

# Failure Mode Effects and Analysis (FMEA)

## Problem

How to anticipate and mitigate potential problems?

## Difficulty

Some training required

**FMEA** is a **systematic, proactive method** for evaluating a process

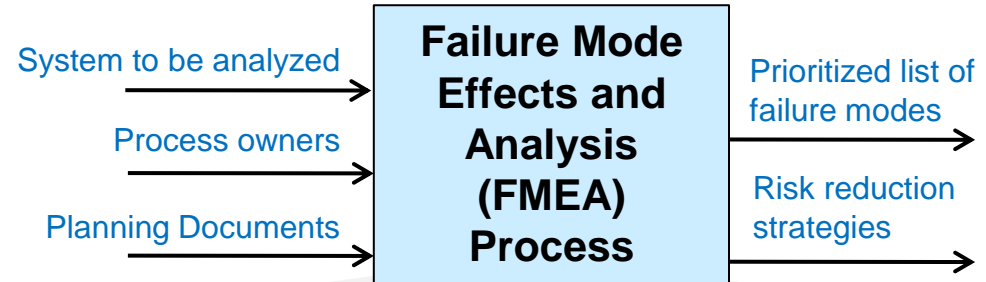
- to identify **where and how it might fail** and
- to assess the **relative impact of different failures**

in order to **identify** where the process must be **changed**

FMEAs should be created whenever a failure can result in harm.

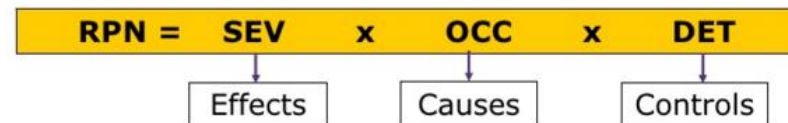
**FMEA types include:**

- **Design (DFMEA)** focuses on components and subsystems
- **Process (PFMEA)** focuses on manufacturing and assembly processes



## Process

1. Determine **FMEA type**: **Defect** (FMEA), **Design** (**DFMEA**), or **Process** (**PFMEA**) and obtain appropriate standardized tables
2. Identify potential failure modes.
3. For each failure mode, using standardized tables, assess the following on a 1-10 scale:
  - **Severity** rating (how bad it is, if it occurs)
  - **Occurrence** rating (how often it will occur)
  - **Detectability** rating (how likely it is to be detected, if it occurs)
4. For each failure mode, multiply the above three numbers (each 1 to 10) to obtain a **Risk Priority Number** (RPN)
5. For the failure modes with the **highest RPN** values, determine mitigation strategies



# FMEA – Example – Giving a 6in6 presentation

Comprehensive list of failure modes

For simplicity, instead of using values 1 to 10 for {S,O,D}, use {1,3,9} for {low, medium, high}. The values in the grid match the words used.

RPN value is the product of the S, O, D values

Failure mode	Severity	Occurance	Detection	S	O	D	RPN	Mitigation
Forget to show up	High	Medium	Medium	9	3	3	81	Contact on event day
Forget to bring presentation	High	Low	Medium	9	1	3	27	Email presentation
Can't find location	High	Low	High	9	1	1	9	
Hungry during presentation	Low	Medium	High	1	3	1	3	

High severity – which is bad – gets a '9'. High detectability – which is good – gets a '1'

Low RPN values do not need mitigation strategies

Automobile Industry Action Group (AIAG) created the following standards for the North American auto industry

## Severity

EFFECT	CRITERIA: SEVERITY OF EFFECT	RANKING
Hazardous - without warning	May endanger machine or assembly operator. Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation. Failure will occur without warning.	10
Hazardous - with warning	May endanger machine or assembly operator. Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation. Failure will occur with warning.	9
Very High	Major disruption to production line. 100% of production scrap. Vehicle/item inoperable, loss of primary function.	
High	Minor disruption to production line. Product not usable. Vehicle/item inoperable (less than 100%) scrapped. Vehicle operable with warning. Customer dissatisfied.	
Moderate	Minor disruption to production line. A portion of production scrap. Vehicle/item inoperable. Customer dissatisfaction. Comfort/Convenience item(s) inoperable. Customer dissatisfaction.	

## Likelihood / Occurrence

Probability of Failure	Possible Failure Rates	Ppk	Ranking
Very High: Failure almost inevitable	≥ 1 in 2	≤ 0.33	10
High: Generally associated with processes similar to previous processes that have often failed	1 in 3	≥ 0.33	9

## Detectability

Detection	Criteria: Likelihood the Existence of a Defect will be Detected by Process Controls Before Next or Subsequent Process, or Before Part or Component Leaves the Manufacturing or Assembly Location	Ranking
Almost Impossible	No known control available to detect cause/mechanism of failure or the failure mode	10

# FMEA – Notes

## Slide 1

1. For a given process, FMEA uses a weighted decision matrix to identify potentially high risk problems.
2. The risks – and there can be hundreds – are prioritized so that only the most important ones need to be addressed.
3. Three values are determined that characterize each risk; they are multiplied together to obtain the RPN. The RPN values are then ordered, largest to smallest.

## Slide 2

1. Different industry groups have determined appropriate {S, O, D} value for their industry.
  - For AIAG, the “Occurrence” value is '10' if it happens more than half the time, but a value of '4' if it occurs 1 time in 2,000 potential occurrences.
2. Risks with low RPN values may not need to be mitigated.
3. The mitigations identified should be implemented *before* the process is rolled out.