Failure Mode Effects

Analysis (FMEA)

What is it?
Who needs it?
LEARNING

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- Baldrige Factors for evaluating processes:
  - Approach
  - Deployment
  - Learning
  - Integration

- Focus on the Learning factor
  - To capture Performance Excellence

- Be dedicated to (CPI)
  - Continuous **Performance** Improvement
Learning & Success

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- The **best process** will fail when:
  
  **The workforce is not trained.**

- The **best trained workforce** will fail when:
  
  **The process is flawed.**
A Little Bit of History

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- FMEA previously documented in
  MIL-STD-1629 (1974),

PROCEDURES FOR PERFORMING A FAILURE MODE, EFFECTS AND CRITICALITY ANALYSIS (FMEAC)
A Little Bit of History

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- FMEA is an established tool for risk management employed by:
  - Manufacturers
  - Builders
  - Six Sigma and other quality management methodologies.
FMEA and PFA

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• Could be compared with Feigenbaum’s Cost of Quality (COQ) concept (PFA)
  – Prevention - Quality planning
  – Appraisal - Inspection and testing
  – Failure - External and internal

• Cost of Poor Quality:
  – $1.00 to prevent a problem
  – $10.00 to find it
  – $100.00 or more to fix it
Types of FMEAs

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- FMEAC
  - Failure Mode Effects Analysis & Criticality

- FMEAD
  - Failure Mode Effects Analysis in Design

- FMEAP
  - Failure Mode Effects Analysis for Processes
Project Planning

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✓ FMEA is a planning tool to:
  – Identify potential causes of risks.
  – Analyze the impact of those risks.

✓ A mitigation plan ensures that identified risks are addressed:
  – During the project-planning phase.
  – As the project progresses.
What is a Failure Mode?

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- Something that could occur, and might:
  - Inhibit the progress of the project.
  - Affect the end result (quality).

  ➢ *"that could occur"*
  - The probability of occurrence is less than 100%.

- NASA: Flight Assurance Procedure (P-302-720)
  - A particular way in which an item fails, independent of the reason for failure.
**Risk Categories**

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- **Budget**: Uncertainties related to funding.
- **Indefinite Requirements**: Uncertainties related to customer’s/end user’s requirements.
- **Technical Challenges**: Uncertainties related to capability of available technology to satisfy requirements.
- **Resources**: Uncertainties related to:
  - Workforce availability.
  - Equipment availability.
  - Facility issues.
A Risk Analysis Tool

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- The FMEA addresses these questions:
  - What event might occur that will affect performance, cost or schedule?
  - If it occurs what will be the impact?
  - What is the likelihood of it occurring?
  - What can be done about it?
A Risk Mitigation Tool

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- Identifies actions that might be employed to avoid or mitigate the risk.
  - Directed at potential cause and effect.
## The FMEA Worksheet

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<table>
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<tr>
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**Enter brief statement of tasks**

| What is the mode of the failure? |
| Technology? | Resource? | Time? |
| What is the effect of the failure caused by the risk? |
| Rate the severity of the effect in the next column. |

| What are the potential causes of the failure? |
| Rate the likelihood of occurrence of the cause in the next column. |
| Rate the possibility of detection in the next column. |

| What controls are in place to detect the occurrence? |
| RPN = Risk Priority Number |

| What actions are planned to mitigate the risk? |
| When will these actions be taken? |

---

May be for a task, design, part or process

May be for the over-all project funding
FMEA Chart Entries

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• Entries are made typically by the Project Team Leader.
  
  – Subjective: Based on Team Member’s expertise and knowledge.

  • Technology
  • Work load
  • Application
  • User
FMEA Chart Entries

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- Entries are brief summaries:
  - Supported by descriptive statements.
  - Included in overall Project Plan.
  - Should be reviewed as project progresses.
    - Revised as necessary.
The FMEA Worksheet

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- What will be the effect of the failure caused by the risk?
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- What actions are planned to mitigate the risk?
- When will these actions be taken?

Project Average RPN
### The FMEA Worksheet

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**Event, or Mode of a possible failure. What could happen?**
The FMEA Worksheet

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The result(s) of the event:
- Cost
- Schedule
- Quality
The FMEA Worksheet

## Failure Mode and Effects Analysis (FMEA) Worksheet

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**Severity of the effect: 1 - 10**

**Enter brief statement of tasks**
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- Technology?
- Resource?
- Time?
- What is the mode of the failure caused by the risk?
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- What actions are planned to mitigate the risk?
- When will these actions be taken?

**Project Average RPN**

F = 10 (10 - 10) = 0

FTG Franklin Training Group
The FMEA Worksheet

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Enter brief statement of tasks:
- **What is the mode of the failure?**
- **Technology? Resource? Time?**
- **What will be the effect of the failure caused by the risk?**
- **Rate the severity of the effect in the next column.**
- **What are the potential causes of the failure?**
- **Rate the likelihood of occurrence of the change in the next column.**
- **What controls are in place to detect the occurrence?**
- **Rate the possibility of detection in the next column.**
- **What actions are planned to mitigate the risk?**
- **When will these actions be taken?**

**Potential cause(s) of the event, or failure mode. The Xs? X_1, X_2, etc.**
The FMEA Worksheet

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**Likelihood of occurrence:** 1 - 10

Project Averge RPN: 0

Enter brief statement of tasks

- What is the mode of the failure?
- Technology?
- Resource?
- Time?

What will be the effect of the failure caused by the risk?

Rate the severity of the effect in the next column.

What are the potential causes of the failure?

Rate the likelihood of occurrence of the cause in the next column.

What controls are in place to detect the occurrence?

Rate the possibility of detection in the next column.

What actions are planned to mitigate the risk?

When will these actions be taken?
# The FMEA Worksheet

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Project Average RPN

What processes are in place to detect the occurrence, or the cause?
## The FMEA Worksheet

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<td>FMEA = Failure Priority Number</td>
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What is the possibility of detection?  
1 = High  
10 = Low
The FMEA Worksheet

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**Identify the “lemons”**

Prioritize the risks.

\[
\text{RPN} = S \times O \times D
\]

Range = 1 – 1,000

**Project Average RPN**

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*Franklin Training Group*
Risk Priority Number (RPN)

- No standard score level for the RPN.
- Actions are typically based on the top three.
- Coordinated effort with Team Lead, and Team Members.
**The FMEA Worksheet**

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### Failure Mode and Effects Analysis (FMEA) Worksheet

<table>
<thead>
<tr>
<th>TASK</th>
<th>POTENTIAL FAILURE MODE</th>
<th>POTENTIAL FAILURE EFFECTS</th>
<th>SEVERITY</th>
<th>POTENTIAL CAUSES</th>
<th>OCCURRENCE</th>
<th>CURRENT PROCESS CONTROLS</th>
<th>DETECTION</th>
<th>RPN</th>
<th>PLANNED ACTION</th>
<th>ACTION DUE DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding</td>
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<tr>
<td>Enter brief statement of tasks</td>
<td>What is the mode of the failure?</td>
<td>What will be the effect of the failure caused by the risk?</td>
<td>Rate the severity of the effect in the next column.</td>
<td>What are the potential causes of the failure?</td>
<td>Rate the likelihood of occurrence of the cause in the next column.</td>
<td>What controls are in place to detect the occurrence?</td>
<td>Rate the possibility of detection in the next column.</td>
<td>RPN</td>
<td></td>
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</tr>
</tbody>
</table>

**Project Average RPN**

Action plans to mitigate the risk. Should be preventive and aimed at the potential causes and effects.
The FMEA Worksheet

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Schedule the action, when possible (especially for preventive actions). May only be if and when the event occurs.
The FMEA Worksheet

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<table>
<thead>
<tr>
<th>TASK</th>
<th>POTENTIAL FAILURE MODE</th>
<th>POTENTIAL FAILURE EFFECTS</th>
<th>SEVERITY</th>
<th>POTENTIAL CAUSE</th>
<th>FREQUENCY</th>
<th>CURRENT ACTION</th>
<th>RPN</th>
<th>PLANNED ACTION</th>
<th>ACTION DUE DATE</th>
<th>Action Tracking</th>
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<tbody>
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<td>Actions, status, issues, etc.</td>
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</tbody>
</table>

**Funding**

**May be added to track progress on the actions**
Action Tracking

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<table>
<thead>
<tr>
<th>Actions</th>
<th>Actionee</th>
<th>Due Date</th>
<th>Actual Date</th>
<th>Actions Taken</th>
<th>S</th>
<th>O</th>
<th>D</th>
<th>RPN</th>
</tr>
</thead>
</table>

- Can be added to the FMEA worksheet or as a separate file.
• How does **Failure Mode and Effects Analysis (FMEA)** relate to Six Sigma, **Define Measure Analyze Improve and Control (DMAIC)**?
## FMEA & Define

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### Failure Mode and Effects Analysis (FMEA) Worksheet

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</table>

### Defin

- **Enter brief statement of tasks**
- **What is the mode of the failure?**
- **Technology?**
- **Resource?**
- **Time?**
- **What will be the effect of the failure caused by the risk?**
- **Rate the severity of the effect in the next column.**
- **What are the potential causes of the failure?**
- **Rate the likelihood of occurrence in the next column.**
- **What controls are in place to prevent the occurrence?**
- **Rate the possibility of detection in the next column.**
- **Defin = Risk Priority Number**
- **RPN = Severity x Occurrence x Detection**
- **What actions are planned to mitigate the risk?**
- **When will these actions be taken?**
### Failure Mode and Effects Analysis (FMEA) Worksheet

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<td>Project Average RPN</td>
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</table>

- **Enter brief statement of tasks**
  - What is the mode of the failure?
  - Technology? Resource? Time?
  - What will be the effect of the failure caused by the risk?
  - Rate the severity of the effect in the next column.
  - What are the potential causes of the failure?
  - Rate the likelihood of occurrence of the causes in the next column.
  - What controls are in place to detect the occurrence?
  - Rate the possibility of detection in the next column.
  - RPN = SEVERITY x OCCURRENCE x DETECTION
  - For Action Number: What actions are planned to mitigate the risk? When will these actions be taken?
### FMEA and Analyze

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#### Failure Mode and Effects Analysis (FMEA) Worksheet

<table>
<thead>
<tr>
<th>Task</th>
<th>Potential Failure Mode</th>
<th>Potential Failure Effects</th>
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<td></td>
<td>Technology?</td>
<td>Resource?</td>
<td>Time?</td>
<td>F 1 = Low (0-4)</td>
<td>F 2 = Mid (5-16)</td>
<td>F 3 = High (17-62)</td>
<td>F 4 = Low (0-4)</td>
<td>F 5 = Mid (5-16)</td>
<td>F 6 = High (17-62)</td>
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</tbody>
</table>
| Project Average RPN | | | | | | | | | | 0

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**FMEA and Improve**

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### Failure Mode and Effects Analysis (FMEA) Worksheet

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**Implement/Improve**
## Opportunities For Improvement (OFI)

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<table>
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<tr>
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<th>Actionee</th>
<th>Due Date</th>
<th>Actual Date</th>
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<th>S</th>
<th>O</th>
<th>D</th>
<th>RPN</th>
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</thead>
</table>

- **Due date for Preventive Action**
- **Establish targets for improvements in S, O, D & RPN**

Identify and document Preventive Actions Directed at Causes, Detection, and mitigation of Effects
# FMEA and Control

## COPE

Capture Opportunities for Performance Excellence

### Failure Mode and Effects Analysis (FMEA) Worksheet

**Project:**

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**Project Average RPN**

- Enter brief statement of tasks
- What is the mode of the failure?
  - Technology?
  - Resource?
  - Time?
- What will be the effect of the failure caused by the risk?
- Rate the severity of the effect in the next column.
- What are the potential causes of the failure?
- Rate the likelihood of occurrence in the next column.
- What controls are in place to detect the occurrence?
- Rate the possibility of detection in the next column.
- RPN = Severity x Occurrence x Detection
  - FMEA - Risk Priority Number
  - What actions are planned to mitigate the risk?
  - When will these actions be taken?

---

**FTG**

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### Improve & Control

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**Capture Opportunities for Performance Excellence**

<table>
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<tr>
<th>Actions</th>
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<th>O</th>
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<th>RPN</th>
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**Identify and document Preventive Actions**

1. **Compare Plan with Actual**
2. **Evaluate Actions ROI**
3. **Measure the result, i.e. changes in S, O, D & RPN**
**Failure Modes of FMEA**

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1. We’ve never done it that way.
2. We tried that once and it didn’t work.
3. We’re not ready for something so sophisticated.
4. We’re doing OK the way we are.
5. It will cost too much.
6. We don’t have time for that right now.


Success Modes of FMEA

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- ✔ Team work!
  - Team training
- ✔ Training on FMEA tools.
- ✔ Problem Solving:
  - Problem Statements.
  - Measures definitions.
  - Action Planning.
- ✔ Follow-up and analysis.
Who needs FMEA?

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- Project managers
  - Avoid schedule slippages
  - Avoid over-runs
  - Avoid injuries

- Anyone with an important objective
  - Getting the house remodeled
  - Getting that degree
Use with other tools

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- Ishikawa Diagram
- Pareto
- Histogram
Ishikawa Diagram

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X_2 and X_4 may have low RPNs but both may contribute to schedule delays

Schedule Delay
Schedule Delay Pareto
All Projects
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Ave. Days Delay

Proc A  Proc B  Proc C  Proc D

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Information Sources

- Websites on FMEA
- ANSI Webstore (risk management)
- ISO Guide 73, *Risk management vocabulary*
- ISO 31000, *Risk management – Principles and guidelines on implementation*
ISO 31000

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Risk Management – Principles and guidelines on implementation

4 Risk management:

a) Creates value

b) Is an integral part of organizational processes.

c) Is part of decision making.

d) Explicitly addresses uncertainty
ISO 31000

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Risk management (contd.)

e) Is systematic, structured and timely.
f) Is based on available information.
g) Is tailored.
h) Takes human and cultural factors into account.
i) Is transparent and inclusive.
j) Is dynamic
k) Facilitates continual improvement
A New Tool Emerges

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• Success Mode Effects Analysis (SMEA)
  – What worked well?
    • Mode
  – What does “worked well” mean?
    • Effect
  – What caused it?
    • Analysis
  – Can it (the process) be replicated?

• A Benchmarking Tool
Quality is meeting or exceeding stakeholder expectations

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QUESTIONS?
COMMENTS?
FAILURE MODES?
AREAS FOR IMPROVEMENT?