ENGR 345 - Failure Modes and Effects Analysis (FMEA)

Support obtained from: George, M. L., Rowlands, D., Price, M. & Maxey, J. (2005). The lean six sigma pocket toolbook. New York: McGraw-Hill.

Purpose:

1. Identify ways a product, service, process can fail
2. Estimate risk associated with the failure (NOTE: risk is often associated with cost)
3. Prioritize actions to reduce risk of failure
4. Evaluate design validation plan (product/service) or current control plan (process)

Terms:

Failure Modes: "A failure mode is the way in which the component, subassembly, product, input, or process could fail to perform its intended function. They may be the result of upstream operations or may cause downstream operations to fail" (George et al, 2005, p. 271).

SEVERITY: Severity of failure or impact on customers. Bear in mind that severity can depend on point of view (where one is in the food chain).

OCCURRENCE: Likeliness of failure.

Risk Priority Number (RPN): Priority equation used to determine which potential failure will impact the customer. Higher numbers have a more significant potential impact and are attended to first.

RPN = SEVERITY * OCCURENCE * DETECTION

Detectability: Likeliness to be noticed with current monitoring, training, controls, inspection, testing, procedures.

Process (PDCA):

1. Review product/service/process - Determine the items/steps that contribute the most value. Select input and output variables.

2. Determine possible failure modes (Ask: What can go wrong?).

3. Determine potential effects of each failure mode (Ask: What are the consequences of something going wrong?).

4. Determine scale used (1-5 or 1-10). A 10-scale is most common, more precise, and helps make distinctions when more variables are involved. A 5-scale easier to use.

5. Assign SEVERITY and OCCURENCE ratings. LARGER numbers indicate HIGHER severity or HIGHER incidence of failure.

6. identify the causes of failure modes.

7. Determine existing monitoring or controls used to prevent failure. Examples include training, inspection, testing, and procedures. Assign a DETECTION rating for each. SMALLER numbers indicate the controls are MORE likely to detect the failure. Generally no controls will result in high detection values.

8. Calculate the RPN to determine high priority failure modes. Target any failure that has a SEVERITY rating of 10 (not currently satisfying customer). Target high RPN's for elimination.

9. Develop action plans - assign persons responsible for carrying out actions/steps. Plans may be preventive (reducing the likeliness at all), focusing on reducing/eliminating root cause. Plans can be contingent, thereby limiting damage and focusing on the goal knowing there will be challenges.

10. Carry out plans, document actions, and re-compute RPN's.

Recommendations:

1. Do not get caught up or bogged down in extremely small details to the point where the tool becomes useless. Categorize/classify failure modes, effects, and causes if necessary.

2. Establish a threshold after rating all potential failure modes. All potential failures may be concerns, but the FMEA Form is used as a priority tool.

Example Scenario: *"A carafe must be filled with water to make coffee."*

Input Variable = Carafe *Output Variable(s) = Coffee*

Process/Product FMEA Form

Process or Product Name: Coffee Preparation						Prepared By: Smith (reproduced from George et al, 2005, p. 273)						Page 1 of 1			
Responsible: Secretary 1						Date: January 2012						Rev. No. 1			
Process Step or Input (What process, step, or input variable is being investigated?)	Potential Failure Mode (What ways does the input variable go wrong?)	Potential Failure Effects (What is the impact on the output variables?)	SEVERITY	Potential Causes (What causes the key input variable to go wrong?)	OCCURRENCE	Current Controls (What existing controls, procedures, testing, or inspections prevent the cause of the failure mode?)	DETECTION	RPN	Actions Recommended (What are actions for reducing the occurrence of the cause or improving detection?)	Person Responsible	Actions Taken (What actions are completed?)	SEVERITY	OCCURRENCE	DETECTION	RPN
Fill carafe with water	Wrong water amount	Coffee too strong or weak	8	Marks on carafe worn	4	Visual inspection	4	128	Replace carafe	Mel	Carafe replaced	8	1	3	24
			8	Spilled water	5	None	9	360	Train employees	Flo	Employees trained	8	2	7	112
	Water too warm	Coffee too strong	8	Faucet not allowed to run and cool	8	Finger	4	256	Train employees	Flo	Employees trained	8	2	6	96
			8	Employee not aware of	7	None	10	560	Train employees	Flo	Employees trained	8	1	8	64
	Carafe not clean	Foreign objects in coffee	10	Carafe not washed	4	Visual inspection	4	160	Inspect before storing	Alice	Vera is new inspector	10	1	4	40
		Bad taste	10	Carafe improperly stored	7	Training	5	350	Train employees & Create storage bin	Alice	New storage bin & employees trained	10	2	3	80

Example Scenario:

Input Variable = *Output Variable(s) =*

Process/Product FMEA Form															
Process or Product Name:						Prepared By: (form reproduced from George et al, 2005, p. 273)						Page of			
Responsible:						Date:						Rev. No.			
Process Step or Input (What process, step, or input variable is being investigated?)	Potential Failure Mode (What ways does the key input variable go wrong?)	Potential Failure Effects (customer impact) (What is the impact on the output variables?)	SEVERITY	Potential Causes (What causes the input variable to go wrong?)	OCCURRENCE	Current Controls (What existing controls, procedures, testing, or inspections prevent the cause of the failure mode?)	DETECTION	RPN	Actions Recommended (What are actions for reducing the occurrence of the cause or improving detection?)	Person Responsible	Actions Taken (What actions are completed?)	SEVERITY	OCCURRENCE	DETECTION	RPN

In the action plan...

Example Scenario:

Input Variable = *Output Variable(s) =*

Process/Product FMEA Form															
Process or Product Name:						Prepared By: (form reproduced from George et al, 2005, p. 273)						Page of			
Responsible:						Date:						Rev. No.			
Process Step or Input (What process, step, or input variable is being investigated?)	Potential Failure Mode (What ways does the key input variable go wrong?)	Potential Failure Effects (customer impact, consequences) (What is the impact on the output variables?)	SEVERITY	Potential Causes (What causes the input variable to go wrong?)	OCCURRENCE	Current Controls (What existing controls, procedures, testing, or inspections prevent the cause of the failure mode?)	DETECTION	RPN	Actions Recommended (What are actions for reducing the occurrence of the cause or improving detection?)	Person Responsible	Actions Taken (What actions are completed?)	SEVERITY	OCCURRENCE	DETECTION	RPN

In the action plan, ...