

Failure Mode And Effects Analysis (FMEA)

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Paul Barringer, P.E.

Barringer & Associates, Inc.

P.O. Box 3985

Humble, TX 77347

Email: hpaul@barringer1.com

Phone: 1-281-852-6810

<http://www.barringer1.com>

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What's A FMEA?

- **FMEA** is a procedure for analyzing each potential failure mode in a product* to determine the results or effects of failure on the product. ←This 20% of the effort gets 80% of the impact!
- **FMECA** extends the FMEA analysis to classify each potential failure mode according to its severity and probability of occurrence. ←Big effort, smaller gains for more precision!

*MIL-HDBK-338's FMEA definition has been expanded by SAE to include designs, processes, procedures, and services

FMEA Is A Team Approach

- FMEA's end result is a never-ending improvement to eliminate/reduce failures, reduce errors, reduce costs, reduce mistakes, improve safety, and so forth to better satisfy internal and external customers.
- **This goal requires a team approach.** The one-man band is cheap, but it does not achieve the best results! However the one-man band does satisfy bureaucratic compliance.
- You need many eyes and experience to find and eliminate the problems. The group knowledge is **VERY** important.
- Also include experienced hourly employees on the team for buy-in of findings and to impart practical knowledge in the heads of new engineers in a quick and efficient manner.

Pros/Cons Of FMEA Templates

- Can you use canned FMEA's (templates)? **Yes, but use the FMEA team for supplementing and localizing details!**
- Rubber stamping canned FMEA's as the one man band isn't good practice. Add/delete template details for local operating conditions!
- Remember, **templates provide the basics** but lack the buy-in from the FMEA team for insight, training, and understanding local situations.

Some Quick Definitions

- **Failure:** Loss of function when you needed it
- **Failure mode:** How you observe the damage
- **Failure cause:** What motivates the failure
- **Failure effect:** Results or consequences of a failure on operations or other components
- **Failure occurrence:** How often does it happen
- **Failure severity:** How much damage occurs
- **Failure detection:** Can I find the failure before the failure blows my leg off

A Real Short FMEA Example

Memory Joggers For Use By The FMEA Team

Occurrence Ranking Index (Frequency for customer?):		Severity Ranking Index (How bad is customer's problem?):		Detection Ranking Index (Can Customer See Defect?)	
Rank	Criteria	Rank	Criteria	Rank	Criteria
1	Remote chance for failure	1	Undetectable effect on system	1	Almost certain detection of failure mode
2	Low failure rate based on previous designs	2	Low severity impact because failure will cause	2	Very high likelihood of detecting failure mode
3	with low failures	3	slight customer annoyance	3	High likelihood of detecting failure mode
4	Moderate failure rates based on similar	4	Moderate severity. Some customer unhappiness	4	Moderately high likelihood of detecting failure mode
5	designs which have some occasional	5	& with performance loss noticeable by customer	5	Moderate likelihood of detecting failure mode
6	failures but not in major proportions	6		6	Low likelihood of detecting failure mode
7	High failure rates based on similar designs	7	High severity with high degree of customer	7	Very low likelihood of detecting failure mode
8	which have been troublesome.	8	dissatisfaction	8	Remote likelihood of detecting failure mode
9	Very high failure rates and the failures will	9	Very severe problem involving potential safety	9	Very remote likelihood of detecting failure mode
10	be major occurrences.	10	problem or major non-conformity	10	Can not detect failure mode

System: Right Front Wheel Assembly Of A Light Truck In Assembly Plant

It's as tough to do as arithmetic!

Component Name	Component Function	Cause(s) Of Failure	Effect(s) Of Failure	Failure Mode(s)	Occurrence Index (O)	Severity Index (S)	Detection Index (D)	Risk Priority Number (O)*(S)*(D)	Recommended Corrective Action
Rt Front Spindle Assy	Support vehicle	Overload	Bent Shaft	Out-of-alignment	1	7	8	56	Check alignment and/or avoid high loads
	Bearings	Lack of lube	Noise & Wear	Wearout	2	6	5	60	Check vendor procedures
	Seals	Lack of lube	Heat & Wear	Wearout	3	4	5	60	Check vendor procedures
	Nuts	Mis-assembly	Wheel	Wobble	2	7	7	98	Need tightening assembly procedures

Failure Mode & Effect Analysis

- FEMA is the search for potential failures that might occur within the system
- This bottom-up approach says we don't know the problem—**find it & fix it**
- Best done during design but also works to ferret-out existing problems
- Works in the design room and on the shop floor using a small team—it's **complication involves arithmetic**

What

Why

When

Where

Sharpen Problem Solving With FMEAs By Finding & Fixing Them

- FMEAs search for known/unknown failures to prioritize problem solving attacks
- Use the wisdom and experience of the team members to search and destroy potential failures
- The Lone Ranger isn't riding in to solve your problems! FMEA is not a one person effort for finding or solving your issues.
- FMEA techniques are a well proven method to find and solve problems at a reasonable cost and in a short time interval. It's simple. Use it.

Suggested Reading List

1. **The Basics Of FMEA**, CRC Press, 2nd edition, 2009, 90 pages, ISBN 0-978-156327-377-3, <http://www.crcpress.com> ~\$15/copy Few pages
2. **Failure Mode and Effect Analysis**, 2nd edition by D. H. Stamatis, ASQ Quality Press, Milwaukee, WI, 2003, ISBN 0-87389-598-3, <http://www.qualitypress.asq.org>, ~\$105/copy Great checklists
3. **FMEA-4 Potential Failure Mode and Effects Analysis**, 2008, Automotive Industry Action Group (AIAG), phone 1-810-358-3003, 151 pages, <http://www.aiag.org>, ~\$75/copy Technical equivalent of SAE J1739
4. **Potential Failure Mode and Effects Analysis in Design (Design FMEA) and Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA) and Effects Analysis for Machinery (Machinery FMEA)**, Document: J1739 Rev A, January 2009, <http://www.sae.org>, ~\$61/copy SAE Standard J1739
5. **MIL-STD-1629A, Procedures For Performing A Failure Mode, Effects and Criticality Analysis**, 54 pages, http://www.barringer1.com/mil_files/MIL-STD-1629A.pdf, no cost download as PDF file Historical Document --Now Use J1739