
</tr>
<tr>
<td>Problem Detection Post-Process</td>
<td>Post-processing failure mode detection by operator using visual, tactile, or audible means.</td>
<td>8</td>
<td>Remote</td>
</tr>
<tr>
<td>Problem Detection at Source</td>
<td>In-station failure mode detection by operator using visual, tactile, or audible means, or by attribute gages.</td>
<td>7</td>
<td>Very Low</td>
</tr>
<tr>
<td>Problem Detection Post-Process</td>
<td>Post-processing failure mode detection by operator via variable gages or in-station by operator using attribute gages.</td>
<td>6</td>
<td>Low</td>
</tr>
<tr>
<td>Problem Detection at Source</td>
<td>In-station failure mode or error (cause) detection by operator via variable gages or by automated in-station controls that notify the operator. Also gaging on set up; first piece inspection.</td>
<td>5</td>
<td>Moderate</td>
</tr>
<tr>
<td>Problem Detection Post-Process</td>
<td>Post-processing failure mode detection by automated controls that detect nonconforming parts and prevent further processing.</td>
<td>4</td>
<td>Moderately High</td>
</tr>
<tr>
<td>Problem Detection at Source</td>
<td>In-station failure mode detection by automated controls that detect nonconforming parts and prevent further processing on them.</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>Error Detection with Problem Prevention</td>
<td>In-station error (cause) detection by automated controls that detect an error and prevent bad parts from being made.</td>
<td>2</td>
<td>Very High</td>
</tr>
<tr>
<td>Detection does not Apply; Error Prevention</td>
<td>Error (cause) prevention via fixture design, machine design, or part design. Bad parts can not be made; product and process error-proofed.</td>
<td>1</td>
<td>Near Certain</td>
</tr>
<tr>
<td>--------------</td>
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<td>------------------------</td>
<td>-----------------------------</td>
</tr>
</tbody>
</table>

**Severity** evaluates the impact of the effect.

**Occurrence** rates how often a specific cause is likely to result in the failure mode being analyzed.

**Detection** ranks our ability to detect either a cause or a resulting failure mode. Use best detection available.
Example of Severity, Occurrence, Detection

- **Cause 1**: Feed Rate Too High
  - Occurrence: 2
  - Control 1: Set Up Verification
  - Detection: 5

- **Cause 2**: Spindle Speed Too Low
  - Occurrence: 2
  - Control 2: Set Up Verification
  - Detection: 5

- **Cause 3**: Wrong Size Drill
  - Occurrence: 2
  - Control 3: First Piece Inspection
  - Detection: 5

- **Cause 4**: Dull Drill
  - Occurrence: 4
  - Control 4: Load Meter
  - Detection: 2

- **Cause 5**: Drill Improperly Sharpened
  - Occurrence: 2
  - Control 5: Set Up Verification
  - Detection: 5

- **Cause 6**: Wrong Tool Geometry for Material
  - Occurrence: 2
  - Control 6: Set Up Verification
  - Detection: 5

- **Failure Mode**: Hole Too Large
  - Process Item/Functional Requirement: Drill Hole Thru
  - Hole Size: Ø12.5 ± 0.25
  - Failure Mode Control: No Go Gage
  - Detection: 6

- **Effect 1**: Violation of Spec
  - Severity: 2

- **Effect 2**: Bolt May Not Hold Torque
  - Severity: 5
Example of Severity, Occurrence, Detection

Failure Mode: HOLE NOT DRILLED

Process Item/Functional Requirement:
DRILL HOLE THRU
HOLE SIZE Ø 12.5 ± 0.25

Effect 1: WILL NOT ASSEMBLE CORRECTLY
Sev. 5

Effect 2: ASSEMBLE WITH MISSING FASTENER
Sev. 6

Effect 3

Effect 4
Prioritization of Risk

Several strategies exist for the mitigation of risk, for example:

1. High Risk Priority Numbers
2. High Severity Risks (regardless of RPN)
3. High Design Risks (Severity x Occurrence)
4. Other Alternatives (S,O,D) and (S,D)

NOTE: “The use of an RPN threshold is NOT a recommended practice for the need for action.”
### Identify Current Controls – Traditional Format

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<td>2</td>
<td>DOE Results</td>
<td>Set Up Verification</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spindle speed too slow</td>
<td>2</td>
<td>DOE Results</td>
<td>Set Up Verification</td>
<td>5</td>
<td>50</td>
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<td></td>
<td></td>
<td></td>
<td>Dull drill bit</td>
<td>4</td>
<td></td>
<td>Load Meter</td>
<td>2</td>
<td>40</td>
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<tr>
<td></td>
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<td></td>
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<td>50</td>
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</table>
9. Recommend Actions

• The intent with recommended actions is to reduce risk.

• Recommended actions will be focused to:
  – Reduce Severity
  – Reduce Frequency of Occurrence
  – Improve Detection
Managing **Recommended Actions**

- Transfer FMEA action items onto the mechanism used to track and ensure closure of open issues on the project.

- Decisions to take different actions or not to act must be approved.

- Review status of FMEA action items on a regular basis.
<table>
<thead>
<tr>
<th>Recommended Actions</th>
<th>Responsibility &amp; Target Completion Date</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Actions Taken</td>
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<td>S e v</td>
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</table>
10. Verify Results

- Whenever you change a process one of two things happen:
  - Things Get Better
  - Things Get Worse

- Verify actual performance following the implementation of the recommended actions.
Summary and Closure
Key Points to Remember

Upon successful completion of this course, you should know:

2. Severity scores of 9 or 10 must be used for safety related risks.
3. Occurrence ranks how often each cause is likely to result in failure.
4. It is appropriate to focus on high severity items first.
5. Credit for preventive actions shows up in the frequency of occurrence.
6. Risk Priority Numbers provides a rank order to risks and action items.
7. An effective approach is to continually focus on the top five concerns.
8. Process FMEA should result in tangible improvement to process performance.
Questions and Answers
Please type your questions in the panel box
Thank You For Attending

Please visit our website www.asq-auto.org for future webinar dates and topics.